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Technical Paper on Laboratory Management- the Place of Any Scientific Research

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Introduction:
Laboratory provides controlled conditions where measurement, scientific research and experiments are performed. Good Laboratory practices are required for quality scientific output. Such tasks require the use of different chemicals that are toxic or non toxic and simple to sophisticated without which the experiments are withheld. Now-a-days there are many research labs that constantly work on medicines and drugs, food products, medical equipments, etc. Such lab needs to have well certified chemicals and equipments, which does not create any hazardous effect on the research work.

Laboratory a steering place for scientific work:
1. Every laboratory needs certified chemicals which can be used in its day-to-day task.
Such certified materials can be directly supplied by the manufacturers, wholesalers and retailers. There are many Indian chemical industries that sell their products with the help of online services. Due to this, purchase of lab products become easier.

2. The Teacher presence is must in the Practical classes.
Laboratory chemicals including equipments which may be dangerous if they are not handled with utmost care. There is a need to have proper storage facilities and guidelines to be followed. Most of the toxic chemicals in laboratory may lose its stability if they are stored for a long period of time and become quite dangerous to use. Even there are many chemical-groups which are incompatible and can produce hazardous effect if accidentally mixed. Therefore ,it is mandatory that every practical classes should be conducted in the presence of an expert responsible Teacher, a Laboratory Assistant and an attender.

Here is one of the most practical negligence in the Laboratory-

- A science practical class left a terrifying lasting images in the mind .It was a class of B.Sc students who were practically learning about Media pouring techniques. The teacher explained the techniques with all the minute details. The students were very confident of theoretical aspect of the technique and also ready to do it practically. Unfortunately the teacher had to leave for sometime the class as there was an emergency. The students started their work by melting the media in the conical flask which was prepared the previous day. They melted the media in the conical flask on a hot plate for a long time. The media started boiling, but unfortunately, all of a sudden the conical flask burst and the student who was holding the conical flask was injured.
- Another incident was, the students were preparing acid reagent for estimation. It was found that the students added the measured amount of distilled water to concentrated Hydrochloric acid and suddenly there was a cracker bursting sound. Again the student who added water was injured. Though the teacher in charge of the practical had strictly instructed the students how to go about preparing the reagent and inspite of her presence in a fraction of second the student did the mistake.

All these incidents though instilled only minor injuries, the thought of it immediately exaggerated into a much major damage to the students. Henceforth, a solution to avoid such accidents to the students and the laboratory, though most of the lab manuals reads a lot of instruction, is it practically followed in the laboratory has to be strictly surveyed. First, the teacher in charge of the practical or the Lab personnel should strictly be there in the lab and vigilantly deliver his or her duty .Second, the laboratory should be with fire and acid proof sheets on the working table. Third the students must be given spectacles while preparing chemicals that gives out fumes, mask and also gloves that are acid proof apart from the apron which is mandatory. A first aid kit must be immediately available. Teacher should also teach some basic First aid to be done if any accident occurs in the laboratory.

3. Laboratory Supplies.
Laboratory supplies include equipments, instruments, chemicals and lab safety devices. A laboratory must not only contain essential equipments which are necessary to conduct research task or any experiments but it should also be well equipped with safety devices required for the lab workers. Proper lab with all the basic necessities will provide a safe platform for the smooth conduction of any research works. The Lab Manager should purchase all the required chemicals from certified Chemical supplier with high quality analytical reagent. It is better to buy minimum quantity of good quality chemical rather than a large quantity of less quality which will not give proper results. Lab manager when receiving the chemicals should check for the manufactured and expiry dates of the chemicals and should enter in the stock book with receiving date. Most important while receiving the acid bottles specially, should check for the proper seal of the bottle or else there will be spilling and may cause some injury while handling. Therefore the vigilance of the lab manager is essential.

4. Laboratory safety tips
Every individual working in the lab, student, teacher, scientist an attender , laboratory assistant or cleaner becomes responsible for his or her and the laboratory safety. One should work with presence of mind and utmost simple common sense while in the lab such that any mishap should not be handled panicking .Care and cleanliness must be practiced at all times .No personnel should be indulged in eating, drinking, smoking or any other entertainment activities apart from the work. When working in the lab it is better to wear protective coat. The floor space should be kept perfectly free from spillage, broken glass, paper, straw etc, as their presence may lead to accidents.

Workers in a biological laboratory are in frequent contact with microbes. Whenever pathogenic microorganisms are handled, the work should be done in an area having controlled ventilation and safety cabinets. The person should have appropriate vaccination. Fire buckets, containing sand and water should always be available in easily accessible places. In case of emergency medical attention should be quickly obtained. Many accidents are caused by failure to seek advice or information .Never attempt to use any equipment that you have not fully understood. First aid kit is essential in the laboratory. In the lab handle glassware items carefully at all times. While cleaning any glassware, attender should be careful as glass is brittle .The attender should also be aware that those glassware used for microbiology practical should be heat killed and only then washed otherwise the exposure to the microbes maybe fatal for his or health .This way he or she can avoid contamination in the laboratory. Bottom of Form

Laboratories have clear rules on the labelling and handling of chemical reagents and on the maintenance of clean work areas. Laboratory rules and instructions should be followed about the disposal of materials, such as used gloves, needles and biological tissue. In some cases the penalties for non-compliance, including fines, are clearly indicated.

“Defining and strictly enforcing safety regulations are high priorities for us. One of the first things we do at the start of each semester is let students know what safety criteria they will be responsible for. “We teach students to be honest in how they deal with the results of experiments. We stress that this process is heavily reliant on professional ethics, behaviour, academic and intellectual integrity.

5. Biological Contaminations:
In order to reduce the frequency of biological contamination, it is important to understand how biological contaminants can enter culture dishes. In most laboratories, the greatest sources of microbes are those that accompany laboratory personnel. These are circulated as airborne particles and aerosols during normal lab work. Talking, sneezing, and coughing can generate significant amounts of aerosols. Clothing can also harbour and transport a range of microorganisms from outside the lab, so it is crucial to wear lab coats when working in the cell culture lab. Even simply moving around the lab can create air movement, so the room must be cleaned often to reduce dust particles. The lab should be fumigated once in month or depending upon the use.

Certain laboratory equipment, such as pipetting devices, vortex, or centrifuges without bio-contaminant vessels, can generate large amounts of microbial-laden particulates and aerosols. Frequently used laboratory equipment, including water baths, refrigerators, microscopes, and cold storage rooms, are also reservoirs for microbes and fungi. Improperly cleaned and maintained Incubators can serve as an acceptable home for fungi and bacteria. Overcrowding of materials in the autoclave during sterilization can also result in incomplete elimination of microbes.

Without proper autoclaving or heat killing the culture vessels leads to infection to the individual washing it and may contaminate the whole laboratory. A delay in or improper cleaning of such vessels may lead to health hazard. This is evident from the very attender in the lab who washed all the glassware without heat killing. This went on for a long time. Some rashes started to appear on her neck. She ignored it .But when it started to itch and became severe, medical attention and case study of the infection showed that it was because of negligence. Here the lab attender should be educated regarding the lab rules and regulation .The most important for them is to wear mask and gloves while handling the contaminated vessels. The lab manager also should be vigilant enough to deliver his or duty.

Contamination in Animal Cell culture laboratory:
Culture media, bovine sera, reagents, and plasticware can also be major sources of biological contaminants. While commercial testing methods are much improved over those of earlier decades, it is paramount to use materials that are certified for cell culture use. Cross-contamination can occur when working with multiple cell lines at the same time. Each cell type should have its own solutions and supplies and should be manipulated separately from other cells. Unintentional use of non-sterile supplies, media, or solutions during routine cell culture procedures is the major source of microbial spread.

Contamination is a prevalent issue in the culturing of cells, and it is essential that any risks are managed effectively so that experiment integrity is maintained. Antibiotics can be used for a few weeks to ensure resolution of a known microbial contamination; however, routine use should be avoided. Regular inclusion of antibiotics not only selects for resistant organisms, but also masks any low-level infection and habitual mistakes in aseptic technique.

The best approach to fighting contamination is for each person to keep records of all cell culture work including each passage, general cell appearance, and manipulations including feeding, splitting, and counting of cells. If contamination does occur, make a note of the characteristics and the time and date. In this way, any contamination can be detected at the time it occurs and improvements can be made to aseptic techniques or lab protocols.

Avoid Contamination by following instructions:
A proper fumigation in proper time can reduce a little contamination.

If any pure cultures are maintained in the laboratory, one should take care of both the pure culture and as well should take care of laboratory to avoid contamination.

Proper guidance should be given to the students while handling with the both fungi and bacteria culturing, inoculation and maintaining them.

The inoculation chamber i.e Laminar Air Flow should be maintained free from microorganisms. Students should disinfect the chamber before and after inoculating the culture to avoid the contamination to their culture as well others.

Chemical bottle and Chemical disposable:
Laboratories frequently accumulate bottles of old chemicals, often toxic or hazardous, that are no longer used. Laboratory managers can use several strategies to properly reuse or dispose of these chemicals. These strategies are not mutually exclusive. Laboratory managers can apply more than one to meet the requirements of maintaining laboratory safety and environmental protection.

These strategies are discussed in the individual sections below.
Proper disposal can be expensive. So it is essential to minimize the need for proper disposal, by minimizing chemical purchases. Even if yours is a small laboratory, centralizing chemical purchasing is an effective way to do this. Having a single person assigned to purchase all chemicals for the entire laboratory will help ensure that duplicate orders are not made by different members of the laboratory staff. More people may be assigned to do this in larger laboratories, and departments may be set up to manage chemical purchasing, storage and waste disposal. Once old chemical samples are identified and selected for disposal, proper procedures must be followed. Lab managers can have samples packed properly by lab personnel for pickup and disposal by a qualified chemical disposal firm. Some disposal firms will perform all the work themselves. This approach may be more appropriate for large laboratories.

While any chemical to be discarded is chemical waste, hazardous chemical waste is defined by the Environmental Protection Agency (EPA) or a relevant state authority as waste

that presents a danger to human health and/or the environment. The EPA defines four key properties that determine whether a chemical is hazardous waste: ignitability, corrosivity, reactivity and toxicity (EPA, 1997)

Potentially hazardous chemicals must be disposed of in accordance with federal and state regulations and procedures.

While state requirements vary somewhat by locality, the basics remain the same. However, it is best to consult with your relevant state agency or the EPA to determine whether particular chemicals are defined as hazardous and what the requirements are for storage and disposal. These requirements should be defined on the chemical's Material Safety Data Sheets (MSDS). However, if the chemical was purchased some time ago, the available MSDS sheet may be out of date and you should consult the current version of the MSDS.

Material Safety Data Sheet-MSDS

A Material Safety Data Sheet (MSDS) is designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance. MSDS's include information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill/leak procedures. These are of particular use if a spill or other accident occurs.

Many labs use one or more large containers labelled "chemical waste" for solvents and other chemical wastes. Extreme care must be used in combining chemicals in such containers, as some chemicals may be incompatible. For example, addition of a strong oxidizing agent may result in oxidizing another chemical in the container and leading to heat evolution and an explosion or fire. Because of the dangers of such chemical incompatibilities and the hazards of chemical spills occurring in a busy work area, chemical waste containers should be stored away from normal work areas and away from sinks and floor drains. Every addition of a chemical waste to a storage container should be noted in a permanent record such as an online file or a laboratory notebook.

Do not completely fill waste containers, particularly waste storage bottles. While the amount of empty headspace at the top of the container can vary with the size of the container, it is usually best to allow about 20 percent vacant headspace at the top of the container for possible vapour formation or liquid expansion due to heat evolution. To remove chemical wastes from your laboratory site, contact professional, licensed hazardous waste haulers and transporters. Trained personnel from these firms will package waste chemicals properly for transport and disposal.

Maintaining a computer-searchable chemical database.

The first step in proper recycling or disposal of chemicals is to know what you have. The best way to do this is by maintaining an inventory of all the chemicals in use or stored in your laboratory. Supply room personnel should record the receipt of all purchased chemicals. Among the data that should be recorded are the supplier, the amount of chemical purchased, its purity, its amount, the person ordering the chemical and the laboratory room number to which it was delivered.

New chemicals should be added to the database as they are purchased and old ones deleted as they are consumed. This last requirement means that laboratory personnel and not just stockroom personnel should be able to access the database to update information. Laboratory personnel should record when samples are completely consumed or transferred from one laboratory to another. This inventory can be used to tell laboratory managers and staff members when samples become so old that disposal is necessary. This database can also be a money saver by enabling lab personnel to learn from whom they can obtain a needed chemical without purchasing a new sample. Should it be necessary to purchase a fresh sample of a particular chemical, the purchaser can review the chemical inventory to identify a supplier and the chemical purity of previously purchased samples of the same chemical. Several firms offer commercially available chemical inventory database software. Using an Internet search engine and keyword phrases such as "chemical inventory management software" can identify software suppliers and retrieve a description of their products.

These computer programs vary in sophistication and features. Software search features can include one or more of the following search options: searching by chemical name, chemical supplier, the storage location, and the laboratory department and/or individual who purchased the chemical. The chemical name can be the proper IUPAC (International Union of Pure and Applied Chemistry) systematic name designation or one or more common names of the chemical. Other search options include the CAS (Chemical Abstracts Service) Number of the chemical and the date of purchase. Some programs provide storage of MSDS information.

More sophisticated software can print barcode labels for chemicals that can be affixed to the chemical sample container and used to track movement of chemicals within the laboratory and their consumption. Should supply of a chemical be recorded as falling below a specified level, some software can automatically issue an alert informing the user of that particular chemical and that it needs to be re-ordered. Some chemicals may arrive with an expiration data beyond which the chemical should not be used. Some software offer features that include issuing an alert when a particular chemical sample usage date is due to expire.

Some software suppliers such as Chemoventory offer limited capability versions of their software for free (www.chemoventory.com) to educational and other nonprofit institutions. Other software provides more features but must be paid for. One example is Nexxis Chemical Inventory Manager (www.labtronics.com/chemical_inventory_management.htm).

Holding periodic lab cleanup days.

Having periodic cleanup days during which old chemical samples and unused/non functional equipment is collected and disposed of can be a useful way of putting labs in clean, tidy and safe operating condition. These cleanup days are most effective in achieving these goals if lab managers insist that all routine work stop for the day to focus on cleanup.

Sometimes only an individual laboratory rather than the entire facility needs to have a laboratory cleanup day. This situation can arise if a laboratory is being relocated from one location to another either within the facility or from one facility to another. Alternatively, the termination of a project or its relocation from one laboratory to another may be facilitated by a lab cleanup day.

If an individual laboratory rather than the entire facility is cleaning up and disposing of old chemicals, have the appropriate lab staff members advertise their lack of availability to co-workers before this process begins. Interruptions can greatly reduce the efficiency of the cleanup process and increase the time required for it.

Training lab personnel

Training lab personnel in proper disposal and storage procedures is essential. This is a particular issue in academic laboratories because the students using a laboratory can change from semester to semester. Larger laboratories often have a Health, Safety & Environment Department whose personnel are qualified to conduct such training. If your laboratory does not, there are consultants who offer training programs in proper chemical storage and disposal.

When supervising students working in laboratories, professors and teaching assistants should review the safety concerns and required safety procedures associated with each laboratory exercise or experiment.

Solvents and glassware cleaning

Solvents produced as waste in laboratory equipment such as rotary evaporators and distillation apparatus are often as clean as what initially comes from a fresh solvent bottle. Do not dispose of these solvents; reuse them instead for routine laboratory operations such as glassware cleaning. Often one can filter and reuse solvents for at least initial cleaning of glassware. Laboratory personnel should limit the use of solvents and other chemicals in routine operations such as cleaning laboratory glassware. Chromium-containing cleaning agents can be highly effective but should be used only as a last resort.

Volatile solvents such as isopropyl alcohol routinely used for sterilizing equipment should be replaced by quaternary amine-based detergents. Replace highly toxic solvents such as benzene or carbon tetrachloride with less toxic ones whenever possible. For example, cyclohexane is often used as a substitute for carbon tetrachloride.

Mechanical cleaning methods should be used instead of solvents whenever possible. These may be as simple as using cleaning brushes in good condition or ultrasonicators instead of solvents. Large laboratories often use industrial dishwashers instead of solvents for cleaning glassware. This will reduce the tendency to rinse glassware with volatile solvents such as acetone to quickly dry glassware for reuse. Neutralize aqueous acids and bases. Pour only nontoxic, pH 4 to 9 aqueous fluids down drains. Neutralize and clean up spills so that all or most of the waste can be disposed of properly.

Chemical compatibility is a measure of how stable a substance is when mixed with another substance. If substances mix and do not change they are considered compatible. If substances mix and change or do not mix at all they are considered incompatible. For example, because bleach and ammonia, both commonly used as cleaners are not compatible chemicals, as they react. The recant in this case are dangerous so care must be taken not to allows these chemicals to mix when attempting to use them as cleaners.

Chemical Compatibility Chart

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Inorganic Acids																								
2	Organic acids	X																							
3	Caustics	X	X																						
4	Amines & Alkanolamines	X	X																						
5	Halogenated Compounds	X		X	X																				
6	Alcohols, Glycols & Glycol Ethers	X																							
7	Aldehydes	X	X	X	X		X																		
8	Ketone	X		X	X			X																	
9	Saturated Hydrocarbons																								
10	Aromatic Hydrocarbons	X																							
11	Olefins	X				X																			
12	Petrolum Oils																								
13	Esters	X		X	X																				
14	Monomers & Polymerizable Esters	X	X	X	X	X	X																		
15	Phenols			X	X			X																	
16	Alkylene Oxides	X	X	X	X		X	X																	
17	Cyanohydrins	X	X	X	X	X		X																	
18	Nitriles	X	X	X	X																				
19	Ammonia	X	X					X	X																
20	Halogens			X			X	X	X	X	X	X	X	X	X	X									
21	Ethers	X																							
22	Phosphorus, Elemental	X	X	X																					
23	Sulfur, Molten									X	X	X	X												
24	Acid Anhydrides	X		X	X		X	X																	

X Represents Unsafe Combinations

Represents Safe Combinations

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NOTE: Identify class to which a specific compound belongs, read unsafe combinations with other classes both horizontally and vertically.

Chemical accessibility by students.

The chemicals should be available to the students that are required for their research work or practical classes. This accessibility can be made to students according to the infrastructure of the institution:

A General Rack may be provided with compartments. In each compartment the chemicals should be arranged in alphabetical order. Store all items on secure shelves below eye level and large containers on low shelves. Never store chemicals on the floor. Storage areas should be cool, dry, ventilated and well lit. Appropriate chemical spill kits and fire extinguishers should be kept near storage areas. Containers must be sealed, capped and in good condition. Keep the outer surface of containers clean of chemical residue. The acids and other fumable chemicals are arranged in a separate mud stand.

The second method of chemical arrangements depends on the Infrastructure of the Institute; there should be separate cabin for the chemical storage. Students should list out the chemicals required for their practical class and they should go to the chemical room and should enter in the Indent book provided by the lab attender. The required amount of chemicals they should weigh there only. One laboratory personal should be there to look after for all these.

Cylinders must be stored in ventilated areas. Closets and lockers are not acceptable storage locations. Hallways, corridors, stairwells or near elevators are also unacceptable. Additionally, cylinders of oxygen and other oxidizers must not be stored within 20-feet of fuel-gas or other combustible materials unless separated by a specific barrier, e.g., a non-combustible wall, not less than 5-feet high, having a fire-resistance rating of ½-hour.

Instruments usage:
The Instruments required for the practical class are Indented by the teacher in charge and entered in the Log book . After using the particular equipment it is returned back and followed up by the respective lab personal. Thus maintaining the equipments this way will record who has used a particular equipment specifying the date and time. It is also easier to maintain the equipment in working condition. Timely monitoring of the equipments and servicing will increase the life of it.

Conclusion:
We've all heard the saying – recycle reduce reuse – and if we apply this to our lives, Apart from monetary saving it helps the environment thus helping ourselves. At home, this means composting food, recycling plastic and reusing glass containers. In the lab, we can start by reducing.

One of the head-scratchers that we see in the lab is throwing away expired chemicals, and sometimes unopened containers! Reducing waste will save money and space in the lab. I bet you can think of a better use of the funds. A lab using inventory best practices will have the minimum necessary amount of chemicals on site, based on what each department needs. I'm not sure I can even list all the benefits to this. It saves storage space; it lowers risk from hazardous materials; it makes fire code compliance simpler by having lower amounts of regulated materials. The materials are always at their freshest, and you have a good chance of using them before they expire

Sometimes you can search and find the manufacturer's expiry date on the label, but that means you have to look at the bottle in front of you. By the time it's checked, it could be too late. With a smaller, dedicated inventory solution, expiry dates can be optimized and new orders can be made in a timely manner so that there is no rush delivery necessary. Researchers can get back to research, and the whole operation can save money and get more quality work done!

Expired chemicals get two thumbs down for being a financial burden and a liability risk. Wouldn't it be great if you could forecast the expiry dates so you could use the chemicals before they go bad? Wish no more, this dream is a reality with best practices not only by one , but by all of us who works in the laboratory for better tomorrow. Without a well maintained laboratory there is no scientific invention, as long as the earth has life scientific invention goes on for those individual with scientific temper.

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