الدليل الارشادي لشعبة السلامة والامن الكيمياوي والبايلوجي والاشعاعي

اعداد

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Introduction:

Practical study, experiment, and observation are of great importance in developing students' perceptions, creativity and the degree of their information absorption. A new culture and contexts for occupational and community safety and security have emerged and developed now regarding education in laboratories and research centers in academic institutions. Working in laboratories requires full awareness of the importance and danger of the materials and devices used, as many of the materials are toxic, irritating to membranes, and materials that are incendiary or flammable, so before starting laboratory work, we must be aware of the importance and danger of the materials used, and take caution how to be careful and to follow the safety instructions recommended by each laboratory according to the requirements of quality and reliability. The rules of safety and security for employees come first. This guide deals with the general foundations of safety and security in scientific and biological laboratories that students must follow under the supervision of laboratory officials and supervisors to achieve the maximum levels of safety and security and to preserve the environment. It is also an important reference for all university employees, especially faculty members, so everyone is required to bear the responsibility entrusted to him in this regard, because **security and safety is everyone's responsibility to maintain the health of the work environment, the safety of individuals, and the property that falls under their responsibility**. The guide contains security and safety rules policies and procedures, emergency plans programs, and procedures that aim to reduce the risks to which laboratory workers are exposed to, by avoiding and limiting risks and minimizing losses that may result from damage to their property. Achieving safety and security requires the participation of all members of the college and university in applying the instructions, recommendations and procedures of the Safety and Security Committee at once , in order to reach our applied and educational laboratories to the degree of "**Good Trained Laboratories**" (GLP). During training and educational programs that reflect positively on them and their performance, therefore, emphasis must be placed on the quality of management, system and accreditation programs in public and private laboratories in order to determine the level of rapid change in **measuring the efficiency of performance**, so the application of this guide is one of the basic means to achieve the highest levels of quality and institutional accreditation.

This guide represents a high measure of safety and security levels and institutional quality, and we are working to implement the items and procedures contained in this book as possible, stressing our determination to develop in order to reach the optimum for the continuation of safety and institutional security levels for individuals and environment.

Chapter One

" Occupational Safety and Security of Technical college of health and medicine"

" Occupational Safety and Security policy and programs are well suited and confirmed in our college technical of health and medicine and implemented by all of our students and health care professionals stuff according to internal and external safety and security regulations laid by the international organizations and agencies on bases of World health organization. In this guide report, risk assessment, engineering and administrative controls, potential risks and emergency plans were discussed.

Technical college of health and medicine:

Table-1 lists the 23 scientific laboratories for the technical college of health and medicine regarding three departments:

1,1- Technical department of pathological analysis.

1,2- Department of optics.

1,3- Department of orthodontics.

1-Risk assessment:

Careful examination of any case in your work or workplace which cause harm to people or environment, so that **precautions or controls** are necessary to prevent such harm should be extensively determined via the following:

-**Collecting information** on chemical industries and sites where hazardous **chemicals are produced and/or stored.**

-Gathering of **information on toxic effects of involved chemicals**.
-Evaluation of information to determine possible risks associated with **exposure**.
- Systematic evaluation of the likelihood of an adverse effect arising from exposure in a defined **population**.

- Systematic process for describing, qualifying and characterize the risks associated with hazardous substances**, action or events as seen in table-2**.

Risk assessment will ensure a comprehensive analysis of the most current data related to a hazard and will result in an output; and provide several opportunities for control. The final intention is to prevent accidents or work-related damage to health in the workplace. It is important to remember that performing risk assessment entails **a great deal of computer work** with specialized software to help analyze the different type data and model different scenarios and it is a **teamwork** continuous process.

Risk assessment of hazards:

It is a process which entails the following: It is a process which entails the following:

1-Hazard identification:

1.1 Is to identify the adverse effects which a chemical, substance or a certain situation (case) has an inherent capacity to cause a particular effect in the assessment process.

1.2 Gather and evaluate data on types of health effect or disease that may be produced by exposure, neurological effects or cancer.

2-Exposure assessment:

Is the **determination/estimation of the emissions**, pathways, and rates of movement of a substance and its transformation or degradation in order to estimate the **concentrations/doses** to which human populations or environmental compartments are or may be exposed to.

3-Risk management:

Is a decision-making process that involves weighing **political**, **social**, **economic**, and **engineering** information against risk-related information to develop, analyze and compare regulatory options and **select the appropriate regulatory response and** solution to a potential health or environmental hazard.

Management of health care workers exposed to, colonized by, or infected with microorganisms; an outbreak management process for exposures and/or healthcare workers who are symptomatic or colonized with infectious disease; and access by occupational health professionals to utilize medical assessment and diagnostic services for timely follow-up for health care worker exposures.

4. Risk Characterization:

Is the estimation of the incidence and severity of the adverse effects likely to occur in a human population or environmental compartment due to actual or predicted exposure to a substance.

5.Risk reduction:

Risk reduction is achieved using risk assessment matrix (table-3) according to the value of the risk assessment process and the hierarchy of controls as seen by figure-1, thus **keeping people away from the hazard**, changing the way people work to reduce exposure to the hazard, allowing workers to be exposed to the hazard while **wearing personal protective equipment (PPE)** taking measures to **protect humans and/or the**

environment against the risks identified. Additional factors should be taken into account before a risk management decision is taken, including: **Effectiveness, practicality, monitor ability, objectivity, administrative simplicity, consistency, public acceptability, time, and the nature of the legislative mandate.**

Table – 3 Risk assessment matrix.

CONSEQUENCE	IMPACT	TIME (DAYS)	INJURY DEATHS	RISK ASSESSMENT MATRIX							RISK LEVEL
	MAJOR PERMANENT IMPACT	60-180	Multiple deaths	6	6	7	8	9	10	11	VERY HIGH SEVERITY RISK (10 – 11) CATASTROFIC – DEATH LOSS OF SYSTEM
	MODERATE PERMANENT IMPACT	30-60	Single death and/or multiple major injures	5	5	6	7	8	9	10	
	MINOR PERMANENT IMPACT	12-30	Major injures and hospitalization	4	4	5	6	7	8	9	HIGH SEVERITY RISK (8-9) CRITICAL - SEVERE INJURY MAJOR DAMAGE TO SYSTEM
	MAJOR TEMPORARY IMPACT	3-12	Injures requiring treatment by medical practioners - lost from workplace	3	3	4	5	6	7	8	
	MINOR TEMPORARY IMPACT	1-3	Minor injures or first aid treatment	2	2	3	4	5	6	7	MEDIUM SEVERITY RISK (5 – 7) MINOR INJURY/SYSTEM DAMAGE
	VERY LOW TEMPORARY IMPACT	0-1	No injury or fist aid treatment	1	1	2	3	4	5	6	VERY LOW (1) / LOW RISK (2-4) NO INJURY – NO SYSTEM DAMAGE
					1	2	3	4	5	6	
					VERY UNLIKELY 0-1%	UNLIKELY 1-5%	RARE 5-10%	MODERATE 10-25%	LIKELY 25-50%	ALMOST CERTAIN 50-100%	
					PROBABILITY OF OCCURRENCE						

RISK = ƒ(H, E, Po, Pr)
CONSEQUENCE = ƒ(H, E, Po)
LEVEL OF SEVERITY RISK = ƒ(Co, Pr)
H = Hazard
E = Exposure
Po = Population
Pr = Probability

10-11 CATASTROPHIC - STOP
8-9 UNACCEPTABLE-URGENT ACTION
5-7 MARGINAL-UNDESIRABLE - ACTION
2-4 ACCEPTABLE - MONITOR
1 NEGLIGIBLE - NO ACTION

Control Strategies to Mitigate the Risks

With such ergonomic hazards include:

1-Engineering controls:

Many engineering controls are available for controlling the hazard at the source and along the path of transmission. For chemical hazards, common engineering controls include and according to hierarchy of controls triangle as seen by figure 1:

1- Elimination.

2-Substitution.

3- Local exhaust ventilation.

4- General ventilation (only appropriate for non-toxic chemicals).

5- Isolation/enclosed processes.

6- Proper chemical storage.

7- Facility design.

Elimination:

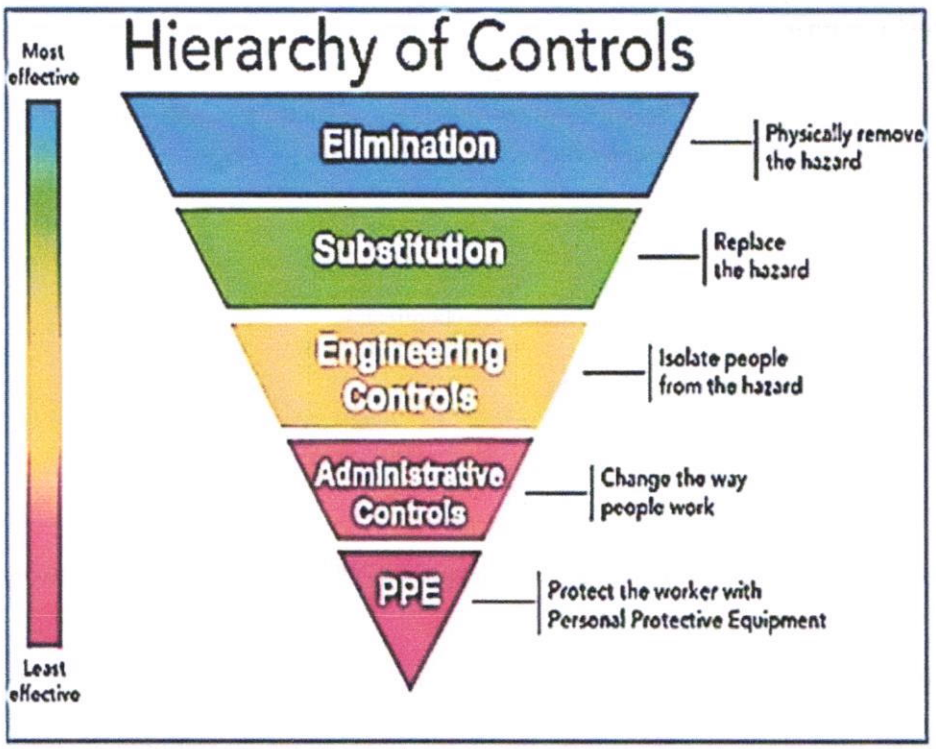
Elimination of a hazardous chemical from the workplace is always desirable but not always possible.

Substitution:

Some chemicals used in the process or experiment are chosen based on tradition or cost. In recent years, efforts have been made to find less hazardous alternatives to some of the chemicals commonly used.

2-Administrative controls:

As administrative controls, **policies and procedures** should be in place to ensure that there are safe work procedures for storing, using chemicals and discarding chemical wastes appropriately that health care workers may come into contact with a number of **chemicals** or infectious matters through their work. **Workplace Hazardous Materials Information System (WHMIS) training** should be provided to all health care personnel. In addition, emergency call lines that provide expertise and advice regarding toxic chemicals should be made available.
Administrative controls include **policies**, **procedures**, **work practices**, **rules**, **training**, and **work scheduling.**



Source: http://www.cdc.gov/niosh/topics/hierarchy/

Fig.-1 Hierarchy triangle control.

Hazardous Materials Information System (WHMIS) Program:

A WHMIS program is an **administrative control to reduce the risk of exposure to hazardous materials in the workplace and is a legal requirement for all employers who use controlled products in their work place.** Material Safety Data Sheets for all products in the workplace, ensuring all products are appropriately labelled and ensuring that all workers are instructed on how to use the chemicals safely.

Exposure follow-up emergency response equipment:

Two types of **exposure follow-up** are considered as administrative controls. **The first is the provision of appropriate emergency response equipment to reduce the impact of the exposure. The second is the medical follow-up for workers who have bio infected or had a**

chemical exposure. Emergency response equipment for healthcare workers usually refers to emergency eyewashes that can provide sufficient water to dilute the contaminant before it can cause extensive damage. **Wherever chemical exposure could pose a hazard to eyes and skin, emergency wash devices are required**. Appropriate signage that is easily visible must be provided to indicate where the eyewashes are kept. **A worker who has had a chemical exposure may require medical follow-up.** Guidelines are available to provide information on the treatment and monitoring of workers with exposure to specific hazardous agent.

Chemical waste handling and disposal:

Chemical wastes must be addressed with a good chemical waste management system. Municipal and or provincial codes address appropriate disposal requirements and aim to reduce contamination, possible injuries, illness or reactions related to chemical exposures.

Additional considerations for reducing risk of exposure:

It is prudent to be aware of the need for modification of the work environment, conditions or the required PPE for workers who may be medically vulnerable to the effects of some substances. Higher risk workers may include **pregnant workers, workers with allergies or those who are sensitized to certain chemicals.** Some common approaches to accommodate these workers include temporary reassignment to areas or tasks where the exposure potential is eliminated; **work scheduling** to reduce the amount of exposure, and changes to the PPE to accommodate limitations.

1- **Adjustment of the workstation** to the patient each time.
2- **Scheduling of patients** to reduce risk.
3- **Training** regarding ergonomic hazards and control strategies.

Training:

Training in biological hazards and controls should be provided to all health care professionals and workers who **must understand the employer's infection prevention control, IPC and occupational safety and health, OHS programs as they relate to his or her job duties. To ensure that health care workers understand and apply this information to their jobs, specific training should also be provided to address job-specific biological hazards. Periodic refresher training to reinforce policies and procedures and introduce any new practices will benefit all healthcare workers:**

1- **Education about vaccine-preventable diseases.**
2- Risk assessment to determine the need for immunization or surveillance based on potential exposure.
3 - Administration of immunizations (or referral for immunizations, as appropriate).

4-Documentation and follow-up of any baseline health assessments, communicable disease status and immunizations. Ideally, the immunization and surveillance programs should provide easy, authorized access to healthcare workers immune status records for follow up of exposure incidents and outbreaks. In some cases, immunizations or baseline testing may be required prior to commencement of work. Post-exposure follow-up management Post-exposure routine practices and additional precautions Procedural controls may include procedures that relate to the use of Routine Practices and Additional Precautions as directed, baseline health assessments and periodic screening of workers, and hazard identification and control processes. Awareness of the infectious disease status of patients is another good control, though this is not always possible for healthcare workers. All work procedures should include the consideration and control of the risk of exposure to workers. Routine Practices and Additional Precautions (where required) greatly assist in reducing the transmission of infectious agents from both known and unknown patient sources **by treating all contacts as potential risks.**

5- Early **reporting** system to capture symptoms of ergonomic concerns.

6- **Alternating working posture frequently** and performing stretches during any micro-breaks.

7- Including ergonomic considerations in all workstation/work equipment procurement policies.

8-Maintenance of all work equipment as per **manufacturer's recommendations.**

Levels of Bio Clinical Laboratory

A Biological Safety Level (BSL 1, 2, 3 & 4) is assigned to a biological lab as a safeguard to protect laboratory personnel, as well as the surrounding environment and community.

The assignment of the biosafety level of a biological laboratory can be seen in table-4, takes into consideration the **organism** (**pathogenic agent**) to be handled with, the **available facilities**, **equipment** as well as **practice programs** for the **laboratory officials training as well as** the **procedures** required to conduct work There are individual safeguards designed to protect laboratory personnel, as well as the surrounding environment and community.

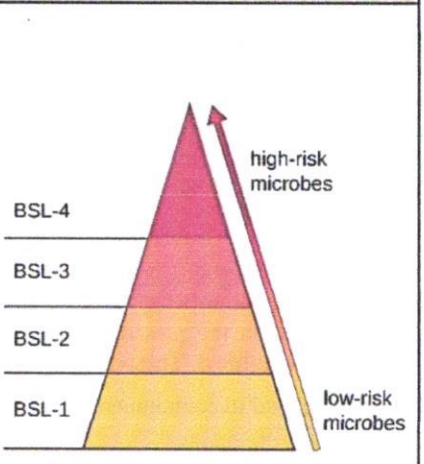
These levels, which are ranked from one to four, are selected based on the agents or organisms that are being researched or worked on in any given laboratory setting. For example, a **basic lab setting specializing in the research of nonlethal agents that pose a minimal potential threat to lab workers and the environment are generally considered BSL-1 which is the lowest biosafety lab level**. A specialized research laboratory that deals with potentially deadly infectious agents like Ebola would be designated as BSL-4 which is the highest and most stringent level.

The Centers for Disease Control and Prevention (CDC) sets BSL lab levels as a way of exhibiting specific controls for the containment of microbes and biological agents. Each BSL lab level builds upon on the previous level, thereby creating layer upon layer of constraints and barriers as seen in **table 4**. These lab levels are determined by the following

1. Risks related to containment.
2. Severity of infection.
3. Transmissibility.
4. Nature of the work conducted.
5. Origin of the microbe.
6. Agent in question.
7. Route of exposure.

The reason biosafety levels are so important is because they dictate the type of work practices that are allowed to take place in a laboratory setting. They also heavily influence the overall design of the facility in question, as well as the type of specialized safety equipment used within it.

Table-4 Biosafety levels of bio laboratories with respect to pathogen, practice and equipment according to risk assessment.

Biosafety Levels			
Biological Safety Levels	**Description**	**Examples**	**CDC Classification**
BSL-4	Microbes are dangerous and exotic, posing a high risk of aerosol-transmitted infections, which are frequently fatal without treatment or vaccines. Few labs are at this level.	Ebola and Marburg viruses	
BSL-3	Microbes are indigenous or exotic and cause serious or potentially lethal diseases through respiratory transmission.	*Mycobacterium tuberculosis*	
BSL-2	Microbes are typically indigenous and are associated with diseases of varying severity. They pose moderate risk to workers and the environment.	*Staphylococcus aureus*	
BSL-1	Microbes are not known to cause disease in healthy hosts and pose minimal risk to workers and the environment.	Nonpathogenic strains of *Escherichia coli*	

Bio safety level -1 (BSL–1):

Biosafety level 1 as seen in figure 2 applies to laboratory settings in which personnel work with low-risk microbes that pose little to no threat of infection in healthy adults such as a nonpathogenic strain of *E. coli*. This laboratory setting typically consists of research taking place on **benches without the use of special contaminant equipment. A BSL-1 lab, which is not required to be isolated from surrounding facilities, houses activities that require only standard microbial practices, such as:**

1. Mechanical pipetting only (no mouth pipetting allowed).
2. Safe sharps handling.
3. Avoidance of splashes or aerosols.
4. Daily decontamination of all work surfaces when work is complete.
5. Hand washing.
6. Prohibition of food, drink and smoking materials in lab setting.

7. Personal protective equipment, such as; eye protection, gloves and a lab coat or gown.
8. Biohazard signs.

BSL-1 labs also requires immediate decontamination after spills. Infection materials are also decontaminated prior to disposal, generally through the use of an autoclave.

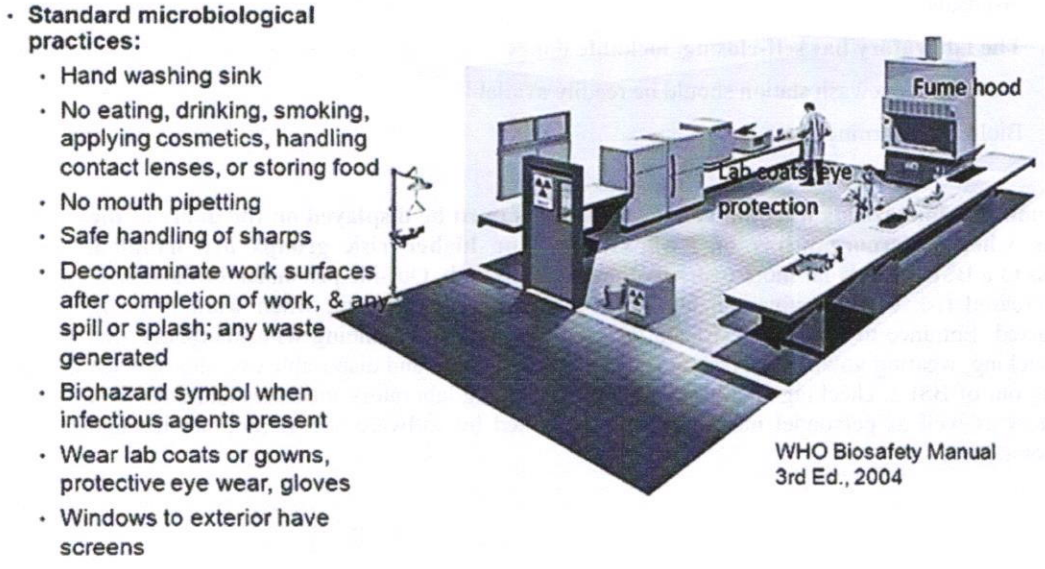


Fig.- 2 A typical biosafety laboratory of level-1

Bio safety level-2 (BSL–2):

This biosafety level covers laboratories that work with agents associated with human diseases (i.e. pathogenic or infections organisms) that pose a moderate health hazard which include equine encephalitis viruses and HIV, as well as *Staphylococcus aureus (staph infections)* as seen by figure 3, BSL-2 laboratories maintain the same standard microbial practices as BSL-1 labs, but also **includes enhanced measures due to the potential risk of the aforementioned microbes.** Personnel **working in BSL-2 labs are expected to take even greater care to prevent injuries such as cuts and other breaches of the skin, as well as ingestion and mucous membrane exposures**. In addition to BSL 1 expectation, the following practices are required in a BSL 2 lab setting:

1. Appropriate personal protective equipment (PPE) must be worn, including lab coats and gloves. Eye protection and face shields can also be worn, as needed.

2. All procedures that can cause infection from aerosols or splashes are performed within a biological safety cabinet (BSC).
3. An autoclave or an alternative method of decontamination is available for proper disposals.
4. **The laboratory has self-closing, lockable doors**.
5. A sink and eyewash station should be readily available.
6. Biohazard warning signs.

International biohazards warning symbols and signs must be displayed on the doors of the rooms where microorganisms of Risk Group-2 or higher risk groups are handled. Access to a BSL-2 lab is far more restrictive than a BSL-1 lab. Outside personnel, or those with an increased risk of contamination, are often restricted from entering when work is being conducted. Entrance to BSL2 is restricted to trained personnel, beginning with interphase area for checking, wearing gowns with personnel measuring devices and disposable overshoes, when getting out of BSL2, checking should be implemented using laboratory measures and analytical detectors as well as personnel movements are governed by software access program through electronic gates.

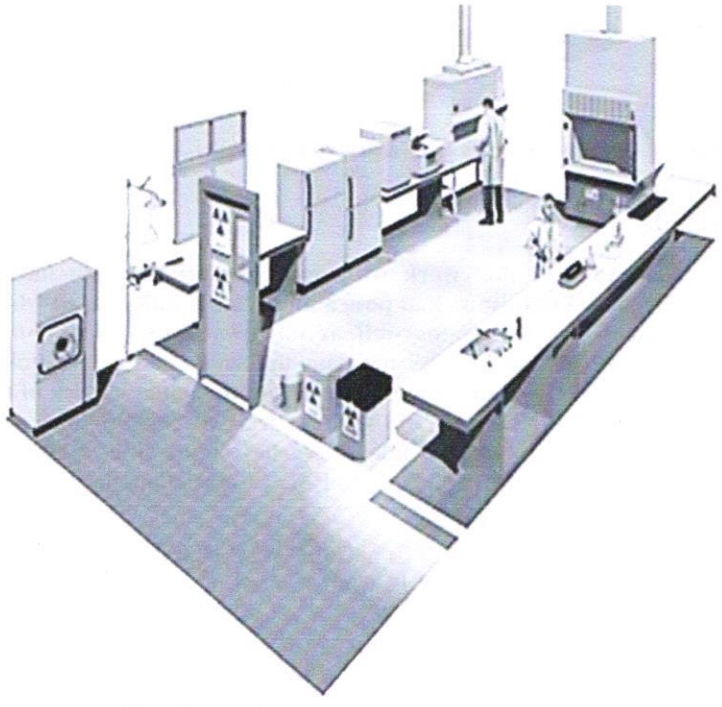


Fig.- 3 A typical biosafety laboratory of level-2.

Bio safety level-3 (BSL-3):

BSL-3 laboratory typically includes work on microbes that are either **indigenous or exotic**, and can cause serious or potentially lethal disease through inhalation which include yellow fever, west Nile virus, and the bacteria that causes tuberculosis (figure 4). **The microbes are so serious that the work is often strictly controlled and registered with the appropriate government agencies**. Laboratory personnel are also under medical surveillance and could receive immunizations for microbes they work with. Common requirements in a BSL-3 laboratory include:

1. Standard personal protective equipment must be worn, and respirators might be required.
2. Solid-front wraparound gowns, scrub suits or coveralls are often required.
3. All work with microbes must be performed within an appropriate BSC.
4. **Access hands-free sink and eyewash are available near the exit.**
5. **Sustained directional airflow to draw air into the laboratory from clean areas towards potentially contaminated areas (Exhaust air cannot be re-circulated)**
6. **A self-closing set of locking doors with access away from general building corridors.**
7. **Access to a BSL-3 laboratory is restricted and controlled at all time.**

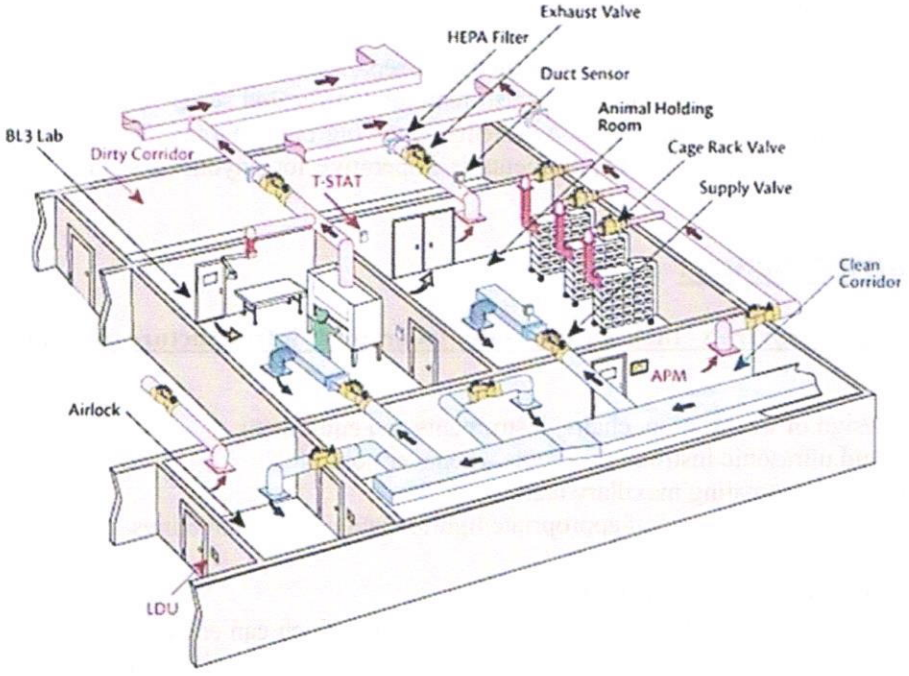


Fig.- 4 A typical biosafety laboratory of level-3

Bio safety level-4 (BSL-4):

BSL-4 labs are rare. However some do exist in a small number of places in the US and around the world. As the highest level of biological safety, a BSL-4 lab **consists of work with highly dangerous and exotic microbes. Infections caused by these types of microbes are frequently fatal, and come without treatment or vaccines. Two examples of such microbes include Ebola and Marburg viruses.**

In addition to BSL-3 considerations, BSL-4 laboratories have the following containment requirements:

1. Personnel are required to change clothing before entering, shower upon exiting
2. Decontamination of all materials before exiting.
3. Personnel must wear the recommended personal protective equipment as well as a full body, air-supplied, positive pressure suit.
4. A Class III biological safety cabinet.

A BSL-4 laboratory is extremely isolated, often located in a separate building or in an isolated and restricted zone of the building. The laboratory also features a dedicated supply and exhaust air, as well as vacuum lines and decontamination systems. Knowing the difference in biosafety lab levels and their corresponding safety requirements is imperative for anyone working with microbes in a lab setting.

Laboratory Infrastructure:

Engineering thoroughly controls that ensure safe laboratory infrastructure are the following tasks:

1- Good ergonomic design of workstation, chairs, instruments and equipment.
2- Use of automatic and ultrasonic instruments / tools whenever possible.
3-Use of indirect vision when treating maxillary teeth.
4- Minimization of glare through the use of appropriate lighting and window coverings.

1-Local exhaust ventilation hoods (LEV):

LEV-Hood is a defined as a suction device, regardless of its shape which can enclose or capture (remove) any contaminants close near the working zone (figures 5-7) used for different purposes, also it is called as a fume hood or fume cupboard. The fume hood should be checked to the recommended design withdrawal velocity regarding each hazardous agent, **cubic feet per minute (fpm)** values as seen in table-5 using a mechanical vinometer (figure- 8) or electronic vinometer (figure- 9).

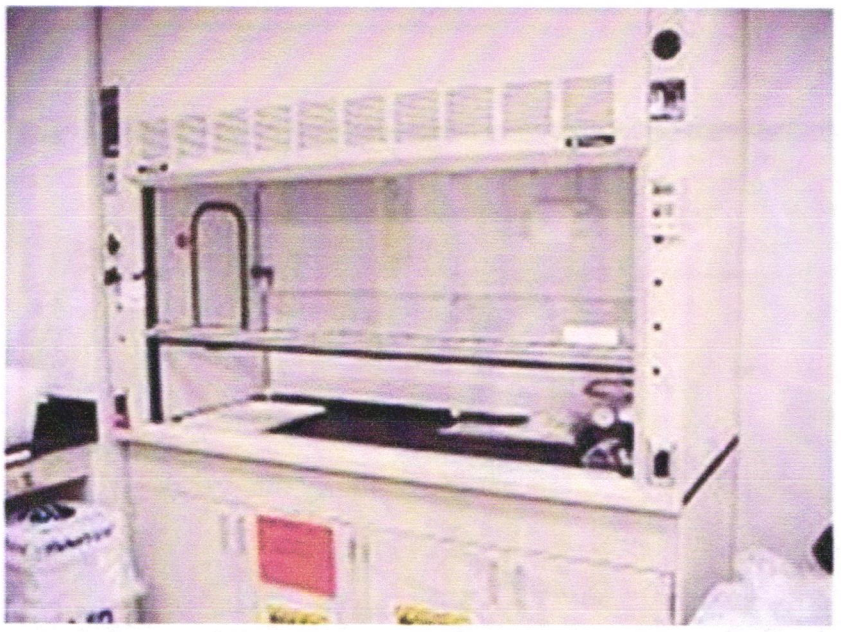


Fig.- 5 Laboratory chemical fume hood for chemicals.

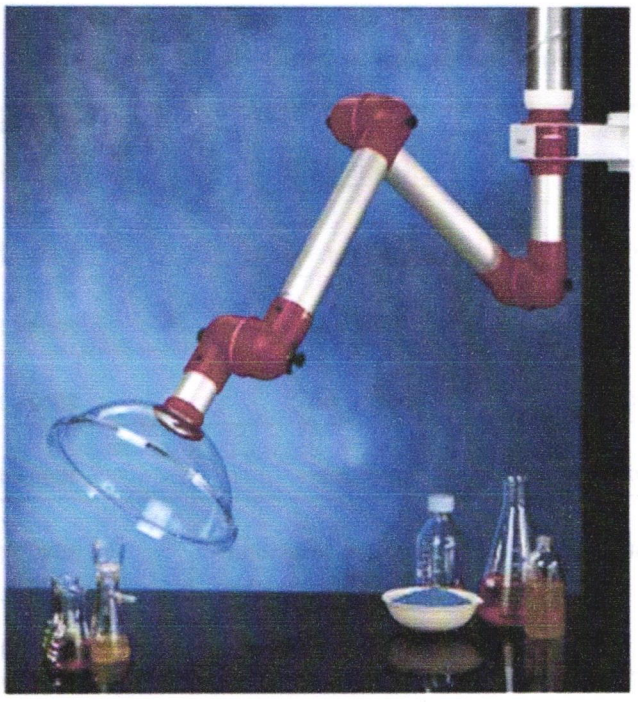


Fig.-6 LEV elephant trunk hood.