STANDARD SPECIFICATIONS FOR SETTING UP OF A BASIC FUNCTIONAL FOOD ANALYSIS LABORATORY

Abstract This is a resource document intended to help in setting up a Basic Food Analysis and Testing laboratory for regulatory purposes, which can act as the silent 'expert system' ensuring the safety and quality of food. These laboratories do not require very high-end state-of-the-art equipment yet would fulfil testing a large number of samples for regulatory compliance as well as regular surveillance activities. The document is a very comprehensive document which includes different aspects of the laboratory set-up, such as planning the laboratory layout, security, educational qualification and experience of personnel, equipment required for a variety of analysis and their housing in appropriate environmental conditions, laboratory safety design and waste disposal measures. The document is not "all inclusive. It does not cover all design situations and building design.

Food Safety and Standard Authority of India

www.fssai.gov.in

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LIST OF ABBREVIATIONS

Abbreviation	Expansion
AAS	Atomic Absorption Spectroscopy
BSC	Biosafety Cabinet
CCTV	Close Circuit TV
ECD	Electron Capture
DO	Designated Officer
FSO	Food Safety Officer
FSSAI	Food Safety and Standards Authority of India
FLD	Fluorescence Detector
FT-IR	Fourier Transform-Infra Red
FTL	Food testing Laboratory
FA	Food Analyst
GC	Gas Chromatography
HPLC	High Performance Liquid Chromatography
ICP	Inductively Couple Plasma
LAN	Local Area Network
LIMS	Laboratory Information Management System
MS	Mass Spectrometry
MSDS	Material Safety Data Sheet
NABL	National Accreditation Board of Calibrating and Testing Laboratories
NMI	National Measurement Institute
NPD	Nitrogen Phosphorus Detector
PDA	Photo Diode array
PT	Proficiency testing
QC	Quality Control
RID	Refractive Index Detector
SI	International System of Units

1.0 Introduction

Food safety issues and the enhancement of health security are of growing national and international concern. Key global food safety concerns include spread of microbiological hazards, chemical food contamination and related hazards, assessment of rapidly changing technologies in food production, processing and marketing. Increasing scientific understanding of the adverse consequences of unsafe food, amplified by the rapid global transmission of information has heightened consumer awareness about food safety risks to new levels. Microbiological hazards, contaminants in the form of pesticides and heavy metals and addition of adulterants (substitution of cheaper raw materials or look alike ingredients) and antibiotics in high doses to gain a competitive economic advantage are major food safety concerns. Increased attention to safety concerns in the handling, processing and packaging of foods stems from the demand of ready to eat, ready to cook and semi-prepared foods. National standards for both domestic and export trade lay down parameters for pesticide residues, antibiotic and veterinary residues, heavy metals, mycotoxins, pathogens, and other contaminants. Therefore, a basic food analytical laboratory is the silent model 'expert system' and an imminent need for ensuring the safety and quality of food.

1.1 Food Testing Laboratories

Food testing and analysis laboratories deploying a comprehensive range of analytical techniques are required for a responsible, responsive food regulatory system to support robust implementation, surveillance and enforcement of the regulations with timely analysis of samples towards compliance to international and domestic standards, being the mission. These laboratories with adequate infrastructure, facilities, equipment, supplies, reference materials, access to calibration and maintenance, and operating under an international quality assurance programme are benchmarks of a functional food testing and analysis laboratory. An adequate number of food analysts with suitable qualifications, training, experience and integrity; management and support staff form the heart of a testing laboratory. Formal accreditation, operation of effective internal quality control procedures together with participation in laboratory proficiency testing (PT) schemes are key elements in ensuring the quality of results generated by analytical laboratories. Food testing laboratories that meet the recognized best practices of analytical competency will allow FSSAI, the regulatory agency to more expeditiously utilize laboratory data for risk assessment and management.

Although a diverse array of sophisticated analytical equipment and techniques exist for food analysis and testing, the most common food testing would include microbiological and chemical analysis. The types of analysis, which do not require the use of high-end state-of-the-art equipment, like LC-MS/MS, GC-MS/MS and ICP-MS, and can be carried out by new and upcoming food testing laboratories are listed in Figure 1. The sample quantity, type of analysis that can be done, speed of the analyses, and ease of use and competent personnel are factors that would dictate the operation of new laboratories.

General Parameters	Nutritional parameters
Moisture Total ash Acid insoluble ash Water soluble/ insoluble ash Alkalinity of ash Acidity Total Soluble solids Rodent hair Extraneous matter Uric acid Drained weight	Total fat Total protein Amino acids Crude/Dietary Fibre Fatty acid composition Trans fatty Acid Cholesterol Vitamins Trace elements Total sugar Energy value
Food additives & Contaminants	**Microbiological analysis**
Colours Antioxidants Preservatives Artificial sweeteners Pesticide residues Heavy metals Mycotoxins Common food adulterants	Total Plate Count Coliform count Aerobic plate count Anaerobic count Yeast and mold count Flat sour organisms *Staphylococcus aureus* *Salmonella* *Shigella* *Clostridium botulinum* *E. coli* *Vibrio cholera* *Listeria monocytogenes*

Figure 1 Types of analyses to be carried out in a Basic Food Analysis and Testing Laboratory

The types of analyses will determine the investment and the space needed for carrying out such analyses. Proximate analysis is used for the characterization of general nutritional parameters, and the capacity to perform these analyses should be seen as the minimum requirement for every Food Testing Laboratory. Other types of analyses (contaminants, drug residues, pesticide residues, antibiotic residues, authenticity etc.,) are more specialized and need specific high-end equipment and facilities. Consequently, these analyses require highly qualified skilled personnel with deep knowledge and expensive equipment, but also demand superior working environment to avoid contamination.

The high-quality analytical demands in a new food testing laboratories requires large investments in terms of personnel, equipment and infrastructural facilities and guarantee the independence of the

laboratory and avoid conflict with commercial interests.

2.0 Scope and Objectives

Currently, in India, neither a comprehensive set of legislation nor standards related to laboratory design, organization of different sections, number of personnel for regulatory testing, etc are available. Shortage of space and manpower are among the crucial factors that exist in many food testing laboratories. The objective is to provide a consistent and harmonized reference for establishing food testing laboratories to progressively raise the quality of testing and safety standards of food testing laboratories.

3.0 Setting up a Basic Food Testing and Analysis Laboratory

The major components of a laboratory involve:

a. Selection, identifying building facilities and construction, if required for various analyses

b. Developing an organizational structure and assigning responsibilities

c. Selection of analyses to be performed

d. Selection and purchase of equipment/chemicals

e. Appointment and maintaining qualified analysts/technicians/skilled and unskilled staff

f. Establishing standard operational and working procedures.

g. Establishing a Quality Assurance system based on ISO/IEC 17025:2017 and obtain the NABL accreditation within 6 months of setting up of a basic Food Testing Laboratory

All of these issues are related to the analytical work and more specifically to the methods that the laboratory intends to conduct. The choice of methods is therefore a critical step. Therefore, an overview of the analytical process and available methods, followed by their implications for construction or selection of buildings and facilities, purchase of equipment and putting in place an organizational structure with defined responsibilities for the personnel are presented in this document.

3.1 The analytical process for regulatory compliance

The foundation of a regulatory laboratory for food analysis and testing is the analytical process. The procedures and protocols to be followed must meet the rigor and highest standard of regulatory compliance and meet international requirements.

The various stages of the analytical process shown in Figure 2 remain the same, irrespective of the size, location and infrastructure of the laboratory. This process starts with the receipt of samples from the Food safety officer (FSO)/Designated Officer (DO)/ Food Business Operator (FBO) with a request for the analyses. On receipt of the samples, security and appropriate storage of samples is initiated followed by sample preparation and analyses. The results of these tests are collated, verified and following approval from an authorized person, a final report is dispatched to the FSO/DO/FBO. It is important to ensure that the accountability, security, integrity and chain of custody of the sample is met as per Food Safety and Standards Rules and Regulations (FSSR). The laboratory must ensure the legal defensibility of analytical data produced by the laboratory in case of regulatory samples. Responsibility for maintaining all these details should be clearly defined. Sample materials stored in

the laboratory for a fixed time, e.g., one month, from completion of analyses are either discarded or destroyed.

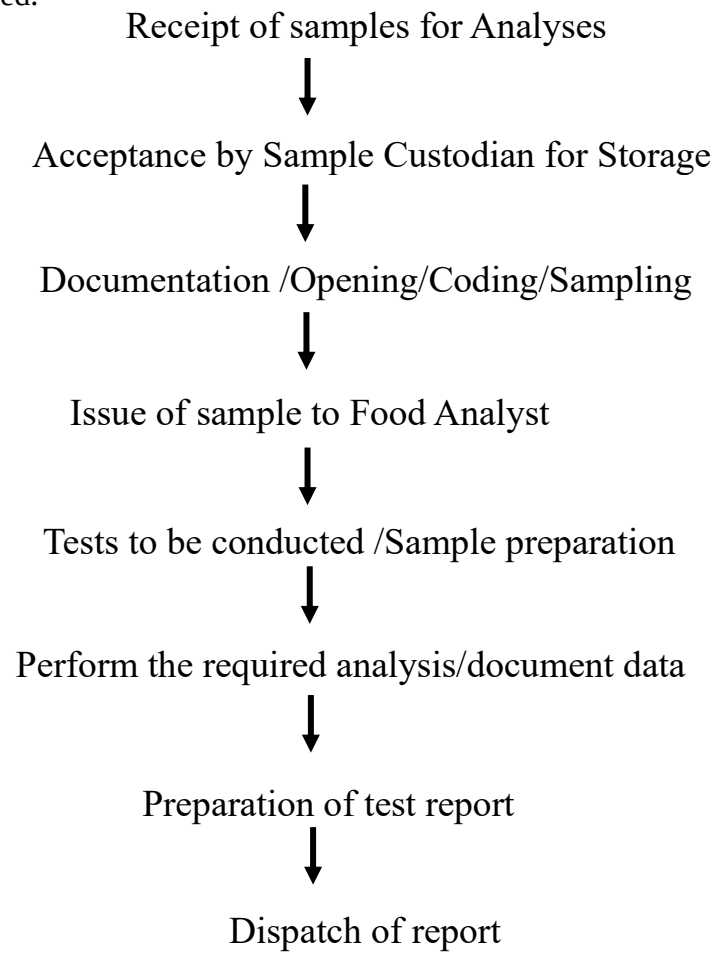


Figure 2 Various stages of an analytical process in a regulatory food analysis and testing laboratory

3.2 Specific requirements as per National Accreditation Board for Testing and Calibrating Laboratories (NABL)

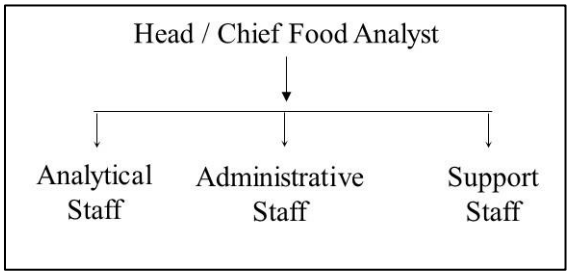
The laboratory shall ensure that measurement results are traceable to the International System of Units (SI) through:

a) Calibration provided by an NABL accredited laboratory;

b) Certified values of Certified Reference Materials (CRM) are provided by an accredited Reference Material Producer with stated metrological traceability to the SI) from NMI (such as CSIR-National Physical Laboratory, New Delhi, India)

3.3 Laboratory Organisation

A skeleton structure for the Organisation of a typical regulatory food analysis laboratory is as follows:



3.3.1 Analytical staff

Head/Chief Food Analyst of the Laboratory should preferably be a PhD in Science (Chemistry/ Microbiology/ Biochemistry/Food Science or related subjects) with 5-10 years hands on experience in food analysis or a qualified Food Analyst with a minimum of 15 years experience in an established Food Testing and Analyses Laboratory. He/she should be dynamic with strong interpersonal skills, well -versed with analytical procedures (chemical and microbiological), instrumentation and quality assurance required for regulatory compliance. He/she will be responsible for laboratory safety and good house-keeping practice and ensure that the lab has necessary chemicals in required quantities in stock and functional instruments and that there are sufficient staff to attend to the workload. A key role at this position is to ensure analytical reports are reliable and have been thoroughly checked prior to their release and undertake full responsibility for the reported results. The Head of the laboratory is the spokesperson for the laboratory and should have a thorough and deep knowledge and understanding of FSSAI, FSS Rules and Regulations (2011), Quality Management Systems, documentation and procedures as per NABL requirement (ISO/IEC 17025: 2017) and other National and International rules and regulations. As per Food Safety and Standards (Recognition and Notification of Laboratories), 2018, Chief Food Analyst/ Head of the Laboratory/Authorized signatory designated by NABL will be a FSSAI qualified Food Analyst and will be responsible for implementing ISO/IEC 17025:2017 and taking care of other regulatory requirements. The Chief Food Analyst/ Head of the Laboratory can also be designated as the Director of the Laboratory.

Senior Food Analyst: Each analytical section should preferably be headed by a Senior Food Analyst (Section manager). Desirable qualifications are M. Sc (Chemistry/ Microbiology/ Biochemistry/Food technology/Food science/), with minimum of 5 years experience in food analysis for specific category of tests (Chemical/ Microbiological or both). It is preferable to have a FSSAI certified Food Analyst (FA). Having FAs assigned to specific units or areas of work permits the laboratory Head to effectively execute the total workload of the laboratory. The Senior Food Analyst is responsible for ensuring that daily and weekly deadlines for test results are met; quality control for each batch of testing meets requirements and is recorded; staff training is up-to-date and ensuring that proper laboratory safety and housekeeping practices are followed in the section. The Senior Food Analyst should possess the ability to optimize methods, develop standard operating procedures (SOPs) and make independent decisions on recommending procurement of additional specialized chemicals and new instruments/ equipment. He or she must be capable of answering questions and assisting in solving analytical problems posed by the individual analysts. Maintaining stocks of the necessary chemicals and consumables is also the responsibility of the Senior Food Analyst so as to enable ordering and delivery prior to stocks running low. In addition, he/she must train and prepare Junior Analysts of the section for the Food Analysts' certification exam. The Senior Food Analyst can also be designated as the Joint Director/ Deputy Director/ Assistant Director of the Laboratory

Analysts: Analytical personnel are the heart of every laboratory. They have to be reliable, precise, competent and motivated. The personnel required to perform the analyses in a food analysis laboratory can be divided into:

1.Junior Analyst: Junior analyst(s) are responsible for performing analytical work following SOPs, under the direction of the Senior Food Analyst. The essential qualification required is M.Sc. in Chemistry/Biochemistry/Analytical Chemistry/Microbiology/Food Science/Food Technology and related subjects). Post graduates who are FSSAI certified Food analysts are preferred. The analysts should have knowledge of basic chemical reactions and the principle of the methods used; be aware of laboratory safety when working with solvents, strong acids and bases; computer competency; use and handling of gas cylinders; analytical equipment like spectrophotometer; use of manuals and use of specific equipment for proximate analysis *viz*., ash, fiber, fat, protein estimation, gravimetric analysis, thin layer chromatography, paper chromatography, titration, qualitative tests for food adulterants, energy, etc. Laboratory experience is essential. Microbiological testing should be performed and supervised by an experienced person, qualified in Microbiology. Alternatively, a graduate in chemistry or microbiology with three to five years of experience in food analysis may also be considered for the post of analysts and can be trained in sample preparation and other analyses as described above. Junior Analysts should prepare and take FSSAI Food Analysts exam after working experience of three years in the laboratory.

2. Technical officers. The qualification required for Technical officers is MSc (Chemistry/ Microbiology/ Biochemistry/Food technology/Food science/Food and Nutrition/Edible oil technology/Dairy technology/Agricultural and Horticultural sciences and related subjects or BE/BTech in Food Technology/Dairy Technology/ Oil Technology and related subjects). Technical officers should be able to carry out the chemical and microbiological analysis in foods, responsible for maintenance of log books/ documents, data records and documentation of all technical activities as per the Quality manual and existing regulations.

3.Technical assistants. The qualification required for technical assistants is high school graduation (10+2) having studied Chemistry and/or Biology to carry out certain routine laboratory tasks. They can be trained in tasks, such as sample grinding, sieving/ mixing, subsampling/media preparation/autoclaving etc. Familiarity with the use of weighing balances, pH meter, preparation of reagents with details, such as chemical names, expiry date, purity of the chemicals, etc is essential.

3.3.2 Administrative Staff

The Administrative staff includes all the administrative assistance, such as General administration, Finance & Accounts, Stores and Purchase, Secretary, typing and filing etc. These staff are generally involved in "office" or "paperwork" functions, such as looking after the office, Finance and purchase/ stores procedures and maintaining the records of samples, preparation of test reports, maintenance of accounts, etc. and general welfare of the employees. Lack of sufficient administrative staff often results in delay in reporting of the results by the analytical staff. The Secretary/Assistant for the laboratory generally works directly under the control of the Head of the Laboratory. Qualification: Any recognized Bachelor's degree with computer knowledge and knowledge about the use of relevant software, tender preparation, Laboratory Information Management System (LIMS, TALLY etc and any specific experience commensurate to the field

3.3.2 Support Staff

Operational Head (Instrumentation) will be responsible for the upkeep and optimal functioning of specific equipment and operating methods, especially trouble-shooting, maintenance and solving problems, as well as continuous training of junior staff when required. Training records for the staff should be regularly maintained.

Technician(s) for instrument and general maintenance shall have Diploma in Electronics or Electrical or Instrumentation Engineering with two years of experience in the operation and maintenance of state-of -the-art equipment. Alternatively, a graduate in Instrumentation Engineering may also be considered.

Laboratory attendants: are all those persons working in and for the laboratory but not conducting analyses or are not involved in the administrative duties. Usually, there are no prescribed educational qualifications for this post but they must be literate and able to read and write with the ability to support the Food Analyst/Chemist/ Technical Officers through glassware washing, cleaning & housekeeping, sterilization, disposal of sample reserves (when no longer required), pest control and other laboratory activities. It is most important that sufficient number of persons are hired for the support function. About, 15-20% of the total number of analytical staff or one per lab/ section is often sufficient

3.4 Manpower requirements for a basic Food Analysis and Testing Laboratory in a Government set up (indicative list).

The number of personnel and their educational and experience levels depends on the analyses to be conducted, methods chosen and the expected sample throughput. The analysis of enforcement and surveillance food samples can be carried out analytical parameter wise (Figure 1). A detailed typical organizational structure (indicative) is shown in Figure 3

Essential staff needs to be deployed by the respective Government departments; however, the support staff and the desirable staff may be outsourced.

The manpower listed in Table 1 is ideally required for a government laboratory to carry out the analyses of about 1000 samples per month. The analyses include: general and proximate compositional analysis, nutritional analysis, heavy metal analysis, pesticide residue analysis and microbiological examination. Individual laboratories may decide on the number of Assistant Directors, Technical Officers and support staff based on their scope of testing and available facilities

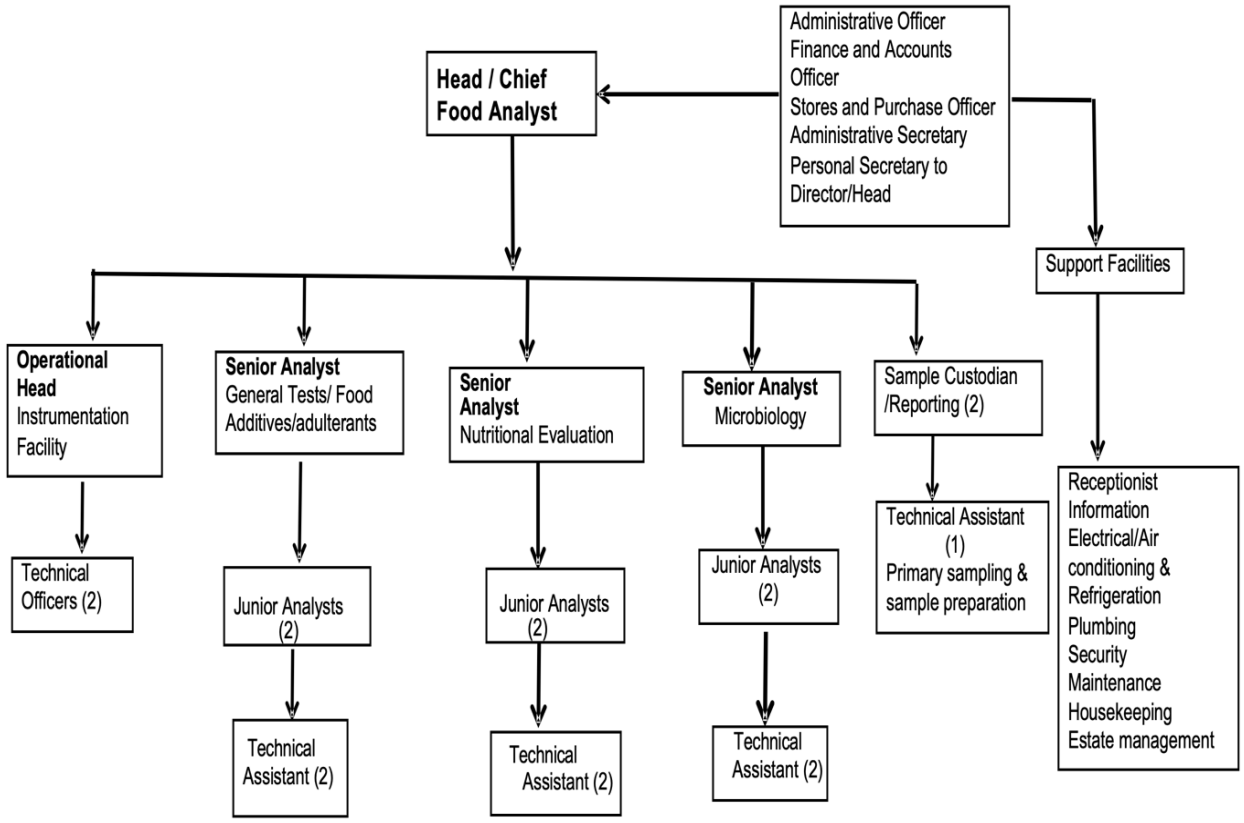


Figure 3 A typical organization chart for a Basic Food Analysis and Testing laboratory

Table 1 An indicative list of the manpower for a food laboratory analysing 1000 samples per month in a Food Testing Laboratory is given below

S. No.	Position	Numbers required
1.	Director	1 (Essential)
2.	Joint Director/Deputy Director	1 (Essential)
3.	Assistant Director (Technical)	4 (Essential)
4.	Food Analysts	2 (Essential) with 1 having background in Microbiology
5.	Technical Officers	10 (Essential) with at least two having background in Microbiology
Administrative and Accounts Staff		
6.	Administrative Officer	1 (Essential)
7.	Accountant	1 (Essential)

8.	Personal Secretary	1 (Desirable)
9.	Office Assistants/ Executives	4 (Desirable)
Support Staff		
10.	Laboratory Assistants	3 (Essential), 2 (Desirable)
11.	Technical Assistant (Electronics)	1 (Desirable)
12.	Technical Assistant (Electrical)	1 (Essential)
13.	Laboratory Attendants	3 (Essential), 3 (Desirable)
14.	Multitasking Staff (MTS)	3 (Desirable)
15.	**Total**	**41, 27 (Essential), 14 (Desirable)**

The Designations mentioned above may be different for some laboratories but the functional responsibilities of the officers and staff and their qualification and experience will by and large remain similar

3.5 Quality Control (QC) Section (optional)

The goal of the food analysis laboratory is to guarantee the generation of accurate and reliable analytical results. Having an optional QC section minimizes the reporting of erroneous results and prevents excessive repetition of analytical runs. Quality control is designed to detect deficiencies in the laboratory's internal analytical processes and ensure that the samples are representative and data are reliable and reproducible prior to the release of results. QC samples are samples chosen randomly and the testing process is carried by analysts in the QC section using the established methods and operating conditions. The purpose of including analysis of samples by the QC section is to evaluate the reliability of lab results. The analysts of the QC division play an important part in assuring the quality and consistency of the laboratory tests.

4.0 Laboratory Building Requirements and Design

4.1 General requirements

The laboratory should be located in an area with some basic facilities, including good infrastructure, good access (road system) with assured potable water and uninterrupted power supply. The regulatory laboratory should be secure to provide for confidentiality and be accessed only by the authorized personnel. The use of chemicals and other potentially hazardous compounds separates a laboratory from other types of building spaces. Primarily, the laboratory must provide a safe and healthy working environment which complies with current thinking on comfort, energy efficiency, energy conservation and impact on the environment. It should be adequately equipped with essential services and utilities, good ventilation with fume extraction where needed, adequate lighting, safety systems, such as fire control measures, secure and protected storage for records, including computer back-up and water and gas supplies. Adequate arrangements for different types of testing must be addressed by a combination of management practices and physical segregation. All health and safety hazards must be identified and carefully evaluated so that protective measures can be incorporated into the

design.

4.2 Laboratory Building and Facilities

4.2.1 Laboratory Layout

The laboratory is generally designed on the basis of the analysis to be carried out and the methods to be used, keeping in mind future analytical requirements and expansions. Laboratories must have separate zones/rooms, depending on types of analysis and functionality. The separation of laboratory space to perform various activities is primarily required to avoid cross- contamination with undesirable substances and to maximize the use of space.

Such demarcation would include but are not limited to: sample receipt and storage conducted in designated areas; wet chemistry laboratories/sections are separated from the microbiology laboratories/sections; separate storage for standards and reference materials and cultures, media preparation and sterilization in microbiology labs are separated from work areas. Primary sample preparation involves grinding. sieving, which produces dust and noise, and should be physically separated from other activities. Gravimetric analysis involves weighing, drying and incineration, which are mostly linked to each other and do not involve working with chemicals.

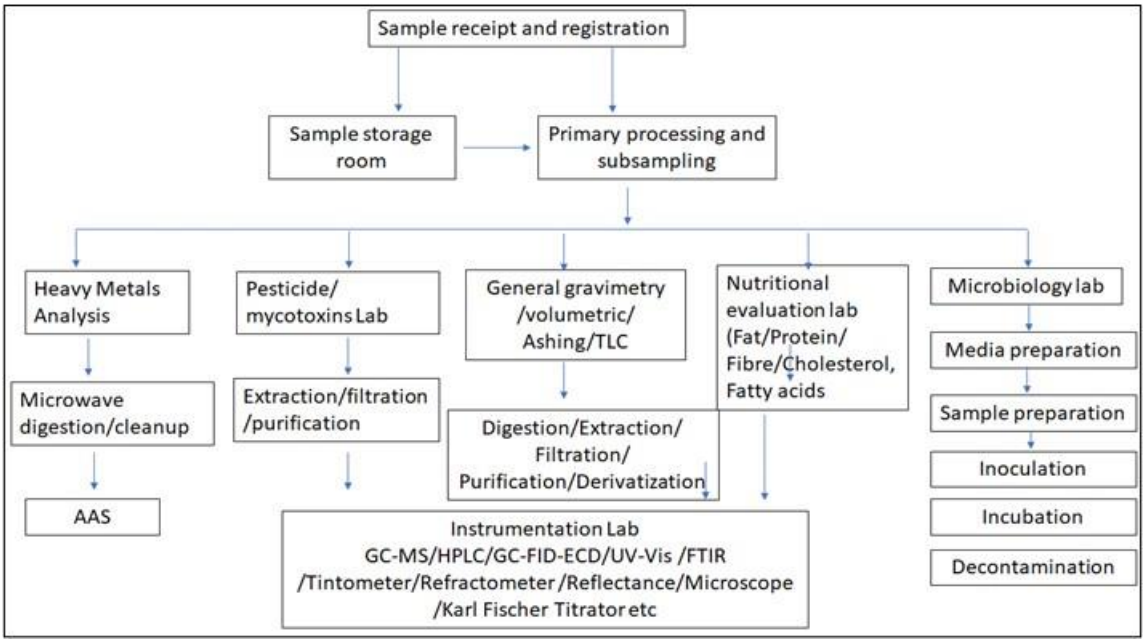


Figure 4: Schematic representation of laboratory sections of a food analysis laboratory

Traditionally, wet chemistry labs and sample preparation for contaminants/mycotoxins are physically separated to avoid cross contamination. Mixing of flammable solvents and corrosive chemicals is a chemical hazard and such operations are carried out in separate sections, for e.g., microwave digestion with acids prior to Atomic Absorption Spectroscopy (AAS) and extraction of pesticides with organic solvents and clean-up prior to analyses using Gas Chromatography. Instruments, such as High Performance Liquid Chromatograph (HPLC), GC with Flame ionization detector (FID)/Electron

Capture Detector (ECD) etc. are placed in a dust-free room , which has provision to maintain and control humidity and temperature. A small dark room may be included in the instrumentation room for analysis of aflatoxins. If mycotoxins are to be analysed, there will be a requirement for a biological safety cabinet in the laboratory. The layout for a microbiology laboratory involves a unidirectional flow of events with suitable air handling units. The restrooms and rooms where food and beverage are consumed should not be in a close proximity to the Microbiology lab. Figure 4 shows a schematic presentation of different sections of a food analysis laboratory. In order to achieve maximum efficiency, laboratory activities should be separated into different sections, each with different requirements as elaborated below

4.2.1.1 Sample receipt and registration. An area convenient for courier personnel/postman/ delivery personnel to deliver samples. Most often, this room is at the entrance of the laboratory. Sample should be received through a large window and all the communications should be carried out through this route. Here the samples are logged into a booking system, which is either done manually in a register or using LIMS or relevant software. The sample is given a unique identification number by the laboratory. The requested analysis by the FSO is logged in the sample register. The sample parcel is opened under CCTV surveillance. All information about the sample package including number of seals, packing material, etc. is recorded and then passed on to the primary sample processing and sub-sampling section. If the analysis cannot be processed, it is stored under appropriate conditions.

Area	ca 50 sq. m with a large window with access control for authorised personnel
Equipment and related item	Computer and printer with Local Area Network (LAN) CCTV surveillance
Furniture	Office tables and chairs Secured sample storage facilities Refrigerator (8-10 °C), Upright freezer (-25 to-20 °C)
Safety	Fire extinguisher Hand washing facility First aid kit Segregated waste disposal containers

4.2.1.2 Sample storage room: Storage of the sample must not alter the sample in any significant way – whether through contamination, loss, deterioration or any other means. Physical security of sample prevents intentional adulteration and alteration of the sample. Hence entry to the storage area should be restricted to the authorized personnel. Maintenance of proper storage temperatures is required to maintain the integrity of the sample/analyte to be analysed. The room should be under CCTV surveillance.

Area	ca 50 sq m with access control for authorised personnel Air-conditioned temperature 20± 2 °C RH 50-70%

Equipment and related items	Computer and printer with Local Area Network (LAN) CCTV surveillance Secured sample storage facilities Refrigerator (8-10 °C), Upright freezer (-25 to-20 °C)
Furniture	Office tables and chairs Storage possibilities, such as shelves and cupboards/almirah for sample material
Safety	Fire extinguisher First aid kit Segregated waste disposal containers

4.2.1.3 Primary sample processing and subsampling preparation: The analytical samples are prepared by grinding the laboratory sample. Homogeneity of samples is achieved with grinding in mills, homogenizers, coffee grinders, or a suitable equivalent device, depending on the size and the structure of the laboratory sample. In case, where the laboratory sample is flour or liquid, homogenization is not needed, but mixing or shaking may still be required. This section must have an independent room inter connected to the sample receipt room, where sub-sampling, blending, grinding and, if necessary, pre-drying can be performed. If necessary, an air extraction unit can be utilized to remove odour as well as excess heat. Grinding will produce noise and dust, therefore safety precautions like wearing masks/ear plugs/muffs should be made compulsory for these operations.

Area	ca 50 sq m
Equipment and related items	Computer and printer with Local Area Network (LAN) CCTV surveillance Grinding mill/Waring Blender with jars and sieves Brushes for cleaning sieves and grinder Cubicles connected to a ventilation system for grinding Sample splitter Drying oven Top pan balance Secured sample storage facilities Refrigerator (8-10 °C), Upright freezer (-25 to-20 °C)
Furniture	Work table with sink/bench, chairs
Safety equipment/protection	Dust masks/Lab coats Safety glasses and ear protection Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Segregated waste disposal containers

4.2.1.4 Wet Chemistry Laboratory: Digestion, filtration, distillation, titration, extraction, derivatization and dilution are all unit operations in a typical food analysis laboratory. Independent laboratory rooms can be provided for independent activities as shown in Figure 4. In each laboratory, a separate area must be designated for acid use and storage. A separate area for flammable solvent use and storage must be identified for these laboratories. This area requires access to water and should be

close to glassware supplies, balances, fume hood and chemical supplies. Laboratory space must be arranged for maximum utilization as well as proper work flow. It is usual to allow about 10 square meters of laboratory space and 3 meters of bench surface per analyst.

Room 1 Proximate and General analysis

Area	ca 60 sq m
*Equipment and related items	Weighing balance (0.1 and 0.001 g) Auto titrators Muffle Furnace Hot air ovens (110-130 °C) Refrigerator (8-10 °C Water bath Hotplates Freezer (-20-25 -20°C) Fume hoods connected to an exhaust system Water and gas supply Vacuum facilities Network connection or Computer and accessories
Furniture	Work table with sink/bench, chairs Safety cabinets for storage of chemical solutions (acids & bases, flammable solvents to be stored separately) and chemicals Glassware storage cabinets for beakers, crucibles, dispensers, pipettes and measuring cylinders etc
Safety equipment/protection	Dust masks/Lab coats Safety glasses and ear protection Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Solvent cabinets Chemical spill kits Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper. Computer waste/batteries etc
*Indicative list can vary with the test being performed. Equipment from the attached list mentioned in Annexure-I as required for the test can be procured	

Room 2 Nutritional evaluation	
Area	ca 60 sq m
*Equipment and related items	Weighing balance (0.1 and 0.001 g Auto titrators Filtration unit

	pH meter Soxhlet Fat extractor Automated Protein digestor and titrator for Kjeldhal Nitrogen Reflux system Acid concentrator Rotary evaporator Fibre and fat analyser Centrifuges Incubator shakers Hot air ovens (110-130 °C) Refrigerator Water purification system Vortex mixer Ultrasonic bath Water bath Hotplates Freezer Fume hoods connected to an exhaust system Water and gas supply Vacuum facilities Network connection or Computer and
Furniture	Work table with sink/bench, chairs Safety cabinets for storage of chemical solutions (acids & bases, flammable solvents to be stored separately) and chemicals Glassware storage cabinets for beakers, crucibles, dispensers, pipettes and measuring cylinders etc
Safety equipment/protection	Dust masks/Lab coats Safety glasses and ear protection Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Solvent cabinets Chemical spill kits Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper. Computer waste/batteries etc
*Indicative list can vary with the tests being performed. Equipment from the list (Annexure I) as required for the test can be procured	

Room 3 Wet Lab for pesticide residues/mycotoxin sample preparation

Area	ca 40 sq m
*Equipment and related items	Weighing balance (0.1 and 0.001 g) Solvent Filtration unit pH meter

	Nitrogen evaporator Rotary evaporator Centrifuges Incubator shakers Refrigerator Water purification system Vortex mixer Ultrasonic bath Water bath Solid phase extraction unit Freezer (-25 to-20 °C) Fume hoods connected to an exhaust system Water and gas supply Vacuum manifold Network connection or Computer and accessories
Furniture	Work table with sink/bench, chairs Safety cabinets for storage of chemical solutions (acids & bases, flammable solvents to be stored separately) and chemicals Glassware storage cabinets for beakers, crucibles, dispensers, pipettes and measuring cylinders etc
Safety equipment/protection	Dust masks/Lab coats Safety glasses and ear protection Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Solvent cabinets Chemical spill kits Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper. Computer waste/batteries etc
*Indicative list can vary with the tests being performed	

Room-4 Instrumentation room

Area	ca 100-120 sq m Temperature (20±3 °C) and Humidity controlled (50-70%RH)
*Equipment and related items	Gas Chromatograph with FID /ECD/NPD detector HPLC with RI, Fluorescence and Photodiode array detector (PDA) UPLC with binary solvent system and detectors Tintometer/Reflectance spectrometer Karl Fischer Titration Unit UV-Visible Spectrophotometer Elemental-analyser Microscope Fluorescence spectrometer

	Nitrogen/hydrogen generator Gas purifying panels and systems Uninterrupted power supply Water and gas supply Air conditioners *Cassette type) Purified water system for chromatography work Thermohygrometer Network connections to allow direct laboratory access to data generated from the equipment connection or Computer and accessories
Furniture	Instrument table (vibration free) with chairs Safety cabinets for storage of Manuals and records
Safety equipment/protection	Lab coats Dedicated footwear Safety glasses/goggles Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Solvent cabinets Chemical spill kits Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper. Computer waste/batteries etc
*Indicative list can vary with the test being performed Annexure I provides a list of equipment required for food testing labs and the required instruments can be installed as per the scope of testing of parameters	

Room-5 Heavy Metal Analysis (a suite of two rooms side by side) using AAS

Area	ca 30 sq m for housing AAS or ICP-MS ca 15 sq m for sample preparation room
Room and environment requirements	Dust Free Controlled Temperature (20±3 °C) Short-term variations must be at a maximum rate of change of 3 °C per hour Advisable to have two air conditioners so that each can run for 24×7 & alternatively. The relative humidity should be between 20 and 80%. Temperature and hygrometer to record temperature and humidity. A sturdy table with space at the rear and sides of the system for air to circulate freely. A cart or table close to the AAS for flame autosamplers, sinks, hand wash facilities in sample preparation rooms A venting system for removing the combustion fumes and vapors from the flame or graphite furnace. The

	flow rate of venting system should be approximately 7000-8500 L/min Provide space for air circulation, gas lines & electrical connections (24" behind the system). Dissipate room heat and allow for routine maintenance (at least 3 feet above the system Graphite furnaces require electrical power, cooling water and a supply of inert gas, normally argon Uninterrupted power supply Water and gas supply
Equipment	AAS with all accessories Microwave digester and Clean-bench for AAS sample preparation room Fume Hood in sample preparation room Refrigerator for storing standards and reference material Freezer Analytical balance (0.0001 mg)
Furniture	Instrument table (vibration free) with chairs Cabinets for storage of Manuals and records
Power supply	Main's voltage fluctuations must not exceed ±10%. A measured ground to neutral potential of greater than 3 volts ac or dc indicates grounding problems that will need correction. The power supply boards with sockets must be located within 2 m (6.5 ft.) of the instrument It is recommended that time delay fuses and circuit-breakers are used to prevent nuisance tripping Additional protection to be provided for the instrument by means of Ground Fault Circuit Interrupters
Gas requirements	*Compressed Air*: For flame operation, the air supply should provide a minimum of `28-30 L/min at a minimum pressure of 350 kPa. *Acetylene:* For majority of analyses, acetylene is the preferred fuel gas. Air-acetylene is the preferred flame for the determination of about 35 elements by atomic absorption. Minimum purity specification is 99.6%. Acetylene tanks should always be stored and operated in a vertical position, rather than horizontally. *Nitrous oxide*: 99.0% minimum purity. A dual-stage regulator is mandatory. *Argon:* required for external and internal gas streams. The argon must be dry, high purity (≥ 99.996%, Oxygen content ≤ 5 ppm, Nitrogen ≤ 20 ppm and water ≤ 4 ppm, and regulated), using a two-stage high purity gas regulator with stainless steel diaphragm Gas lines: the appropriate gas lines, regulators, connectors and valves to which the hoses are connected must be provide

Safety equipment/protection	Lab coats Dedicated footwear Safety glasses/goggles Eyewash Safety shower Hand washing facilities Fire extinguisher First aid kit Facility to fasten gas cylinders Solvent cabinets Chemical spill kits Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper. Computer waste/batteries etc

Room 6 Glassware washing and drying area

Area	ca 30 sq m
*Equipment and related items	Hot-air oven (110 °C) Drying cabinets (50-60 °C) Automated Glassware washer
Furniture and related items	Water supply and rodent free drainage system Tiled floor and walls Work table and bench Storage facilities for washed and dried glassware Separate waste disposal containers for broken glass, plastic ware, paper etc
Safety equipment/protection	Lab coats Safety glasses/goggles Eyewash First aid kit Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper etc

An example of a single laboratory room for analysts and layout for instrument room with mandatory space between work tables and analysts is shown in is Figure 5A&B. The schematic layout for a complete laboratory setup is shown Figure 5C.

Microbiology Laboratory: The Microbiology laboratory and support equipment (e.g., Autoclaves, Laminar Air Flow, Biosafety cabinet etc., and glassware) should be dedicated and physically separated from other areas. There should be adequate suitable space with separate storage locations for e.g., biological indicators, reference cultures and media etc. The lab should be away from the restrooms to prevent cross contamination. The air supply to the microbiology laboratory should be through separate air-handling units and other provisions. Temperature and humidity must be maintained. The quality of the air supplied to the laboratory should be as per the ISO specifications and not be a source of contamination. Laboratory equipment used in the microbiology laboratory should not be used outside the defined microbiology area/space.

Access to the microbiological laboratory should be restricted to the authorized personnel (Biometric or use of card readers). Personnel should follow

a) the appropriate entry and exit procedures including gowning

b) the intended use of a clean rooms and corridors

c) the restrictions imposed when working in such areas

d) Use the appropriate containment level biosafety (e.g BSL-2 for *Clostridium botulinum)*

e) Use back-fastening laboratory gowns or coats

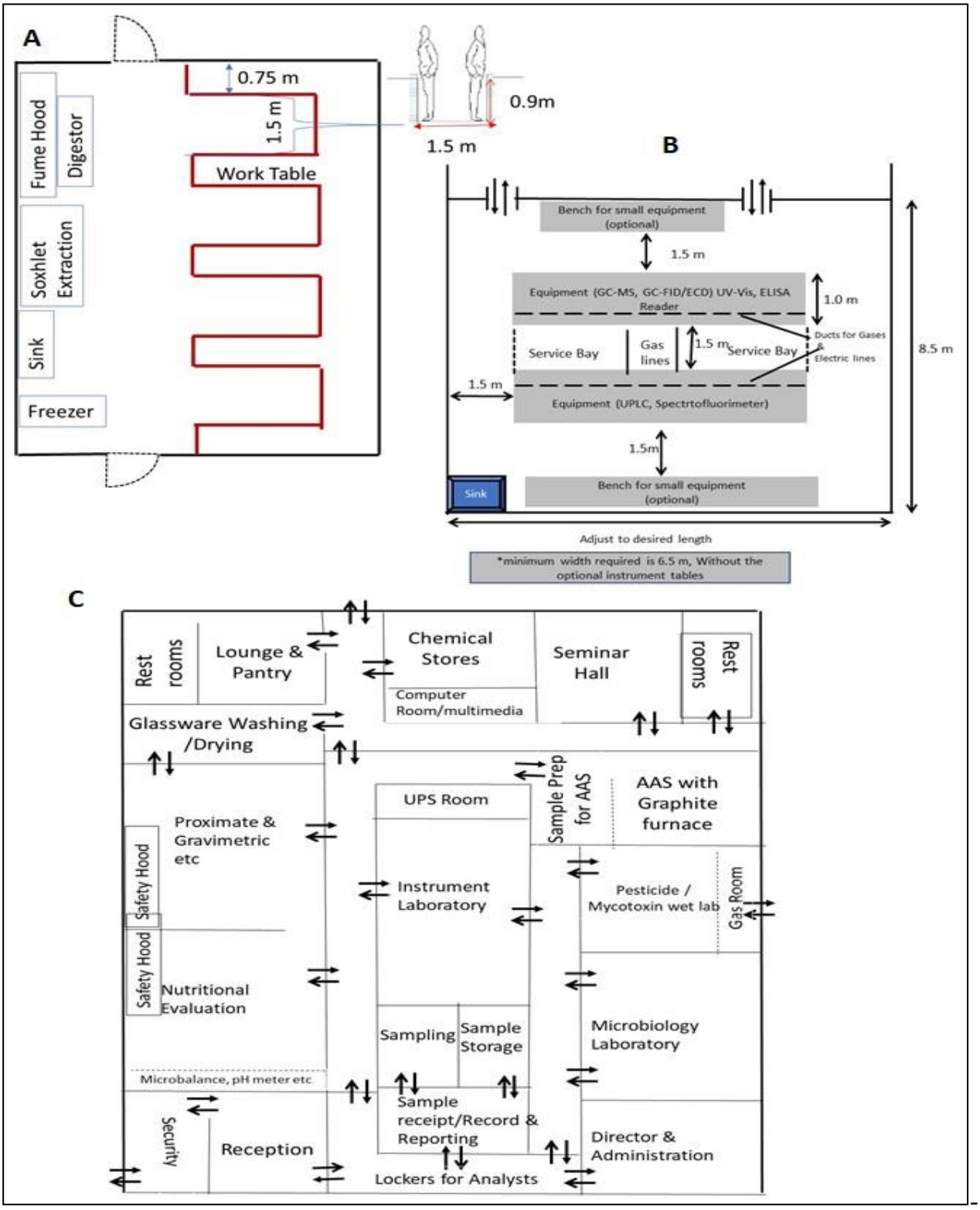


Figure 5 Schematic layout for A) laboratory for eight analysts B) Instrument room and C) Complete Food Testing Laboratory

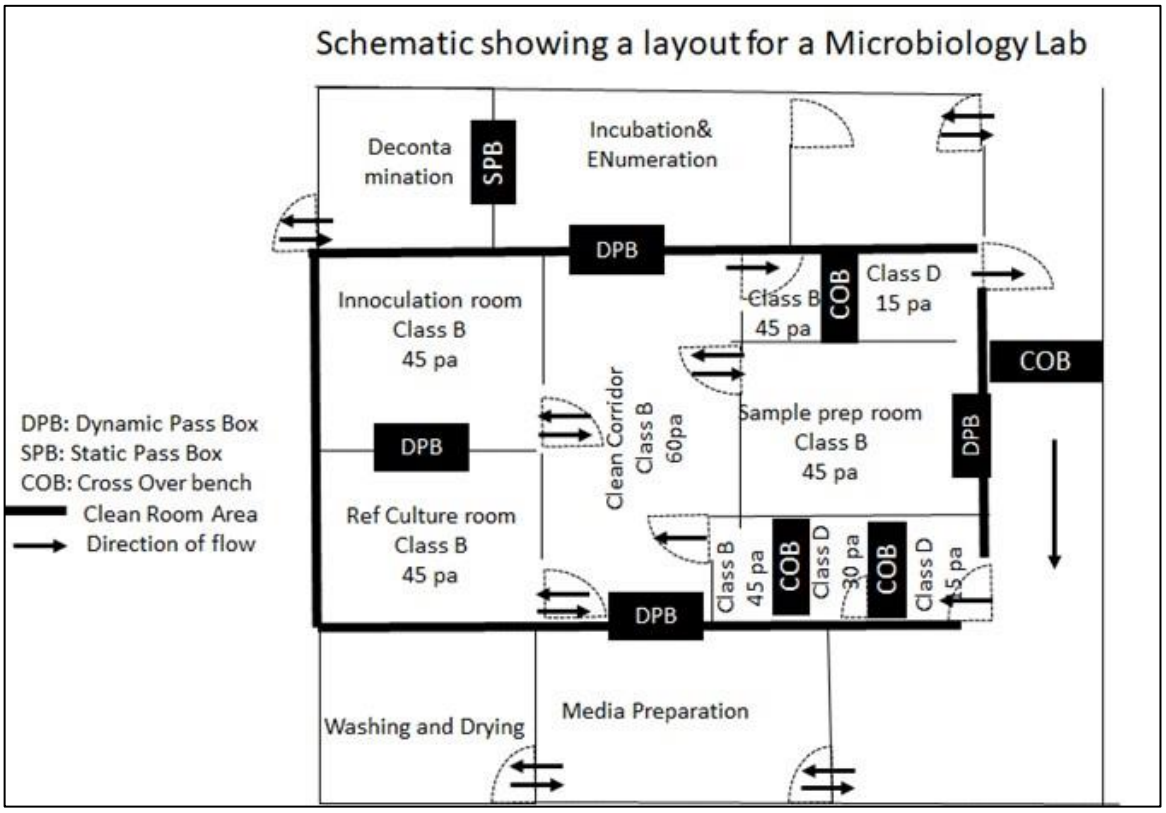


Figure 6 A schematic layout for the Microbiology section of a food laboratory

4.2.2 Microbiology Lab Layout

a) If entry to the laboratory is *via* a lobby, there should be some means of safeguarding the pressure differential between the laboratory and the lobby

b) Operations should be carried out preferably in the following zones

Working zone	Installation grade	Maximum number of cfu in the environment
Sample Receipt	Unclassified	Not Applicable
Media Preparation room	Grade D	<200 cfu/m^2
Sample preparation room	Grade B	<50 cfu/m^2
Inoculation room	Grade B	<50 cfu/m^2
Reference culture room	Grade B	<50 cfu/m^2

Incubation and Enumeration Room	Grade D	<200 cfu/m^2
Decontamination room	Grade D	<200 cfu/m^2

c) A change room should provide lockers to store street clothing, storage shelves for laboratory clothing

d) Floors should be smooth, slip resistant and seamless

e) Coving should be provided on the interface between the walls and the floor

f) There should be a documented cleaning and disinfection programme.

g) There should be a procedure for dealing with spillages.

h) Entry to the clean room should be *via* a system of airlocks and change room where operators are required to wear suitable clean-room garments.

i) The final change room should be of the same grade as the room it serves.

j) Change rooms should be of adequate size for ease of changing.

k) There should be clear demarcation of the different zones.

l) Adequate hand-washing and hand sanitization facilities should be available

m) A wash-hand basin(s) should be located near to the exit of the laboratory.

n) Appropriate waste disposal containers in each section must be provided

4.2.3 Equipment for microbiology laboratory

Dedicated equipment should be available in each of the clean areas. They should not be moved around. Pass boxes must be used to move the sample from one clean area to another. An indicative list of the instruments is provided in Annexure I

4.2.4 Administration or office area

Area	ca 20 sq. m each for General administration, Finance and Stores and Purchase
Facilities	Computers and Printers, Local Area Network Air conditioning unit Scanner Photocopier Paper shredder Fax Phone

Furniture and related items	Work tables, including chairs Filing cabinets Storage facilities for archiving test reports Waste disposal container

4.2.5 Chemical and Supplies: Storage of the chemical and supplies must be easily accessible to the laboratory area. The store is a secure area, hence entry to the stores should be restricted to authorized personnel. Maintenance of proper storage temperatures is required to maintain the integrity of the chemicals. The room should under CCTV surveillance. An indicative list of chemicals, solvents, general equipment and microbiology media required for a Basic Functional Food Testing Laboratory is provided in Annexures II-V.

Area	ca 50 sq m with access control for authorised personnel only Air-conditioned temperature 20± 2 °C, RH of 50-70% Completely vented to remove toxic fumes
Facilities	Computers and Printers, Local Area Network Air conditioning units Scanner Photocopier Paper shredders Fax Phone
Equipment and related items	Frost free refrigerator Upright freezer (-20 to – 25 °C) Storage racks CCTV surveillance
Furniture and related items	Storage possibilities, such as shelves and cupboards for sample material Specialised storage cabinets for acids, bases, flammable solvents, oxidisers etc., Work tables, including chairs Filing cabinets
Safety equipment	Fire extinguisher Gloves Lab coats Safety Glasses and goggles Sink with eyewash Safety shower Spill kits First aid kits

	Emergency phone Segregated waste disposal containers for broken glass, chemical waste, plasticware, paper etc

A waste disposal area must be identified depending on the available area.

4.2.6 Overall Space Utilization Guidelines

The design of a laboratory should conform to the following principles:

a) The laboratory area should include or have access to all the support spaces required, such as instrument and preparation labs, laboratory stores, sample stores, chemical stores, washing area, media preparation rooms, sterilization facilities, waste storage and waste treatment facilities.

b) Administration and office accommodation should not be within the laboratory working area but should ideally be in close proximity to the laboratories they serve.

c) Access to offices or other non-laboratory areas (lounge, seminar hall, restrooms) should not require going through laboratory spaces

d) Documentation area are permitted within the working area of the laboratory; however, these should be separated from areas where hazardous materials are stored or processes are undertaken.

e) Documentation area should not be located right opposite to the fume cupboard or biological safety cabinet, but should be located near the exit.

f) A laboratory area should contain the microbiological, chemical, radiological or physical hazards sections with proper demarcation as far as possible.

g) Sufficient floor space should be provided for refrigerators, freezers, incubators, autoclaves and large centrifuges.

h) Furniture or equipment should not protrude into passage ways and exit routes of a laboratory.

i) Provision for adequate space and facilities for safe handling and storage of chemicals, compressed gas cylinders and other hazardous materials, etc. if they are to be used.

j) Consideration should be given for the provision of a pantry or separate room for consumption of food & beverages to avoid eating & drinking in laboratories.

k) Meeting or seminar areas should be separated from the laboratories.

l) Facilities for storage of street clothing and personal items of analysts should be provided outside the laboratory working areas. Suitable storage space for Personal Protective Equipment should be provided.

4.2.7 Security

a) The building must be planned for security. Restriction of access is of considerable importance to protect the integrity of the official regulatory samples, prevent unauthorized personnel from gaining access and also because of the extremely valuable and sensitive equipment used in the laboratory

b) Fire proof construction for the building must be ensured and such a building should be completely separated from the outside areas.

c) Adequate office space, isolated from the laboratory, but still near the laboratory (within the vicinity). It is prohibited to store and consume food, apply make-up or chew gums or any other edible material in areas where hazardous materials are used/stored.

d) The laboratory shall have means of securing specifically regulated materials, such as legal samples, controlled substances (cyanide, alcohol, radioactive materials etc.)

e) A security system for a typical lab should include some means of access control, often arranged in layers within a building

- A computerized security management system (SMS) like
- Keypad access control systems
- Biometric
- Card reader
- Special door hardware locksets

f) A means of visually monitoring sensitive or secure areas

- Security Guards
- Visitor control
- Video surveillance/Security camera

4.2.8 Laboratory Signages

All labs must be provided with the following globally harmonized signs:

a. A Laboratory Information Card at the entrance door of each laboratory shall be identified and the Emergency exits shall be marked accordingly.

b. Health and Safety information should be posted on the door of each laboratory indicating accurately the hazards that could be there in the laboratory, personal protection required and the emergency contacts.

c. Identifier signs for all safety emergency equipment/devices

d. "Danger" identifier for toxic chemicals

e. "Flammable liquid" identifiers on all cabinets intended for flammable liquids.

f. "Acids" identifier on all cabinets intended for acids.

g. "Bases" or "alkalis" identifiers on all cabinets intended for alkaline liquids.

h. "Oxidizers" identifiers on all cabinets intended for strong oxidizers.

Globally harmonized laboratory signages are listed in Annexure VI

4.2.9 Corridors and aisles

1. Corridor widths and escape routes must be in accordance with the norms prescribed under the Building Codes of India.
2. Corridors and passages to the exits should be clear of all obstructions, such as furniture, instruments etc.
3. The minimum separation between a working bench and equipment placed on the floor (eg autoclave, refrigerator, centrifuge, etc) should be as per the following norms:
4. No worker on either side (90 cms)
5. Workers on one side of the aisle, no through traffic (100 cms)
6. Workers on both sides of the aisle, no through traffic (150 cms)
7. Workers on both sides of the aisle, plus through traffic (180 cms)
8. Heat generating equipment, such as ovens and incubators, should be located away from the corridors, aisles, passage ways and frequently occupied spaces and generally can be kept in a room designated as "Hot Room".

4.2.10 Exits/Doors and Windows

a. The number of emergency exits must be in accordance with the building laws and codes.

b. The laboratory should have an Emergency Evacuation Plan and route for all buildings floors and areas and instructions must be posted in every laboratory section and corridor

c. Two or more well- marked & unobstructed evacuation exits are recommended in a lab

d. Laboratories shall have access doors which swing in the direction of egress (exit travel). Automatic self-closing doors are advisable and should open with minimum effort without the use of a key from inside at all times

e. Exit paths shall not be obstructed by lab furniture or equipment. To prevent blocking egress, lab benches and other furniture should be placed at least 5 feet (1.5m) from the exit door.

f. The main emergency egress from the laboratory shall have a minimum clearance of 3 ft (0.90 m).

g. All exit and emergency doors serving hazardous occupancies shall swing in the direction of egress (exit travel).

h. Each door in a laboratory room must have a view panel. or alternative means of viewing the laboratory activities from outside. Panels should be made of tempered/toughened glass.

i. On the wall/panel next to each door, entry into a laboratory must have a standardized clear frame (Board) with the room number/lab name and any hazard warning signage.

j. Provision for light switches, telephone, thermostat/ Relative humidity meter and fire extinguisher must be made inside the laboratory, adjacent to the door latch.

k. Laboratory doors which open towards egress/access corridors must not be vented

l. If the laboratory has openable windows, they must be fitted with insect screens

m. Special facilities should be provided for the safe access and egress of disabled persons, wherever applicable.

4.2.11 Flooring

a. The floor must be a one piece (seamless construction) impervious to water, resistant to acids, alkalis, solvents and disinfectants, easy to clean, slip- and wear-resistant and be chemical resistant and shall have covings to the wall. The floor area marked as classified in the Microbiological laboratory should be epoxy coated.

b. Tiles and wooden planks are not appropriate because liquids can seep through the small gaps between them.

c. The floor surface shall be coved, where it meets the walls and fixed benches/cabinets to ensure spills cannot penetrate underneath floors/cabinets.

d. Floors in storage areas for corrosive liquids shall be of liquid tight construction.

e. All edges at the walls should be sealed or welded to prevent seepage of spilled

materials.

f. Supported coving should be used to facilitate easier cleaning and prevent contaminants from seeping into floor level service voids behind false walls.

4.2.12 Walls and ceiling

a. Wall surfaces should be free from cracks and unsealed penetration.

b. Walls should be non-porous and painted with a durable, impervious finish to facilitate decontamination and cleaning.

c. Ceiling heights should be sufficient to accommodate the safe installation of fume cupboards and Biological safety cabinets, where applicable.

d. Gypsum board ceilings should be finished with durable and impervious paint.

e. Ceiling-mounted lighting in laboratories where potentially infectious materials are handled should be recessed with a cover/diffuser flush at the ceiling level.

4.2.13 Sinks

a. Each laboratory must contain a sink with proper plumbing for hand washing alone. Hand free operation faucet controls (e.g. elbow-, foot-or sensor-operated) to prevent direct hand contact are recommended especially in Biosafety level 2, and other Microbiology laboratories

b. Hand wash facilities should be provided close to the exit of the laboratory for hand washing immediately before leaving the laboratory.

c. Each laboratory where hazardous materials are used should have a sink for hand washing.

d. Separate hand-washing sinks should be provided for Biosafety level 2 and Microbiology laboratories.

e. Sink faucets and hose bibs that are intended for use with attached hoses must be equipped

with back siphon prevention devices.

f. Laboratory sinks shall have lips that protect sink drains from spills.

g. Stainless steel sinks should be preferred.

h. In the glassware washing room, a sink with a draining board will be more useful. It is preferable to have two-way or three-way laboratory type taps for the sinks.

4.3 Storage

4.3.1 Chemical Storage in the Laboratory/Bulk storage

a. Always read the chemical's label and mark it with the date of receipt before storing.

b. Never store highly reactive chemicals for more than 6 months.

c. Never store a chemical with an obscured or missing label.

d. Open shelves used for storage of chemicals or any other hazardous materials should have edge guards having dimensions (height 12.7 mm to 19 mm) to prevent containers/reagent bottles from falling off the back/front of the shelf

e. The shelves should be no higher than eye level. The shelves should be made of a chemically resistant material.

f. Never store liquids/ hazardous chemicals above the eye level.

g. Designate separate storage areas for highly toxic chemicals**.**

h. 'Flammable liquid storage cabinets' are required for flammable and combustible liquid storage.

i. Acids and bases should be stored separately in 'Corrosion resistant'-storage cabinets

j. Exhausts vents are usually not recommended for these cabinets, because the volatile vapours can escape into the building.

k. Chemicals should never be stored in a fume hood or directly on the floor.

l. Chemical storage rooms should be ventilated by at least 15 air changes per hour and should have dedicated exhaust systems.

m. Chemicals should be stored in plastic or metal containers whenever possible, not in breakable glass containers.

n. All chemicals should be properly labelled, and should be arranged on the shelf in ***chemically compatible families, and not alphabetically***. Chemicals can be stored alphabetically within the groups. A schematic layout for a Chemical storage room is shown in Figure 7

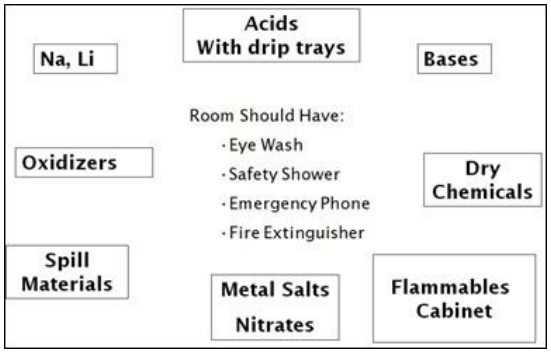


Figure 7 Schematic layout for a chemical storage area layout

4.3.2 Gas cylinder storage and gas lines

a. Empty and full cylinders should be stored in separate cages outside the laboratory on the ground floor

b. It is preferred and recommended to supply piped gas through clearly identifiable metal piping to instrument rooms and other equipment.

c. Compressed gas cylinders if used in the lab must be firmly attached to a secure structure by a non-combustible material, such as a metal chain. Nylon straps are not recommended.

d. Gas cylinders must be transported on purpose-built trolleys within the laboratory

e. Oxygen cylinders, full or empty should not be stored in close proximity to the flammable gases.

4.4 Laboratory and Personnel Safety

4.4.1 Safety Equipment

The availability and use of a number and type of safety equipment is essential and must be present in well-marked, highly visible and easily accessible locations in or near all the laboratory rooms in the facility and must be maintained in working conditions. **All laboratory rooms should be provided with the following Safety and Emergency Equipment**

a. Fume hoods (60–100 ft/minute capture velocity, vented outside) and safety shields with heavy base

b. Hand wash facility

c. Hand-free eye-wash stations (not eye-wash bottles) that conform to ANSI Z358.1– 2004

d. Safety showers that conform to ANSI Z358.1–2004

e. Fire extinguishers (dry chemical and carbon dioxide extinguishers) and Sand buckets

f. Fire blankets

g. Fire detection or alarm system with pull stations

h. Chemical storage cabinets (preferably with an explosion proof ventilation system)

i. Emergency lights

j. Emergency signs and placards

k. First-aid kits

l. Spill control kit (absorbent and neutralizing agents)

m. Large plastic buckets for carrying chemical bottles

n. Ground-fault interrupter electrical outlets

o. Separate Containers for broken glass and sharp materials

p. Material Safety Data Sheets (MSDSs) of all hazardous chemicals

q. Emergency action plan for the laboratory

4.4.2 Safety design in labs

a. In most cases, labs should be organized with the highest hazards (e.g., fume hoods) farthest from the entry door and the least hazardous elements (e.g., write-up stations) closest to the door.
b. Write-up desks and benches should be accessible without having to cross in front of fume hoods.
c. All safety equipment, such as emergency showers, eyewashes, first-aid kits and spill kits should be readily accessible.
d. An emergency centre in a central location on each floor, provides easy access for everyone. This centre should have reagent neutralizers, spill kits, first aid kit, etc
e. There should be at least one ABC fire extinguisher either inside the lab, or in close proximity.
f. Extinguishers should not be covered up or block access.
g. In each lab, there should be an eyewash unit, provided at least 10 seconds away from any analyst.
h. It should supply a multi-stream cross flow of water at 20-25 °C (65°- 75°F)
i. Contaminated eyes should be flushed for 15 minutes
j. Water flow at a rate of 10-20 L (3 to 7 gallons) of water per minute
k. Safety showers should never be more than 100 ft. away from the analyst, along a clear and unobstructed path.
l. Safety showers should be located in the corridor, clearly visible from the lab exits. All safety showers should include an eyewash.
m. Putting a floor drain under the shower is not recommended. To prevent contamination, it is preferable to allow the chemicals at the shower to be mopped up
n. Electrical apparatus, telephones, thermostats, electrical control panels, or power sockets should not be located within 0.5 m of the emergency shower or eyewash or within any area that may be considered as a splash or flood zone.
o. Safety showers should provide low-velocity water at 25-30 °C (70° to 90° F).
p. Manual close valves are recommended for all safety showers. A safety shower should be designed with an automatic cut-off.

4.4.3 Electrical Services and Safety

In a laboratory, a wide variety of electrically-powered equipment including stirrers, shakers, pumps, hot plates, heaters, power supplies, ovens, and others are used. The following are some basic guidelines for electrical services in the laboratories:

a. Electrical outlets should have a grounded connection (with earthing) and accept three-prong plugs. Multiple plug outlet adapters should not be used.
b. General power outlets should be above the bench height. Ceiling-mounted, or floor- mounted receptacles should be provided as needed for laboratories where equipment will be located away from walls to avoid trailing cables on the floors.

c. Electrical socket outlets, outlets for telecommunication appliances and outlets for computer networks should be positioned away from sinks/showers etc.

d. Electrical outlets should also be positioned as far as possible from valves for flammable gas and flammable solvent storage

e. Location of electrical panels and shut-off switches must be easily identifiable for quick disconnection of power in the event of an emergency.

f. Leave at least a 3-foot clearance around electrical panels, circuit boxes, etc for easy and ready access. Maintain an unobstructed access to all electrical panels.

g. Uninterrupted power supply required for equipment must be considered while designing the laboratory power supply system.

h. Emergency lighting and illuminated exit signs are mandatory to facilitate emergency evacuation in the event of power failure.

i. All the circuit breakers and the fuses should be labelled to indicate whether they are in the "on" or "off" position

j. Fuses must be properly rated.

k. Avoid using extension cords

l. Electric cables should not be routed over metal objects, such as emergency showers, overhead pipes or frames, metal racks, etc.

m. Avoid multi-outlet plugs unless they have a built-in circuit breaker.

4.5 Lab Furniture

4.5.1. Work Tables

a. The working surfaces should be hard, non-corrosive and non-adsorbent

b. The surfaces must be compatible with any chemicals likely to be used in the laboratory and must be impervious to water, resistant to acids, alkalis, solvents and disinfectants and easy to clean.

c. Bench tops should be of seamless design. If the bench top is placed against a wall, it shall be coved or have a backsplash against the wall.

d. Work surface front corners may be rounded for ergonomic reasons but rounded work bench with front edges should be avoided to prevent spills following the contours on to the under surfaces.

e. Bench height should depend on the working position of the laboratory users. Typical bench is about 90 cm high for standing work.

f. Typical bench depth is in the range of 60-90 cm (optimum 75 cm) for ease of access to the rear of the bench.

g. Work surface area for each worker must be more than 1.2 m across (recommended to be

at least 1.5 m) and 0.6 m deep, excluding bench space for laboratory equipment (Figure 5a)

h. Deeper worktop may be required for specific and large equipment where access to back of the worktop is not normally required.

i. Sufficient leg/knee clearance should be left under the bench top for persons who use the bench top as a working/write-up area.

j. Personnel working within laboratory areas must be able to work and move unimpeded by each other and by fixed equipment.

k. As a minimum, there must be a 1.5 m passageway between benches, or 1.7 m passageway between back-to-back working benches (Figure 5A).

4.6 Waste Disposal

It is the clear responsibility of the Head/Chief Food Analyst and all analysts of the laboratory to ensure the safe and correct disposal of all the wastes produced during the analysis. Waste must be categorized by its identity, constituents, and hazards so that it may be safely handled and managed. Improper and irresponsible disposal of chemical wastes down drains or into the atmosphere is forbidden. **The Aldrich Handbook** provides a useful summary of the correct disposal procedure for most chemicals. '*Generated knowledge*' can be used for waste characterization, such as the knowledge of waste characteristics and constituents by laboratory personnel who conduct the process, procedure, or experiment. It is essential that all the laboratory personnel accurately and completely identify and clearly label all the chemical and waste containers in their respective sections/laboratories.

4.6.1 Chemical Waste can be in the form of solvents, aqueous solutions, dry powders, and unwanted old chemicals. The following procedure should be implemented for proper disposal of chemical wastes:

I. Chemicals that can be washed down the drains with excess water
   a. Concentrated acid after dilution and dilute acids and alkalis
   b. Harmless soluble inorganic salts (including all drying agents, such as $CaCl_2$, $MgSO_4$, Na_2SO_4, P_2O_5)
   c. Alcohols containing salts (e.g. from destroying sodium)
   d. Hypochlorite solutions from destroying cyanides, phosphines, etc.
   e. Fine (TLC grade) silica and alumina

II. No material on the "Red List" should ever be washed down a drain. This list is as follows:
   a. Substances that do not mix or dissolve readily in water (e.g. fats)
   b. Compounds of the following elements: - antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, tellurium, thallium, tin, titanium, uranium, vanadium and zinc.

c. Halogenated organic solvents/ organochlorine compounds (e.g. chloroform, dichloromethane, epichlorohydrin, carbon tetrachloride).

d. Toxic organic solvents (e.g. methanol, acetonitrile, xylene)

e. Organohalogen, organophosphorus or organonitrogen pesticides, triazine herbicides, any other biocides.

f. Cyanides and azides; Cyanide wastes must be placed in an appropriate waste bottle and the solution kept alkaline at all times.

g. Antibiotics

h. Formaldehyde or paraformaldehyde solutions

i. Phenol, benzene or derivatives of these

j. Mineral oils and hydrocarbons

k. Poisonous organosilicon compounds, metal phosphides and phosphorus element

l. Fluorides and nitrites

III. Solvent Waste collection in individual labelled containers for:

a. Halogenated solvents (methylene chloride, tetrachloroethylene, and chlorinated fluorocarbons)

b. Nonhalogenated solvents (acetonitrile, xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, methanol, and *n*-butyl alcohol).

c. Soluble organic waste including most organic solids

d. Paraffin and mineral oil (from oil baths and pumps)

IV. Each laboratory section should have the following waste bins preferably color coded and labelled. Ensure every bin has a lid. When the laboratory bin is ¾ full, the lid should be placed on the bin and the contents transferred to the larger solid waste bins:

a. ***Controlled waste***: Items in this category includes dirty paper, plastic, rubber and wood, which will be collected by the cleaners daily.
b. ***Glass***: All broken laboratory glassware including disposable test tubes, bottles etc
c. ***Bottles***: Empty reagent bottles to be collected separately. The tops/caps must be removed from all the bottles put out for disposal and there should be no detectable smell of chemicals from any bottle put for disposal.
d. ***Metal sharps***: Any sharp object like can tops, pins, syringe needles, scalpel blades, razor-blades, scalpel blades. Under no circumstances must any item of glass, sharp metal or fine powder ever be put in a normal laboratory waste bin
e. ***Plastic ware***: All disposable plasticware including, Eppendorf vials, syringes, pipette, tips, plastic bottles etc.
f. ***Batteries***: All used batteries
g. ***Waste for special disposal*** collected in labelled individual bottles
    - Mercury

- Cyanide solutions
- the quantity of special waste must be kept to an absolute minimum and stored under suitable conditions.
- Should be disposed as per the regulations of the State Pollution Control Board

4.6.2 Biological Waste (Microbiology Lab)

Each individual laboratory may negotiate a contract with a commercial firm which is licensed by their respective State Pollution Control Board, to remove and transport biological wastes to a designated disposal site for incineration.

For safety reasons, all the disposable petri-plates used for the inoculation and enumeration of the microorganisms, should be autoclaved (steam sterilized) to inactivate the microorganisms. Once autoclaved, the wastes can be safely disposed of.

Do not pour melted agar into sink or floor drains. Allow it to cool and solidify for disposal as a bio waste, which can be placed with non-hazardous waste in the designated waste containers.

4.7 Laboratory Information Management System (LIMS)

It is necessary for any laboratory to have an effective tracking system to track the information about the sample right from the place where it was picked up, its receipt in the laboratory till the report is generated. This software should also provide details about the usage of instruments, calibration and break down record, audit trail etc. Integrating LIMS with INFoLNET will enable the FTLs and FSSAI to have complete information of the product analysis including the instrument details.

5.0 Budget allocations and delegations of powers

For running the lab smoothly and efficiently, minimum budget needs to be allocated for the maintenance of equipment, purchase of routine consumables, attending to minor repairs in the laboratory, meeting contingency expenses, etc. For smooth running of the day-to-day activities of the lab, an imprest amount/permanent advance of Rs 20,000 needs to be allocated to the Directors of the Labs/ Lab-in-charges/ Head of the laboratories, which can be recouped in 15 days/ one month based on the work load and geographic location of the laboratory. The Directors of the Labs/ Lab-in-charges/ Head of the laboratories should be delegated minimum financial powers of Rs.20,00,000/- (Rupees Twenty Lakhs) per annum for regular purchase of glassware / plasticware / chemicals, meeting expenses for breakdown of equipment or meeting contingent expenditures. This will help in efficient functioning of the laboratories and will improve the timely generation of reports as well as the productivity in the analysis of the samples.

It is important for all the food testing laboratories to have a minimum inventory of solid chemical stock, solvents, other reagents and liquid chemicals, glassware and microbiological media to avoid delay in testing of the food products or abandon the tests. The indicative list, but not complete of consumables and glassware with required quantity, wherever applicable can be found at Annexures II-V, while the complete details of the equipment along with specifications, warranty, CMC, outages, etc is presented separately as an attachment.

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Annexure-I

List of Equipment for a Basic Functional Food Analysis Laboratory

(Detailed technical specifications are appended with this document)

I. Equipment for Chemical analysis

1. Abbe's Digital Refractometer
2. Analytical Balance
3. Analytical Balance (Top Pan)
4. Atomic Absorption Spectrophotometer
5. Auto Titrator
6. Automated Fat Analyzer
7. Automated Fibre Analyzer
8. Automated Protein Analyser
9. Automatic Digital Polarimeter
10. Bomb Calorimeter
11. Conductivity and TDS Meter
12. Digital Butyro Refractometer
13. ELISA Reader with Plate Washer
14. Flame Photometer
15. Flash Point Apparatus (Pensky-Martens)
16. FT-IR with ATR & Liquid Cell
17. Gas Chromatograph
18. High Performance Liquid Chromatograph (HPLC)
19. Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
20. Ion Chromatograph
21. Karl Fischer Coulometer/ Titrator
22. Lovibond Tintometer
23. Muffle Furnace
24. pH Meter
25. Soxhlet Fat Extraction System
26. Spectrofluorometer
27. Turbidity Meter
28. UV-Visible Spectrophotometer

29. Viscometer
30. Water Activity Meter

II. Equipment For Microbiology Lab

1. Anaerobic System with Anaerobic jar
2. Automatic Safety Bunsen Burner
3. Binocular Microscope
4. Bio Safety Cabinet Class II Type B2
5. BOD Incubator
6. Digital Colony Counter
7. Fumigator (Fogger)
8. Howard Mold Counter (Proprietary)
9. Incubators (37, 55, And 70 °C)
10. Lab Blender (Paddle Type)
11. Laminar Air Flow (Horizontal)
12. Micro Filtration Unit
13. Serological Water Bath
14. Trinocular Microscope with Digital Display System
15. Vertical Autoclave

III. General Equipment for both Chemical and Microbiology Analysis

i. Automated Solid Phase Extraction System
ii. Bench Top Oil Bath
iii. Bottle-Top Dispenser
iv. Centrifugal Vacuum Concentrator
v. Centrifuge (Refrigerated
vi. Circulating Cum Shaking Water Bath
vii. Deep Freezer (Upright)
viii. Digital Thermohygrometer
ix. Dry Bath Incubator Mixer with Heating and Cooling
x. Electromagnetic Sieve Shaker
xi. Frost Free Refrigerator
xii. Fume Hood
xiii. Glassware Washer/Dryer

xiv. Homogenizer
xv. Hot Air Oven (Forced Air Convection Oven)
xvi. Hot Air Oven (Glassware drying)
xvii. Hot Plate
xviii. Hot Plate Cum Magnetic Stirrer
xix. Laboratory Grinding Mill
xx. Microfuge
xxi. Micropipettes
xxii. Microwave Digestion System
xxiii. Multi Tube Vortexer
xxiv. Nitrogen Evaporator
xxv. Nitrogen Generator
xxvi. Orbital Shaker
xxvii. Rotary Evaporator
xxviii. Solvent Filtration Unit
xxix. Ultra Low Temperature Vertical Deep Freezer
xxx. Ultra-Sonic Bath
xxxi. Vacuum Oven
xxxii. Vortex Mixer (Cyclomixer)
xxxiii. Water Purification System

ANNEXURE-II

List of general chemicals

S.No.	Chemical Name	Quantity
1.	Aluminium ammonium sulphate	500 gms
2.	Aluminium oxide (active neutral)	100 gms
3.	Ammonium acetate	500 gms
4.	Ammonium carbonate	500 gms
5.	Ammonium chloride	500 gms
6.	Ammonium dihydrogen orthophosphate	500 gms
7.	Ammonium ferric sulphate	500 gms
8.	Ammonium ferrous sulphate	500 gms
9.	Ammonium formate	500 gms
10.	Ammonium molybdate	500 gms
11.	Ammonium heptamoldybdate tetrahydrate	500 gms
12.	Ammonium oxalate purified	500 gms
13.	Ammonium purpurate	500 gms
14.	Antimony trichloride	500 gms
15.	Ammonium phosphorate dibasic	500 gms
16.	4-Aminoantipyrine (99%)	100 gms
17.	Auramine standard	1 gms
18.	Antifoam Emulsion	100 gms
19.	Antimony metal powder	100 gms
20.	1-Amino-4-sulphonic acid	500 gms
21.	Barbituric acid	500 gms

22.	Barium chloride	500 gms
23.	Barium hydroxide	500 gms
24.	Benzoic acid	500 gms
25.	Boric acid	500 gms
26.	Bromocresol green	100 gms
27.	Bromate standard	50 gms
28.	Calcium carbonate	500 gms
29.	Calcium chloride	500 gms
30.	Chloroacetic acid	500 gms
31.	Citric acid	500 gms
32.	Cupric acetate monohydrate 99 %	500 gms
33.	Cupric sulphate	500 gms
34.	Calcium carbide	500 gms
35.	Calcium hydroxide	500 gms
36.	Chloramine- trihydrate 99%	50 gms
37.	C18 silica powder 10 um	500 gms
38.	Cis bixin	10 gms
39.	Ciprofloxacin	10 gms
40.	Carboxy methyl cellulose	100 gms
41.	Cobalt sulphate	500 gms
42.	Diphenyl carbazide	500 gms
43.	Di potassium hydrogen phosphate	500 gms
44.	Di sodium hydrogen orthophosphate	500 gms
45.	2,1 Dichloroflurescein	100 gms
46.	4-(1-Methylamino) benzaldehyde	100 gms

47.	4-Dimethylaminobaenzaldehyde for synthesis	100 gms
48.	Disodium tartrate	500 gms
49.	Borax (di-sodium tetraborate)	500 gms
50.	Dioctyl sodium sulphosuccinate	500 gms
51.	Activated charcoal	500 gms
52.	Diastase from *Aspergillus*	100 gms
53.	Dextrose anhydrous	500 gms
54.	Eosin	10 gms
55.	Ethylene diamine tetra acetic acid	500 gms
56.	Fast green FCF	25 gms
57.	Ferric chloride anhydrous	500 gms
58.	Fluoride standard	1 gm
59.	Ferric citrate	500 gms
60.	Gelatin powder	500 gms
61.	Guaiacol	100 gms
62.	Gamma Oryzanol	1 gm
63.	8-Hydroxyquinoline	100 gms
64.	Hydroxynapthol blue	100 gms
65.	Hydrazine sulphate	100 gms
66.	Hexane sulphonic acid sodium	500 gms
67.	Hydroxynaphthol blue	25 gms
68.	Hydroxylamine hydrochloride	100 gms
69.	Iodine	100 gms
70.	Iron (II) sulphate heptahydrate	500 gms
71.	Iron (III) chloride anhydrous	500 gms

72.	Indoxyl acetate	100 gms
73.	L- Tryptophan	500 gms
74.	L(+)-Tartaric acid	500 gms
75.	Lactose	500 gms
76.	Lead (III) acetate trihydrate	500 gms
77.	Lead carbonate 99%	500 gms
78.	Selenium dioxide	500 gms
79.	Magnesium chloride	500 gms
80.	Magnesium sulphate	500 gms
81.	Methyl orange	100 gms
82.	Methyl red	100 gms
83.	Methyl blue	100 gms
84.	Mercuric oxide red	250 gms
85.	Mercury (II) iodide red	250 gms
86.	Metanil yellow	100 gms
87.	Methyl 4 hydroxybenzoate	500 gms
88.	Mercuric sulphate	500 gms
89.	Mercuric chloride	100 gm
90.	Meso erythritol	100 gm
91.	Ninhydrin	100 gms
92.	N-1- Naphthyl ethylene diamine dihydrochloride	250 gms
93.	2-Nitrobenzaldehyde	250 gms
94.	Neotame	100 gms
95.	N, N, Dimethyl-1,4 phenylenediamine	5 gms
96.	N-1-Naphthyl ethylene diamine	25 gms

97.	N, N diethyl p-phenylenediamine	50 gms
98.	Orange-G stain	100 gms
99.	Oxalic acid	500 gms
100.	Oxytetracycline hydrochloride	100 gms
101.	Phenolphthalein	100 gms
102.	Phloroglucinol	100 gms
103.	Picric acid	100 gms
104.	Potassium bromide (99.5%)	500 gms
105.	Potassium chromate	500 gms
106.	Potassium dihydrogen orthophosphate	500 gms
107.	Potassium ferrocyanide 98.5%	500 gms
108.	Potassium hydroxide pellets	500 gms
109.	Potassium iodate	500 gms
110.	Potassium oxalate	500 gms
111.	Potassium permanganate	500 gms
112.	Potassium sodium tartrate	500 gms
113.	Potassium ferrocyanide	500 gms
114.	Potassium sulphate	500 gms
115.	p- Rosalic acid	500 gms
116.	p-Toluidine pure	500 gms
117.	Potassium chloride	500 gms
118.	Phenol (hydroxy benzene)	500 gms
119.	Potassium thiocyanate	500 gms
120.	Potassium lactate solution	500 ml
121.	Phenol crystals	500 gms

122.	Phosphorus pentoxide	500 gms
123.	Pyrrolidine	500 gms
124.	Potassium dihydro orthophosphate	500 gms
125.	Potassium persulphate	500 gms
126.	Rhodamine B for microscopy	100 gms
127.	Silica gel (60-120) mesh	2 x 500 gms
128.	Sodium acetate	500 gms
129.	Sodium carbonate	500 gms
130.	Sodium chloride	500 gms
131.	Sodium hydrogen carbonate	500 gms
132.	Sodium hydroxide pellets	2 x 500 gms
133.	Sodium molybdate dihydrate 99%	500 gms
134.	Sodium nitrite	500 gms
135.	Sodium phosphate monobasic dihydrate	500 gms
136.	Sodium sulphite	500 gms
137.	Sodium sulphite anhydrous	500 gms
138.	Sodium thiosulphate	500 gms
139.	Solochrome black	100 gms
140.	Sodium arsenite 98%	500 gms
141.	Sorbic acid	100 gms
142.	Stannous chloride	500 gms
143.	Starch soluble	500 gms
144.	Sudan Dye lll	100 gms
145.	Sulphanilamide 99%	500 gms
146.	Sulphur powder	500 gms

147.	Silver nitrate	100 gms
148.	Silica gel pore size (60A 70-230 mesh)	5 x 500 gms
149.	Silica gel (Coarse)	5 x 500 gms
150.	Silica gel	5 x 500 gms
151.	Sodium lauryl sulphate	500 gms
152.	Sodium thiosulfate pentahydrate	500 gms
153.	Sulphanilic acid	500 gms
154.	Sodium tungstate dinydrate 98%	100 gms
155.	Sodium diethydithio carbamate trihydrate	100 gms
156.	Starch from rice	500 gms
157.	Starch from corn	500 gms
158.	Sodium propionate 99.0%	100 gms
159.	Sodium perchlorate	100 gms
160.	Sodium hydroxide pellets	500 gms
161.	Sodium metasilicate	100 gms
162.	Tetrabutylammonium hydrogen sulphate	100 gms
163.	Trisodium citrate	250 gms
164.	Trisodium phosphate	250 gms
165.	Tannic acid	250 gms
166.	Tartaric acid	500 gms
167.	Toluene	2 x500 gms
168.	Urea	500 gms
169.	Uric acid	250 gms
170.	Zinc acetate	500 gms

171.	Zinc metal	500 gms
172.	Zinc oxide	500 gms
173.	Zinc heptahydrate sulphate	500 gms

Annexure III

List of Solvents, acids and other chemicals

S.no.	Name of the solvent	Quantity
1.	Acetone	5 x 500 ml
2.	Aniline	1 x 500 ml
3.	Acetic acid	2 x 500 ml
4.	Amyl alcohol	2 x 500 ml
5.	Acetonitrile	5 x 500 ml
6.	Benzene (crystalizable)	3 x500 ml
7.	Bromine water	3 x 100 ml
8.	Butan-1-ol	3 x 500 ml
9.	Boron trifluoride methanol complex	3 x 100 ml
10.	Bromine for analysis	1 x 100 ml
11.	Carbon disulfide	3 x 500 ml
12.	Chloroform	3 x 500 ml
13.	Carbon tetrachloride	5 x 500 ml
14.	Castor oil	1 x 500 ml
15.	Chloral hydrate	1 x 100 ml
16.	Dichloromethane	2 x 500 ml
17.	Dimethyl ether	5 x 500 ml
18.	Diethylene glycol	1 x 500 ml
19.	Dimethyl sulphoxide	1 x 500 ml
20.	Dibromopropane	1 x 500 ml
21.	Ethanol (absolute)	10 x 500 ml

22.	Ethyl acetate	3 x 500 ml
23.	Furfuraldehyde	1 x 500 ml
24.	Formaldehyde solution	3 x 500 ml
25.	Formic acid (85%)	1 x 500 ml
26.	Furfural	1 x 500 ml
27.	Glycerol	3 x 500 ml
28.	Hexane	5 x 500 ml
29.	Hydrofluoric acid	5 x 1 litre
30.	Hydrogen peroxide	500 ml
31.	Hydrochloric acid	5 x 1 litre
32.	HPLC grade water	10 x 500 ml
33.	Hydrogen peroxide (30%)	500 ml
34.	Isobutanol	5 x 500 ml
35.	Liquid ammonia	3 x 500 ml
36.	Methanol	5 x 500 ml
37.	Methyl -tert -butyl ether	1 x 500 ml
38.	n-Butanol	5 x 500 ml
39.	n- Heptane	5 x 500 ml
40.	Nitric acid 65%	5 x 500 ml
41.	Nitric acid (Conc)	2 x 500 ml
42.	Orthophosphoric acid	2 x 500 ml
43.	Olive oil	1 x 500 ml
44.	Petroleum ether (40-60°)	10 x 25 litre
45.	Petroleum Ether (60-80°)	10 x 25 litre
46.	Propan 2-ol	5 x 500 ml
47.	Pafaffin	2 x 500 ml

48.	Pyridine	2 x 500 ml
49.	Sulphuric acid	5 x 2.5 litre
50.	Silicone oil	1 x 500 ml
51.	Silicone	1 x 500 ml
52.	Sesame oil	1 x 500 ml
53.	Trifluoracetic acid	1 x 500 ml
54.	Toluene	5 x 1 litre
55.	Triethylamine	1 x 500 ml
56.	Tetrachloroethylene	1 x 500 ml
57.	Wij's solution	10 x 100 ml
58.	Xylene	5 x 500 ml

Note: The chemicals may be selected from the list as per the testing scope of the Lab and as per the procedure for analysis mentioned in the FSSAI Manual. Food Testing Laboratories may enter into Rate Contract with the reputed manufacturers/ suppliers of glassware, chemicals, consummables, etc or adopt the rate contracts done by any Central Government /State Government Academic and /or Research Organisation for procurement of chemicals, reagents, other consumables from their Authorized distributors.

The Laboratories are advised to buy the grades of purity as recommended in the FSSAI Manuals of analysis or as prescribed in the method adopted.

Laboratory reagents are classified on the basis of purity and intended use. Choice of the right grade of reagent by the analyst is essential for the application in hand and it is also important to use reagents from same source for high precision of results.

1. ***ACS Reagent grade***- means that it conforms to specifications defined by the Committee on Analytical Reagents of the American Chemical Society. Such grades are useful for high quality work.
2. ***ANALAR***-Such reagents used mainly for analytical applications, research and quality control.
3. ***AR (ANALYTICAL REAGENT)*** grade –essential for high precision analytical purpose and research work having high purity. Trace impurities are restricted to lowest possible limits for high precision. The certificate of guarantee gives the minimum assay and maximum limits of trace impurities. If such reagent meets the ACS specifications it will be denoted as AR (ACS).
4. ***CP (CHEMICALLY PURE)***: Chemicals being used for regular practical having its original purity.
5. ***Extra pure grade –*** suitable for laboratory accreditations and also work requiring compliance with pharmacopoeia standard requirements.

6. ***General reagent (GR)*** – reagent that meets or exceed AR grade specifications

7. ***Guaranteed Reagent (GR)*** — Suitable for use in analytical chemistry, products meet or exceed American Chemical Society (ACS) requirements.

8. ***Lab Grade***: A chemical grade of relatively high quality with exact levels of impurities unknown; usually pure enough for general applications. Not pure enough to be offered for food, drug, or medicinal use of any kind.

9. ***LR: (LABORATORY REAGENTS):*** This grade consists of Pure, Extra Pure, Purified organic and inorganic chemicals having reliable accuracy in Routine Laboratory Analysis.

10. ***N.F. Grade***: A grade of sufficient purity to meet or exceed requirements of the National Formulary (NF).

11. ***P.A***. (Proanalysis) These reagents comply to maximum tests of ACS grades,

12. PURISS

13. ***Reagent Grade***: High purity generally equal to A.C.S. grade and suitable for use in many laboratory-and analytical applications.

14. ***Synthesis grade*** – for organic synthesis and preparative tasks having many potential applications in laboratories

15. ***Technical grade*** – suitable for non-critical tasks such as rinsing, dissolving, etc.

16. ***U.S.P. Grade***: A chemical grade of sufficient purity to meet or exceed requirements of the U.S. Pharmacopeia (USP); acceptable for food, drug, or medicinal use; may be used for most laboratory purposes.

Classification based on applications

1. ***Microscopy (M.S.) Grade***: Highly purified reagent for use in biochemical research and analysis. They are free from inhibitors, such as traces of heavy metals and tested with a view for biochemical work.

2. ***HPLC Grade***: Solvents meet strict UV absorbance specifications and are filtered for removal of sub-micron suspended solid with low acidity and alkalinity, and low evaporation residue levels.

3. ***HPLC-Gradient grade***: HPLC Gradient solvents offer the same high quality as HPLC solvents, but with added testing for suitability in HPLC with gradient analysis and spectrophotometry. These solvents enable one to minimize the gradient effect of the solvent involved

4. ***LC-MS grade****:* This grade of solvent is especially optimized and tested for LC-MS suitability in that they have low level of ionic background and low ion suppression to meet all the requirements of LC-MS ionization methods (ESI/ APCI – positive and negative mode) and ensure high reproducibility and high ionization efficiency

5. ***Deuterated solvents*** (Spectroscopy Grade): Nuclear magnetic resonance spectroscopy is the most commonly used technique in the structural analysis of compounds obtained by organic synthesis. It normally requires the sample to be dissolved in a solvent whose hydrogen atoms have been replaced with deuterium atoms of differing isotopic purities. The most usual is 99.8% but we also have purities of up to 99.98%.

6. ***Residue grade solvents***: Solvents suitable for pesticide residue analysis, which have GC impurities below ppt/ppb levels as tested by the ECD.

7. ***Nano grade*** –meet ACS grade specifications used for extraction and pre-concentration applications

Annexure-IV

List of glassware, general apparatus and miscellaneous accessories

1. Beakers (Different capacities)
2. Bell Jar
3. Blue litmus paper
4. Burettes
5. Crucibles
6. Conical flasks with stoppers
7. Desiccators/vacuum desiccators
8. Digestion Flasks (300 ml)
9. Erlenmeyer Flasks
10. Filter paper circles and sheets of different grades
11. Funnels
12. Glass Pipettes
13. Glass beads
14. Gooch crucibles
15. Kjeldhal Distillation flasks
16. Litmus Paper
17. Measuring cylinders
18. Pipette bulbs
19. Pumice fine powder
20. Litmus papers
21. Separating Funnels
22. Sieves
23. Silica dishes
24. SO_2 Distillation set
25. Soxhlet Extraction Unit
26. Test tubes all sizes (stoppered and un stoppered
27. Thimbles 20/80
28. TLC Chamber rectangular
29. (250 x 250 x 120 mm)
30. Tripod Stand
31. Volumetric flasks
32. Vacuum grease
33. Wash bottles (glass and plastic)
34. Wire gauze
35. Microbiology Laboratory:

a. Test tubes
b. Petri Dishes
c. Durham’s tubes
d. Dilution and media storage bottles
e. Spreaders.
f. Slides and cover slips.

g. Disinfectant jars
h. Inoculation loops
i. Non – adsorbent cotton wool

Annexure V

Indicative list of media used in microbiology analysis

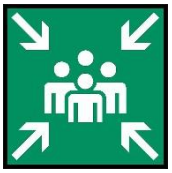
Sl. No	Name of media
1.	Acetate Agar
2.	Andrade peptone water
3.	Asparagine-Proline Broth
4.	Baird Parker Agar
5.	Bile Esculin Azide Agar
6.	Bile salts agar
7.	Bismuth Sulphite Agar
8.	Blood agar
9.	Brain Heart Infusion Broth
10.	Brilliant green agar
11.	Brilliant Green Lactose Bile Broth
12.	Bromocresol Purple Carbohydrate Broth
13.	Buffered Peptone Water
14.	Butterfield's Buffered Phosphate Diluent
15.	Carbohydrate Utilization Broth
16.	Cetrimide agar
17.	Chloramphenicol Yeast Glucose Agar
18.	Cooked Meat Salt Medium
19.	Czapek Yeast (Autolysate) CYA agar

20.	Decarboxylase Test Medium (Lysine, Ornithine, Arginine provide separately)
21.	Deoxycholate Citrate Agar Medium
22.	Dextrose Tryptone Agar
23.	EC Broth
24.	Egg Yolk Tellurite Supplement
25.	Frazer Broth
26.	Gelatin agar
27.	Gelatin Phosphate Salt Broth
28.	Glucose Salt Teepol Broth
29.	Gram Negative Broth (GN)
30.	Half Frazer Broth
31.	Hektoen Enteric Agar
32.	Hugh Leifson Medium
33.	Kauffman Mueller's Tetrathionate Broth Base
34.	Kligler Iron Agar
35.	Koser's Citrate Broth
36.	Lactobacillus MRS Agar
37.	Lactose Broth
38.	Lactose Gelatine Medium
39.	Lauryl Tryptose Broth
40.	Levine Eosin-Methylene Blue Agar (L- EMB Agar)
41.	Liver Broth

42.	Lysine decarboxylase broth
43.	Lysine Iron Agar
44.	Malonate Broth
45.	Malt Agar
46.	Mannitol Yolk Polymyxin (MYP) Agar
47.	McConkey broth/agar
48.	Methyl Red Voges Proskauer (MR-VP) (Glucose Phosphate Broth
49.	Milk agar with cetrimide
50.	Modified Oxford Agar
51.	Motility Test Medium
52.	MY-40 Agar
53.	Nitrate Broth
54.	Nutrient Agar
55.	Nutrient Broth
56.	Palcam Agar
57.	Peptone
58.	Peptone Water Diluent
59.	Phenol Red Carbohydrate Broth
60.	Phosphate Buffered peptone water
61.	Plate Count Agar
62.	Potato Dextrose Agar
63.	*Pseudomonas* Presumptive Test Broth

64.	*Pseudomonas* confirmation medium (Skim Milk Agar)
65.	Rappaport Vassiliadis Soya Broth
66.	Selenite Cystine Broth
67.	Selenite F broth
68.	Sheep Blood Agar
69.	Simmons Citrate agar
70.	Slanetz and Bartley Medium
71.	Sulphite Agar
72.	T1 N1 Agar
73.	Tergitol-7 Agar Base
74.	Tetrathionate Broth
75.	Thioglycollate Agar
76.	Thiosulfate-Citrate-Bile Salts-Sucrose Agar (TCBS)
77.	Triple Sugar Iron Agar
78.	Trypticase Soy Broth
79.	Tryptone Broth
80.	Tryptone Glucose Extract Agar
81.	Tryptone soya agar
82.	Tryptose-Sulfite Cycloserine (TSC) Agar
83.	Urea Broth
84.	Violet Red Bile Agar
85.	Xylose Lysine Deoxycholate Agar (XLD)

Annexure VI:
Lab Signage Definitions and Symbols.

Personal Protection: Mandatory requirement				
 Protective clothing	 Hearing protection	 Eye protection	 Hand protection	 Hand wash
 Respiratory protection	 Foot Protection	 Eye and face protection		
Safety Equipment				
		 First aid	 Emergency assembly location or Assembly point	 Emergency exit

 Fire extinguisher	 Fire Blanket	 Fire hose		 Recycling symbol

Prohibition signages				
 Prohibition symbol	 No admittance to unauthorized personnel	 No smoking	 No open toed shoes	 No food or drink allowed
 No open flames	 No dumping chemical in sink.	 Non-potable water not for drinking	 Do not touch	 No pacemaker /metallic implants
 Do not eat or drink	 Do not enter			
Physical Hazards/Danger				
 Unstable explosives	 **Flammable**	 **Oxidizing**	 **Compressed Gas**	 **Corrosive & health hazard**

 Systemic Health Hazard	 Toxic Acute toxicity	 Harmful	 Environmental Hazard	 Radiation Symbol
Warning signages				
 Biological hazard	 Laser hazard	 Radioactive/ ionizing radiation	 High voltage	 Hot surface/high temperature
 Extreme cold temperature	 Non-ionizing radiation	 Strong Magnetic Field	 Optical Radiation	 Chemical Weapon