

# LABORATORY MEDICINE — M D

## I. COURSE DESCRIPTION

### 1. Name of the Course

Doctor of Medicine (MD) in Laboratory Medicine.

### 2. Duration of the Course

Three Years full-time residency

### 3. Recognition of the Course

Obtained from different Statutory Bodies at A .I. I. M. S

Also recognized by Medical Council of India

### 4. Eligibility for Admission

The essential qualification shall be MBBS Degree of any Indian University/Deemed University/Autonomous Institutions etc., as recognized by the Medical Council of India (MCI) or any other qualification of a foreign university that is recognized by the MCI and the concerned university as equivalent to the MBBS Degree.

### 5. Method of Selection

As per other MD course of AIIMS

### 6. Total number of Candidates

Not more than two per each semester to be admitted to the course and a total number in three years not exceeding twelve at any given time.

## II. PROLOGUE: INTRODUCTION TO THE CURRICULUM

The Laboratory services by tradition are practiced under the heading of 'Clinical Pathology' in most of hospitals / medical institutions in our country. These services are divided into 4 subdivisions: **clinical biochemistry, clinical pathology, clinical hematology, and clinical microbiology**. With advancement of technology, like automation and shift of various new investigations from research laboratory to routine laboratory, the management of laboratory investigations has acquired a new dimension and has now been grouped under a new discipline 'Laboratory Medicine'. Further, this new discipline has been slowly encompassing much other important subdivisions used for diagnostic investigations. Thus, the

discipline of Laboratory Medicine is soon becoming an important wing of patient care services not only in terms of screening and diagnosis of diseases but also in monitoring the course of the disease and management of patient.

This discipline encompasses three major objectives, namely, (1) Test Selection (2) Operational Aspects, (3) Interpretation of results. However, at present throughout most of the country this discipline is entrusted only with operational aspect i.e., performing the tests. However, it has been now becoming evident that the discipline of Laboratory Medicine, in close and active collaboration with clinical disciplines, has a larger role to play in terms of other two objectives namely test selection and interpretation of results. Other important aspects of this discipline are (i) quality assurance (ii) understanding of instrumentation including automation and their maintenance (iii) active participation in Medical Audit.

### **III. THE NEED AND SCOPE FOR SUCH CURRICULUM**

#### **A. The Need**

At present, this important discipline which is most relevant in patient care system exists in a very primitive condition in almost all the hospital / medical institutions as well as in tertiary care centers in our country. Further, the individuals trained in only one of the subdivisions are asked to look only at the operational aspect and manage this discipline. In the process innovation and application of newer technology for patient care services is practically nonexistent. The quality assurance programs and proper instrumentation are either nonexistent or not practiced. The situation is worse, if not all the same, in the mushrooming private Laboratories. Therefore, it is felt to *transform* the present 'state of affair' to the necessary 'state of art'. There is a National imperative to take a lead in this matter. Even in our Institute, this discipline has remained in a primitive state compared to several other specialties and super-specialties which have developed and are now occupying a prime position in the country. It is, therefore, extremely essential to train a breed of medical specialists in the discipline of Laboratory Medicine who can actively and constantly interact with clinical colleagues for evolving a relevant and rational diagnostic approach and thereby improving the patient care services.

The separate department of Laboratory Medicine has been created in the Institute in 1988. Its different faculty members are well trained and are from different subdivisions, like pathology, hematology, microbiology and biochemistry. At present the department is also adequately equipped to impart the requisite training to the students towards obtaining a M. D. degree in Laboratory Medicine. The department of Laboratory Medicine, since 1997, has been engaged in offering a postgraduate course leading to M.D. degree in Laboratory Medicine at the Institute. The institute has always taken a lead in starting courses in newly established and set a trend for other medical institutions to follow.

#### **B. The Scope**

The state of affairs regarding the discipline of Laboratory Medicine mentioned above is largely due to non-availability of trained personnel in all aspects of Laboratory Medicine (including quality control and instrumentation). This trend can be reversed once the postgraduates with special training with proportionate weightage in all aspects of this discipline are available and join the mainstream of medical institutions and hospitals of our country to plan and manage a multidisciplinary laboratory in patient care system. The postgraduates in Laboratory Medicine will emerge also as 'teacher' in Laboratory sciences.

There is also a large need of such trained personnel in private hospitals run by public sector and those who are in general medical Laboratory practice in order to bring the private laboratory service in consonance with National Quality Assurance Program.

There is already a move to create the new discipline of Laboratory Medicine in most hospitals and Medical Institutions in our country. Tata Memorial Hospital, Bombay, and Safdarjung Hospital, Delhi, have already opened up the Department of Laboratory Medicine. In further, the postgraduates with M.D. in Laboratory Medicine could be absorbed in such departments.

#### IV. AIM AND OBJECTIVES

The Aim of this curriculum is to train medical professionals who will be capable of planning and managing a multidisciplinary Laboratory attached to patient care systems, with the following objectives:

1. To acquire the knowledge of pathophysiology of diseases involving Biochemical, Hematology, Microbiological, Endocrinological & Immunological aspects.
2. Test Selection & Interpretation of results in context of a clinical condition along with concerned clinical specialty.
3. The operational knowledge for performing the laboratory investigations which include:
  - (a) Instrumentation
  - (b) Methodologies
  - (c) Quality Assessment and Assurance
4. The requisite knowledge of:
  - (a) Independent management of clinical Laboratory
  - (b) Safety Measures in a Patient-care Laboratory
  - (c) Cost Effectiveness of Tests
  - (d) Personnel Management

#### V. OBJECTIVE DETAILS

##### ***A. Broad objectives to be achieved at the end of the course***

##### **Cognitive Domain**

1. Diagnosis of routine and complex clinical problems on the basis of Laboratory investigations.
2. Interpret laboratory data in relation to clinical findings with reasonable accuracy.
3. Advice on the nature of appropriate specimens and the tests necessary to arrive at a diagnosis in a difficult or problematic case.
4. To be able to identify non-correlation and the causes of death due to diseases.
5. Should be able to teach Laboratory Medicine to undergraduates, postgraduates, nurses and paramedical staff including laboratory personnel.
6. To carry out research on laboratory science related topics.
7. Maintain accurate records of tests results for reasonable periods of time so that these may be retrieved as and when necessary.
8. Make and record observations systematically that is of use for archival purpose and for furthering the knowledge of Pathology.
9. Able to systematically write a paper and publish in a relevant journal.
10. Able to present a paper in a conference through an oral presentation and poster presentation.

11. Should be able to identify problems within and outside the laboratory pertaining to reliable test result and offer solutions thereof so that a high order of quality control is maintained.
12. Should be capable of effectively disposing laboratory waste to ensure minimization of risk to infection and accidents to laboratory personnel.
13. Able to supervise and work with subordinates and colleagues in a laboratory.
14. Subject himself/herself to continuing education and constantly update his/her knowledge of recent advances in Laboratory Medicine and allied subjects.

**Psychomotor Domain**

1. Able to perform most of the routine tests in a Laboratory including gross sampling of specimens, processing, and instrumentation.
2. Able to collect specimen by routinely performed non-invasive out-patient procedures such as venepuncture, finger-prick, and bone-marrow aspiration. It is implied that the complications of these procedures and handling of complications are apparent. Further, whenever necessary must be able to provide appropriate help to colleagues performing an invasive procedure.
3. Should be familiar with the operation, function and routine maintenance of equipment.

**Affective Domain**

1. Should be able to function as a part of a team that is essential for the diagnosis and management of a patient. He/she should therefore develop an attitude of cooperation with his/her colleagues so necessary for this purpose. It is implied that he/she will, whenever necessary, interact with the patient and the clinician or other colleagues to provide the best possible diagnosis or opinion.
2. Always adopt ethical principles and maintain proper etiquette in his/her dealings with patients, relatives and other health personnel.
3. Respect the rights of the patient including the right to information and second opinion.
4. Should seek and give second opinion only where necessary and is requested for.
5. Provide leadership and inspire members of the team with whom he/she is involved with in the fields of diagnostic, teaching and research.
6. Develop communication skills not only to word reports and professional opinions but also to interact with patients, relatives, peers and paramedical staff.

**B. Specific Learning Objectives**

At the end of the training in M. D. Laboratory Medicine, the candidate will be able to:

1. Discuss the etiology and the pathophysiological basis of diseases in children and adults.
2. Explain the salient aspect of epidemiology, clinical presentation and prognosis of these disorders.
3. Discuss rationality of the treatment and diagnosis of the above disorders.
4. Make rational and relevant selection of tests (biochemical/ hematological/ microbiological etc.)
5. Perform the specified important tests belonging to physiology, biochemistry, microbiology, pathology, hematology & immunology disciplines with a high order of mastery.
6. Plan and manage a large multidisciplinary laboratory services
7. Supervise and train technical staff of the laboratory

8. Modify/develop and establish newer techniques belonging to all subspecialties of laboratory medicine.
9. Simultaneous exercise on quality assessment and quality assurance in all laboratory services.
10. Explain the underlying principle and design of important laboratory, instruments, their use as well as maintenance of the same.
11. Take safety measures in performing tests.
12. Assess cost-effectiveness of laboratory tests including budgeting and auditing.
13. Design and implement research plans in the field of laboratory medicine.

## **VI. SYLLABUS (COURSE CONTENT)**

Curriculum is a course of study especially in a University. The curriculum for a postgraduate course leading to the highest non-research degree in any subject is extremely difficult to compile. To put it bluntly, the candidate is expected to know everything! This obviously looks impractical. Even an entire lifetime is not sufficient to master a subject. Therefore a practical and a common sense approach is required. With this in mind this curriculum for MD course was constructed.

The course content will include the following aspects :

1. Organization of Laboratory
2. Quality Assurance
3. Instrumentation
4. Clinical Biochemistry
5. Clinical Pathology
6. Clinical Hematology
7. Clinical Microbiology
8. Clinical Immunology
9. Clinical Physiology
10. Clinical Pharmacology
11. Technology
12. Clinical Medicine

## **THE DETAILS OF SYLLABUS**

### **1. Organization of the Laboratory**

- (i). Spatial organization, flooring, ventilation, drainage, disposal of waste
- (ii). Lab. Safety – Prevention of Physical, Chemical & Biological Hazards. First Aid in Lab. Accidents. Legal aspects
- (iii). Financing, Budgeting and Cost accounting.
- (iv). Management of Laboratory stores.
- (v). Special reference to glasswares, chemicals & dangerous poisonous chemicals.
- (vi). Personal Management and Training of technical staff
- (vii). Streamlining of ‘in-put’ and ‘output’ of lab. Specimen collection and dispatch of report
- (viii). Computerization of laboratory services.

- (ix) Legal aspect of laboratory services.

## **2. Quality Assurance**

- (i) Source of errors in laboratory results
  - Pre-instrumental
  - Instrumental
  - Post-instrumental
- (ii) Methods of detection of errors
- (iii) Corrective measures to minimize the errors
- (iv) Methods of documentation of the whole procedures
- (v) Onward transmission of the knowledge and skill to the other laboratory
- (vi) Preparation of internal 'control'
- (vii) Proficiency testing programme
- (viii) Participation in E.Q.A.P. & Preparation of Biological Standards

## **3. Instrumentation**

To know the:

- (a) Principle of functioning
- (b) Major parts
- (c) Operational aspect
- (d) Preventive maintenance, and
- (e) Calibration/standardization, if applicable of the following instruments

### **A. Minor Instruments**

- (i) Different types of Shaker, roller Mixer, Cyclomixer etc.
- (ii) Thermometer
- (iii) Different kinds of refrigerators
- (iv) Incubators
- (v) Ovens
- (vi) Water-baths
- (vii) Distillation plant
- (viii) Electrolyte analyzer
- (ix) Deionizer
- (x) Autopipettes
- (xi) Ph Meter
- (xii) Autodispensors
- (xiii) Analytical Balances

### **B. Major Instruments**

- (i) Photoelectric Colorimeter

- (ii) Spectrophotometer
- (iii) Centrifuge machines of different types cold center fuse
- (iv) Blood Cell Counter, semi automated or fully automated
- (v) ELISA Reader
- (vi) Autoanalysers – Fully automated, semi-automated
- (vii) Flame photometer
- (viii) Blood Gas Analyser
- (ix) Electrolyte Analyser
- (x) Microscopes: Light, Fluorescent, Dark ground, Phase contrast, Electron microscope
- (xi) Electrophoresis apparatus

**C. The principle and working manual of following techniques**

- (i) Chromatography of different kinds
- (ii) Flow Cytometry
- (iii) Beta and Gamma Counting
- (iv) HLA typing
- (v) Radionucleotide Studies
- (vi) Some common Biotechnology Methods
- (vii) Immuno assays

**4. Clinical Biochemistry**

**(a) Physical Chemistry**

*Theory (Knowledge)*

- (i) Mol wt, Atomic wt, Eq. wt, Periodic table. Water of crystallization, Colloid, Crystalloid, Osmolality, Osmolarity, Specific gravity etc.

*Practical (Skill)*

- Preparation of standard, normal & molar solution
- Preparation of buffers
- Preparation of Laboratory reagents
- Handling of corrosives, poisonous chemicals

**(b) Clinical Biochemistry**

*Theory (Knowledge)*

1. Chemistry, identification, synthesis, determination, separation, metabolism, and disorders of carbohydrate metabolism. Diabetes Mellitus, Hypoglycemia
2. Structure, synthesis, function and physiological significance of proteins. Hypo- and Hyperproteinemia

3. Amino acids & related metabolites
4. Glycoproteins, proteoglycans and collagen
5. Porphyrins
6. Lipids, lipoproteins, apoproteins. Their metabolism and their physiological and pathologic significance
7. Enzymology: Regulations & diagnostic values of enzymes & isozymes in health and disease
8. Acid-base and electrolyte imbalance
9. Tumor-markers
10. DNA-RNA chemistry & current perspectives on their significance in human disease
11. Vitamins, & Trace elements and other important metals
12. Chemistry of various body fluids
13. Toxicology & health hazards

*Practical (Skill)*

- (i) Manual method of estimation of sugar, urea, bilirubin protein (total and fractional) creatinine, cholesterol, uric acid, amylase, acid and alkaline phosphatase.
- (ii) Automated method of estimation of:
  - (a) Above chemicals
  - (b) SGOT, SGPT, LDH, CPK, Uric acid, Calcium, Phosphate etc.
- (iii) Blood pH & arterial gases
- (iv) Electrolytes
- (v) Blood gases and pH.
- (vi) Lipids, apo-proteins and lipoproteins
- (vii) Tumor markers
- (viii) Chemical analysis of body fluids
- (ix) Practical on Quality assurance in a clinical chemistry laboratory

Students are supposed to be familiar with various Profiles of investigations, e.g., Cardiac. Renal, Liver profile etc.

**Counseling:** Pre-test and Post-test counseling of the patients.

**(c) Endocrine Chemistry**

*Theory (Knowledge) & Practical (Skill)*

- (i) Hormones: chemistry, metabolism, physiology and pathology
- (ii) Endocrine Function Tests (Theory & Practical)
- (iii) Hormone Assay
- (iv) Ligand Binding Assays

**Counseling:** Pre-test and Post-test counseling of the patients



## 5. Clinical Pathology (*Clinical microscopy of body fluids*)

### Theory (Knowledge) and Practical (Skill)

- |     |                                         |   |                         |
|-----|-----------------------------------------|---|-------------------------|
| i.  | Urine                                   | : | Physical                |
| ii  | CSF                                     | : | Chemical and            |
| iii | Peritoneal, pleural, pericardial fluids | : | Microscopic examination |
| iv  | Amniotic fluid                          | : |                         |
| v   | Sputum                                  | : |                         |
| vi  | Semen Analysis                          | : |                         |
| vii | Synovial fluids                         | : |                         |

**Counseling:** Pre test and Post test counseling of the patients.

## 6. Clinical Haematology & Transfusion Medicine

### A. Clinical Hematology

#### Theory (Knowledge)

- (i) Detection and typing of anemia
- (ii) Polycythemia
- (iii) Neutrophilia, Eosinophilia, Basophilic, Lymphocytosis, Neutropenia, Lymphopenia, Agranulocytosis.
- (iv) Leukemia diagnosis, classification, clinicopathological correlation.
- (v) Thrombocytosis, thrombocytopenia, platelet function.
- (vi) Investigation of bleeding disorders.
- (vii) Automation in hematology
- (viii) Bone marrow physiology and pathology.

#### Practical (Skill)

- (i) Collection, transport and processing of blood samples for different hematological investigation.
- (ii) Performance of routine hemogram, Hb, TLC, DLC, ESR.
- (iii) Preparation staining and interpretation of peripheral blood smear.
- (iv) Aspiration of bone marrow, preparation of touch smear and bone biopsy. Staining and interpretation of marrow.
- (v) Cytochemistry of blood smear and bone marrow smear and their interpretation.
- (vi) Serum iron, folate and B12 estimation
- (vii) Hemolytic studies e.g. osmotic fragility, sick living HbF, HbA<sub>2</sub>, Coombs test.
- (viii) Leucocyte function test.
- (ix) Screening coagulation and DIC studies. BT, CT, PT, APIT, Clotability.
- (x) Investigation of prothrombotic states. Protein C, Antithrombin III, Lupus anticoagulant.
- (xi) Demonstration of common blood parasites.

**Counseling:** Pre-test and Post- test counseling of the patients.

**B. Transfusion Medicine***Theory (Knowledge)*

It is expected that students should possess knowledge of the following aspects of Transfusion Medicine.

- (i) Basic immunohematology
- (ii) ABO and Rh groups
- (iii) Clinical significance of other blood groups
- (iv) Transfusion therapy including the use of whole blood, RBC concentrates and Blood component therapy
- (v) Rationale of pre-transfusion testing
- (vi) Transfusion transmitted Infections
- (vii) Adverse reactions to transfusion of blood and components
- (viii) Quality control in blood bank

*Practical (Skill)*

- (i) Selection and bleeding of donors
- (ii) ABO and Rh grouping
- (iii) Resolving ABO grouping problems by secretor status in saliva and expanded panel
- (iv) Demonstrate familiarity with Antibody screening by
  - (a) LISS (Low-ionic salt solution)
  - (b) Enzymes
  - (c) AHG (Anti-Human Globulin)
- (v) Steps to be taken if the above are positive
- (vi) Demonstrate familiarity with Cross-matching by
  - (a) LISS (Low-ionic salt solution)
  - (b) Enzymes
  - (c) AHG (Anti-Human Globulin)
- (vii) Steps to be taken if there is incompatibility
- (viii) Preparation of blood components i.e. Cryoprecipitates, Platelet concentrate, Fresh Frozen Plasma, Single Donor Plasma, Red Blood Cell concentrates
- (ix) Demonstrate familiarity with Antenatal and Neonatal work
  - (a) Direct antiglobulin test
  - (b) Antibody screening and titre
  - (c) Selection of blood for exchange transfusion
- (x) Demonstrate familiarity with principle and procedures involved in
  - (a) Resolving ABO grouping problems
  - (b) Identification of RBC antibody
  - (c) Investigation of transfusion reaction

- (d) Testing of blood for presence of
  - 1. HBV (Hepatitis B Virus Markers)
  - 2. HCV (Hepatitis C Virus Markers)
  - 3. HIV (Human Immunodeficiency Virus markers)
  - 4. VDRL
- (xi) Investigation of hemolytic jaundice of adult and new born.

**Counseling:** Pretest and Post test counseling of the patients.

## **7. Clinical Microbiology**

### **Theory (Knowledge)**

- (i) Medically important microbes in general. Their general behaviors, life history, metabolism, genetics and mode of infection.
- (ii) Epidemiology of infectious diseases
- (iii) Hosp. Acq. Infection/Nosocomial infection
- (iv) Medically important parasites
- (v) Medically important viruses
- (vi) Medically important fungi
- (vii) Systemic Microbiology:  
Gastroenteritis and bacterial food poisoning, Septicemia, wound infection, burn, U.T.I., R.T.I., C.N.S. infection, meningitis, encephalitis, STDs/AIDS, opportunistic infection, congenital infections and infections in vulnerable groups e.g. AIDS, Cancer, Geriatrics, Premature babies, Pregnancy etc.
- (viii) Immunity to microbial disease
- (ix) Vaccines for infectious disease
- (x) Laboratory acquired infections
- (xi) Diagnosis & Prevention of infection
- (xii) Lab. Safety:  
Blood borne disease including-Viral Hepatitis & AIDS Air borne infections  
Universal precautions  
Principals of Bio-safety
- (xiii) Medico-Legal aspects of infectious diseases including postmortem findings and evidence based opinion on criminal cases in regard to infections/vaccines.

### **Practical (Skill)**

- (i) Methods of collection and transportation of specimen and techniques used for clinical samples:  
Blood  
Bone marrow, Splenic, Liver, LN aspirates  
CSF, Pus from closed cavities & open wounds

- Urine
- Stool
- Semen
- Sputum
- Saliva,
- Swabs (nasal, pharyngeal, rectal, conjunctival etc.)
- (ii) Principles of Microscopy (all types)
- (iii) Commonly used stainings in microbiology: Grams, Romanowsky, A.F.B, Kinyouns' Albert's special stains for spores, capsules, inclusion bodies, parasites & fungi
- (iv) Culture Media: their preparation, inoculation, and uses.
- (v) Antibiotic sensitivity testing including automation in Microbiology and Interpretation of antibiograms
- (vi) Immunological techniques e.g. Widal, VDRL, CFT, ID, ELISA, IFA, RIA, IPO, etc. In-vitro demonstration of CMI, Complement cycles, Blast transformation, Monoclonal antibodies, skin test and others.
- (vii) Biochemical tests for microbial diagnosis
- (viii) Serotyping of microbes.
- (ix) Bed side tests: FNA, intradermal tests, cord blood, lumbar puncture etc.
- (x) Animal inoculation studies
- (xi) Egg inoculation, cell culture studied for the diagnosis of viral & other microbial infection.
- (xii) Human parasites including Protozoa, Nematodes, Cestodes and Trematodes and their diagnosis by gross, microscopic and serological techniques.
- (xiii) Fungal infections in human and their diagnosis.
- (xiv) Hospital infection surveillance.

**Counseling:** Pretest and Post test counseling of the patients.

## **8. Clinical Immunology**

### **Theory (Knowledge)**

- (i) Physiology of Immune System
- (ii) Hypersensitivity Reactions
- (iii) Autoimmune Diseases
- (iv) Transplantation Immunology
- (v) Host-Parasite interaction

### **Practical (Skill)**

- (i) Demonstration of T and B cell.
- (ii) Functional evaluation of T and B cell.

- (iii) Immunoglobulin estimation
- (iv) Serological techniques
  - CFT
  - Agglutination test ) with particular, reference
  - IHA ) to ANF, RF, CRP, Microbial
  - Elisa ) serology
- (v) Radioimmunoassay
- (vi) Immunohistochemistry, Immunofluorescence and Immunoelectorn microscopy
- (vii) Immunoglobulins in health and disease
- (viii) Complements in health and disease

### **9. Clinical Physiology**

#### **ORGAN FUNCTION TESTS:**

##### **Theory (Knowledge) and Practical (Skill):**

- (i) Liver function test
- (ii) Kidney function test
- (iii) Gastric function test
- (iv) Pancreatic function test
- (v) Splenic function test
- (vi) Tests for malabsorption
- (vii) Resp. function test
- (viii) Cardiac function test

### **10. Clinical Pharmacology**

##### **Theory (Knowledge) and Practical (Skill):**

#### **DRUG ASSAYS**

### **11. Technology**

- (i) Molecular biology - Structure of DNA & RNA
  - Genetic configuration of commonly used
  - Genomic vectors/host and their uses in molecular biology
  - Blotting technology
  - DNA hybridization
  - RNA hybridization
  - Polymerase Chain Reaction in various diseases
  - LCR Ligase Chain Reaction
  - TMA
  - MASBA (Nucleic acid sequence based analysis)
  - Micro-assay technology

- (ii) Histopathology technique, Cytopathology technique
- (iii) Histochemistry technique
- (iv) Chromosomal analysis
- (v) HLA typing
- (vi) Bioassays
- (vii) Bio-chips
- (viii) Nano-technology
- (ix) Cell culture technology
- (x) Basic immunological technology

## **12. Clinical Medicine**

- (i) Independently history taking, examination and assessment of the patients, formulation of panel of tests, sending samples and requisition forms to the central or satellite lab services. The patient may be in the OPD, casualty, general or private wards, intensive care units, operation theatre of different specialties of Medicine.
- (ii) They are expected to participate and do post-test and pre-test counseling with patients or their relatives.
- (iii) Clinico-pathological correlation of laboratory results.
- (iv) Constant interaction with the clinical resident to make them aware of:
  - (a) the pre-instrumental sources of error in laboratory result
  - (b) Limitation of laboratory results in patient management.

## **VII. EXPOSURE TO RESEARCH**

All efforts are made so that research methodology is apparent at the end of the course. It is an accepted norm at AIIMS that students submit a Thesis six months prior to examination as a partial fulfillment to the award of the degree of MD (Laboratory Medicine). Students are also encouraged to present papers in conferences and publish papers in peer reviewed journals. Due emphasis is laid on the importance of obtaining ethical clearance from appropriate committees for both animal and human studies.

A separate course for training in research methodology may not be necessary. Skills is usually acquired largely depending on the topic of research. The following points are guidelines to what may be expected of the student at the end of the course.

1. Recognize a research problem – basic or applied.
2. Clearly state the objectives in terms of what is expected to be achieved in the end.
3. Plan rational approaches with appropriate controls with full awareness of the statistical validity of the size of experimental material.
4. Carry out most of the technical procedures required for the study.
5. Accurately and objectively record on systematic lines the results and observations made.
6. Analyse the data with the aid of an appropriate statistical analysis, if necessary.
7. Interpret the observations in the light of existing knowledge and highlight in what ways the study has advanced existing knowledge on the subject and what further remains to be done.

8. Take photomicrographs, of a quality fit for publication in an international journal.
9. Write the thesis or a scientific paper in accordance with the prescribed instructions, as expected of international standards.

## VIII TRAINING METHODS

The training programme is designed to enable the student to acquire a capacity to learn and investigate for himself, to synthesize and integrate a set of facts and develop a faculty to reason. The curriculum programme and scheduling of postings are done in such a way that the student are given opportunities to embrace the above broad objectives.

The student himself accomplishes much of the learning. Interactive discussions are preferred over didactic sessions.

The student are blend as an integral part of the activities of an academic department that usually revolves around three equally important basic functions of teaching, research and service.

The following is a rough guideline to various teaching/learning activities that are employed.

1. Collection of specimens.
2. Sampling of specimens.
3. Instrumentation
4. Discussion during routine activities such as during signing out of cases.
5. Presentation and work-up of cases including the identification of special stains and ancillary procedures needed.
6. Clinico-pathological conferences.
7. Intradepartmental and interdepartmental conferences related to case discussions.
8. Conferences, Seminars, Continuing Medical Education (CME) Programmes.
9. Journal Club.
10. Research Presentation and review of research work.
11. Guest and in-house lectures.
12. Participation in workshops, conferences, and presentation of papers etc.
13. Laboratory work.
14. Use and maintenance of equipment
15. Maintenance of records
16. Teaching undergraduates and paramedical staff.

## ***IX. Structured Training Programme***

**(Time Schedule of Posting during Residency)**

### **Interaction with Clinical counterparts**

It needs to be emphasized that the Department of Laboratory Medicine caters for both Routine and Emergency (round the clock) services to the main hospitals as well as to the various centers. During the course of 3 years and particularly during their emergency posting the students are expected to interact with clinical disciplines continuously during the ward round. Pre-test and post-test counseling of the patients are advised.

**Weekly Intradepartmental Case discussion**

There will be weekly intradepartmental rounds and case discussion on selected cases whose investigations have been done over the week in different sections of the laboratory, particularly with the following departments, Medicine, Pediatrics, Surgery, Gastroenterology, Endocrinology, Gynae and obstetrics, Neurology, Casualty and ICU.

**Weekly combined round and grand round**

In weekly combined round and grand round of the AIIMS the residents of Laboratory Medicine will actively participate for discussion on the investigative aspects of the case presented.

**A. Duration of posting in different sections of Laboratory Medicine: (26 months)**

Orientation in three sections	03 months (One month in each section)
Emergency Laboratory/Casualty	06 months
Clinical Microbiology & Fluid and excretion Laboratory	05 months
Hematology	05 months
Clinical Chemistry	05 months
Thesis	02 months

In thesis, special emphasis will be laid on quality assurance, management of lab, medical audit and development of newer and simpler technology.

**B. Posting in other specialty of AIIMS Labs : (10 months)**

Blood Bank	: 2 months
Hematology Department	: 2 months
Pathology	: 2 months
Microbiology Deptt.	: 2 months
R. I. A. Lab., HLA lab,	: 2months
Clinical Immunology Lab & Biotechnology lab, Nuclear Medicine	:

**X. THE DETAILS OF EVALUATION AND CONDUCTING EXAMINATIONS**

A standardized scheme of evaluation is adopted to assess the candidates in any teaching programme. Both formative and summative evaluations are followed.

***Internal (Formative) Assessment***

Internal Assessment in fact is done everyday to assess the training and to identify the weakness as well as the strength of the candidate. Thus appropriate corrective methods can be adopted at the right time so that a well-trained and competent laboratory specialist worthy of a postgraduate degree is available for the society.

1. However a formal assessment is recorded at the end of every posting and reviewed every six months.
2. Research work is assessed or reviewed every six months. The protocol and the final results are presented to the entire department.



3. For evaluation of presentations, evaluation sheets may be incorporated for the purpose of assessment. The following points are usually considered in the scheme such as seminars and journal clubs:

- (i) Choice of article/topic (unless specifically allotted)
- (ii) Completeness of presentation
- (iii) Clarity and cogency of presentation
- (iv) Understanding of the subject and ability to convey the same
- (v) Whether relevant references have been consulted
- (vi) Ability to convey points in favour and against the subject under discussion
- (vii) Use of audio-visual aids
- (viii) Ability to answer questions
- (ix) Time scheduling
- (x) Overall performance

In the case of specific posting similar points may be assessed with regard to knowledge and skills.

It is also usual that the candidates are assessed on the AFFECTIVE aspect of the training particularly with regard to the following:

1. Ability to get along with colleagues
2. To conduct with patients and nursing staff in a dignified way

*During Formative Assessment Grading are done in one of the following ways:*

- (i) Awarding actual marks
- (ii) Awarding scores:
 

0	=	Poor
1	=	Below average
2	=	Average
3	=	Above average
4	=	Good
- (iii) Awarding grades:
 

A+	=	90% – 100%
A	=	80% – 89%
A–	=	75% – 79%
B+	=	70% – 74%
B	=	60% – 69%
B–	=	50% – 59%
C	=	< 50%

The grades are endorsed by more than one faculty member or an average obtained by pooling the grades of different faculty members. This is conveyed to the candidate periodically (at least once in every six months) so that the candidate knows where he or she stands.

### **FINAL (Summative) ASSESSMENT**

The final examination is held at the end of three years of the training programmes. This would include

assessment of the thesis and a formal examination on the theoretical and practical aspects of the specialty of Laboratory Medicine.

### **Examiners**

At present for conducting the postgraduate Examination at AIIMS, there are four (4) examiners two Internals and two Externals. As laboratory medicine encompasses a multidisciplinary forum, the care will be taken to select examiners who are specialized in different aspect of laboratory investigations so that the entire spectrum is covered during final examination.

1. The thesis/dissertation are evaluated by at least two external examiners well versed in the topic studies. It is therefore recommended that thesis/dissertation be submitted for evaluation six months prior to the theory and practical examinations. The results of the evaluation are made available prior to the practical examinations.
2. The examination will include:
  - A. Theory
  - B. Practical
  - C. Viva Voce

### **A. THEORY**

**4 Theory papers of 100 marks each**

#### **Paper I (Basic Pathology and Clinical Pathology)**

Etiology and Pathogenetic Mechanisms of diseases.

Basic pathological processes. Degeneration, Necrosis, Inflammation, Circulatory disturbances, Disorders of Growth including Neoplasia, Metabolic disorders, Organ failure etc.

Factors which determine the course of diseases, and genesis of complications

Various diagnostic techniques to arrive at diagnosis and laboratory follow up of diseases

Physiology and Pathology of Immune system. Complement function, Hypersensitivity reaction, Immune complex diseases, Autoimmune disease. Transplantation pathology

Tissue typing. HLA and disease

*Chromosomal and Genetic disorders:*

Antenatal Diagnosis of diseases

Radionucleide Studies

*Organ Function tests in different Pathological conditions:*

Gastric function test,

Pancreatic function test

Liver function test

Intestinal function test. Malabsorption syndrome

Kidney function test

Endocrine function tests.

Placental function test

Pregnancy test and related investigations

Tumor Markers: Diagnostic and Prognostic values  
Collection, Transport and Examination of Body fluids  
Physical chemical and microscopic examination of Urine, Cerebrospinal fluid, Pleural, Peritoneal and Synovial fluids.  
Examination of Semen  
Examination of Sputum  
Examination of Fistula's fluid.  
Examination of Amniotic fluid  
Flow cytometry: Technique and applications  
Some diagnostic techniques for Anatomic pathology  
FNAC technique, Papanecoulau and Giemsa stain  
Technique of grossing, different histopathological staining techniques, Frozen section.  
Immune histochemistry and immunofluorescent techniques.  
Exposure to technique of electron microscopy  
Learning the Essence of histopathological reporting  
Cytology to distinguish benign from malignant lesions  
Recent Advances in Clinical Pathology  
Quality Assurances in general: Principle and Methods  
Laboratory Organization, Management, Laboratory Safety, Purchase procedure and Development  
**Paper II (Clinical Biochemistry)**  
Biochemical basis of disease (Molecular Medicine).  
**Carbohydrate:** Digestion, Absorption, Metabolism.  
Classification, Identification, Estimation and Disorders of metabolism.  
**Proteins:** Digestion, Absorption, Metabolism  
Classification, Structure, Biosynthesis and Disorders of amino acids and proteins metabolism.  
Lipids and Lipoproteins: Digestion, Absorption, Metabolism, Estimation and diagnostic significance.  
Apoproteins. Disorders of Lipid Metabolism  
Inborn errors of Metabolism  
DNA and RNA chemistry, Structure, Biosynthesis ,gene expression  
**Enzymes:** Kinetics, cofactor, inhibitors and diagnostic enzymology.  
Isoenzymes of clinical importance  
Blood gases and Acid base imbalances  
Estimation and importance of Serum and Urine electrolytes, Various electrolyte imbalances  
Serum tumor markers: Biochemistry  
**Hormones:** Chemistry and Metabolism. Estimation of thyroid, reproductive and protein and other hormones

Porphyrins

Trace elements, vitamins etc.

Immunology

Immunoglobulins, lymphokines, leukotrienes , prostaglandins, complement system

Immunotechniques

Chemistry of Body fluids like, CSF, urine, pleural and peritoneal fluids.

Clinical chemistry of digestive system: gastric, pancreatic and intestinal juices and various estimation

Analytical Instruments in a clinical chemistry laboratory including Microtechniques

Automation: Steps, types, advantages, disadvantages, limitation and scope (advances)

Quality Assurance in a clinical chemistry laboratory.

Laboratory Safety

Recent advance in techniques and in clinical chemistry

### **Paper III (Clinical Microbiology and Immunology)**

Systemic and taxonomic classification of medically important bacteria, viruses, fungi and Parasites

Principles of Metabolism, Molecular biology of bacteria

Sterilization, collection, transportation and processing of fecal, urine, semen, sputum, blood and other body fluids for various investigations.

Epidemiology of Infectious Diseases including molecular epidemiology

Hospital Acquired Infections and their control including universal precautions and prevention of infection in health care workers.

Systemic Microbiology.

CNS infections including meningitis and encephalitis, Respiratory tract Infections including pulmonary tuberculosis, Gastroenteritis and hepatobiliary infection, Infections of Cardiovascular system, urinary tract infections, Sexually transmitted diseases including HIV/AIDS, Torch complex and tegumentary infections.

Immunity of Microbial infections both cellular and humoral, including various cytokines.

Principles and development of Vaccines and adjuvants including Extended Programme of Immunization

Antibiograms

Various methods of Infectious disease diagnosis including conventional, serological, molecular and animal inoculation techniques.

Quality Assurance

Automation in Clinical Microbiology laboratory

*Recent Advances in Microbiology and Immunology*

For example,

Newly Emerging infectious Disease

Recent advances in molecular biology: NASBA, Ligase Chain Reaction (LCR), Polymerase Chain Reaction (PCR), Fluorescent In-situ-Hybridization (FISH),

Gene Sequencing

Vaccine development to prevent HIV infection

Sigma factor in tuberculosis

Chemokines in HIV infection

Third generation cephalosporins

Multidrug resistance in Mycobacterium

#### **Paper IV (Hematology and part of Transfusion Medicine)**

##### *Syllabus for Hematology*

Normal Hemopoiesis

Anemia, causes, types, diagnosis, monitoring

Polycythemia

Hemoglobinopathies, Thalassemia and Porphyria

Leucocytosis causes and various types, Leukopenic state.

Leucocyte functions

Leukemia, diagnosis, classification, clinicopathological correlation.

Thrombocythemia, Thrombocytopenia, Platelet function disorders.

Myeloproliferative and Lymphoproliferative disorders

Investigation of Bleeding disorders. DIC studies

Bone marrow physiology and pathology

Examination and assessment of Bone marrow for different hematological disorders

Blood and Bone marrow parasites

Macrophage disorders

Hematological abnormalities in Systemic disorders

Quality assurance in Hematology

Automation in hematology

Recent Advances in Hematology

##### *Syllabus for Blood banking (Transfusion Medicine)*

##### *Selection of Donors and Collection of blood and its storage*

Screening for Transfusion-mediated diseases

Grouping and cross matching

Major and minor blood groups.

Various transfusion reactions, their investigations.

Investigation of Hemolytic Jaundice of adult and new born.

Blood Components: Preparation, Storage and Use

Quality assurances.

Recent Advances

**B. PRACTICAL EXAMINATION is conducted for two days:**

Date & Time	Exercise	Resident I	Resident II
<b>First day</b>			
09-10 AM	Clinical Pathology case discussion		
10-11 AM	Microbiology sample processing		
11-12 AM	Microbiology slide spotting		
12-01 PM	Transfusion Medicine Practical		
<b>1.00-1.30 Lunch</b>			
1.30-2.30 PM	Hematology & Path. slide drill		
2.30-3.15 PM	Cl. Chemistry Ex. 1		
3.15-4.00 PM	Cl. Chemistry Ex. 2		
4.00-4.45PM	Cl. Chemistry Ex. 3		
4.45-5.30 PM	Cl. Chemistry Ex. 4		
	Continue Micrbiol. Processsing		
<b>Second Day</b>			
9.15- 9.45 AM	Bleeding disorder Exercise & Practical		
9.45-10.30 AM	Prothrombine Time/Platelet count		
10.30-11.00AM	CSF Exercise and analysis		
11.00-11.45AM	Urine examination		
11.45-12.30 PM	Stool Examination		
12.30-1.30 PM	Serology Exercise		
<b>1.30-2.15 PM Lunch</b>			
2.15-3.00 PM	Microbiol. processing follow up		
3.00-5.00 PM	Grand Viva		

**C. VIVA VOCE**

During two days of practical examination viva voce will be conducted on selection, operational and interpretative aspects of tests performed. **Grand viva** will be on day 2 at the end for 2 hours.

**Grading**

The Candidate is declared as 'Pass' or 'Fail'

**XI. RECOMMENDED READING MATERIALS****Periodicals**

1. The American Journal of Clinical Pathology
2. Indian Journal of Pathology and Microbiology
3. National Medical Journal, India

4. Archives of Pathology and Laboratory Medicine
5. Laboratory Medicine
6. Journal of Clinical Pathology
7. Laboratory Investigation
8. The American Journal of Pathology
9. The American Journal of Hematology
10. British Journal of Hematology
11. Blood
12. Seminars in Hematology
13. Seminars in Diagnostic Pathology
14. Journal of Clinical Microbiology
15. The Journal of Parasitology
16. Parasitology
17. Tuberculosis
18. Virology
19. Year Book Series
20. Recent Advances Series
21. Reviews in biochemistry
22. J. Biol. Chemistry
23. Hepatology
24. Biochemistry
25. J. Immunol Methods
26. Nature
27. Science

### **Books**

1. Clinical Diagnosis and Management by Laboratory Methods, *Henry JB*, WB Saunders. (Indian Edition, Eastern Press, Bangalore).
2. Clinical Laboratory Medicine, Editor *Kenneth D. McClatchey*, Lippincott Williams & Wilkins.
3. Laboratory Medicine Test Selection and Interpretation, Ed. Joan H. Howanitz & Peter J. Howanitz. Churchill Livingstone.
4. An Introduction to Clinical Laboratory Science, *Clerc*.
5. Widmann's Clinical Interpretation of Laboratory Tests, *Sacher*.
6. Clinical Laboratory Science Education & Management, *Wallace*.
7. Most Commons in Pathology and Laboratory Medicine, *Goljan*.
8. Advances in Pathology and Laboratory Medicine, *Graham*.
9. Interpretation of Diagnostic Tests, *Wallace*.

10. Delmar's Guide to Laboratory & Diagnostic Test, *Deniels*.
11. A Manual of Laboratory & Diagnostic Tests, *Fischbach*.
12. General Pathology *JB Walter, MS Israel*. Churchill Livingstone, Edinburgh.
13. Robin's Pathologic Basis of Disease *Ramzi S. Cotran, Vinay Kumar, Stanley L Robbins* WB Saunders Co., Philadelphia.
14. William's Hematology *Beutler E, Lichtmann MA, Collier BS, Kipps TJ*, McGraw Hill, New York.
15. Postgraduate Hematology *Hoffbrand AV, Lewis SM, Tuddenham EGD*, Butterworth Heinemann, Oxford.
16. Wintrobe's Clinical Hematology, *Lee GR, Foerster J, Lupeus J, Paraskevas F, Gveer JP, Rodgers GN*, Williams & Wilkins, Baltimore.
17. Practical Hematology, *Dacie JV, Lewis SM*, Churchill Livingstone, Edinburgh.
18. Bone Marrow Pathology, *Bain BJ, Clark DM, Lampert IA*, Blackwell Science, Oxford.
19. Leukemia Diagnosis – A guide to the FAB Classification, *Bain BJ*, JB Lippincott, Philadelphia.
20. Fundamental of Clinical Chemistry, *N. W. Teitz* WB Saunders Company, Philadelphia.
21. Varley's Practical Clinical Biochemistry, *JR Mc Murray, DM McLauchlan*, Heinemann Professional publishing, Oxford.
22. A New Short Textbook of Chemical Pathology, *Baron*.
23. Glossary of Biochemistry and Molecular Biology, *Glick*.
24. Diagnostic Microbiology, *Bailey & Scott's*.
25. Principles of Bacteriology, Virology and Immunity, *Topley & Wilson's*.
26. Medical Microbiology, *Mackie and McCartney*.
27. Medical Microbiology and Immunology, *Levinson, Jawetz*.
28. Genes, *Benjamin Lewin*.
29. Immunology, *Roitt, Brostoff, Male*, Bailliere Tindall, Churchill Livingstone, Mosby, W.B. Saunders.
30. Harrison's Principles of Internal Medicine, McGraw Hill.

## **XII. EPILOGUE**

1. At the end it is better said that no curriculum is Final. It requires constant updating and change commensurating with the changing need of the Institution and the Country.
2. Maintenance of a logbook for the Residents is probably the best way to keep track of their record of training. The Department of Laboratory Medicine is in the process of preparing this Logbook.
3. What we envisage is the TRANSFORMATION of Laboratory Science in such a way that MD Laboratory Medicine remains its basic post graduate degree followed by superspecialization with DM degree in Histopathology/Cytology, Hematology, Microbiology, Clinical Chemistry etc. (Reference: Hospital Administration, (1997), 34 (1&2), pp. 51-57.