Laboratory Management & Ethics

H.S.C. (VOCATIONAL)

MEDICAL LABORATORY TECHNICIAN

STD: XI (PAPER-2)

LABORATORY MANAGEMENT AND ETHICS

THEORY

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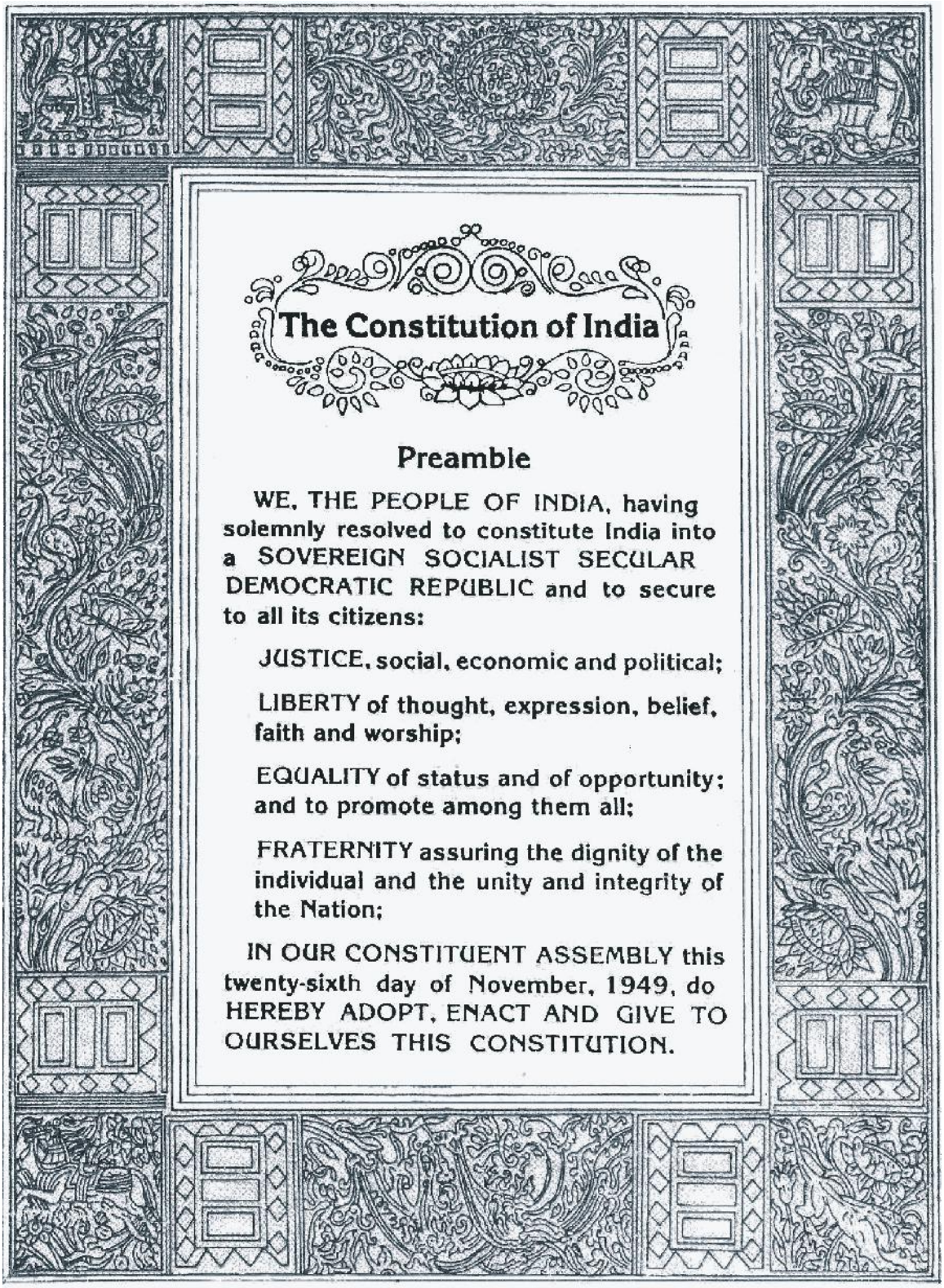


The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all;

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

****

NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā
Punjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga
Vindhya-Himāchala-Yamunā-Gangā
Uchchala-jaladhi-taranga
Tava subha nāmē jāgē, tava subha āsisa māgē,
Gāhē tava jaya-gāthā,
Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,
Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya jaya hē.

****

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

PREFACE

The national policy of education (1986) envisages that the introduction of systematic, well planned and rigorously implemented programme of vocational education is crucial in the proposed educational reorganization. In accordance with the policy of Govt. of India, State govt. of Maharashtra introduces +2 Vocationlization of Education in 1988-89. During last 25 years no substantial efforts has been taken to revamp the curriculum.

Ministry of Human Resource Development, Govt. of India developed the National Skill Qualification Framework (NSQF) to introduce vocational courses according to series of levels of knowledge & skills. Qualifications are made up of vocational standards for specific areas of learning units or units of competency. Units of competency are the specification of the knowledge and skill to the standard of performance expected in the workplace. The unit of competency or National Occupation Standards comprising generic and technical competencies an employee should possess is laid down by the Sector Skill Council of the respective economic or social sector.

The challenges before us were to make smooth transition of curriculum from knowledge based to skill based and rapid technological changes in all sectors of economy. Hence, the few obsolete courses were either merge with core courses or deleted. Hence, in first phase 30 courses were converted into 20 courses. In second phase 20 more courses can be added sector wise as per National Occupational Standards.

I acknowledge the hard team work done by District Vocational Education & Training Officer, who were the coordinators for curriculum designing, theory & practical books writing, along with the vocational teachers of various vocational field & experts from the industry. Shri.S.M.Haste, Joint Director & Shri.A.G.Gavit, Dy.Director has taken the sincere efforts from Directorate to produce the best text material with limited resources & time.

J. D. Bhutange,
Director (Vocational Education)
Directorate of Vocational
Education and Training, Mumbai,
Maharashtra State

INDEX

LESSON 1

HUMAN HEALTH & DISEASES

Objectives.– *At the end of the lesson the students will be able understand the meaning of the term Health, the various dimensions of health, the causative agents and the modes of transmission of diseases and ways to diagnose a disease.*

HEALTH

1.1 Definition of Health.—

Definition of Health given by WHO is as follows – Health is a state of complete physical, mental and social well-being and not merely an absence of disease or infirmity. In recent years, this statement has been amplified to include the ability to lead a "Socially and economically productive life."

1.2 Dimensions of Health.—

Health is a multidimensional. The WHO definition includes smainly three specific dimensions, the physical, mental and the social, many more may be included namely economical, spiritual, emotional, vocational, etc. These dimensions of health function and interact with one another

Figure 1.1 Dimensions of Health

(a) **Physical Dimension.—** This implies the state of perfect functioning of the body. It means every cell and organ of the body is functioning at optimum capacity and in perfect harmony with the rest of the body. The signs of physical health in an individuals are A good complexion, Bright eyes, A clean skin, Lustrous hairs with body well clothed with firm flesh, Not too fat, Sweet breath, Good appetite, Sound sleep, Regular activities of bowels and bladder, Smooth and easily co-ordinated movements. All the special senses are intact, The resting pulse rate, blood pressure and exercise tolerance are within normal range.

(b) **Mental Dimension.—** Mental Dimension of health is not only absence of mental illness but it is a state of balance between the individual and the surrounding world, a state of harmony between oneself and others, a co-existence between the realities of the self and that of other people and that of the environment.

Following are the characters of mentally healthy person

(1) A mentally healthy person is free from internal conflicts

(2) He is well adjusted or get along well with others

(3) He accepts criticism and is not easily upset

(4) He searches for own identity

(5) He knows himself that is his needs, problems and goals

(6) He has good self-control-balances rationality and emotionality

(7) He can cope easily with stress and anxiety.

(c) **Social Dimension.—** Social wellbeing implies harmony and integration within the individual, between each individual and other members of society. It is interpersonal ties and the extent of involvement with community. These dimensions include the levels of social skills one possesses, social functioning and the ability to see oneself as a member of a large society.

1.3 DISEASE

The term disease literally means without ease (un easiness).

Definition.— The Oxford English Dictionary defines disease as a condition of the body or some part of the organ of the body in which its functions are disrupted or deranged.

1.4 Classification of Diseases

Diseases can be classified according to certain characteristics of the disease or injuries or its aetiology, its agent or morbid condition.

There are many ways of classification but following two are important :

1. Communicable and Non communicable Disease
2. International classification of Disease

1. Communicable and Non communicable Disease.—

Communicable Disease.—

An Illness due to a specific infectious agent or its toxic products capable of being directly or indirectly transmitted from man to man, animal to animal or from the environment (through air, dust, soil, water, food, etc.) Example: Tuberculosis, AIDS, Malaria, Chicken Pox,etc.

Non communicable Disease.—

Those diseases which do not transfer from source of infection to person or susceptible host but they develop in the individual due to some other causes like genetic, nutritional, metabolic, hormonal, etc. Example: Diabetes, Anaemia, Hypertension, Cancer, etc.

2. International Classification of Diseases.—

The International Classification of Disease tenth revision (ICD-(10) is a system of coding created by the World Health Organization that notes various medical records including diseases, symptoms, abnormal findings and external causes of injury.

Chapters of ICD – 10

- Chapters I to XVII: Diseases and other morbid conditions.
- Chapter XVIII: Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified.
- Chapter XIX: Injuries, poisoning and certain other consequences of external causes.
- Chapter XX: External causes of morbidity and mortality,
- Chapter XXI: Factors influencing health status and contact with health services.

Chapter I	Infectious and parasitic diseases
Chapter II	Neoplasms
Chapter III	Diseases of the blood and blood forming organs and certain disorders affecting the immune mechanism
Chapter IV	Endocrine, nutritional and metabolic diseases
Chapter V	Mental and behavioural disorders
Chapter VI	Diseases of the nervous system
Chapter VII	Diseases of the eye and adnexa
Chapter VIII	Diseases of the ear and mastoid process
Chapter IX	Diseases of the circulatory system
Chapter X	Diseases of the respiratory system
Chapter XI	Diseases of the digestive system
Chapter XII	Diseases of skin and subcutaneous tissue
Chapter XIII	Diseases of musculoskeletal system and connective tissue
Chapter XIV	Diseases of the genitourinary system
Chapter XV	Pregnancy, childbirth and the puerperium
Chapter XVI	Certain conditions originating in the perinatal period
Chapter XVII	Congenital malformations, deformations and chromosomal abnormalities
Chapter XVIII	Symptoms, signs and abnormal clinical and laboratory findings
Chapter XIX	Injuries, poisoning and certain other consequences of external causes
Chapter XX	External causes of morbidity and mortality
Chapter XXI	Factors affecting health status and contact with health services of a person not currently sick

Figure 1.2-International Classifications of Diseases.

1.5 Concept of Causation of disease.—

Various concepts of disease causation were in vogue. e.g. supernatural theory, theory of spontaneous generation, etc. Discoveries in microbiology by Louis Pasteur (1822-1895) marked a turning point in aetiological concept.

Germ theory of disease.— This concept emphasizes one to one relationship between causal agent and disease e. g. Disease agent —Man—Disease

Epidemiological triad.— There are other factors relating to the host and environment which are equally important to determine whether or not disease will occur in the exposed host. This made the basic factors of agent, host and environment which are referred to as epidemiological triad.

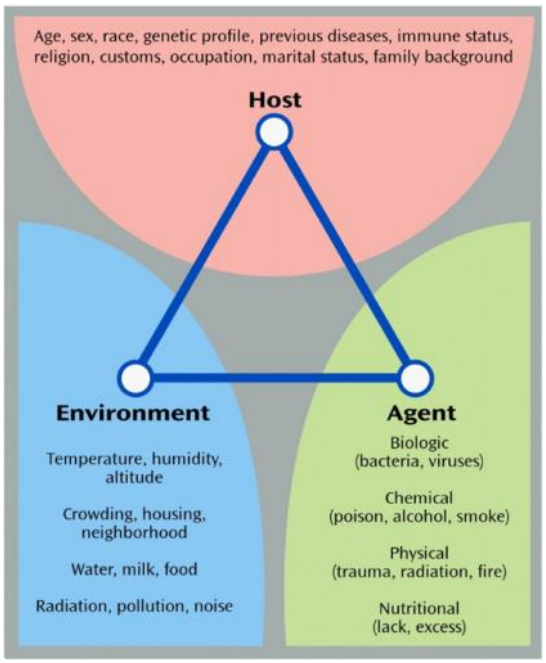


Figure 1.3-Triad

Multifactorial Causation.— As a result of advances in public health, chemotherapy, antibiotics and other aetiological factors like social, economic, cultural, genetic & psychological, this multifactorial causation theory of disease developed. According to this the disease is not caused by a single factor but by multiple factors. e.g. infectious agent, socio-economical factors,etc.

1.6 Modes of disease transmission.—

Communicable diseases are transmitted from the source of infection to a susceptible individual in different ways depending upon the infectious agent, portal of entry and local ecological conditions.

Modes of Transmission of disease

Direct Transmission	Indirect Transmission
1. Direct Contact	1. Vehicle borne
2. Droplet Infection	2. Vector borne
3. Contact with soil	3. Air borne
4. Inoculation into skin or mucosa	4. Fomite borne
5. Transplacental (Vertical)	5. Unclean Hands and Fingers.

(A) Direct Transmission.—

I. Direct Contact – Infection may be transmitted by direct contact from skin to skin, mucosa to mucosa or skin e.g. by touching, kissing, sexual intercourse. Diseases transmitted are STD, AIDS, Skin & Eye infection, etc.

II. Droplet Infection – This is direct projection of a spray of droplets of saliva & naso-pharyngeal secretions during sneezing, coughing, spitting, etc. The expelled droplets directly fall on the skin, conjunctiva of a susceptible host in close proximity. Diseases transmitted are common cold, whooping cough, TB, etc.

III. Contact with soil – The disease agent may be acquired by direct exposure of susceptible tissue to the disease agent in soil, compost, etc. Diseases transmitted are tetanus, mycosis, hookworm infestation, etc.

IV. Inoculation into skin or mucosa - The disease agent may be inoculated directly into the skin or mucosa.Diseases transmitted are Rabies by dog bite, hepatitis B & other viruses through contaminated needles.

V. Transplacental Transmission – Disease agent transmitted through placenta from mother to foetus.Diseases transmitted are Toxoplasma, Rubella Virus, Cytomegalo Virus, AIDS, Hepatitis B, Herpes, etc.

(B) Indirect Transmission.—

An essential requirement for indirect transmission of disease is that the infectious agent must be capable of surviving outside the human host in the external environment and retain its basic properties of pathogenesis and virulence.

(i) Vehicle Borne – Transmission of the infectious agent through the agency of water, food, ice, blood, etc. Diseases transmitted are hepatitis A, Acute diarrheas, typhoid fever, polio, etc.

(ii) Vector Borne – Vector is defined as an arthropod or any living carrier which transmit disease. Diseases transmitted are malaria, plague, encephalitis, Dengue, etc.

(iii) Air Borne – Droplet Nuclei and Dust.

- Droplet nuclei - are type of particles implicated in the spread of air borne infections. These are tiny particles which contains infectious agent. Diseases transmitted are TB, influenza, chicken pox, measles, etc.
- Dust – Some of the larger droplets which are expelled during talking, coughing or sneezing settle down by their weight on the floor, carpet, furniture,etc. in the immediate environment & become part of dust. Infectious agents present in this dust particle transmit diseases. Diseases transmitted are streptococcal infection, TB, etc.

(iv) Fomite Borne – Fomite include soiled clothes, towels, cups, spoons, pencils,etc& infectious agent present on this fomite will transmit disease. Diseases transmitted are diphtheria, typhoid fever, eye & skin infections,etc.

(v) Unclean hand and fingers – Hands are the most common medium by which pathogenic agents are transferred to food from the mouth, nose, bowels, etc. Diseases transmitted are streptococcal infection, typhoid fever, etc.

1.7 Disease Agents

(a) Definition.— Disease agent is defined as a substance living or non-living or a force tangible or intangible, the excess presence or relative lack which may result in disease.

(b) Types of disease agent.—

I. Biological agents – These are the living agents of diseases. e.g. viruses, bacteria, fungi, parasites etc. These agents exhibit certain host related biological properties such as Infectivity, Pathogenicity and Virulence.

e.g. Bacteria – TB, dysentery, etc.

Virus – AIDS, Polio, Hepatitis, etc.

Fungus – Tinea infection.

Parasite – Malaria, Amoebiasis.

II. Nutritional Agents - These are nutrients like protein, fat, carbohydrate, vitamins, and water. Any excess or deficiency of these factors may result in disease process e.g. Anaemia, Goiter, Obesity, etc.

III. Chemical agents – These agents are divided into two groups

(1) Endogenous chemicals - increased level results in disease like uraemia, jaundice, ketonemia, etc.

(2) Exogenous chemicals - agents enters the body from outside e.g. dust, allergens, fumes, etc.

IV. Physical agents – Exposure to excessive heat, cold, pressure, sound, electricity, etc.

V. Mechanical agents – The mechanical forces or friction resulting in sprain, dislocations, fractures.

VI. Social agents – These are poverty, smoking, abuse of drugs and alcohol, social isolation, etc.

1.8 Diagnosis of Diseases

Procedure of diagnosis of disease involves multiple steps including examination by doctor, lab investigations and other investigations and overall assessment of patient.

A physician (Doctor) must be able to assess the state of health of the individual. This assessment would include a clinical diagnosis which is mainly based on signs and symptoms and making of inferences from them. Next step includes asking for relevant lab investigations and other investigations like X-ray, sonography, etc. Therefore the procedure of diagnosis includes.—

(a) History taking regarding clinical illness by physician.

(b) Physical examination by physician for provisional diagnosis.

(c) Laboratory investigation – To confirm or to find out the diagnosis of disease. Physician may ask for variety of test in the lab including hematological, pathological, biochemical, cytological, histopathological, etc.

(d) Other investigations like X-ray, Ultrasonography, CT scanning, MRI can also be asked to find out disease.

These are the variety of useful procedures in the diagnosis, prevention & treatment of disease or assessment of medical condition.

Review Questions:

(1) Define health.

(2) What are the different dimensions of health?

(3) Define disease. Classify diseases.

(4) Give international classification of diseases.

(5) What are different modes of disease transmission?

(6) What is disease agent? Which are the different types of disease agents?

(7) What is the procedure of diagnosis of disease?

(8) Give the meaning of following words-

(a) Infection

(b) Contamination

(c) Infestation

(9) What are the characters of mentally healthy person?

(10) What are the signs of physically healthy person?

(11) What is the concept of causation of disease?

LESSON 2

Health Delivery System In India

(HEALTH CARE SYSTEM IN INDIA)

Objective.– *At the end of this lesson students should able to state about –*

(*a*) *Concept of health delivery system or health care system in India.*

(*b*) *Different sectors of health delivery system.*

(*c*) *Primary health center and sub centers.*

(*d*) *Voluntary health agencies.*

(*e*) *National health program.*

(*f*) *Different levels of laboratory in India and their services.*

(*g*) *Goals* of Pathology laboratory.

2.1 Health delivery system or Health care system in India-

Health delivery system in India is to give promotive, preventive and curative services to the people, to keep the people of country healthy.

2.2. Sectors of Health delivery system -

Health delivery system is divided into 5 major agencies or sectors. These 5 sectors are.—

1. Public Sector

(a) Primary health care.

- Primary health centers (PHC)
- Sub centers

(b) Hospitals/Health centers.

- Community health centers
- Rural hospitals
- District hospital/health center
- Specialist hospitals
- Teaching hospitals

(c) Health Insurances schemes.

- Employees State Insurance Scheme (ESIS)
- Central Govt. Health Scheme (CGHS)

(d) Other agencies.

- Defence services
- Railway Hospital

2. Private Sector

(a) Private Hospitals, polyclinics, Nursing homes and Dispensaries.

(b) General practitioners and clinics.

3. Indigenous system of Medicine

Ayurveda, Siddi, Unani and Tibbi, Homeopathy

4. Voluntary Health Agencies.

5. National Health Programmes

2.2.1. Primary health Centre (PHC)

2.1 PHC

PHC is basic health unit to give promotive, preventive and curative health care services to the rural population of the country. PHC helps in preventing diseases of the rural population of the country and also giving treatment to them. This will help to keep the rural people healthy. PHCs are situated in villages.

In India there is one PHC for every 30,000 rural population in the plains and every 20,000 populations in hilly and backward areas.

Staff of PHC:

1. Medical Officers
2. Block extension educator
3. Health Assistant – male as well as female
4. Supporting staff like Compounder, Technician, driver, etc.

Functions of PHC:

(1) Medical care.

(2) Safe water supply and sanitation services.

(3) Prevention and control of epidemic and common diseases.

(4) MCH (Maternal & Child Health) including family planning.

(5) Collection of vital statistics like birth rate, death rate, family planning cases, etc.

(6) Health education.

(7) Running national health program like National immunization program

(8) Referral services.

(9) Training of health workers, health guides, local dais and health assistants.

(10) Basic pathology lab services.

2.2.2. Primary health sub Centre.—

This is present at village level. This is the smallest health center of primary health care system.

These sub centers are not managed by doctors but by health assistants (Male & Female). These people are from their village. These health assistants are called as health guides, health workers and dais.

Requirement for becoming health assistant is 10th standard education. These people have given training at sub center or PHC. Training period is 200 hours, in three months. They are trained in simple medicine application. Their work is supervised by health assistant at PHC. Because of this sub-center, basic health problems of villagers are solved.

2.3. Voluntary Health Agencies.—

The voluntary health agencies occupy an important place in community health programmes. It is defined as an organization that is administered by autonomous board which holds meetings, collects funds in directing programmes to increase health by providing.—

(1) Health services.

(2) Health education.

(3) Health research.

(4) Making the laws for health.

Following are the names of voluntary health organization in India—

(1) Indian Red Cross Society.

(2) Hind Kusht Niwaran Sangh.

(3) Tuberculosis Association of India.

(4) The Kasturba Memorial Fund.

(5) Family Planning Association of India.

(6) Bharat Sevak Samaj.

(7) All India Blind Relief Society.

(8) All India Women's Conference.

(9) International Agencies.

(1) Indian Red Cross Society

Red Cross Society is established in 1920. Red Cross Society works for promotion of health & Prevention of diseases. Its activities are –

(a) Blood bank & first aid – R.C.S. run the blood banks. They also give first aid facilities.

(b) Relief work - Natural disasters like earthquake, floods, and droughts or epidemic occurs in any part of the country. R.C.S. immediately takes all its resources to the affected people and does its work for rescue of affected people.

(c) Armed forces – To give the service to sick and wounded among the armed forces people. This is the main duty of R.C.S.

(d) Maternal and child welfare services - RCS gives milk powder, medicines and vitamins to the mother and child. It also gives funds to the centers which work for mother and child welfare. Many family planning programs are run with the help of R.C.S.

(e) Milk and medical supplies – Number of hospitals, dispensaries, schools and orphanages receives assistance from Red Cross society every year, in the form of milk powder, medicines and vitamins.

(f) Family Planning - Many family planning clinics are running with the help of R.C.S.

(2) Hind Kusht Niwaran Sangh

It was founded in 1950 and has Headquarters in New Delhi. It has branches all over India.Its functions are.—

(a) Financial assistance to leprosy clinics.

(b) Education about leprosy through publication of magazines, posters.

(c) Training of medical workers.

(d) Conducting research.

(e) Hold the conferences.

(f) Organizing conferences.

(g) Work for rehabilitation of patients recovered from illness.

(3) Tuberculosis Association of India

It was formed in 1939 and has branches in all the states in India.

The Associations' activities are.—

(a) Financial assistance to TB clinics.

(b) Training of doctors, health workers and social worker in anti TB work.

(c) Publications of journals.

(d) Hold the conferences.

(4) The Kasturba Memorial Fund

It was created in commemoration of Kasturba Gandhi after her death in 1944. The fund was raised with the main object of improving the lot of women, especially in the villages, through gram-sevikas.

(5) Family Planning Association of India

It was formed in 1949 and has HQ in Mumbai. It has done pioneering work in propagating family planning in India. It has trained several hundred doctors, health visitors and social workers.

(5) International Agencies

Various international agencies like–

1. WHO (World Health Organization),
2. UNICEF (United Nations international Children's Emergency Fund)
3. World Bank.
4. The Rockefeller foundation.
5. Ford foundation.
6. CARE – Co-operative for American Relief Everywhere
7. USAID (United States Aid for Integrated Development)

2.4. National Health Programmes

Several National health programmes have been started by the Government of India to improve the health of the people of the India. The main aims of these programmes are.—

(a) To control communicable diseases.

(b) To eradicate communicable diseases.

(c) Improvement of environmental sanitation.

(d) To control the population.

(e) To improve the nutritional status.

Following are the different National Health programmes.—

(1) National Malaria Eradication Programme.

(2) National Leprosy Eradication Programme.

(3) National Guinea Worm Eradication Programme.

(4) National Filaria Control Programme.

(5) National Diabetes Control Programme.

(6) National AIDS Control Programme.

(7) National Tuberculosis Control Programme.

(8) Diarrhoeal Diseases Control Programme.

(9) STD Control Programme.

(10) National Immunization Programme.

(11) National Family Welfare Programme.

(12) National programme of Nutrition.

(13) National Water Supply & Sanitation Programme.

(14) Twenty Point Programme.

(15) Minimum Needs Programme.

(16) Iodine Deficiency Disorder Programme.

2.4.(a.) National Malaria Eradication Programme

In the year 1950 malaria was India's number one health problem. National Malaria Control Programme was started in 1953 by national government to control malaria. This gave very good results decreasing the cases from 75 million to 2 million. Encouraged by these results it was upgraded to National malaria eradication programme. In this programme following anti – malarial activities are done.

(1) Collection of blood smears & examination of them for malarial parasite.

(2) Giving medicine to the positive cases.

(3) Insecticide (DDT) spraying.

(4) Guppy fish distribution. (These fish eats the larva stage of mosquito and so, there will be no mosquito and no spread of disease.)

(5) Research work on malaria.

2.4.(b.) National Tuberculosis Control Programme

Tuberculosis is commonest disease of India. The main aim of this program is to reduce the incidence of TB to that level when it ceases to be a public health problem. For this, work is done for prevention of disease, its diagnosis and treatment.

Following work is done in national tuberculosis control programme.—

(1) Detection of maximum number of cases of TB from OPD

(2) Giving them adequate treatment.

(3) Giving vaccine to all newborn (BCG)

(4) Giving training to the health workers and doctors.

(5) Research works.

(6) 'DOT' (Directly observed treatment) service has come in recent years. Central government & state government work with 50-50 contribution for medicines. These medicines are supplied to the all TB clinics run by state government.

2.4.(c.) National AIDS Control Programme

With the spread of AIDS from one country to another country, it became necessary to start national AIDS control programme. The government of India started this programme in 1985. An AIDS Centre was established in Directorate general of health services in New Delhi.

AIDS control program is under supervision of Directorate General of Health Services. In national AIDS control program following work is done :

(1) Identification of maximum number of cases. For this, high risk areas are screened for presence of HIV in the people of that area.

(2) Giving HIV positive patients specific guidance for their management.

(3) Keeping follow up of these cases.

(4) Making guidelines / rules for blood bank, blood donors & dialysis units. (i.e. blood purification).

(5) Giving education to the citizens through posters & other mass media like newspaper, Radio, TV, etc.

(6) Research work about AIDS.

(7) Counselling of patient and keeping their follow up.

2.4. (d). Twenty point programme

This is a special program to promote social & economic growth. Eight of the 20 points are related to health directly or indirectly. These eight points are –

(1) Providing clean drinking water.

(2) Two child norm.

(3) Expansion of education of people.

(4) Housing for the people.

(5) Improvement of slums.

(6) Protection of environment.

(7) Attack on rural poverty.

(8) Health for all.

2.4. (e). National Immunization programme

Government started this program in 1978. Aim of this program is to reduce the incidence of common preventable childhood diseases.

Immunization include vaccine against following diseases.—

(1) Diphtheria

(2) Pertussis

(3) Tetanus

(4) Poliomyelitis

(5) Tuberculosis

(6) Measles

(7) Typhoid

(8) Mumps

(9) Rubella

(10) Hepatitis A

(11) Hepatitis B

National Immunization Program Schedule.—

National Immunization Schedule for Infants, Children and Pregnant Women				
Vaccine	**When to give**	**Dose**	**Route**	**Site**
For Pregnant Women				
TT-1	Early in pregnancy	0.5 ml	Intra-muscular	Upper Arm
TT-2	4 weeks after TT-1*	0.5 ml	Intra-muscular	Upper Arm
TT- Booster	If received 2 TT doses in a pregnancy within last 3 yrs*	0.5 ml	Intra-muscular	Upper Arm
For Infants				
BCG	At birth or as early as possible till one year of age	0.1ml (0.05ml till 1mth age)	Intra-dermal	Left Upper Arm
Hepatitis B	At birth or as early as possible within 24 hours	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
OPV-0	At birth or as early as possible within the first 15 days	2 drops	Oral	Oral
OPV 1,2 & 3	At 6 weeks, 10 weeks & 14 weeks	2 drops	Oral	Oral
DPT 1,2 & 3	At 6 weeks 10 weeks & 14 weeks	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
Hep B 1, 2 & 3	At 6 weeks 10 weeks & 14 weeks	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
Measles	9 completed months-12 months.	0.5 ml	Sub-cutaneous	Right upper Arm
Vitamin-A (1stdose)	At 9 months with measles	1 ml (1 lakh IU)	Oral	Oral
For Children				
DPT booster	16-24 months	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
Measles 2nd dose	16-24 months	0.5 ml	Sub-cutaneous	Right upper Arm
OPV Booster	16-24 months	2 drops	Oral	Oral
Japanese Encephalitis**	16-24 months	0.5 ml	Sub-cutaneous	Left Upper Arm
Vitamin-A***				
(2nd to 9th dose)	16 months. Then, one dose every 6 months up to the age of 5 years.	2ml (2 lakh IU)	Oral	Oral
DPT Booster	5-6 years	0.5 ml.	Intra-muscular	Upper Arm
TT	10 years & 16 years	0.5 ml	Intra-muscular	Upper Arm

Table 2.1 : National Immunization Schedule

NOTE :

1. Interval between two doses should not be less than 1 month.
2. Minor cough, fever is not contraindication to vaccination.
3. Expanded program of immunization was started by WHO. The word 'expanded' means covering each area of country.
4. Immunization services are given through same health delivery system like PHC, Sub centers, hospitals etc. There is no separate staff for immunization.

Review Questions :

1. What is Health Delivery System of India?
2. Describe the different sectors of health delivery system.
3. Write a short note on Primary Health centre.
4. Enlist any six Voluntary Health Organizations.
5. Enlist any six National Control Programmes.
6. Describe the National Immunization Schedule.

LESSON 3

LABORATORY SERVICES IN INDIA

Objectives.–*To make students aware of the functions and staffing pattern of laboratory at different levels in India. They should know the role of pathological laboratory at various levels of health care system.*

The lab plays an important role in improving the quality, efficiency, cost effectiveness, planning and management of health care.

A laboratory service network in India consist of -

1. Laboratory at Taluka level- PHC Laboratory.
2. Laboratory at District Level- District Hospital Laboratory.
3. Laboratory at Regional Level- Regional Hospital Laboratory.
4. Laboratory at Central Level- Central And Public Health Laboratory.

3.1 Laboratory at Taluka Level– PHC Laboratory

The work of the Taluka Level Lab is to support PHC in investigating, controlling & preventing major diseases in the community.

Staff- It is usually be staffed by a junior lab Technician or trained laboratory worker.

Other Staff- Depending on the work load (1-2 helpers)

Functions—

- To investigate by referral or testing on site important diseases and health problems affecting the local community e.g. TB, Leprosy, Cholera, Dysentery, Malaria, Anaemia, etc.
- To collect and refer specimens for testing to the district lab including, water, etc.
- To notify the district hospital at an early stage of any lab result of public health importance and send specimens for confirmation test
- To screen pregnant women for anaemia, proteinuria and malaria.
- To promote health care and assist in community health education.
- To keep careful records which can be used by health authorities in health planning.
- To assist district and regional epidemiologists and sanitary officers.
- To request from the district lab on a regular basis for the supplies of reagents, standards, etc.
- To send a simple information monthly report to the district labs.

3.2 Laboratory at District Level- District Hospital Laboratory

Staff– A district lab is usually staffed by at least one lab technician and depending on work load by two to four assistants and several aids. Staff also includes a lab tutor to train PHC Lab workers.

Functions–

(1) To Perform a range of tests relevant to the medical, surgical and public health activities of the district Hospital.

(2) To Support the work of the PHC Lab by—

- Testing referral specimens.
- Providing reagents, controls, other essential lab support.
- Training PHC Lab Workers.
- Visiting each PHC Laboratory to inspect lab.

(3) To refer specimens to the regional lab that cannot be tested in the district laboratory.

(4) To notify the regional lab of any result of public health importance and to send specimen for confirmation test.

(5) To participate in the external quality assurance programme organized by the regional lab.

(6) To Prepare a report every 3 months to send to the regional lab of the work and need of all the lab in the District.

3.3 Regional Hospital Laboratory

Staff– One Coordinating (Chief) laboratory officer, an experienced specialist, trained technician and two or three technicians in each department, labs tutor, a safety officer, a stores officer, clerical staff and several aids according to the work load.

Functions:

(1) To perform a range of test as required by the medical and health needs of the regional Hospital.

(2) To operate a regional blood transfusion center.

(3) To prepare reagents, controls, clinical chemistry standards and specimen containers.

(4) To investigate epidemics and perform tests of public health importance in the region.

(5) To support the work of the district hospital labs in the region by

- Testing referred specimens.
- Providing reagents, standards stationary, etc.
- Visiting each district Hospital lab every 3 months to inspect and quality control check, install and demonstrate new equipment and discuss system measures.
- Training lab technicians.

(6) To send specimens that require specialist investigation to the central and public health laboratory.

(7) To participate in the external quality assessment programme organized by the central laboratory.

(8) To prepare a report every 6 months to send to the central and public health lab of the work and need of all the labs in the region.

3.4 Central and Public Health laboratories

Staff- A director (M.D. Pathologist), a senior coordinating officer, several senior technologists and technicians, a senior safety officer, lab tutor, a finance officer, a stores officer, clerical staff and several aids according to the size and workload of the lab.

Functions:-

(1) To formulate a professional code of conduct for medical lab personnel.

(2) To perform a range of specialist tests.

(3) To carry out appropriate research into important national health problems

(4) To organize a national blood transfusion service.

(5) To evaluate new technologies, standards, techniques and test the appropriateness of new equipment.

(6) To purchase and supplies equipment for the national lab service.

(7) To prepare control sera, blood grouping antisera, culture media,etc.

(8) To communicate and collaborate International organizations in promoting lab standards.

(9) To train specialist technicians and to organize lab teaching seminars.

(10) To prepare lab request forms, record sheets, stationary, etc.

(11) To prepare and distribute an annual report on the activities of the country lab services, to co-ordinate the work of the lab service and to prepare budget for presentation to health authorities.

(12) To support the work of the regional hospital lab by

- Providing control, reagents, chemicals, etc.
- Visiting each regional lab every six months.
- Co-coordinating an external quality assessment programmes, etc.

Review Questions:-

(1) Give the levels of laboratory services In India.

(2) What are the Functions of Laboratory at PHC level?

(3) What are the Functions of Laboratory at District level?

(4) What are the Functions of Laboratory at Regional level?

(5) What are the Functions of Laboratory at Central and Public level?

(6) Give the staffing Pattern of Central Lab.

Visits:-

(1) Arrange visits to observe activities of primary health centre and its Laboratory.

(2) Arrange Visits to observe activities of lab at District, Rural or Civil Hospital level.

(3) Arrange visits to observe activities of lab in any major hospital in the major city like Mumbai, Delhi, etc.

Lesson 4

Ethics

***Objective**: To make the students morally and professionally good laboratory technicians. To make them understand the Dos and Don'ts while working in a laboratory and how to maintain relations with coworkers, patients, medical and paramedical persons and to teach them communication skills.*

4.1 Definition of Ethics

Like other jobs, medical technologist and technicians job has its standards of performance based on moral obligations towards our fellow human beings. Such rules of conduct, both personal and professional are called ethics.

The most important consideration of professional ethics is honesty and the data provided by the technicians should be reliable.

The professional attitude is self-imposed and also self-rewarding. Some of the professional qualities include:

1. Dedication of high standard of performance.
2. A feeling of personal responsibility, the awareness that others depend on his performance.
3. A drive to continuously improve and update personal skills and knowledge.
4. Pride and satisfaction in his work.
5. Commitment towards the profession.

4.2 Professional Code of Conduct for a Laboratory Technician

It should include those practices and attitudes, which characterize a professional and responsible laboratory officer. It also emphasizes the professional status of medical laboratory practice.

Code of professional conduct:

1. Be dedicated to the use of clinical laboratory science to benefit mankind.
2. Place the well-being and service of patients above your own interests.
3. Be accountable for the quality and integrity of clinical laboratory services.
4. Exercise professional judgment, skill and care while meeting established standards.
5. Do not misuse your professional skills or knowledge for professional gain and never take anything from your place of work that does not belong to you.
6. Be at all times courteous, patient and considerate to patients and their relatives. Safeguard the dignity and privacy of patients.
7. Do not disclose to a patient or any unauthorized person the results of your investigations and treat with strict confidentiality any personal information that you may learn about a patient.
8. Respect and work in harmony with the other members of your hospital staff or health center team.
9. Promote health care and the prevention and control of disease.
10. Follow safe working practices and ensure patients and others are not put at risk. Know what to do when an accident or fire occur and how to apply emergency first aid.

4.3 Dos and Don'ts for the Laboratory Technician

Do's

1. Give first importance to the service and wellbeing of the patient.
2. Be punctual always.
3. Keep yourself & the lab hygienically clean and pleasant.
4. Work scientifically with complete honesty.
5. Observe laboratory rules and practices.
6. Ensure accuracy in tests.(Follow quality control)
7. Keep any information about the patient confidential.
8. Respect and work in harmony with other worker.
9. Protect yourself by wearing apron, gloves while working, immunized yourself, follow safety rules and learn first aid.
10. Keep the lab, neat and tidy, use equipment & lab ware correctly.
11. Be at all times courteous, patient and considerate while working in the lab.
12. Strive to improve professional skills and knowledge.
13. Fulfill reliably and completely the terms and conditions of your employment.
14. Inform your seniors when any problem arises while working.

Don'ts

1. Do not misuse your professional knowledge and skill for your personal gain.
2. Do not take anything from work place that does not belong to you.
3. Do not drink alcohol or smoke in laboratory.
4. Do not pipette concentrated acids, alkalis, infected & poisonous liquid by mouth.
5. Do not waste reagents, chemicals and other materials.
6. Do not handle or keep inflammable material near flame or burner.
7. Do not disclose patient's report or any other information to patient or any other unauthorized person.

4.4 Definition, Qualification & Subject Knowledge of Medical Lab Technician.

Medical laboratory technicians are bench workers who receive 1 to 2 years of certificated training after higher secondary school.

Medical laboratory technologists on the other hand, have Bachelor of Science (B.Sc.) degree and receive 1 to 2 years of undergraduate training at a university level.

These technicians and technologist requires a basic understanding of the anatomy and physiology of the body under healthy and disease conditions, specimen collected and process for lab diagnosis of the pathologic state, mastery in performing various diagnostic test, calculation of results, adoption of quality control measures for the reliability of lab findings and appropriate method of communicating the results to the physician.

4.5 Maintaining relations with other staff of the lab and patients.

A. Maintaining relations with Doctors & senior staff.

- Always work under supervision of doctor & other senior staff.
- Always respect Doctors & Senior staff.
- Follow the order given by them regarding lab investigations.
- Strive to improve your professional skills with the help of Doctor's guideance.
- In case of any difficulty or misunderstanding always consult senior staff or doctors while working in the lab.
- Fulfill reliably & completely the terms and conditions of your employment.

B. Maintaining relations with Co-workers.

- Respect and work in harmony with other workers of the lab.
- Be co-operative.
- Give helping hand in any problematic situation.
- Always try to learn good things from your co-workers.
- Be cheerful and smiling and have pleasant appearance.

C. Maintaining relations with patient and the relatives.

- Give importance to the wellbeing and service of patients above your own interest.
- Be at all times courteous, patient and considerate to patient and their relatives.
- Safeguard the dignity and privacy of the patient.
- Do not disclose to a patient or any unauthorized person the result of your investigations and treat with strict confidentiality any information that you may learn about a patient.
- Always give helping hand to the patient when they are in need while working in the laboratory.
- Respect the patient and their relatives.
- Always have a pleasant, friendly, professional manner and a neat, clean appearance.

4.6 Communication skills - Written, Spoken and Actions

Importance of communicating effectively:

Laboratory staff must be able to communicate well if a lab service is to function smoothly & reliably & inspire user confidence.

In communicating it is important to consider -

(1) Nature of the information being communicated.

(2) Person or persons to whom the information is being communicated.

(3) Whether the communicated information has been understood & responded to appropriately.

(4) Selecting most effective way of communicating the information.

Ways of Communication.

By definition, communication is the accurate passing on or sharing of information. There are three main ways of communication–

(a) by writing

(b) by speaking

(c) by actions

(a) Written Communication

To be effective, written communication needs to be

- Presented legibly & neatly.
- Expressed clearly & simply.

(b) Spoken Communication

Important aspect of Spoken (verbal) communication include

- Clarity of speech & language used
- Tone of voice
- Ability to speak informatively

(c) Action communication

Communication through a culturally acceptable bodily manner and actions (body language) is particularly important when relating to patients.

A pleasant, friendly, professional manner and a neat, clean appearance inspire confidence, whereas an impatient, aggressive manner or an untidy appearance can make patients nervous and afraid.

When unable to speak the language of a patient facial expressions & actions become extremely important in reassuring a patient.

Review Questions:

1. What is Ethics?
2. What is the professional code of conduct for medical lab personnel?
3. What are the Do's & Don'ts for the laboratory technician?
4. Who is a medical lab Technician and what are his requirements?
5. How a lab technician should maintain relations with doctors and senior staff member of the lab?
6. How a lab technician should maintain a relation with Co-Workers in the lab?
7. How lab technician should maintain relations with patient and their relatives?
8. What is communication? What are the important points to be considered while communicating?
9. What are the ways of communication? Describe them.

Activities

Prepare a chart of professional code of Conduct and display it in your lab.

LESSON 5

Planning a Basic Health Laboratory

***Objective**: - At the end of the lesson the student will know the basic principles for setting up a laboratory and the requirements for starting a laboratory.*

5.1 Definition of laboratory and its legal aspect

Definition:

A medical laboratory or clinical laboratory is a laboratory where various tests are done on clinical specimens in order to get information about the health of a patient as pertaining to the diagnosis, treatment, and prevention of disease or assessment of medical conditions.

Without reliable laboratory support—

1. Patients are less likely to receive the best possible medical care.
2. Resistance to essential drugs will continue to spread.
3. The source of disease may not be identified correctly.
4. Epidemics and the spread of major communicable disease will not be checked reliably.
5. Valuable financial and human resources may be diverted to ineffective control measures.

Every laboratory should maintain its higher standard of services in health care. To achieve this every laboratory should develop and enforce a professional code of conduct, train appropriately its workers and provide opportunities for continuing education and provide and maintain reliable diagnostic services.

Legal Aspect of a laboratory:

Clinical laboratory provide essential services to the medical practitioners by providing vital information which is essential for determination of the nature, cause, extent and the course of the condition involved.

Unreliable and inaccurate reports may cause unnecessary anxiety, suffering, financial burden due to prolonged treatment and repeated investigations and may even contribute directly to death.

Therefore proper licensing and regulations of such a laboratory and its personnel is necessary from medical council and local Govt. authority for the protection of public and individual health and also to protect the safety and welfare of the people from hazards of improper performance by clinical laboratories and to meet certain minimum standards and other necessary safeguard.

The personnel in the laboratory who are legally bound include–

The lab directors, Supervisor, Technologist and Technician (who are mainly responsible for a clinical work performed in the laboratory). But it would exclude trainees or persons performing clerical and other administrative work.

Note:

(a) All the technical staff should be qualified and registered with a medical officer or director who is M.D. (pathology) should be in attendance.

(b) Laboratory should be licensed or registered with local govt. authority and its renewal should be done as per schedule.

(c) Have appropriate lab facilities for the tests performed in the lab with safety.

(d) Follow standard operating procedures with adequate quality assurance and lab staff should strictly follow the professional code of conduct.

(e) The lab technician should update their knowledge and skills.

(f) Display fees and make these known to patient before performing investigations and keep accurate account of income and expenditures.

(g) Lab Technician should not prescribe drugs & advice to patient.

5.2 General Principles of laboratory.

General considerations – For a good quality and safe laboratory practice the clinical lab must have adequate facilities, standard equipment and supplies and adequate number of qualified staff.

The successful design of functional clinical laboratory either new or renovated requires the close co-operation of several groups of professionals. First the labs directors and labs staff should involve with the process of setting up a lab an outside designer, architect and contractor may be utilized.

General principles for setting up a laboratory

(a) **Site / Location.–** It is important that the location or site of the lab be studied in relationship to hospitals, clinics, polyclinics dispensary services, to traffic (avoid market or very crowded are(a) to other supporting services and to users. It should be easily accessible by the patient.

(b) **Space.–** The laboratory should have adequate space to avoid accidents and breakages and to keep the lab clean floor should be structurally sound, well-constructed and non-slip.

(c) **Design.–** Before designing a lab the safety of the working environment must take in to consideration sectioning of the laboratory into separate rooms or working areas where specimen receiving, data processing, reporting, working, storing can be done without disturbances.

(d) **Water.–** Lab should have reliable water supply either by municipal supply or by reservoir or tank fitted overhead in the lab.

(e) **Ventilation.–** The lab should be airy and well ventilated to avoid cross infection of the patient. (Avoid too much breeze where bacteriological investigation is performe(d) Ventilation should be supplied by wall vents and windows that can be opened.

(f) **Light.–** For microscopic work diffuse sunlight is better than the direct rays of the sun. When light is provided by electricity bulb then use low energy tube light.

(g) **Working Benches.–** Benches of suitable height with smooth, chemical resistant and easily cleanable surface. Wooden benches are preferable with smooth surface.

(h) **Safety cabinets.–** Safety cabinets should be planned properly for storage of chemical and other expensive material and cupboards are also arranged as per requirement.

(i) **Electricity.–** Safe electricity supply with sufficient wall electric points to avoid the use of adaptors and extension leads.

(j) **Mechanical services**: - Proper planning of mechanical services like temperature control, air handling, noise control, etc. is essential for any lab for comfortable working environment.

(k) **Fire extinguishers.–** Sited at accessible points.

(l) **Gas supply.–** Where required gas supply is piped into the lab with the gas cylinders stored in an outside weatherproof locked store.

(m) **Communication.–** For effective communication within and outside lab and physician lab should have intercom system, telephone or fax machine.

(n) **Safety measures.–** Lab director should become thoroughly familiar with safety regulations and should display safety charts & instructions regarding safety keep first aid box and know how to give first aid if accident occurs.

(o) **Other lab support Function.–**

(i) Store Rooms.– Sufficient storage should be available within each lab to handle several days supply.

(ii) Glassware washing.– Glassware washing and appropriate sterilization facilities should be included in the lab designs.

(iii) Staff facilities.– Waiting rooms, lockers, library and toilets are essential for the comfort and moral of the employees where they can have good drinking water & refreshment.

(iv) Proper waste disposal and drainage system.

(p) **Equipment.—** Variety of equipment, chemicals and lab supplies are also required. (The detail list given in Chapter 6).

5.3 Various Sections or Working Components of a Laboratory.

For proper functioning without disturbances and confusion, the lab can be divided or separated into different sections and these sections can be done as per convenience of the lab staff or as per techniques or test performed, so different sections of the labs are:

(1) **Blood Collection or phlebotomy Section**.– Blood is collected by venipuncture & skin puncture method and this section is provided with bulbs, sterilized/ Disposable syringes, needles, lancet, cotton wool, spirit, labels, etc.

(2) **Specimen Collection**.– Various pathological specimens like urine, stool, sputum, swabs are collected and properly labeled. Safety precautions are taken while collecting blood & other specimens.

(3) **Hematology Section**.– Mainly blood is tested for routine investigations like CBC, ESR, etc.

(4) **Serology Section**.– Study of serum is known as serology. Serum contains variety of antibodies of various diseases and tests performed on that are RA, Widal test, VDRL, HIV, ASO, etc.

(5) **Immuno-Haematology**.– Antigens and Antibodies of blood are studied in these sections. e.g. blood grouping & cross matching

(6) **Biochemistry**.– Blood plasma is studied in this section for variety of tests manually or on auto analyzer & tests performed are FBS, PLBS, Sr. Bilirubin, cholesterol, urea, creatinine, etc.

(7) **Clinical Pathology**.– In this section processing of pathological specimens like urine, stool, sputum, swabs and other body fluids are performed.

(8) **Microbiology**.– Infectious micro-organisms are mainly studied in this section either by stained sample or culture medias. Antibiotic sensitivity test is also done. Parasitology is the part of microbiology where varieties of intestinal parasites (worms) are also studied.

(9) **Histology**.– This is the microscopic examination of tissue which is removed either by biopsy or autopsy to find out the disease or cause of death. Tissue processing is done before examination.

(10) **Cytology**.– Examinations of Exfoliated or scraped cells from the surface of the body is done for early detection of Cancer.

(11) **Reception**.–This section or area of a laboratory where patients are received and registered.

(12) **Waiting room**.– Where patient remain seated comfortably.

5.4 Different laboratories in major Hospital.

Above mentioned sections of the laboratory can function individually as a major laboratory in the Hospital. e. g. Haematology laboratory, Serology laboratory,Biochemistry laboratory,Blood Bank, Histology & Cytology laboratory,Clinical Pathology laboratory , Microbiology laboratory, etc.

5.5 Staffing pattern of the laboratory.

Depending upon the size and work load of the laboratory staffing pattern is decided. In a small laboratory only senior technician under supervision of M.D.(pathology) doctor with laboratory attendant can perform all the tests. But in major Hospital requires variety of lab. Staff as follows.

1. **Lab. Director** – M.D.Pathologist who is overall in charge of the lab and responsible for laboratory work.
2. **Senior Coordinating Officer** or administrator who co-ordinate the work of the lab.
3. **Senior Technologist** – They are in many numbers and have B.Sc., D.M.L.T. graduation.
4. **Lab. Technicians** – They are several in numbers and have junior level graduation at HSC level- MLT or CMLT.
5. **Lab.Tutor**– Who is senior qualified technician gives training to the junior staff.
6. **Store keeper** – In major laboratories store keeper is required to maintain the account of variety of laboratory material.
7. **Clerical Staff** – Require for performance of clerical work and to maintain the accounts.
8. **Several Lab. Assistants** – For helping lab technicians to carry out work.
9. **Lab. Attendant** – For cleaning laboratory and lab wares.
10. **Sweeper** – For cleaning laboratory other than lab instruments & lab wares.
11. **Receptionist** – For welcoming patient and other guest and maintaining records of patient.

5.6 Work Schedule

1. **Lab. Director.**– Overall in charge with the responsibility of the lab. All the activities in the lab directly or indirectly involve lab director. He is supposed to sign all the reports.
2. **Administrator.**– Co-ordinating of the work of the lab. Many times lab directors are lab. Administrator who administer lab functions.
3. **Senior Technologist.**– Doing specialist test, operating autoanalyser or advanced lab machines, assisting lab director in coordinating the lab work,preparing reports & maintaining lab records.

4. **Lab. Technician.**– These junior level technician does main bench work in the lab from blood collection, specimen collection, labeling, processing simple tests under the supervision of senior technologist or pathologist.
5. **Lab. Tutor.**– Training of the junior, new or inexperienced technician.
6. **Store Keeper.**– Maintains register of variety of instruments, lab wares, chemical reagent and other material and with help of lab Director and senior technologist, ordering supplies, purchasing equipment, Properly storing of various chemical with proper category and taking its care.
7. **Lab. Assistants.**– Helping lab technicians.
8. **Lab. Attendants.**– Helping the technician in cleaning lab wares and lab.
9. **Sweeper.**– Cleaning the lab other than lab instruments.
10. **Receptionist.**– Maintaining record of patients and welcoming them.

Time schedule of staff is adjusted according to the need of laboratory, Attendance register is maintained. Appointment of emergency duty should be in rotation and properly handover the work while shifting duty. Generally eight hour duty is given to the staff. Over work is avoided.

Record Maintenance – Recording test results in the lab is important. Records are kept by retaining carbon copies of reports, using work sheets or recording tests results in register by lab technician. Separate register can be prepared to record the results of haematological, microbiological, clinical chemistry, urine and faecal test.

Recording of each patient should include name, age, sex, number, diagnosis etc. Computer is very useful in maintaining records.Other records include – Attendance, list of equipment, stock record, Voucher of supplies record, Expenditure and Fees record, etc.

5.7 Laboratory Goals and Aims

1. Lab should plan to give a reliable and quality laboratory service to the patient.
2. Fulfill the needs and expectations of patient and those requesting lab tests.
3. Good management of laboratory finances, equipment and supplies.
4. Make or ensure the working conditions of lab staff are safe and acceptable and paid according to the contract of employment.
5. Standardize the technologies and equipment.
6. Lab should help medical practitioner in diagnosis, prevention and treatment of disease.
7. Do research and help mankind.

Review Questions:

1. Give the definition of Clinical Laboratory.
2. What will happen without reliable laboratory support?
3. What is the legal aspect of a clinical laboratory?
4. Give the general principles in setting up a lab.
5. What are the different sections of clinical laboratory?
6. What is the staffing pattern of a laboratory?
7. What are the goals of a laboratory?

Assignments –

(1) Visit Pathology laboratory near to you.

(2) Mention about staff pattern in that laboratory.

LESSON 6

EQUIPMENT, GLASSWARE,REAGENTS & CHEMICALS OF A LAB AND ITS CARE AND USE

Objective.–*At the end of this lesson student will able to state about*

a. Different equipment, glassware and chemicals used in Pathology lab.

b. Working of different equipment.

c. Uses of different equipment, glassware and chemicals.

d. Care or maintenance of different equipment.

e. Cleaning of glassware.

f. Care of chemicals and their storage and their labeling.

6.1 (a) List of equipments.–

Equipments which are needed for moderate size clinical laboratory are –

- Microscope
- Colorimeter
- Centrifuge
- Incubator
- Autoclave
- Hot Air Oven
- Refrigerator
- Water bath
- Microtome
- Haemocytometer
- Haemoglobinometer
- Cell Counter
- Hot plate
- Analytical Balance
- Chemistry Auto analyzer

6.1.(b) List of glassware.–

Glassware are divided into three groups.–

1. Containers and receivers.
2. Volumetric glassware .
3. Other glassware.

1. Containers and receivers.–These are most common glasswares in the lab. They are available in different volumes. e.g.

- Beakers
- Flasks
- Test tubes
- Bottles

Figure 6.1 Common Glassware

2. Volumetric glasswares

These are also known as graduated glassware. e.g.

- Pipettes
- Burettes
- Measuring cylinders
- Volumetric flask
- Graduated conical testing glasses

Figure 6.2 Volumetric Glasswares

3. Other glasswares

Slides, Coverslip, Petri dishes, syringes, thermometer, etc.

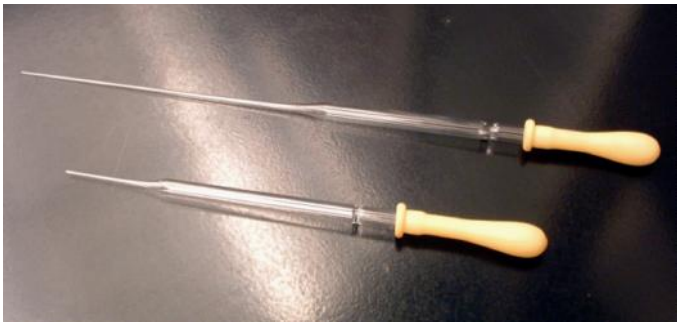


Figure 6.3 Pasteur Pipette

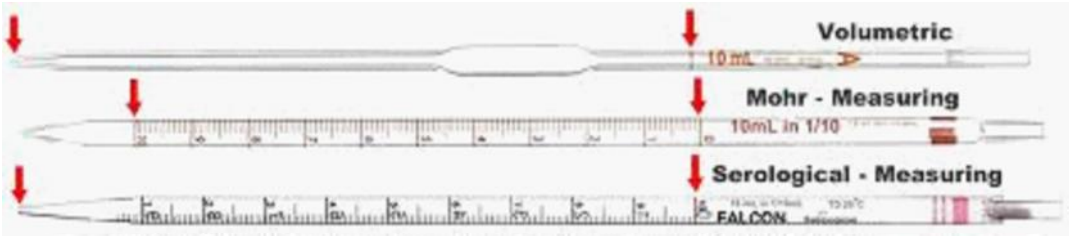


Figure 6.4 Types of Pipettes

Figure 6.5 Micro pipettes

Figure 6.6 Test Tubes

Figure 6.7 Petridishes

6.2 Micropipette–

Micropipette is one type of pipette which is used in lab commonly. Now a days it has almost totally replaced previously used glass pipettes. Micropipette is a laboratory tool commonly used in lab to transfer a measured volume of liquid. This liquid may be chemical or liquid lab sample. These pipettes come in several designs. They may be single volume, adjustable volume. Electronic pipettes are also available.

Advantage of Micropipettes –

- They are more accurate and precise in dispensing the volume of liquid.
- They are easy to use.
- Mouth pipetting is avoided

Figure 6.8 Tips of Micropipettes

Figure 6.9 Parts of Micropipettes

6.3 Principle, use and care (maintenance) of instruments :

6.3.1 MICROSCOPE

Principle – Microscope is the instrument used to see the small things, which we cannot see with the help of naked eyes. This is possible because of lenses used in microscope. The microscope is primary tool in medical lab. Lab diagnosis without microscope is not possible. It enlarges the image of objects that otherwise cannot be seen at all. This enlargement of object is called its magnification.

Simple microscope consists of single lens. Compound microscope is combination of two or more lenses.

Compound microscope- Compound microscope may be monocular or binocular. Monocular microscope is only of one ocular.(Mono – One and ocular – eye piece). Binocular microscope consists of two oculars (Bi – two and Ocular – Eye piece).Ocular or eye piece are lenses through which we look into the microscope. Magnification of image is formed by the objective. Ocular has magnifying power of 10X. The magnification of object obtained by microscope is given by the product of magnificationof objectives and ocular. So, objective of 10X, 40X and 100 X with 10X ocular will give magnification of 100 times, 400 times and 1000 times respectively.

Magnification = Power of objective x power of ocular lens.

Types of Microscope :–

(1) Simple microscope

(2) Compound microscope – They include :—

(a) Light microscope.

(b) Electron microscope.

(c) Ultraviolet microscope.

(d) Phase contrast microscope.

(e) Differential Interference contrast microscope.

(f) Dark field microscope.

(g) Fluorescent microscope.

(h) Polarization microscope.

(i) Differential interference contrast microscope.

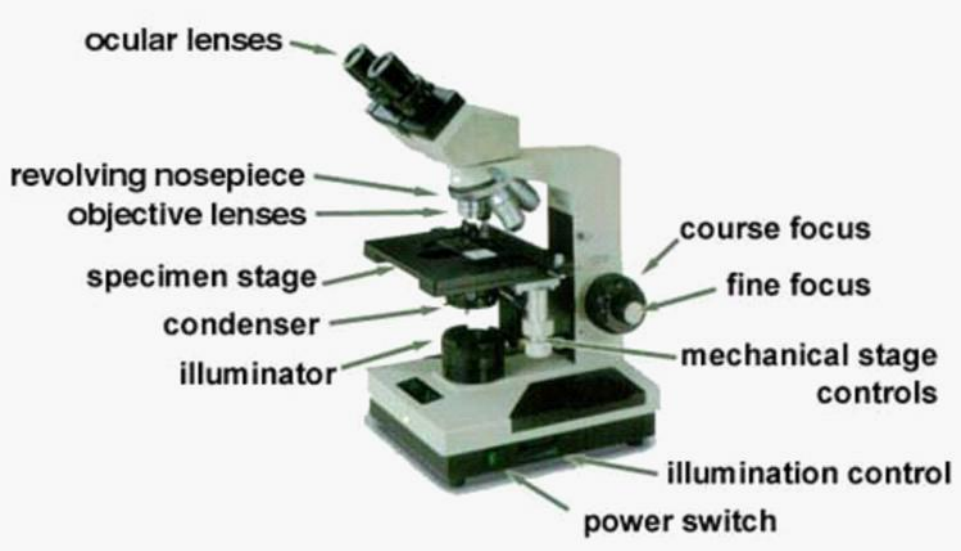


Figure 6.10 Microscope

Uses of Microscope.–

In pathology laboratory microscope is routinely used for –

- Study of blood cells.
- Study of micro-organisms.
- Study of cells in body fluids.
- Study of the histopathology slides .
- For cytology study.

Care Of Microscope .–

(1) Do not touch the lenses.

(2) Wipe the lenses with soft cloth or lens paper.

(3) Use very little xylene to remove oil from oil immersion objective.

(4) Keep the stage clean and dry.

(5) Use machine oil to lubricate controlling mechanical parts.

(6) Cover the microscope when not in use.

(7) Consult the proper scientific instrument repairer if the microscope is damaged optically or mechanically.

6.3.2 CENTRIFUGE

Principle

The working of the centrifuge is based on principle of centrifugal force, which acts on a substance in circular motion, towards the periphery.

The factors which govern the speed of centrifugation are –

(1) The revolution per minute.

(2) Length of radius.

(3) Shape and size of the particles.

(4) Viscosity and specific gravity of the fluid under centrifugation.

(5) Gravitational force acting on particles.

Figure 6.11 Centrifuge

Use of Centrifuge .–

General application of a centrifuge include –

1. Separation of two immiscible liquids.

2. Separation of solid particles in a suspension.

In Pathology lab it is used for –

- The separation of plasma from red blood cells.
- Separations of protein free filtrate.
- Washing of red blood cells by normal saline.

Care Of Centrifuge .–

- Balance the tubes properly before starting centrifugation.
- Oiling of moving parts.
- It should be kept on sturdy/firm platform.
- Put lid during operation.
- Always clean the centrifuge with soft cloth.
- Take care about the maintenance of centrifuge.
- The chamber should be kept clean.
- Never open the (centrifuge) chamber until the rotator has come to a complete stop.
- Observe for usual normal vibration noise during operation. The centrifuge may vibrate excessively if the tubes inside are not balanced properly. This should be checked immediately.
- Place a cover on the centrifuge when not in use.

6.3.3 INCUBATOR

Principle.– When electricity is passed through heating coils, electrical energy is converted to heat energy. The temperature is controlled by thermostat.

Temperature range of Incubator **–** 30°C to 80° C.

Uses of Incubator. —

1. Cultivation of micro-organisms on different culture media.
2. Incubation of reagents and samples during different biochemical test analysis.
3. During reticulocyte count test, Prothrombin time, blood grouping, etc.

Figure 6.12 Incubator

Care of Incubator.—

1. Do not forget to put off the main switch when the heating period is over.
2. Keep the incubator clean.
3. As it is electrical instrument maintain it properly with the help of electrician.

6.3.4 HOT AIR OVEN –Temperature range of oven is 40°C to 200° C.

Figure 6.13 Hot Air Oven

Use of Hot air Oven –

- Dry sterilization of syringes and needles.
- Drying of glass wares.
- Heating of chemicals.
- Preparation of anticoagulant bulbs.

Care of Hot air Oven –

Same as Incubator**.**

6.3.5 AUTOCLAVE –

Principle –When water is heated in a closed container, saturated steam is produced under pressure. According to Boyle's law, when volume of the steam, is kept constant, the temperature is directly proportional to pressure. At 15 pound pressure 121°C temperature canbe obtained. Moist heat coagulates cell proteins of the microorganisms and thus kills all living entities including spores in 15 to 20 minutes.

Uses of Autoclave –

Autoclave is used to sterilize different things like –

- Petri dishes.
- Culture media.
- Killing of microorganisms in different infectious samples.
- Autoclaving of surgical instruments and clothes.

6.14 Autoclave

Care of Autoclave –

- Never heat too quickly to bring up the pressure.
- Never leave the autoclave unattended while pressure is rising.
- Never leave it to cool for too long without keeping the valve open.

6.3.7 WATER BATH

6.3.8 PHOTOELECTRIC COLORIMETER

6.3.9 MICROTOME

Microtome is an instrument used to cut thin and uniform sections of the tissue. It is used in Histopathology laboratory. There are different types of microtomes. They are

1. Rotary Microtome.
2. Rocking Microtome.
3. Base-Sledge Microtome.
4. Freezing Microtome.
5. Cryostat.
6. Ultra-Microtome.

6.3.9 Chemistry Auto analyzer –Chemistry auto analyzer is commonly used instrument in lab. It has replaced colorimeter. Principle of working of both is same. But in auto analyzer advantage is it directly gives us level of the chemicals in sample.

There are two types of auto analyzer –

(1) Fully automatic auto analyzer.

(2) Semi-automatic auto analyzer.

Uses –This is the instrument which is used to determine the levels of different chemicals in different body fluid particularly in blood. e.g.

- Blood glucose level
- Blood urea
- Different enzyme level assay
- Different hormone assay

Care of Autoanalyser–

- Keep it closed when not in use.
- Try to keep it free from dust.
- Check filters regularly.
- Check it regularly from machine engineer.

6.4.– Need to understand the part replacement process of equipment

A spare part is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed units. Part replacement and appropriate maintenance ensures that the equipment is running at a high capacity. Part replacement was simple in the olden days when the machines and equipment were relatively simple. Due to advancement in instrumentation the levels of equipment has gone up and have become more complex. Hence the importance of part replacement has considerably increased. A laboratory technician should know how to use user's manual for each and every equipment and learn the procedure of part replacement.

6.5. Care and cleaning of glassware.–

A. Care of glass ware.–

While working in a laboratory the technician must be familiar with the types of glassware handled in the lab. He should use them properly. Improper use of glassware may lead to their breakage.

There are basically two qualities of the glassware.

- Borosilicate glassware.
- Sodium glassware.

Borosilicate glassware is heat and chemical resistant. It can also stand mechanical stress and will not break due to sudden change of temperature (Thermal shock). This is ideal for beakers and other glassware which are subjected to heating. They are expensive.

Soda lime glassware is less resistant to mechanical shock and thermal shock. It is cheaper than borosilicate glass and is ideal for storage of reagents. It is easy to bend by heat and is used in preparing certain glassware.

Some common tips for the care and maintenance of glassware :—

- Never leave the glassware unattended when it is heated, it will crack or explode when dry condition approaches.
- Avoid thermal shock by putting the hot glassware on an asbestos pad.
- Avoid scratching of glass in its daily use. Whenever possible, use a rubber tipped glass rod or plastic rod if the solution is not too hot.
- For cleaning, use plastic brushes instead of metal brushes.
- Use heat resistant glass while preparing solution of acids and alkalis.
- Polish glass tubing before attempting to insert it into rubber tubing.

B. Cleaning of glassware –

Clean glass wares is important requirement of a clinical lab. The glassware should be clean physically, chemically and in certain cases bacteriologically. If glassware are not clean, it will give wrong results.

(1) Cleaning of new glassware –

The new glassware that has been never used is slightly alkaline in nature. They should be first neutralized. For that do the following procedure –

(i) Prepare a basin full of 3 litres of water and 6 ml of Conc. HCl (0.2 % HCl)

(ii) Leave the new glassware immersed in the above solution for completely 24 hrs.

(iii) Rinse twice with ordinary water and once with distilled water.

(2) Cleaning of Dirty, stained and infectious glassware –Any glassware should be first immersed in tap water or detergent water immediately after use.Dirty, stained or infected glassware first require different type of special treatment and then, they cleaned in samemanner.

- **Preliminary treatment –**

(1) For dirty glassware – These first boiled in water for 10 minutes.

(2) Stained glassware – Never rinse blood stained glassware with hot water, as the proteins gets deposited on inner aspect of the glassware. If glassware have stains of colours then remove these with the help of Potassium dichromate solution or chromic acid solution.

(3) Infectious glassware is to be soaked in 5 % Phenol for 24 hrs.

After this preliminary treatment, all glassware have given following treatment –

- **Soaking in detergents –**

Prepare a bowl of water with washing powder or liquid detergents. Put all glassware in this bowl. Brush inside the container with test tube brush. Leave in bowl for 2-3 hours.

- **Rinsing –**

Remove the articles one by one from the bowl. Rinse each one thoroughly under the tap. Then soak them all in a bowl of ordinary water for 30 minutes.Rinse each article in plain water or in the stream water. A small trace of detergent left in the glassware will lead to wrong results.

Final rinse always should be with distilled water.

- **Draining –**

Place the glassware on a rack upside down in a wire basket for complete draining.

- **Drying –**

Dry the glassware in oven or keep the basket in sunny spot.

6.6. Classification of chemicals –

Chemicals used in lab can be classified in following way –

(a) Organic chemicals –means chemicals which contain carbon e.g. Alcohol, Acetic acid, Acetone

(b) Inorganic chemicals – means chemicals which do not contain carbon.e.g. Sulfuric acid (H_2SO_4), Hydrochloric acid(HCl), Copper sulfate ($CuSO_4$), etc.

(c) Toxic chemicals (Poisonous) – means chemicals which causes hazard to the body, if they enter the body through any route. e.g. Potassium cyanide

(d) Non-toxic chemicals – means chemicals which are harmless to body. Most of the chemicals in dilute form are non-toxic.

(e) Carcinogenic chemicals – means chemicals which produce cancer if body remains in contact with them for long time. For e.g. Asbestos, tobacco smoke, benzene, formaldehyde.

(f) Flammable chemical – means chemicals which catch fire easily. e.g.Ether, benzene, alcohol, acetone, chloroform etc. These are also called as Inflammable chemicals.

(g) Corrosive chemicals – means chemicals which destroys living tissue. For e.g. concentrated acids, alkalis, phenol etc.

(h) Explosive chemical – means chemicals which results in sudden, almost instantaneous release of pressure, gas, heat and light when subjected to sudden shock, pressure or high temperature. e.g. blasting gelatin, RDX, barium azide, etc.

Figure 6.15 New International Hazard Symbols for chemicals

Labeling of chemicals.–Containers should be always labelled before adding the material. No reagent should be placed in an unlabelled container. Never exchange the containers. Bottle of poisonous chemicals should be labeled as 'POISON'. They should be marked with dangerous sign. Unmarked container without any assurance of its content should be discarded entirely. The date of preparation and it its expiry should be written on container.

Storage of chemicals - Chemicals are stored systematically in lab or in store room. This is to avoid damage to the chemicals as well as for prevention of chemical hazards (accidents) in lab.

Following are some of the rules which should be followed while storing the chemicals –

- Inflammable chemicals -

Such chemicals should be kept away from the flame or heat. Lid of the container should be tight as they get evaporated.

- Poisonous chemicals –

These chemicals should be labelled clearly in large red letter as "poison". Also signs for poison should be drawn. They should be kept in lock.

- Photosensitive chemicals -

These chemicals should be stored in dark brown bottle.

- For strong chemicals don't use ground glass stoppers.
- Bottles of strong chemicals should be kept on the lower shelves of cupboard.
- Keep chemicals like alcohols, H_2O_2, Fouchet's reagent in refrigerator. This is to avoid evaporation.
- Follow manufacturer's instruction for storage & handling of chemicals.
- If possible arrange chemicals in alphabetical order.

Care of chemicals –

a. Replace the cover of all reagent bottles promptly and securely.

b. Diluted solution has a shorter shelf life than concentrated stock solution. Hence, do not dilute the stock solution until needed.

c. When reagent from the bottle is removed never put it back in to bottle.

d. Insert only clean spatula or clean pipette into the reagent bottle.

e. Do not leave the reagent bottle open without cap for prolonged period.

f. Never add water to acid.

g. While heating flammable liquid use fume hood to avoid fire hazard.

h. Open flame electric hot plate should never be used for heating flammable reagent.

i. Chemicals should be dated on receipt, on opening and when made up in to solution or mixture.

j. Empty container should be thrown out into the trash basket with their cap or stopper off and only after being thoroughly rinsed with water.

Review Questions:

1. How will you equip Pathology lab?
2. Write about care of microscope.
3. How will you take care of a centrifuge?
4. How will you clean new glassware?
5. What special treatment you will give while cleaning infected glassware?
6. Write full procedure of cleaning of dirty glassware.
7. How will you take care of chemicals?

Assignment

1. Prepare EDTA and sugar bulb.
2. Clean new glassware in your lab.
3. See how autoclave works. Compare it with Pressure cooker.

LESSON 7

SPECIMEN HANDLING

Objective.–*At the end of this lesson the student will be aware of proper handling of laboratory specimens right from the collection up to their disposal. They will also understand that in a clinical laboratory the results are as accurate as the quality of the specimen.*

7.1 Introduction :—

Specimens are the most important component of any clinical laboratory. Accuracy in result depends on proper collection, handling and proper storage of specimen. Technicians should aware of all procedures related to specimen i.e. collection, handling, procedure and its disposal.

It is stated that- "the results are as good as the specimen".

7.2 Types of specimens :—

	Type of specimen	Tests carried out
(1)	Blood	All routine and special haematological tests like CBC, ESR, Reticulocyte count, sickling test, etc. Biochemistry- Blood sugar, protein, urea, SGPT, SGOT, etc. Serology – RA, VDRL, HIV, Widal, etc. Blood bank- Blood grouping, cross matching. Cultural Examination-Blood culture.
(2)	Urine	Routine analysis, 24 hour estimation of substances like albumin and cultural examination.
(3)	Stool	Routine analysis, Screening for malabsorption of fat, cultural examination.
(4)	Sputum	Routine analysis and cultural examination.
(5)	CSF	Routine analysis and cultural examination.
(6)	Semen	Routine analysis.
(7)	Other body fluids like peritoneal, pleural, gastric, synovial fluid, vomitus, etc.	Routine analysis and specific tests and cultural examination.
(8)	Swabs like throat swabs, wound swab, etc.	Routine as well as cultural examination.
(9)	Biopsy or autopsy organs	Histopathological examination.
(10)	Nail, Hairs	Fungal Infection.

7.3 Method of collection, Precautions and containers used for specimen

Sr. No. (1)	Specimen (2)	Collection (3)	Containers (4)	Precautions (5)
1	Blood	Venipuncture Skin puncture	Plain bulb, Anticoagul-ant bulb.	1. Wear gloves. 2. Avoid contact with open wounds. 3. Needle and syringe should be perfectly dry, patent and sterilized. 4. Collect blood from visible, prominent and palpable vein.
2	Urine	Routine analysis-Early morning midstream sample 24 hour estimation-First discard the early morning sample and then collect all the urine passed during the next 24 hour period including the next day early morning sample. Cultural examination-Early morning mid-streamsample collected after proper cleaning of genital part.	Routine- A wide mouth container with screw cap having 20-30 ml capacity Culture-Sterile container (Bottle) For 24 hours-A large plastic container of about 5 litre capacity.	1. The sample should reach to laboratory as early as possible i.e. within half an hour. 2. For cultural exam-should be collected under sterile condition in a sterile container to avoid contamination.
3	Stool	A morning specimen before the breakfast is most suitable or sample can be collected at any time.	A clean, dry, leak-proof container is used for routine analysis. Culture. Sterile container.	1. Sample should not be collected in a waxed paper or paper of any type or small bottle. 2. Patient should not take iron tablet 4-6 days before the sample collection. 3. Sample should be without admixture of urine. 4. For demonstration of intestinal parasites patient should not be on medication at least 2 weeks before sample collection.
4	Sputum	First morning sample For detecting TB bacilli at least three consecutive early morning samples.	A wide mouth container with a screw cap. For culture a sterile container with screw cap.	1. Saliva should not be collected as a sample. 2. Ask patient to do the act of coughing and then the sample should be collected. 3. While collecting sample for culture, the lid should be opened at the time of collection only and immediately closed.
5	CSF	Lumbar puncture method.	CSF is collected in three sterile tubes.	1. Written consent of patient or his relative is must. 2. Should be collected by doctors only or trained nurses.

(1)	(2)	(3)	(4)	(5)
				3. Collection should be under all aseptic precautions. 4. Head low position should be given to patient after collection.
6	a. Pleural fluid b. Ascitic fluid c. Synovial fluid	Collected by tapping the site with the help of puncturing needle.	Collected in sterile tubes.	1. Should be collected by doctor. 2. Written consent is necessary. 3. Complete aseptic precautions are must.
7	Swabs	A throat swab is collected by just scrapping the affected area with the help of sterile swab.	Sterile swab is used and it is kept in a sterile test tube which is plugged with cotton.	Swab should be examined within 4 hours.
8	Bone marrow	Aspiration biopsy or Trephine biopsy	Bone marrow is collected in a sterile tube. In trephine biopsy sample processed histologically	1. Aseptic precautions are must. 2. Should be collected by doctors. 3. Smear should be prepared immediately as fluid clots immediately.
9	Biopsy	Either excisional or incisional biopsy collected in operation theatre.	Tissue should be collected in a fixative.	1. Aseptic precautions are must. 2. Should be collected by doctors.
10	Autopsy	Removal of tissue/ organs from dead body in autopsy room	Tissues/organs should be collected in a jar of fixative.	Should be collected by doctor only.
11	Hair, nail	By extraction either under local anaesthesia or directly.	Sterile tube or petridish.	Proper collection is must.

7.4 Specimen packing, transport and storage

Packing—Wrap the specimen in sufficient absorbent material so that the container will remain safe. Place them separately or along with others in a carton or plastic bag. Make sure that there is sufficient absorbent material around the specimen. Plastic bag should be sealed along with request form/report form. Use sufficient packing material in the insulated container. Insert a freezer pack(s) or ice cubes around the container of the specimen.

Labeling—Label on the outer side of container '**Biological specimen'** or Infectious specimen with preferably biological symbol.The words keep cool should also prominently displayed on the container.

Apart from properly filled requisition forms proper labeling is important to avoid confusion with any other sample.

Figure 7.1 Infectious Specimen Figure 7.2 Biohazard Symbol

Transport of Specimen:

It involves two types -

(i.) From ward to OPD- This is area where sample can be transported by hand delivery. It should be carried by keeping specimen in upright position in racks in a closed container. During the hot season it is carried in an insulator. The request form should be placed in a plastic bag that can be sealed (grip type).

(ii.) Transporting the specimen between the laboratories- Make sure that the specimen container is properly prepared with its screw cap tightly fitting. There should not be leakage. Fix a clearly written delivery address label on the container. Use of hospital transport or other reliable carrier to transport the sample. Use of preservatives and media as per the specimen and time requirement. If specimen is sent by mail it should reach within time and follow postal rules.

Storage- If sample has to be kept for a long time then it should be refrigerated. The container should not be laid down on its sides. Liquid specimens should not be allowed to freeze, preservatives may be added depending on type of specimen and type of test to be carried out

Biopsy specimen should be fixed in a fixative and store in a cool place.

7.5 Receiving specimens in laboratory

Proper receiving of sample is must as any problem at this area will lead to errors in the report. Persons at collecting desk should check that every sample is properly labeled with the patient's name, hospital number and tally these details with request form. Unlabeled samples should not be received. Broken specimen containers should be handled very carefully. The person who receives specimen should take utmost precautions regarding the personal safety.

7.6 Acceptance and rejection criteria for specimen

The specimen should be rejected by the lab if.

- It is unlabeled or the identity on the request slip and container does not match.
- If type of sample, its container and tests which are requested mismatches.
- If container is leaking.
- If there is any evidence of contamination.

- In case of blood sample if it is haemolysed or there is clot in an anticoagulated sample.
- If there is much delay in the collection and receiving of sample or if it has not been transported properly.
- Any abnormal appearance of specimen should be reported and investigated if indicated e.g. Dark coloured urine may be due to bilirubin or black stool sample may be due to gastro-intestinal tract bleeding.
- Check the packing. The keep cool refers to the transportation of specimen in an insulated flask or box that contains a freezing pack or ice cubes. If it is not there, reject the specimen.

7.7 Specimen preservation

Preservation of specimen is required when there is a question of time factor comes. If there is delay in testing the best way of preservation is keeping specimen in refrigerator (Do not freeze) or by keeping freezing packs or ice cubes around the specimen. For long time storage the temperature used is between 5^0C-20^0C. Usually preservation is required whenever repeat analysis is required for confirmation and to analyze several specimens together to save time.

In certain cases chemical preservatives are used such as to prevent the growth of bacteria formaldehyde, Thymol can be used. Blood sample should be properly collected in an anticoagulant bulb with proper proportion of anticoagulant.

For urine specimen toluene is used if it is to be stored for a long time. 37% formalin can be used but it is not suitable for sugar estimation.

For sputum 0.6% of cetylpyridium bromide is used.

Stuart's transport medium is used for bacterial examination for many pathological samples. Cary Blair medium is used for stool sample.

7.8 Disposal of specimens

Proper disposal of specimen is must to avoid any laboratory hazard. First all infectious material and contaminated articles should be made noninfectious so that they do not cause any danger to laboratory workers or surrounding. The specimen should not be thrown into ordinary sinks.

Different methods are used to decontaminate infectious material in laboratory are

- Autoclaving.
- Boiling (Effective method of disinfection).
- Use of disinfectant.

1. **Autoclaving-** This is the most reliable method of achieving decontamination as it completely destroys microorganisms including spores. In autoclaving steam under pressure is used having temperature more than boiling water temperature. Temperature used is 121^0C for 15 minutes. All liquid samples like sputum, CSF, pus, urine, etc. are autoclaved for 30 minutes before disposing them off. After cooling empty the containers in the sink or lavatory and clean with detergent.
2. **Boiling-** Boiling for 20 minutes kill all non-sporing organisms. Adding 20 grams of sodium carbonate to every liter of water increases the effectiveness of disinfection.

3. **Use of disinfectant-** This aims to destroy or at least reduce the number of contaminating microorganisms to the level that are no longer regarded as harmful to health. It destroys vegetative microorganisms but not necessarily spores. The laboratory use of disinfectant should be restricted to discard containers on the bench, disinfecting equipment, bench surfaces and floors and treatment of spillages.When compared with autoclaving and boiling chemical disinfectant method is less reliable. No single disinfectant is likely to kill all microorganisms in any sample of infected waste. They are expensive and hazardous to health. Disinfectant solution should not be used in excess because there is limit to the amount of material which they can disinfect effectively.Phenol, chlorine releasing products, aldehydes, alcohol are commonly used disinfectant.

Methods used for disposal of **laboratory waste** include

1. Incineration.
2. Burial in a deep covered waste pit or landfill.
3. In cities according to rules and regulation of municipal corporation.

Incineration

In district laboratory incineration i.e. destruction by burning is a practical and effective method of disposing laboratory waste.

Local construction of incinerator—Use an empty 300liter petrol drum and obtain a metal lid and piece of fine wire mesh (to replace the lid when burning is in progress). Fix a strong metal grating about a third of the way up the drum, inserting a steel rod to keep it in a place. Cut a wide opening below the level of the grating. Use the incinerator as follows-Place the material on the grating of the incinerator on the top of a waste sheet of a paper or cardboard. Do not overfill replace the lid.

Figure 7.3 Incinerator

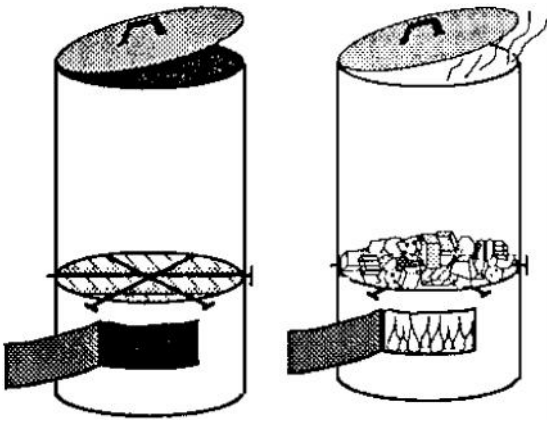


Figure 7.4 Construction and working of Incinerator

Fill the bottom of the drum with sticks, wood shavings and other combustible material. Remove the lid and replace with the fine mesh to retain fragments and smuts. Light the fire and allow it burning until all the waste has been burnt. When it becomes cool the ash in a deep covered pit. Do not empty it on open waste ground.

Burial in a deep covered waste pit or landfill

Burying laboratory waste prevents it from becoming hazardous. The pit is located in a safe fenced off area. It is sufficiently deep (4-5 meters) and wide (1-2 meters). It has strengthened rim and is kept covered. The disposable pit should not be used for items that do not decompose e.g. plastic ware. Once a week the waste should be covered by a layer of quicklime or if unavailable by soil or leaves. If a local landfill site is available local health authority guidelines should be followed regarding its use.

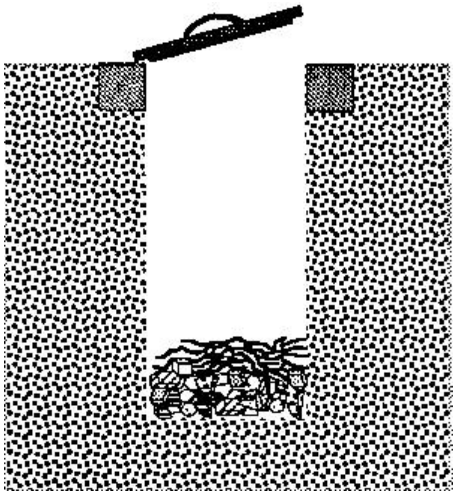


Figure 7.5 Burial

Review Questions :

1. Name different types of specimens received in laboratory.
2. What are various methods of collection various samples?
3. What precautions are taken while handling specimens?
4. Note on specimen transport.
5. What are rejecting criteria for a specimen?
6. How specimens are preserved?
7. How specimens are decontaminated?
8. How specimens are disposed?

LESSON 8

BIOMEDICAL WASTE MANAGEMENT

OBJECTIVE.– *Biological waste carries a higher potential for infection and injury than any other type of waste. It may have serious public health consequences and significant impact on the environment. Therefore, it is essential to have safe and reliable method for its handle. To understand the source, categories, management, disposal and hazards of biochemical waste.*

8.1: DEFINITION:

Biomedical waste means any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities related to the production or testing of biological, human anatomical, animal, microbiological, biotechnological waste materials.

8.2: SOURCE OF HEALTH CARE WASTE:

The institutions involved in generation of bio-medical wastes are:-

1. Government hospitals.
2. Private hospitals.
3. Nursing homes.
4. Clinical laboratories.
5. Physicians' office/clinics.
6. Dentists' office/clinics.
7. Dispensaries.
8. Primary health centers.
9. Medical research and training establishments.
10. Mortuaries.
11. Blood banks and blood collection centers.
12. Animal houses.
13. Slaughter houses.
14. Research organizations.
15. Vaccination centers.
16. Biotechnology institutions/production centers.

8.3: CLASSIFICATION OF HAZARDOUS WASTE

(1) INFECTIOUS WASTE:

Pathogens in infectious waste which is collected from various centers like labs and hospitals may enter the human body through a puncture, abrasion or cut in the skin or through mucus membrane by inhalation or by ingestion. There is particular concern about infection with Hepatitis B, C and HIV virus.

(2) BIOCHEMICAL AND PHARMACEUTICAL WASTE:

Many of the chemicals and pharmaceuticals used in health care establishment are toxic, genotoxic, corrosive, flammable, reactive, explosive. Although present in a small quantity, they may cause intoxication either by acute or by chronic exposure and injury including burns etc. Disinfectants are particularly important when used in large quantities. These are often corrosive. Reactive chemicals may form highly toxic secondary compounds.

(3) GENOTOXIC WASTE:

The severity of the hazards for health care workers responsible for handling or disposal of genotoxic waste is governed by a combination of the substance toxicity itself and the extent and duration of exposure. Exposure may also occur during the preparation of a treatment with particular drug or chemical. It affects genetic material.

The main pathway of exposure is inhalation of dust or aerosols, absorption through the skin, ingestion of food etc.

(4) RADIOACTIVE WASTE:

The type of disease caused by radioactive waste is determined by the type and extent of exposure. It can range from headache, dizziness, vomiting to much more serious problems like affecting genes and chromosomal abnormality in the human beings.

Figure 8.1 Segregated Biomedical Waste

8.4: PERSONNEL AT RISK OF BIOWASTE:

1. Medical doctors, nurses, health care auxiliaries and hospital maintenance personnel.
2. Lab technicians, technologists, assistants, attendants, etc.
3. Patients in health care establishments.
4. Visitors to health care establishments.
5. Workers in support service allied to health care establishments such as laundries, waste handling and transportation.
6. Workers in waste disposal facilities such as landfills, or incinerators including scavengers etc.

8.5: TREATMENT AND DISPOSAL TECHNOLOGY FOR BIOWASTE:

(5) SEGREGATION:

The biomedical waste should be segregated (separation) into containers or bags at a point of generation of the waste.

The color coding and the type of containers used for disposal of waste are as follows:

Color coding	Type of container	Waste category	Treatment options
Yellow	Plastic bag	Category 1,2,3,6	Incineration / deep burial
Red	Disinfected container/ plastic bag	Category 3,6,7	Autoclaving / microwaving / chemical treatment
Blue/white translucent	Plastic bag /puncture proof container	Category 4,7	Autoclaving / microwaving / chemical treatment and destruction / shredding
Black	Plastic bag	Category 5,9,10 (soli(d)	Disposal in secured landfills

CATEGORY 1: human anatomical waste

Figure 8.2 Biomedical waste segregation bins

(Human tissues, organs, body parts)

CATEGORY 2: Animal waste.

(Animal tissues, organs, body parts, bleeding parts, waste generated by veterinary hospitals and colleges.)

CATEGORY 3: Microbiology and biotechnology waste.

(Waste from laboratory cultures, specimens of microorganisms, human and animal cell culture, waste from productions of biologicals and toxins.)

CATEGORY 4: Waste sharps.

(Needles, syringes, scalpels, blades, glass, etc.)

CATEGORY 5: Discarded medicines and cytotoxic drugs.

(Waste comprising of outdated contaminated and discarded medicines)

CATEGORY 6: Solid waste.

(Items contaminated with blood and fluids including cotton with dressings,et(c)

CATEGORY 7: Solid waste.

(Waste generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets,et(c)

CATEGORY 8: Liquid waste.

(Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)

CATEGORY 9: Incineration ash

(Ash from incineration of any biomedical waste)

CATEGORY 10: Chemicals used in production of biologicals, chemicals used in disinfection as insecticides etc.

(6) TREATMENT OF WASTE:

All the waste should be decontaminated either by disinfection or sterilization before disposal.

1. CHEMICAL DISINFECTION:

Chemicals are added to waste to kill or inactivate the pathogen it contains. This treatment usually results in disinfection rather than sterilization. Chemical disinfection is most suitable for treating liquid wastes such as blood, urine, and stool or hospital sewage. Solid wastes including microbiological cultures, shafts etc. may also be disinfected chemically with certain limits.

2. WET AND DRY THERMAL TREATMENT:

i. **Wet treatment:** Wet thermal treatment or steam disinfection is based on shredded infectious waste to high temperature, high pressure steam and is similar to the autoclave, sterilization process. The process is inappropriate for the treatment of anatomical waste and animal carcasses and not efficiently treat chemical and pharmaceutical waste.

ii. **Screw feed technology:** Screw feed technology is the basis of a non-burn, dry thermal disinfection process in which waste is shredded and heated in a rotating angle. This process is suitable for treating infectious waste and sharps but it should not be used to process pathological cytotoxic or radioactive waste.

iii. **Microwave irradiation:** Most microorganisms are destroyed by the action of microwave of a frequency of about 2450 MHZ and a wavelength of 12.24 nm. The water content within the waste is rapidly heated by the microwaves and the infectious components are destroyed by heat conduction.

(7) DISPOSAL:

Incineration and land disposal are the methods of waste disposal.

i. Incineration:

Incineration is the method of choice for most hazardous health care wastes and is widely used. It is a high temperature dry oxidation process produces organic and combustible waste to inorganic and incombustible matter. The process is usually selected to treat wastes that cannot be recycled, reused or disposed off in a land fill.

ii. Land disposal:

(a) *Municipal disposal sights:*

If a municipality or medical authority genuinely lacks the means to treat waste before disposal the use of a landfill has to be regarded as an acceptable disposal route. There are two types of disposal land- open dumps and sanitary landfills. Health care waste should not be deposited on or around open dumps.

(b) *Inertization:*

The process of inertization involves mixing wastes with cement and other substances before disposal, in order to minimize the risk of toxic substances contained in the waste migrating into the surface water or ground water.

(8) STORAGE:

Waste should be stored in a leak proof, rigid, non-breakable and tightly lidded, labeled container before disposal. It should be labeled with international bio-hazard symbol.

Review Questions:

1. What is biomedical waste?

2. What are the sources of biomedical wastes?

3. Classify the hazards of biochemical waste?

4. Who are the people at risk of biomedical waste?

5. What are the methods of treatment and disposal of biomedical waste?

6. What is segregation and color coding of biomedical waste?

LESSON 9

Laboratory Safety

Objective.–

1. *To identify hazard in the work place and assess the risk to staff, patients and others.*
2. *To prepare and implement an effective code of safe laboratory practice and check it if being followed.*
3. *To make sure staff know how to work safely and what to do when accident occurs and how to carry out emergency First Aid.*
4. *To promote safety awareness.*

9.1 General Principles

The following are the important points in making the work place safe.

(a) Laboratory Premises should be structurally sound with reliable water supply and good waste disposal system.

(b) Adequate floor with adequate size i.e. non slip, impermeable to liquid & chemical resistant floor with adequate bench space & storage areas.

(c) Adequate ventilation supplied by wall vents & windows.

(d) Sectioning of the lab into separate rooms or working areas with door at each end of the lab & open outwards.

(e) Benches of suitable height with surfaces without cracks, washable & resistant to chemicals.

(f) Suitable storage facilities.

(g) Safe electricity supply with sufficient wall electricity points.

(h) Good illumination & fire extinguishers field at accessible points.

9.2 Lab Hazard –

The following are important hazards and its associated accidents.

No.	Hazards		Associated Accident
1	Unsafe Premises	1	Burns and inhalation of smoke during a fire (Single exit or blocked emergency exit door)
		2	Staffs are injured by falling on a floor which is slippery or damaged floor.
		3	Risk of infection to staff and others (No reliable water supply, No separate Restroom etc.)
		4	Injury from chemicals (No proper ventilation)
2	Naked Flames	1	Injury from fire caused by lighted Bunsen burners, spirit lamps, alcohol swab, etc.
3	Microbial Hazards	1	Pathogens are accidentally ingested (Mouth pipetting, personal hygiene is neglecte(d)
		2	Pathogens are accidentally inoculated (Through needle stick, careless handling of needles, lancet, etc.)
		3	Pathogens are accidentally inhaled in airborne droplets. (Aerosols)
			(When snap-closing specimen, vigorously disposing or pouring infectious fluid or spilled etc.)

No.	Hazards		Associated Accident
4	Chemical Hazards	1	Toxic or harmful chemicals causing serious ill-health, injury or irritation. (When swallowed or inhaled in poorly ventilated la(b)
		2	Flammable chemicals causing fire. (Flammable chemical stored near flame etc.)
		3	Corrosive chemicals causing serious injury (Corrosive chemical ingested, spilled on skin, etc.)
5	Glass Ware Hazard	1	Broken glass causing cuts, bleeding, infection. (When cleaning damaged slides or other broken glass ware,waste bins containing broken glass, etc.)
6	Equipment Hazard	1	Electric Shock. (Electrical circuits are faulty, not earthed or not installed properly, exposed wire, etc.)
		2	Fire (When cables or electrical equipment overheat due to overloading, over use of adaptors, insulation damage, etc.)
		3	Injury from moving parts (Open hand centrifuge or tries to stop the centrifugal motor with han(d)
7	Explosion Hazard	1	Injury from Explosion. (When incompatible chemicals explode, leaking gas explode, etc.)
8	Insect and Rodent Infestation	1	Damaged equipment causing injury. (When rodent damageearthing or insulation causing electrical shock or fire)
		2	Damage to structure and furnishing of the laboratory. (When ants & rodent damage wooden furniture, etc.)
9	Unreliable Water Supply	1	Contributing to infection (When there is insufficient water supply, no hand washing, no lab cleaning)
10	Biomedical Waste	1	Infections – Pathogens from various waste may enter human body from various route & may cause ill-health or even death.
		2	Chemical may cause intoxication, chronic injuries, corrosions, burns, etc.
11	Radio Active Waste	1	It will depend on type and extent of exposure. It can range from headache, dizziness, vomiting & even chromosomal abnormality.

General factors that contribute to the occurrence of accidents.–

(1) Inexperience and insufficient training of staff and lack of health and safety awareness by senior lab officer.

(2) Untidy working, allowing the bench and floor to become cluttered and not using racks to avoid spillages. Exit doors are blocked.

(3) Too heavy a workload for the size of lab and number of staff.

(4) Rushing to finish work on time.

(5) Loss of concentration due to a noisy working environment, constant interruptions and excessive heat particularly in small poorly ventilated outreach laboratories.

(6) Fatigue due to frequent emergency work during night hours.

9.3 Safety Measures –

(a) **Designing Safe Laboratory** – Laboratory premises that is structurally sound and in good repair conditions. Adequate floor and bench space and storage areas, well-constructed floor that is non-slip, impermeable to liquids and resistant to chemicals, wall that are smooth and free of cracks with washable light colored paint, A door at each end of the lab which open outwards. Adequate ventilation and reliable water supply & waste disposal system, sectioning of the lab into separate working areas with good illumination are the few consideration of safe lab designing and also refer general principles of lab.

(b) **Fire Extinguisher** – Fire extinguisher sited at accessible points with correct positioning. Technician should know its use and maintenance.Fire extinguishers need to be of the dry chemical type. Several buckets of sand and a fire blanket also required. Always follow the fire safety regulations.

(c) **Following Professional Code of Conduct** – Adopting a code of professional conduct helps to remind lab personnel of their responsibilities to patients, duty to uphold professional standard and need to work with complete integrity. (Refer Topic Ethics 4.(2)

(d) **Displaying Safety Charts** –

Figure 9.1 Safety Charts

Displaying suitable safety signs and symbols is one way of promoting safety awareness.

Prohibition signs are always crossed by a red line. No smoking signs should be displayed in the laboratory& adjacent patient waiting areas. The international biohazard sign should be displayed on the lab door it indicates sample that lab handle contains pathogenic microorganisms and therefore access is restricted to authorized person.

(e) **Personal Care Hygiene and Immunization** –

Personal health and safety measures include

(1) Practice of personal hygiene

(2) Wearing of protective clothing

(3) Protective inoculations and medical examinations

(1) **Practice of personal hygiene** – Lab staff must practice a high standard of personal hygiene. This include

a. Washing of hands and arm with soap & water after handling specimen and lab work & before eating.

b. Covering any cuts, open sores or wound with a water proof adhesive dressing.

c. Wearing closed shoes & not walking bare foot.

d. Not eating, drinking, smoking or applying cosmetics in any part of the lab. Food drink should never be stored in a lab refrigerator.

e. Not licking gummed labels or placing pens, pencils or other articles near the mouth, eyes or in hair.

f. Avoid wearing jewellery in the working areas particularly pendent, necklaces & bracelets.

(2) **Protective Clothing** – Protective clothing like apron should be worn over normal clothing (made of polycotton) that can be bleached & frequently laundered. It should have fastness buttons or type closed.

Soiled clothing should be placed in a special bag and not left in cupboard, prior to laundering. The clothing & bag should be soaked overnight in domestic bleach.

Protective clothing should always be left in the lab and never taken home or worn in a room where refreshments are taken.

Gloves– Protective gloves should be worn when handling specimens or cultures which may contain highly infections pathogens. Renewable gloves must be decontaminated & washed after removal.

Safety goggles, face shields & dust masks– This should be worn when necessary to protect the eyes and face from splashes. Dust mask can protect against inhaling particles of chemicals that are toxic or irritants.

Figure 9.2 Gloves

Figure 9.3 Safety Goggles

(3) **Protective Inoculations & Medical Examinations** – The medical officer in charge of the lab should decide which vaccinations are required.

Protective inoculations are usually given against tuberculosis (when Mantoux is not positive), typhoid, diphtheria, tetanus, poliomyelitis & hepatitis B.

9.4 First Aid –

This is the first or immediate treatment given to the victim of accidents in the lab (or knowing what to do immediately if an accident occurs) before proper medical attention.

Advantages –

(1) First Aid can help to reduce suffering and the consequence of serious accidents.

(2) In some situations first aid can be lifesaving (e.g. cardiac resuscitation).

(3) It can also prevent an injured person's condition from worsening.

First Aid Box -

An adequately equipped first aid box and eye wash bottle should be kept in the lab in a place that is known and accessible to all members of staff.

The first aid box should clearly identified by a white cross on a green background. It should be made of metal or plastic to prevent it being damaged by pests and to protect the content from dust and dirt. The first aid box content should inspected regularly.

Content of First Box –

(1) Clear instruction on how to apply emergency treatment of cuts, bleeding, heat burns, chemical burns, chemical injury to the eye, swallowing of acids-alkalis and other poisonous chemicals treatment of fainting, electric shock and how to perform emergency cardiac resuscitation.

(2) Sterile on medicated dressings to cover wounds.

(3) Absorbent cotton wool.

(4) Triangular & roll bandages.

(5) Sterile adhesive, water proof dressing in a variety of sizes.

(6) Sterile eye pads.

(7) Roll of adhesive tape.

(8) Safety pins.

(9) Scissors.

(10) Tincture iodine or Povidone Iodine.

(11) A disinfectant solution. (diluted Dettol)

(12) Sterile saline.

(13) 2% sodium carbonate solution and powder.

(14) 5% acetic acid / boric acid-powder.

(15) 8% magnesium hydroxide. (Milk of Magnesia)

(16) Soap solution. (Savlon)

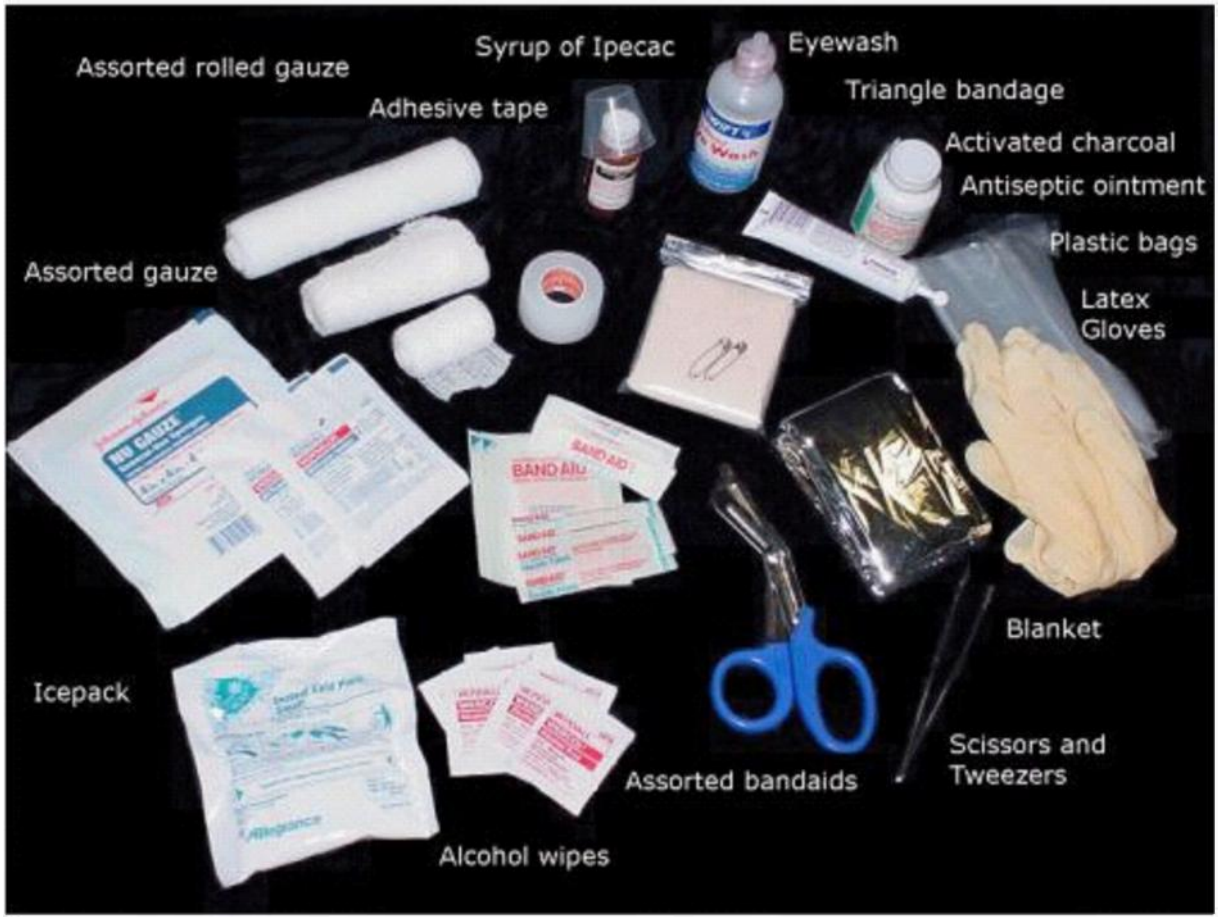


Figure 9.4 Contents of first Aid Box

9.5 First Aid measures in case of accidents in a lab.—

(1) **Emergency treatment of cuts & bleeding**—

(a) If the cut is small – Wash with soap and water.

- Apply pressure with a piece of cotton wool.
- Disinfect the area with skin antiseptic.
- Cover with a water proof dressing.

Note – If the cut has been caused by contaminated glassware or is a needle stick injury, encourage bleeding before washing well with soap and water. Apply skin antiseptic and cover the area with a water proof dressing.

- Seek medical advice.

(b) If there is serious bleeding from a limb

- Raise the injured limb to reduce the bleeding.
- Apply pressure with a clean dressing backed with cotton wool.
- Bandage the dressing in position.
- Immediately seek medical assistance.

(c) Bleeding from the nose

- Seat the person upright with the head slightly forward.
- Tell the person to pinch finely the soft part of his nose for about 10 minutes and breathe through the mouth.
- If the bleeding does not stop, take medical advice.

(2) **Emergency treatment of heat and chemical burns** —

(a) Heat burns

- If clothing is alight (burning), smother the flames using a fire blanket.
- Remove the person from danger area.
- Immediately plunge the burnt area into cold water or apply a pad soaked in cold water to the affected part for 10 minutes.
- Cover with a dry dressing.
- Remove any constructing articles such as ring or bracelet before the affected area starts to swell & becomes blistered.
- Provide frequent small cold drinks to the victim.

Note – If more than a minor burn take medical treatment immediately. Reassurance of the victim is important.

(b) Chemical burns of the skin

- Wash immediately in running water for several minutes, remove any contaminated clothing.
- Neutralize with a suitable chemical as follows-

  If an acid burn, neutralize with sodium bicarbonate powder.

  If an alkali burn, neutralize with boric acid powder.
- Seek medical attention.

N.B.- If inhalation of chemicals & develop respiratory symptoms, immediately transfer victim for medical care.

(c) Chemical injury to the eye

- Wash the affected eye as quickly as possible under running tap water or with water from an eye wash-bottle.
- Neutralize with a suitable chemical as follows-

  If an acid injury neutralize with 5% sodium bicarbonate solution.

  If an alkali injury neutralize with 5% acetic acid or vinegar diluted

  1 in 5 solution.
- Immediately take medical attention.

(3) **Emergency treatment for poisoning**—

(a) Swallowing of an acid or alkali

- Immediately rinse the mouth well with water.
- Neutralize with a suitable chemical as follows-

  If acid has been swallowed, neutralize by drinking 8% magnesium hydroxide suspension or milk.

If an alkali has been swallowed, neutralize by drinking lemon juice or 1% acetic acid.

- Drink three or four cups of water.
- Seek medical attention.

Note – When an acid or alkali has been swallowed, do not encourage vomiting.

(b) Swallowing of other poisonous chemicals

- Rinse out the mouth well with water.
- Depending on the chemical swallowed take a suitable chemical antidote under medical supervision.

Note – Always take medical advice and treatment after swallowing toxic or harmful chemicals.

(c) Swallowing of infected material

- Immediately take medical treatment.
- If required, provide follow-up tests. (Avoid mouth pipetting)

(4) **Emergency treatment when someone is electrocuted (electric shock)**—

- Immediately turn off the electricity from the mains if it can be reached easily, otherwise remove the plug or wrench the cable free.

  DO NOT TOUCH THE PERSON'S FLESH WITH YOUR HANDS

Important – On an account try to free a electrocuted person from the electrical contact without using some form of insulation material such as a dry thick cloth, folded lab coat, folded new papers, wooden or plastic stool or chair. (If insulation is not used the person rescuing will also be electrocuted)

- If the person has collapsed, send immediately for medical help & if the person is not breathing, give artificial respiration until assistance arrives.
- Cool any burns with water. (after rescuing)

Figure 9.5 Eye Washing Station

(5) **Emergency treatment when someone faints** –

- Lay the person down & raise the legs above the level of the head.
- Loosen clothing at the neck, chest & waist.
- Make sure room is well ventilated; reassure the person as consciousness is regained.
- Gradually raise the person to the sitting position.
- Sips of drinking water may be given.

Note – If breathing becomes difficult, place the person in recovery position.

Figure 9.6 First aid in a case of fainting

Figure 9.7 Recovery Position

Review Questions:

1. What are the general principles of a safe laboratory?
2. What are the Hazards? Enumerate them?
3. What are the accidents occurs with various hazards occurring in the clinical laboratory?
4. What are the factors which contributes accident occurrence in the clinical laboratory?
5. What are the safety precautions are taken to make safe working environment in the laboratory?
6. What are the safety precautions taken to protect personnel working in the laboratory?
7. What is First Aid? Give its contents.
8. Give the First Aid or Emergency Treatment of -
   (a) Small cuts & minor bleeding.
   (b) Severe bleeding from the limb.
   (c) Cut&bleeding from infected material.
9. Give the First Aid & Emergency Treatment of
   (a) Heat burns
   (b) Chemical burns
   (c) Chemical injury to the eye

10. Give the Emergency Treatment for Poisoning.
    (a) Swallowing of an acid or alkali.
    (b) Swallowing of other poisonous chemicals.
    (c) Swallowing of infected material.
11. Give the First Aid or Emergency Treatment of Electric Shock. (Electrocution).
12. Give the method of Cardiac Resuscitation.

Activities –

(1) Prepare the charts of safety signs and symbols & display it in the lab.

(2) Prepare the charts of procedure of emergency treatment & display it in the lab.

LESSON 10

QUALITY CONTROL

Objectives: *After studying this lesson you should be able to*

- *Explain the importance of Quality control and quality assurance in the laboratory.*
- *Identify the different errors in the laboratory*
- *Discus the use of standards and controls to ensure quality.*
- *Explain the difference between accuracy and precision*
- *Determine the mean value for a set of test results*
- *Calculate the Standard Deviation for an analytical method.*
- *Explain the coefficient of variation.*
- *Draw and understand the Levey-Jennings chart.*

10.1 Introduction

Quality control is an essential part of every clinical laboratory. QC procedures are performed in clinical laboratories to ensure that patient's results re reliable. Reliable refers both to accuracy and precision.Proper quality control helps ensure that reported results of patient laboratory testing are correct.

Quality control applies not only to specimen testing, but also to collection, storage, and transportation.

10.2 Definitions

Laboratory Quality can be defined as accuracy, reliability and timeliness of reported test results. The laboratory results must be as accurate as possible, all aspects ofthe laboratory operations must be reliable, and reporting must be timely in order to be useful in a clinical or public health setting.

Quality control in the medical laboratory is a statistical process used to monitor and evaluate the analytical process that produces patient's results.

Quality Assurance is defined as the overall program that ensures that the final results reported by the laboratory are correct.

Figure 10.1 Quality Control

- Quality assurance means quality enhancement
- Quality assurance aims at ensuring that the data provided are reliable and relevant
- Quality assurance involves all measures that can be taken to improve laboratory efficiency and effectiveness.
- It ensures laboratory performance with minimum risk for laboratory workers and gives maximum benefit to the individual and community.

Quality Assessment (Also known as Proficiency testing) is a mean to determine thequality of the results generated by the laboratory. Quality Assessment is a challenge to the effectiveness of Quality Control and Quality Assurance programmes.

Quality Assurance includes the evaluation of patient preparation and specimen collection as well as pre-analytical, analytical and post-analytical phases of laboratory testing.

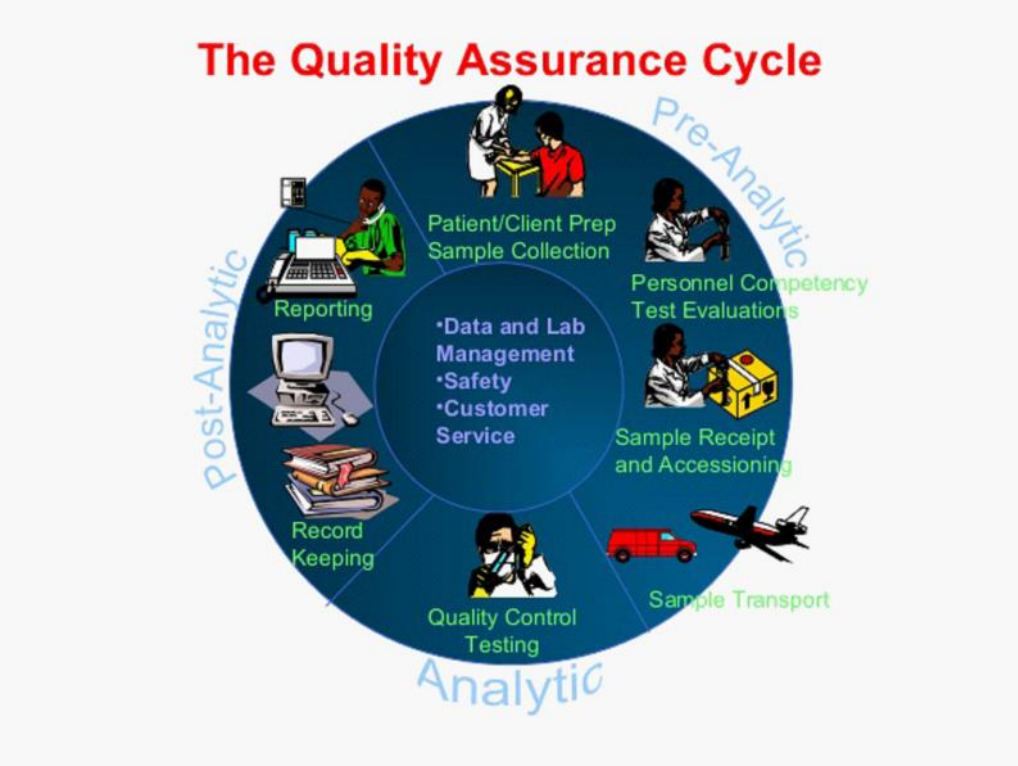


Figure10.2 The Quality Assurance Cycle

10.3 Need of Quality Control in Clinical laboratory

Laboratories produce the test results which are widely used in clinical and public health settings and the health outcome depends upon the accuracy of the test and the result. An error in the result can lead to

- failure to provide proper treatment to the patient.
- Unnecessary treatment, treatment complications and additional expenses.
- Additional and unnecessary diagnostic tests.
- Delay in correct diagnosis.

All the above results in an increased cost in time, personal effort and poor patient's outcomes in terms of morbidity and mortality. Hence it is essential that the laboratory should maintain highest level of accuracy and reliability in all the processes and procedures carried out in the laboratory.

10.4 Laboratory Errors

A laboratory error is defined as "a defect occurring at any part of the laboratory cycle, from ordering tests to reporting results and appropriately interpreting and reacting in these.

The laboratory errors are divides in to 3 categories.

1. Pre-Analytical Errors: -

   Errors that occur before the sample reaches the laboratory.

2. Analytical Errors: -

   Errors that occur during the analysis of the sample.

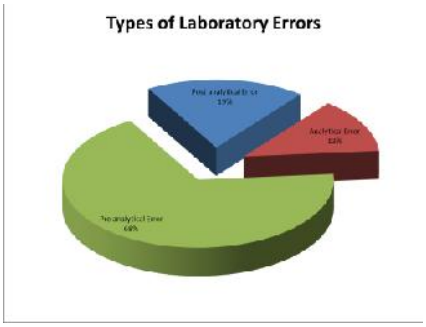


Figure 10.3 Laboratory Errors Types

3. Post-analytical errors: -

Errors that occur after the analysis of the sample.

Pre-Analytical Errors

Majority of the errors affecting the test result occur in Pre-analytical phase and contributes around 68% of the total errors. They include –

1. Improper preparation of the patient: - For example for blood sugar estimation the patient should be fasting or for Lipid Profile 12 hours fasting is required.
2. Misidentification of the patient: - It is very important to identify a patient accurately. Look for patient's full name, address, ID number, Hospital number, etc. Look for ID band in case of indoor patient.
3. Mislabeling of Specimen: -Labeling the correct patient's sample with different patient's label can create problem in the test result.
4. Improper collection of the sample: - For example haemolysed blood sample. This can result from.
    - Traumatic venipuncture.
    - Blood collected from area of haematoma.
    - Blood collected in insufficient amount of additive in the tube.
    - Vigorous shaking of the tube after collection.
    - Blood collected by a small bore needle.
5. Insufficient Sample Volume: - Unable to carry out all requested tests.
6. Improper collection time:- Most of the blood samples are collected at the basal state i.e. early morning 8-12 hours after food ingestion. Patient should not take food if fasting sample is collected.
7. Improper specimen container:- Wrong collection tubes can cause variation in the result. Blood for haematological investigations should be collected in EDTA bulb. Blood for sugar estimation should be collected in fluoride bulb. For biochemical examination when serum is required blood should be collected in plain bulb.
8. Improper Volume of specimen: - All theblood tubes need to be filled to the correct volume as per blood to additive ratio. Incomplete filling will result in specimen dilution and wrong test result.
9. Improper specimen storage: - The blood sample should be stored properly. Sample left overnight at room temperature will give falsely elevated K or red cell enzymes.
10. Improper Transport: - the specimen needs to be transported at appropriate temperature. e.g. for ABG and Serum Ammonia the sample should go on ice, for cryoglobulins it should be warm at 37^0C.
11. Other factors.
    i. The sex of the patient.
        - male or female
    ii. The age of the patient.
        - new born / juvenile / adult / geriatric

iii. Dietary effects.
- low carbohydrate / fat/high protein / fat

iv. When the sample was taken.
- early morning urine collection pregnancy testing.

v. Patient posture.
- urinary protein in bed-ridden patients.

vi. Effects of exercise.
- creatine kinase / CRP

vii. Medical history.
- heart disease / diabetes / existing medication.

viii. Pregnancy.
- hormonal effects.

ix. Effects of drugs and alcohol.
- liver enzymes / dehydration.

Analytical Errors

These errors tough form a small percentage are very important. They include-

1. Problem with specimen.
   - Incorrect volume of the specimen.
   - Incorrect storage of the specimen.
   - Specimen Mix-up
2. Problem with the equipment: - These include glassware, pipettes, balances, etc. If these equipment are used incorrectly or if they are properly calibrated error can occur.
3. Problem with the reagents.
   - Poor quality of reagents.
   - Inappropriate storage of the reagents.
   - Incorrect preparation of the reagent.
   - Stability of the reagents.
4. Problem with the instrument:-
   - Operational limitations.
   - Lack of maintenance.
5. Other factors:-
   - Calculation Errors.
   - Transcription Errors.
   - Dilution Errors – incorrect dilution.
   - Lack of training.
   - Human factor- timelessness, stress, carelessness.

Post- Analytical Errors

These errors though form a small percentage are very important. They include—

1. Wrong matching between sample and laboratory's files.
2. Wrong copy of results from the analyzer's report to the laboratory report. (in cases ofmanual transfer)
3. Delay in delivering the results to the physicians, clinics or patients.
4. Loss of the results.

Some Definitions:

1. **True value**:- An ideal concept, which cannot be achieved
2. **Accepted True value**: - The value approximating the 'True Value'; the difference between the two values is negligible.
3. **Error** :- Error is the discrepancy between the result obtained in the testing process and its 'True Value' / 'Accepted True Value'
4. **Accuracy** is the closeness of agreement between the result of measurement and the true value of the measured.
5. **Precision** is the closeness of agreement between the results of successive measurements of the same value of a quantity carried out under identical conditions at short intervals of time.

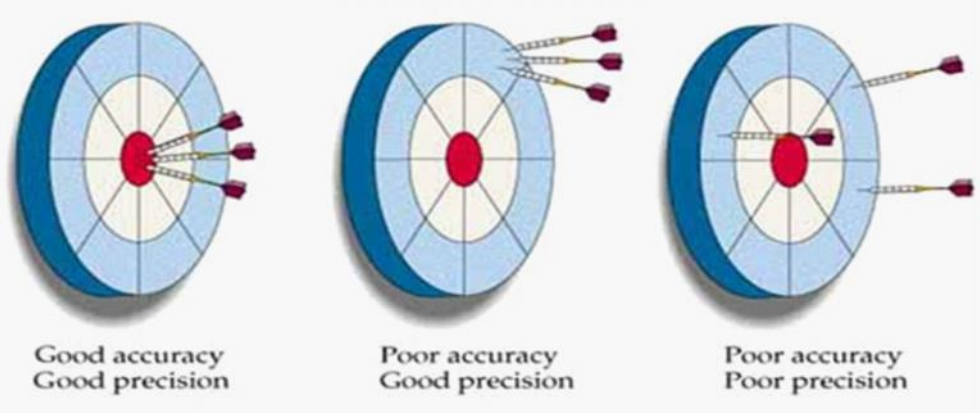


Figure10.4 Precision and Accuracy

6. **Reproducibility** is the closeness of agreement between corrected results of measurement of the same value of a quantity when measurements are made under different conditions.
7. **Resolution** is the smallest difference between indications of a displaying device that can be meaning fully distinguished.

Types of Errors

1. Random error.–

An error which varies in an unpredictable manner, in magnitude and sign, when a large number of measurements of the same quantity are made under effectively identical conditions.Random error is caused by unpredictable fluctuations in the readings of a measurement apparatus, or in the experimenter's interpretation of the instrumental reading. Random errors create a characteristic spread of results for any test method and cannot be accounted for by applying corrections. Random errors are difficult to eliminate but repetition reduces the influences of random errors.

Examples of random errors include errors in pipetting and changes in incubation period. Random errors can be minimized by training, supervision and adherence to standard operating procedure.

2. Systemic error.–

An error which, in the course of a number of measurements of the same value of a given quantity, remains constant when measurements are made under the same conditions, or varies according to a definite law when conditions change.

Systematic errors create a characteristic bias in the test results and can be accounted for by applying a correction.

Systematic errors may be induced by factors such as variations in incubation temperature, blockage of plate washer, change in the reagent batch or modifications in testing method.

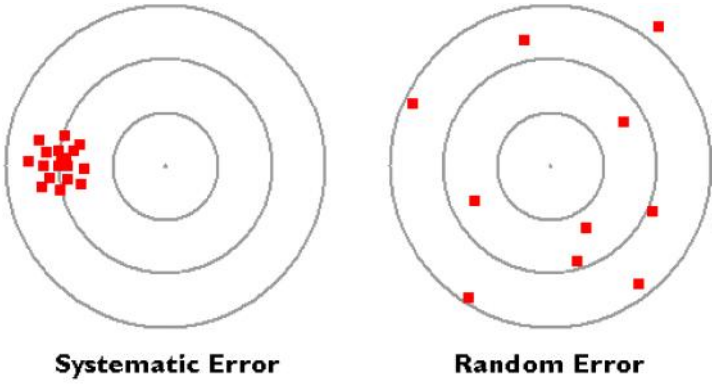


Figure 10.5 Systematic and Random Errors

10.5 BASAL STATISTICS

Quality control involves statistics, the science of collecting and classifying data to show their significance.

Calculating Mean and Standard Deviation

The mean is the average of a set of values.

Calculating the mean

The mean is calculated by computing the sum of all the values in he set and dividing by the number of values in the set (i.e. average of the set of numbers).e.g. if the values obtained in repeated analysis for a glucose control serum were as follows:

82, 85, 90, 86, 91, 90, 81, 86, 94 and 89. The formula for calculating mean is

$$\overline{x} = \frac{\Sigma x}{n}$$

where $\bar{x}$ = mean

x = each individual value in the set

$\sum$ = sum of all individual values and

n = the number of values in the set

So, in the above example mean is

$$\overline{X} = \frac{82+85+90+86+91+90+81+86+94+89}{10} = 87.4$$

Calculating the Variance

Variance is a measure of the variability about the mean. It is calculated by subtracting each value in the set from the mean, squaring the number, and calculating sum of the squares. That sum is then divided by n-1, which is the number of individual values in the set minus one. The formula of variance is

$$s^2 = \frac{\Sigma (X - \bar{X})^2}{N-1}$$

In the above example variance can be calculated as below.

Test value (mg/dl)	Deviation from mean $(X\text{-}X)^2$	Deviation squared (X—X)
82	5.4	29.16
85	2.4	5.76
90	2.6	6.76
86	1.4	1.96
91	3.6	12.96
90	2.6	6.76
81	6.4	40.96
86	1.4	1.96
94	6.6	43.56
89	1.6	2.56
874	Total	152.4

$$\text{Variance} = \frac{152.4}{9} = 16.93$$

Calculating the Standard Deviation (S(D)

The standard deviation is the square root of the variance.

SD = $\sqrt{\text{variance}}$ or S = $S = \sqrt{\frac{(x-\bar{x})^2}{N-1}} = \text{mg/dl}$

SD is commonly used (rather than the variance) since it has the same units as the mean and the original observations.

SD is the principle calculation used in the laboratory to measure dispersion of a group of values around a mean. The SD in above example is $S = \sqrt{\frac{152.4}{9}} = 4.11$

Therefore the standard deviation 1s is 4.11, 2s is 8.22 and 3s is 12.33 for this particular control of glucose.

Normal Distribution Curve (Gaussian curve)

When a set of values with a normal distribution is plotted on a graph, the distribution of the values around the mean forms a curve called as Normal Distribution Curve or Gaussian curve. In a normal distribution half the values are greater than the mean and half the values are less than the mean. There are also more values close to the

mean than values away from the mean. Once we know the standard deviation and values of 1s, 2s and 3s we can divide the graph in to percentage division as shown in the figure.

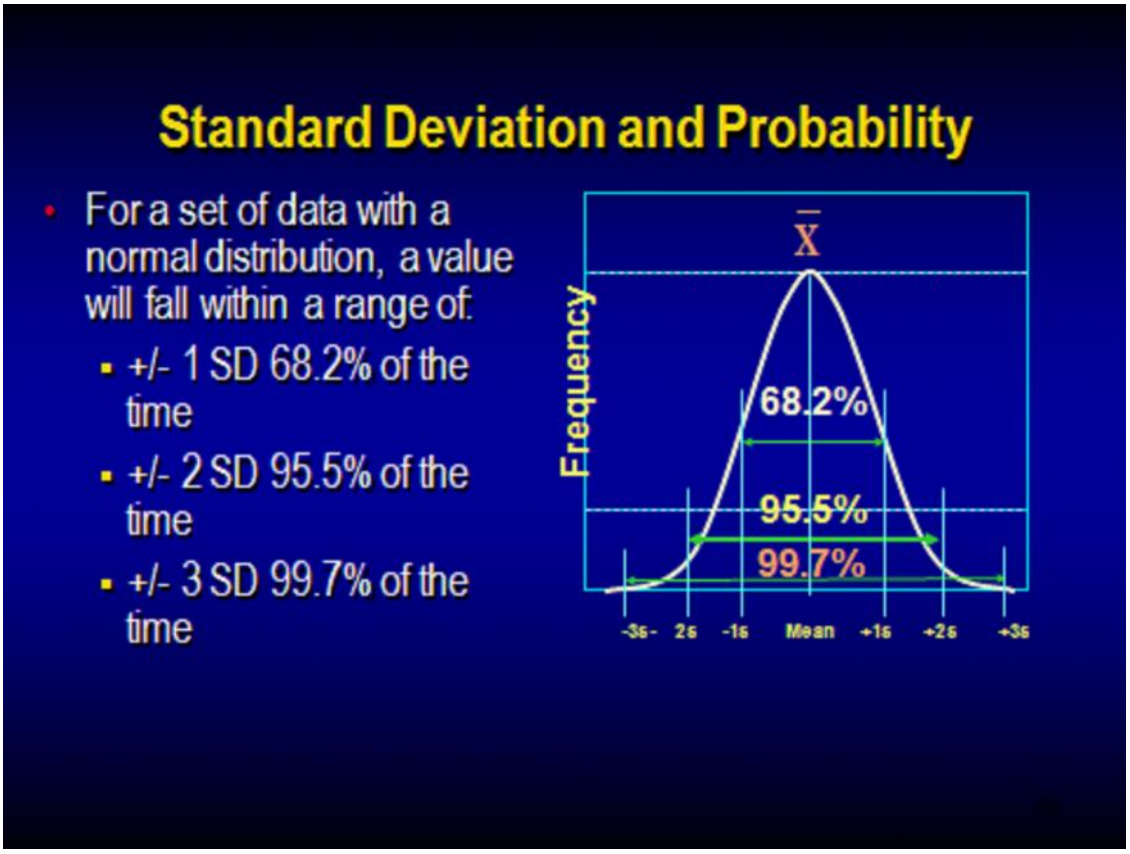


Figure 10.6 Standard Deviation Curve

In the figure you can see 68.2% of all results of this glucose analysis fall into the group 1s to 1s. That means 68.2% of the values fall between 83.29 (87.4-4.1(1) and 91.51 (87.4+4.1(1).

In addition 95.5 % of all results fall between the group 2s to 2s and 99.7% of all results fall between the group 3s to 3s.

Generally up to +/- 2s are the acceptable limits for most of the laboratories for any test. When the QC measurement falls within that range, there is 95.5% confidence that the test is correct. Only 4.5% of the times will a value fall outside the range more likely due to error.

Calculation of Coefficient of Variation

The Coefficient of Variation (CV) is the standard deviation expressed as a percentage of the mean. Ideally it should be less than 5%.

$$CV = \frac{SD}{mean} \times 100$$

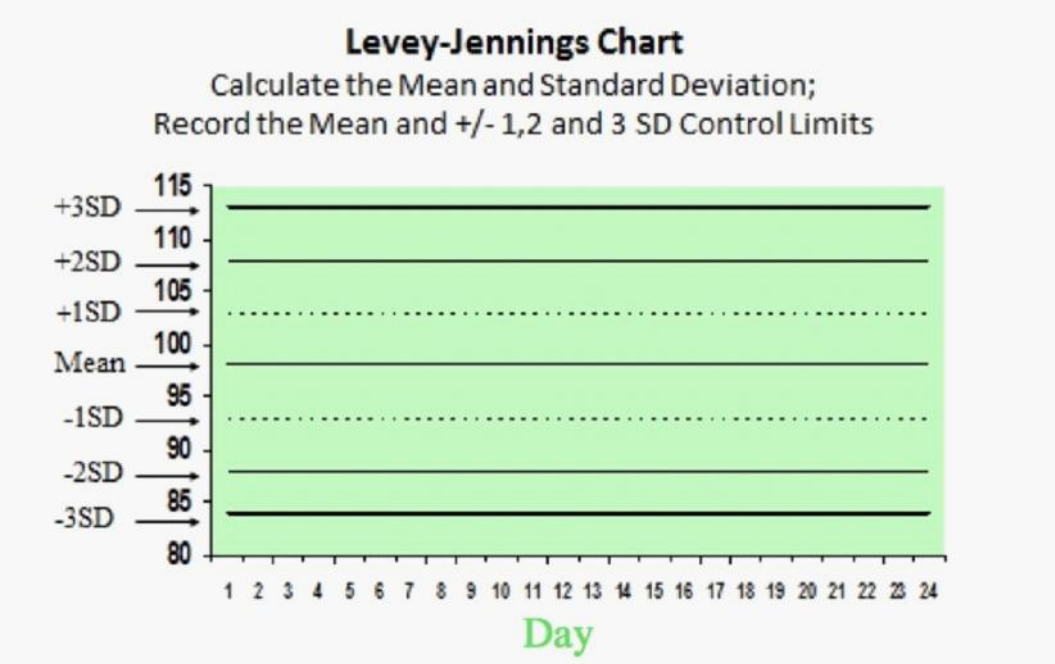
10.6 Levey – Jenning Chart

A Levey-Jennings chart is a graph on which quality control data is plotted to give a visual indication whether a laboratory test is working well.

It is a graphical method for displaying control results and evaluating whether a procedure is in-control or out-of-control.

Control values are plotted versus time.

Lines are drawn from point to point to accent any trends, shifts, or random excursions.



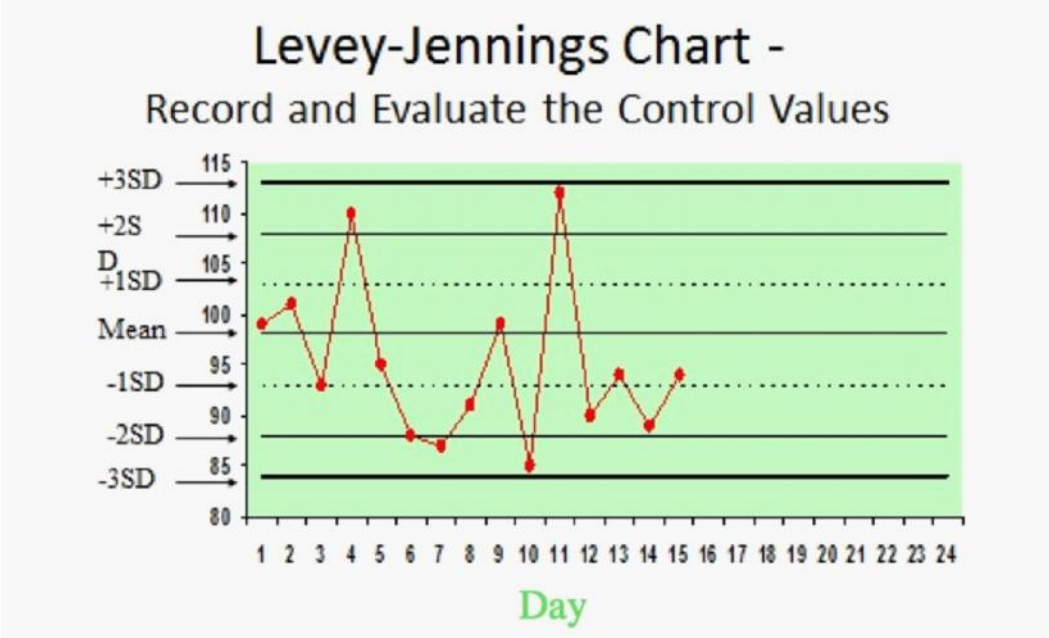


Figure10.7 Levey-Jenning Chart

Three types of change is commonly observed in LJ charts, which results from different sources:

1 Drift or Trend

2 Dispersion

3 Shift

DRIFT OR TREND:

- Seen when the control value moves progressively in one direction from the mean for a minimum of three (3) days.
- Suggests that a problem is gradually developing, such as deterioration of a reagent or control.

DISPERSION:

- Increase in Random Errors and Lack of Precision.
- Suggests inconsistency of technique or fluctuations in instrumentation function.

SHIFT:

- Abrupt changes observed when a problem develops suddenly.
- May be due to instrument malfunction or an error in technique.

Review Questions:

1. What is Quality control? Why is it necessary?
2. Define Quality Control, Quality Assurance and Quality Management.
3. Differentiate between Quality Control and Quality Assurance.
4. Define an error. Which are the commonly seen errors in the laboratory?
5. Classify laboratory errors.
6. Describe the Pre-Analytical errors in short.
7. What is Mean and Standard Deviation? Give formulae.
8. Write in short about Levey-Jennings chart.

LESSON 11

MATERIAL MANAGEMENT

Objective.–*At the end of this lesson the student will be able to purchase the Right quality of materials, in Right quantity, at the Right time, at the Right place and at the Right cost. He will also be able to maintain the stock registry and will know the importance of proper storage of the material.*

11.1 Importance of Material Management

Material may be defined as equipment, apparatus and supplies procured, stocked and utilized by an organization.

The proper management of reagent and supplies in the laboratory is very essential. A proper system of purchasing and inventory control will ensure prompt and reliable supplies and reagents and will also save the cost. The cost of supplies and materials takes about 20% of the overall laboratory budget. The quality, availability and management of these products can have a significant impact on laboratory efficiency and productivity. It is also important that along with the quality of the reagents and supplies it is also essential that they are used and stored in a manner that preserves their integrity and reliability. This is only possible with proper material management.

11.2 Definition of Material Management

Material management is a scientific technique, concerned with Planning, Organizing & Control of flow of materials, from their initial purchase to destination.

11.3 Aim of Material Management

The fundamental objective of material management is often called the famous 5 'R's.

It is to get the material and services...

1. Of the Right quality.
2. In Right quantity.
3. At the Right time.
4. At the Right place.
5. For the Right cost.

11.4 Objectives of Material Management

The objectives of material management can be classified into two categories - primary objectives and secondary objectives.

Primary Objectives: They include

1. Low cost: -The most important aspect of material management is to get correct quality of the material at lowest possible cost.
2. Lower Inventories: By keeping inventories low in relation to sales, it ensures that less capital is tied up in inventories.
3. Low storage Cost: - Which reduces capital and recurring expenses.
4. Procurement of Quality Materials: The quality of material purchased from outside supplier can be monitored by Material management manager.
5. Maintains Regular Supply: -Continuity of Supply of material is very essential.
6. Efficient handling of Materials: - The effective material control techniques help the efficient handling of thereby lowering of production cost.

7. Avoids wastage of materials.
8. Cordial Relationship with the supplier: - Good relations with the supplier increase the goodwill of the laboratory.

Secondary Objectives: They include

1. Favorable Reciprocal relations.
2. New Material and products.
3. Economic make and buy decisions: - The material management manager can decide whether the reagent is to be purchased or can be prepared in the laboratory itself.
4. Standardization: - Standardization of reagents and chemical is greatly helpful in controlling material management process. Non-standardized items can be rejected.
5. Inter-departmental Harmony: - successful management of the material will contribute to the success of other departments of the laboratory which will improve the internal harmony.

11.5 Functional Components of Material Management

The functional components of material management are..

1. Material Requirements Planning (MRP):

Planning of material required in the laboratory is the first step in material management.It involves two major steps.

(a) Identification of Items: - The list of reagents, chemicals and non-consumables required to be purchased should be prepared.

(b) Estimation of Demands: - The expected quantity of all the required items should be calculated.

2. Purchasing or Procurement

Efficient and economic purchasing and procurement of materials forms an important function of MM. Since the function of laboratory and the quality of results totally depend on the reagents and instruments, the purchase of good quality material at lowest cost is very essential. The main functions of purchasing are…

I. Determination of requirements: - The materials required are identified by the concerned department and requisition should be received by a proper authority.

II. Selection of the potential source of supply – It can be done from past orders. Look for qualification and credibility of the supplier.

III. Receipt and analysis of the quotations: - All the quotations received are analyzed on the basis of material specificity and quality, price of material, taxes, terms of payment, place of delivery, delivery period and guarantee period.

IV. Selection of the right source of supply: -The best quotation is selected.

V. Issuing a purchase order – It is prepared from the requisition and quotation.

VI. Monitor the order status: - Follow up the order and reminder if required can be send to the supplier.

VII. Receipt of the material and inventory management: - All the material received is checked as per order. The quantity and quality of the material is confirmed.

VIII. Invoice Verification: - Check for the supplier's invoice and approve for payment.

IX. Maintenance of record and file:- for future reference.

3. Inventory Control

It means stocking adequate number and kind of stores, so that the materials are available wherever required and whenever required

For accuracy of the work of a laboratory it is necessary that all the materials required to run the laboratory are available whenever needed. An effective system of inventory control provides economical laboratory management and avoids unnecessary delay in obtaining the test results. The following are the important steps in inventory control programme.

Figure 11.1 Inventory Control

1. Assign Responsibility: - Depute a person who will take responsibility of all the work related to inventory.
2. Analyze the needs of the laboratory: -Make a list of all the test performed in the laboratory and identify all the reagents and supplies required for these tests.
3. Quantification: -Establish the minimum stock needed for an appropriate time period e.g. approximate usage of particular kits in a month.
4. Develop the needed forms and logs e.g. stock log book, supplies request form, etc.
5. Establish a system for receiving, inspecting and stocking supplies: - all supplies and reagents should be inspected when they are received to be sure that they are in good condition. Also check the things received are the one which was ordered. Storage of the reagent and supplies is also an important part of inventory control.
6. Maintain an inventory system in all storage areas, for all reagents and supplies used in the laboratory.

11.6 Methods of Inventory control

The following are the methods of maintaining the inventory.

(A) Workbench Inventory

Workbench inventory is carried out every day at the end of the day's work. This is because there should not be any shortage next day morning when the work begins. The drawers under the bench should be well organized with proper compartments for pipettes, rubber-tubs, glass rods, slide sand others. Number the drawers and

list the materials as they are kept in these drawers. Take a daily inventory and replenish the items used up during the day's work. This inventory can include items such as glass-wares, reagent solutions, and culture media etc. This daily record of suppliers serves an important aid in measuring the work load of lab and is a source of information for requisitions and for more general inventories of stock rooms.

(B) Store Room inventory

Every store room should have a storekeeper who can be one of the staff of the laboratory. He will care for the storeroom, prepare orders or requisitions, check orders received, distribute supplies as needed, and keep or running inventory.

Stocks should be prepared before the regular supply is exhausted. Whenever an order is placed all the specifications should be mentioned.

11.7 STOCK CARD

It is a simple way of maintaining an inventory list. An index card is prepared of the size approx. 10cm X 15 cm for every item in the stock i.e. Chemicals, stains, glass wares, etc. They are arranged in an alphabetical order. Although time consuming to keep up to date, stock cards have many advantages. They provide information about quantities received, issued and in stock at any time, can be used to calculate orders, and are a useful tool for preventing shortages and over-stocking.

Year 2014 Stock Card

Item: Leishman's stain

Ordered Date	**ORDERED**			**RECEIVED**			**ISSUED**		
XYZ chemicals	Date	Quantity	In Stock	Date	Quantity	In Stock	Date	Quantity	In Stock
	15th March	2 bottles	1 bottle	16th April	3 bottles	3 bottles	15th May	1 bottle	2 bottles

- When an order is made, the name of the place from where ordered should be written in the column "ordered from". The date, amount ordered and balance in stock at the time of placing order should be written in the column "ordered."
- When the order is received from the supplier the date, amount received and stock after addition of new stock should be written in the column "received."
- When the items are issued the date, amount issued and balance in stock should be written in the column "issued".
- All the stock cards are checked one by one to draw up an order. An order must contain an exact description of the item and should be submitted to the central supplies every 3 months. In case of volumetric glassware the grade, size, shape and volume should be mentioned. Biological stains should be ordered using a colour index number.
- Some regents which are to be used before expiry date (e.g. Blood grouping Antiser(a) the date of expiry should be written on the top of the stock card.

4. **<u>Ascertaining and Maintaining the Flow and Supply of Materials</u>**

Distribution of materials requisitioned by the various departmentsmust be ascertained and its flow and continuity of supply must be maintained by the materials management department. Insufficient or zero inventories many times create the situations of stock-outs and affect the working of a laboratory. Alternatives or

emergency supply systems can be used for efficient and uninterrupted working of a laboratory.

5. Quality Control of Materials

The quality and reliability of the result of a laboratory depends upon the quality of the reagents and supplies used. It is a very important and necessary function of materials management to purchase the right quality of materials. The inspection, quality control, simplification, specification, and standardization are the activities which are to be followed for the measurement of quality of the materials. The quality assurance is decided by inspection and checking.

11.8 Stock Register

Every item in the lab should be recorded in stock register. Stock register is having a declaration certificate noting the number of pages on the front page which must be signed by the authority. Every item should be recorded on separate page. The specification, date of purchase should be stated.

There are two types of registers to be maintained.

(A) Dead Stock Register.

(B) Consumable or semi consumable register.

(A) Dead Stock Register :—

This contains the list of all types of equipment, furniture, etc. which are not destroyed or which are not broken and which are not in use.

(B) Consumable or semi consumable register

This contains the list of reagents and kits which are consumed and they should be purchased at regular intervals, when the stock is exhausted. By observing these registers we can get information regarding each and every item in the labs.

11.9 Ordering the Materials (Ordering Supplies)

Lab chemicals, glass-wares and other inventories are procured by one of the following system.

(a) By inviting tenders :

Tender is

(i) Open tender - by advertising in the press.

(ii) Limited tender - by sending written enquiries to known, reputed suppliers.

(iii) Single tender - by sending written enquiries to a single supplier if it is in the knowledge of the indentor that the stores/equipment required is manufactured only by that supplier.

The Items are selected on the basis of price and quality. Orders are placed to the firms as and when required.

(b) Yearly Rate Contract

The rates of different items are finalized with a panel or firms on yearly basis. The lab sends the orders directly to these firms as per their requirements.

(a) Through DGS and D rates

The director general supply and disposal finalizes the rates of different items which are from different firms and informs all the govt. organizations about it. The lab can give order as per their requirement. The DGS & D ensures the supply and inspect the items of respective lab.

(b) Through MSD

(The medical supply department) This is a Govt. organization. It purchases and stores all items all over the country and the lab can place over the orders to their respective depots as per their requirements.

(e) Local Purchase

Some times when certain reagents or chemicals etc. are not in stock the local purchase is availed for certain amount.

(f) Direct purchase

The private labs can purchase the materials directly from the market. There is no compromise done about the standards and quality of the product.

11.10 STORES

Storage of reagents and supplies is a very essential part of inventory control. The important points to be remembered about storage are –

1. The store should be located at a convenient place for receipt of supplies and deliver with adequate space, facilities, preferably located in basement.
2. The storeroom should be clean, organized and locked to protect the inventory.
3. The storage area should be well-ventilated and protected from direct sunlight.
4. The shelf should be strong enough to support items and attached firmly to the walls.
5. Items should be easily accessible to the staff. The heavy items should be placed at lower shelves.
6. Step up stools should be available to reach the higher shelves.
7. Rule of FIFO i.e. first in first out should be applied. Put the new shipment behind existing material that are already in the laboratory. Organize the reagents and material such that the older material gets used first and the items with early expiry dates are used first.
8. Regular pest control should be carried out in the storeroom.

11.11 Laboratory Information Management System (LIMS)

Laboratory information system or LIMS is software used for data management and the efficient sharing of lab data. The primary function of a laboratory information system is to manage samples. Every sample that comes in the laboratory is registered in the LIMS. The system generates a barcode that can be affixed on the sample container. Besides registering the entry of a sample, it also records data such as phenotypic and clinical information related to the sample.

LIMS is also equipped with a database to store all laboratory data generated in various laboratory processes. A laboratory information system can be interfaced with laboratory instruments and other systems to record data related to samples and test results. LIMS also has the ability to track the location of samples in a laboratory. Its tracking feature can provide exact location information, such as freezer compartment, shelf, box, rack, and even the column or row in which the sample is stored. The system also records the thaw and freeze cycle that the sample undergoes while in the laboratory.

Different types of laboratory information systems:

There are two types of laboratory information systems: web based and web enabled LIMS.

(a) Web based LIMS is a 100% web based application requiring no installation of software on the client side. All functions of the laboratory information system can be accessed through an internet browser. This reduces the maintenance cost of LIMS since all data and functions are stored on the server. There are no conflicts of software as the client side does not have any special software installed. The performance of the LIMS depends on the server, which can be upgraded as per business requirements.

(b) Web enabled systems are based on a client server architecture where some or all functionalities of LIMS are available through a web interface. A web enabled system can use web connectivity to replace direct connections between the client and database. The use of web enabled laboratory information system is limited to PCs that have the client software installed. These systems require maintenance and updating of the client software for efficient functioning. The performance of a web enabled system depends on both components of architecture, such as the client and server.

Advantages offered by laboratory information system:

- Electronic data entry: LIMS eliminates the need for manual entry of different laboratory data such as sample data and experiment and test results. It also does away with the need for physical storage space as all data is stored digitally in the database, which can be easily reviewed and retrieved.
- Automated calculations: The laboratory information system is interfaced with laboratory instruments and equipment that enable the collection of data in an automated manner. The system can perform the required calculations electronically, which eliminates the probability of human errors in calculations and eliminates the need for crosschecking of calculations.
- Decreases sample turn around time: Most laboratory processes performed by LIMS do not require human intervention. The system is capable of recording data and test results and performing the required calculations. This helps reduce the turn around time and improves the efficiency of the laboratory.
- Web enabled and web based LIMS have their own set of advantages and disadvantages. It is the business requirement which determines the type of laboratory information system can provide efficient data management and maximum flexibility at reduced costs.

Review Questions:

(1) Define Material Management. Why is it necessary in the clinical laboratory?

(2) What are the objectives of material management?

(3) Which are the functional components of material management?

(4) What is Inventory Control? Give details.

(5) Write in short about 'Stock Card'.

(6) Write in short about 'Ordering Supplies'.

(7) Write in short about LIMS (Laboratory Information Management System).

LESSON 12

MULTI SKILLS FOR LABORATORY TECHNICIAN

Objectives.– *At the end of this lesson the students will know the multiple job options available for them in the other medical fields other than clinical laboratory and also their job responsibilities on that post.*

Medical laboratory technicians are trained to carry out all routine diagnostic tests, as well as set up, clean and maintain medical laboratory equipment. They use automated equipment and computerized instruments capable of performing a number of tests simultaneously, as well as microscopes, cell counters, and other sophisticated lab equipment. With all the teaching of the human body and related subjects they can not only work in a clinical laboratory, but can also get jobs in other medical fields. The important areas where a Medical lab technician can work are:

12.1 Phlebotomist

Phlebotomists are specially trained medical professionals that typically work in clinical laboratories, hospitals, community health centers, nursing homes, physician's offices, and blood banks. There are numerous job opportunities for people with phlebotomy certification and the career is one of the fastest growing in the industry today.

Job description :

Phlebotomist collects blood from a patient for clinical or medical testing, transfusion, donations or research. The blood is collected by a procedure called venipuncture. The various duties of phlebotomist are:

- Proper identification of the patient.
- Interpreting the tests requested on the requisition,
- Drawing blood into the correct tubes with the proper additives,
- Accurately explaining the procedure to the patients,
- Preparing patients accordingly,
- Practicing the required forms of asepsis,
- practicing standard and universal precautions,
- Performing the skin/vein puncture,
- Withdrawing blood into containers or tubes,
- Restoring hemostasis of the puncture site,
- Instructing patients on "post puncture care".

12.2 ECG Technician

An ECG (electrocardiograph) technician is responsible for operating equipment that measures patients' heart activity in order to allow physicians to diagnose and treat problems and diseases of the cardiac and peripheral vascular systems.They can be employed in Cardiac unit of hospitals, Private cardiology offices, Emergency department and Laboratories.

Procedure of recording ECG:

Recording an ECG from a patient is a relatively simple procedure. This should include these steps:

Preparation of the patient

a. Confirm the identity of the patient requiring an ECG.

b. Explain the procedure to the patient.

c. Offer the patient privacy.

d. Remove the patient's clothing to allow ECG recording while minimizing exposure and maintaining warmth.

e. Position the patient in the supine position.

f. The removal of chest hair may be required to ensure adequate contact with skin.

Recoding an ECG

a. Place the ECG electrodes in the correct position on the patient's Limbs and chest.

Limb Leads

They are four in number and are attached as given below.

- Right arm limb lead (RA, Re(d) to right forearm, proximal to the wrist.
- Left arm limb lead (LA, Yellow) to left forearm, proximal to the wrist.
- Left leg limb lead (LL, Green) to left leg, proximal to the ankle.
- Right leg limb lead (RL, Black) to right leg, proximal to the ankle.

Chest Leads

There are six chest leads or precordial leads and are placed on the chest as below.

Electrode	Position
V1	Fourth Intercostal space at the right sternal angle.
V2	Fourth Intercostal space at the left sternal angle.
V3	Midway between V2 and V4.
V4	Fifth Intercostal space in the mid-clavicular line.
V5	Left anterior axillary line at the same horizontal level as V4.
V6	Left Mid-axillary line at the same horizontal level as V4 and V5.

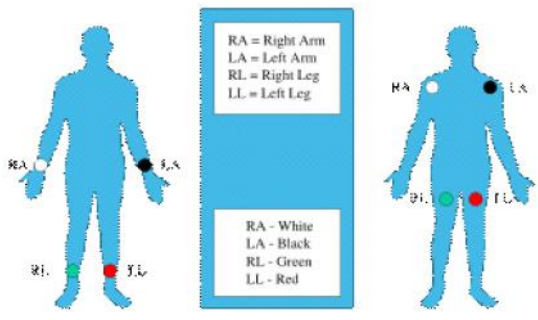


Figure 12.1 Positions of the Limb Leads

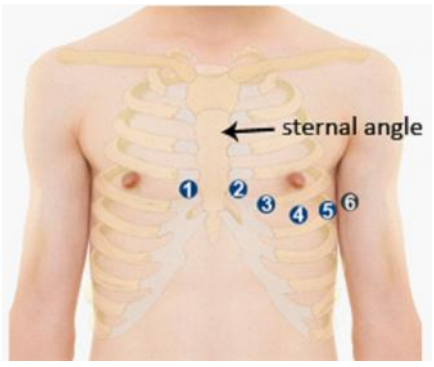


Figure 12.2 Positions of the Chest Leads

b. Connect the labelled ECG leads to their corresponding electrodes.

c. Turn on the ECG machine.

d. Press the 'filter' switch to 'on'.

e. Enter patient details.

f. Advise the patient to relax and lie still.

g. Press the appropriate button on the machine to initiate recording, usually 'start' or 'auto'.

h. Review the printed ECG to confirm adequacy of the tracing.

i. If the ECG machine does not allow direct entry of patient details, these should be attached to the ECG as soon as the tracing is recorded.

j. Mounts ECG Recording onto the adhesive side of the card sheet.

k. Send it to the physician for reporting.

12.3 Hospital Record Technician

Hospital record technicians manage, maintain and organize patient health-care records. Depending on the employer, hospital record technicians may also be called medical record technicians, health record technician, medical records clerks, health information clerks or medical records analysts. The exact duties that hospital record technicians perform are –

1. Compile, process, and maintain medical records of hospital and clinic patients in a manner consistent with medical, administrative, ethical, legal, and regulatory requirements of the health care system.

2. Process, maintain, compile, and report patient information for health requirements and standards.

3. They make sure that patients' initial medical charts are complete, all forms are completed and properly identified and signed, and that all necessary information is in the computer.

4. They regularly communicate with physicians and other health care professionals to clarify diagnoses or to obtain additional information.

5. Some medical records and health information technicians specialize in coding patients' medical information for insurance purposes. Technicians assign a code to each diagnosis and procedure.

6. Maintains patient confidence and protects hospital operations by keeping information confidential.

12.4 Preparation and Distribution of reagents, kits and chemicals

Medical laboratory technician is fully trained in the field of laboratory reagents and chemicals. He knows the needs of the various reagents as well as about the standards and specificity of them. He is also well aware of the quality of the reagents and chemicals and their quality control.

Laboratory medicine is a fast growing filed. The number of diagnostic laboratories is increasing day by day so as the requirement of the various laboratory chemicals and reagents. The medical lab technician can start working as a distributor of these reagents and chemicals or various diagnostic kits after getting a valid license from the concerned department.

(G.C.P.) Ra 751—13(1500-9-2015)

Review Questions:

1. Who is a phlebotomist? What are the job opportunities as a phlebotomist?
2. What are the duties of a Phlebotomist?
3. Which are the different leads of ECG and give their positions.
4. Describe the procedure of recording an ECG.
5. What are the duties of a Hospital Record Technician?

GLOSSARY

1. **Accuracy** – Exactness, the state of being absolutely correct and making no mistakes.
2. **Aerosols** – A suspension of fine particles of a solid or liquid suspended in a gas or air.
3. **Aetiology** – The scientific study of the causes or origin of a disease.
4. **Aggressive** – Always ready to attack, hostile, very energetic.
5. **Anaemia** – Abnormal reduction in the amount of the oxygen carrying capacity of Haemoglobin in the red blood cells due to dcerease in Hb or RBC which is characterized by fatigue breathlessness and which is caused by blood loss, iron deficiency, etc.
6. **Analyzer** – A machine which detect and identify the different chemical compound in the chemical plasma.
7. **Anesthesia** – A reversible loss of sensation in all or part of the body, usually induced by drugs which may be inhaled or injected intravenously or by acupuncture.
8. **Angiography** – The examination and recording of the condition of blood vessels by X- ray after they have had injected by some agent (dye) so that the vessels are more clearly defined which is done by Catheterization.
9. **Angioplasty** – Removal of block in the blood vessels of heart by putting stent during angiography.
10. **Antidote** – A medicine taken to counteract a poison. A thing that counteracts something unpleasant.
11. **Antiserum** – Blood serum containing antibodies.
12. **Arthropod** – Invertebrate – living animal e.g. insects, fleas, bugs etc.
13. **Asbestos** – Fibrous silicate minerals that are highly resistant to heat and it is chemically inert used in fire resistant and insulating materials.
14. **Ascitis** – Fluid collected in the membranes covering intestine in the abdomen.
15. **Assessment** – The act of judging the quality of something especially student's work or evaluator, estimation. Or an amount to be paid.
16. **Assurance** – A promise, guarantee or statement that something is true, Insurance especially life insurance.
17. **Attitude** – A way of thinking or feeling or behaving about someone or something.
18. **Autoclave** – A strong steel container or device that can be made airtight and filled with pressurized steam in order to sterilize equipment etc.
19. **Autoclaving** – Process of sterilization by autoclave.
20. **Autonomous** – Independent of others, or self – governing
21. **Autopsy** – Post mortem examination of dead body to find out cause of death.
22. **Ayurveda** – An ancient system of Hindu medicine.
23. **Biopsy** – An examination of tissue taken from the body to detect the presence or cause of disease.

24. **Bladder** – Hollow & muscular sac in humans to collect urine.
25. **Borosilicate** – Hard glass.
26. **Bowels** –Intestine (Large)
27. **Breeze** – A gentle wind.
28. **Carcasses** – The dead body of animals.
29. **Catheter** – A hollow, slender, flexible tube that can be introduced into a narrow opening or body cavity or blood vessels during diagnosis or treatment.
30. **Catheterization** – Procedure of introducing catheter in the blood vessel to find blocks in the blood vessels of the heart.
31. **Centrifugation** – Is a process of separating solid or liquid particles of different densities.
32. **Centrifuge** – A machine with a rapidly rotating device that used to separate solid or liquid particles of different densities.
33. **Chromosomal** – A thread like structures in a cell nucleus carrying the genes.
34. **Coagulate** – To cause (a liquid, blood) to clot, curdle or form a soft semi-solid mass.
35. **Code** – A set of principles of behavior. A systematic organized set of laws.
36. **Coefficient** – In algebra- a number or other constant factor placed before a variable is to multiplied by that factor.
37. **Compost** – Decayed organic material used as fertilizer
38. **Compounder** – Who mixes, prepares and dispenses medicines in the clinic are dispensary to the patient.
39. **Conjunctiva** – Thin mucous membrane that covers the exposed surface of the sclera (white part) at the front of the eyeball.
40. **Considerate** – Careful not to harm or cause inconvenience to others.
41. **Consume** – To eat or drink, to use up , to destroy absorb all of the attention and energy of Consumable – adjective of consume.
42. **Contamination** – Adulterate, befoul, dirty, infect,polute, etc. mainly infect.
43. **Courteous** – Polite, considerate and respectful.
44. **Cultivation** – To grow.
45. **Culture** – A preparation or growth of cells or bacteria in an artificial medium.
46. **Culture media** – Relating to the growing of bacteria and other micro-organism for scientific studies or for medical diagnosis
47. **Database** – A structural set of data held in computer, collection of computer data.
48. **Decontamination** – Make something safe by removing dangerous, poisonous substance from.
49. **Defibrillation** – Application of an electric current to the heart to restore normal rhythm. Defibrillator – A machine which applies electric current to the heart or chest during defibrillation.

50. **Deviate** – To turn aside or move away from what is considered normal or correct or standard of behaviour.
51. **Deviation** – The act of deviating.
52. **Diagnose** – To identify an illness by examining the symptoms and the patient's medical history.
53. **Dialysis** – Removing of toxic substances from the blood by diffusion through a semi permeable membrane in an artificial kidney machine used in a kidney failure.
54. **Dimension** – Measurable extent such as length, breadth, height or an aspect or feature of a problem, situation.
55. **Electrocardiogram (ECG)** – The diagram or tracing produced by an electrocardiograph.
56. **Electrocardiograph** – An apparatus which registers the electrical variations of the beating heart as a diagram or tracing.
57. **Electrocuted** – To kill someone or something by electric shock.
58. **Electrodes** – A conductor through which electricity enters or leaves something.
59. **Epidemic** – Sudden outbreak of infectious disease which spreads rapidly and affects a large number of people, animals in a particular area for a limited period of time.
60. **Epidemiologist** – The person who does the study of distribution, effects and causes of diseases in population
61. **Eradicate** – To get rid of something completely.
62. **Error** – A mistake, inaccuracy, the possible discrepancy between an estimate and an actual value or amount.
63. **Ethics** – Rules or principles of behaviour or set of moral principles.
64. **Exfoliated** –Shed or be shed from a surface in scales or layers.
65. **Extinguisher** – A person or thing that extinguishes.
66. **Fogging** – Cover or become covered with steam, confuse Blurred patch on a negative print transparency which can be caused by excess light, chemicals or impurities.
67. **Fungal** – Spore producing organism.
68. **Genital** – Referring to the human or animal reproductive organs.
69. **Gravitational** – The process of moving or being drawn by gravity (Earth gravitational field.)
70. **Haemostasis** – Medicine- the stoppage of the flow of blood in a pathological condition or as in a surgical operation.
71. **Hazards** – A danger, a risk of harm.
72. **Homeopathy** – A system of alternative medicine where a disease is treated by prescribing small doses of drugs.
73. **Immiscible** – Two or more liquids when mixed together forming separate layers or not mixing together. Example- Water and oil.

74. **Immunization** – To produce artificial immunity to a disease in someone by injecting them with an antisera or a treated antigen.
75. **Impatient** – Unwilling or lacking the patience to wait, delay.
76. **Impermeable** – Not allowing substances, especially liquids, to pass through or penetrate it.
77. **Incubation** – Process of incubating or warming, to encourage microorganism to grow or develop by creating favourable & controlled condition.
78. **Indent** – Make written order for something or official order for goods.
79. **Indigenous** –Belonging naturally or occurring naturally in a country or area.
80. **Infections** – State of being infected or disease caused by bacteria, virus or other micro-organism.
81. **Inoculation** – Vaccinate – creating immunity (defense mechanism) in human body by injecting a harmless form of an antigen.
82. **Insurance** – An agreement by which one party promises to pay another party money in the event of loss, theft or damage property, personal injury or death.
83. **Integrity** – The quality of being honest and morally up right.
84. **Intoxicates** – Condition in which certain centres in the brain are affected by alcohol (other drugs) gasses, heavy metal or other toxic substances. And it is characterized by impaired intellectual ability, confusion, unsteady walking etc.
85. **Inventory** – A formal and complete list of the article, good etc. found in a particular place.
86. **Invoice** – List of goods supplied, delivered with the goods and giving details of price and quantity.
87. **Lenses** – An optical device consisting of a piece of glass curved on one or both the sides used for converging or diverging a beam of light.
88. **Legibly** – About hand writing – clear enough to read.
89. **Licensing** – Process of giving a permit from an authority or grant license.
90. **Lumbar** – Relating to the lower back. (Vertebra)
91. **Malabsorption** – Badly, wrong or incorrectly absorption.
92. **Monitor** – Any instrument designed to check, record or control something on a regular basis. A television used to view picture or a display from a computer.
93. **Moral** – Belonging or relating to the principles of good & evil or right and wrong behavior following accepted standards of behavior
94. **Morbid** – Relating to or indicating the presence of a disease
95. **Mucosa- mucous membrane** – The moist mucus secreting lining of various internal cavities of the body example nose, mouth etc.
96. **Ocular** –Relating to or in the region of the eye like or having to do with the eyes or vision.
97. **Orphanages** – Home for orphan (Child who has lost both parents)
98. **Parasites** – An organism which lives in or on another organism and gets its food from it.

99. **Patience** – The ability to accept delay, trouble or suffering without becoming angry or upset.
100. **Patient** – Having or showing patience.
101. **Phenotypic** – The absorbable characteristics of an organism determined by its genetic make –up and environment.
102. **Phlebotomy** – Collection of blood by puncturing or a making a surgical incision in a vein.
103. **Placenta** – Structure present in the uterus of a pregnant woman whose exchange of food gases take place between foetus & mother
104. **Pleural** – Covering membranes of the lungs.
105. **Polyclinics** – Clinic or hospital where different specialist doctors treat different diseases
106. **Precision** – Very accurate, said of tools – designed to operate with minute accuracy.
107. **Preservative** – A chemical substance that, when added to food or other perishable material slows down or prevents its decay by bacteria & fungi.
108. **Procured** – Buy, acquire, purchasing.
109. **Proteinuria** – Abnormal presence of proteins in the urine.
110. **Quotations** – A formal statement of the estimated cost of a job
111. **Reactive** – Showing a reaction, liable to react, sensitive to stimuli.
112. **Reservoir** – A container or part of a machine design to hold fluid or a large lake used as a source of water supply.
113. **Resistance** – To oppose, the act or process of resisting.
114. **Resource** – Someone or something that provides a source of help or support when needed. A stock or supply of materials or assets that can be drawn when needed.
115. **Sanitation** – Measures taken to promote and preserve public health, especially through drainage and sewage disposal.
116. **Segregation** – A process of segregating or to separate out into a group or groups.
117. **Sera** – Pleural of serum.
118. **Serum** – It is yellowish fluid which remains after clotting of blood which contains antibodies.
119. **Shipment** – The act or practice of shipping cargo or goods, consignment or goods transported not necessarily by ship.
120. **Slaughter** – The killing of animal for food.
121. **Specimens** – Sample for medical testing.
122. **Spillage** – The act or process of spilling, something that is spilt or an amount of spilt.
123. **Spills** – Liquid flow out from container.

124. **Standard** – A level of quality or achievement, something used as a measure in order to make comparisons.

125. **Standardization** – Cause to conform to a standard.

126. **Stents** – Balloon like artificial structure which is put in the blood vessels of the heart by Catheterization to remove block.

127. **Sterile** – Free from bacteria or other micro-organism. Not able to provide child.

128. **Sterilization** – To make sterile or to make something germ free.

129. **Supine** – Lying on one's back.

130. **Swab** – Cotton pad used for cleaning wounds, applying medicine or collecting sample of wound for investigation.

131. **Synovial** - Relating to joints of the body enclosed in a flexible membrane containing a lubricating fluid.

132. **Thermal** – Relating to heat.

133. **Thermostat** – A device that automatically regulates temperature or activates a device at a set temperature.

134. **Transfusion** – A medical procedure in which blood and blood products are transferred through vein from one person to another.

135. **Transplacental**– Through the placenta.

136. **Venipuncture** – Collecting blood by puncturing vein.

137. **Viscosity** – The measure of the resistance of a fluid to flow due to its thickness (blood is thicker or viscous than water).

138. **Vital** – Absolutely necessary, essential for life.

139. **Waxed** – Polish or treat with wax.

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