

Jan 26, 2022, 8:08 PM



SRI BALAJI VIDYAPEETH
(DEEMED TO BE UNIVERSITY)

U/S 3 OF UGC ACT 1956

Puducherry - 607402

Accredited by NAAC with 'A' Grade

M.D BIOCHEMISTRY
POST GRADUATE CURRICULUM

For course conducted in

MAHATMAGANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE

2021- 2022



Preface 1

The promulgation of the much-awaited Competency Based Medical Education (CBME) for post graduate programs by the National Medical Council is a welcome move. Sri Balaji Vidyapeeth (SBV), Puducherry, deemed to be University, declared u/s 3 of the UGC Act. and accredited by the NAAC with A grade, takes immense privilege in preparing such an unique document in a comprehensive manner and most importantly the onus is on the Indian setting for the first time, with regard to the competency based medical education for post graduate programs that are being offered in the broad specialty departments. SBV is committed to making cardinal contributions that would be realised by exploring newer vistas. Thus, post graduate medical education in the country could be made to scale greater heights and SBV is poised to show the way in this direction.

Prof. Subhash Chandra Parija,
MBBS, MD, PhD, DSc, FRCPath, FAMS, FICPath, FABMS,
FICAI, FISCD, FIAVP, FIATP and FIMSA.
Vice-Chancellor
Sri Balaji Vidyapeeth
Puducherry.

Preface 2

The National Medical Council has laid down the PG curricula in their website <https://www.nmc.org.in/information-desk/for-colleges/pg-curricula-2> that is listing the syllabus course wise, listing competency to some extent, teaching learning methods and the assessment methods as well. The document describes competencies in three domains (knowledge, skill, and attitude). However, the most significant problem in competency-based training is the development of appropriate assessment tools.

The salient feature of this document is defining the program educational objectives (PEO) for its postgraduate program as a whole, defining program outcomes (PO) based on the competencies to be practiced by the specialist, course outcomes (CO) and program specific sub-competencies and their progression in the form of milestones. The compilation of the milestone description leads to the formation of the required syllabus. This allows the mentors to monitor the progress in sub-competency milestone levels. It also defines milestone in five levels, for each sub-competency. Although NMC has described three domains of competencies, the domain 'Attitude' is elaborated into 4 more competencies for ease of assessment. The six-competency model (ACGME) for residency education: Medical Knowledge, Patient Care, Practice Based Learning and Improvement, Systems Based Practice, Professionalism, Inter personal and Communication Skills gives better clarity and in-depth explanation and is used in this document. The sub-competency and their milestone levels are mapped into the entrustable professional activities (EPA) that are specific to the individual postgraduate program. While doing all this, the syllabus prescribed by NMC is fully incorporated into the curriculum. To make the program more relevant, PEO, PO, CO and EPAs are mapped with each other. EPAs which are activity based are used for formative assessment and graded. EPA assessment is based on workplace-based assessment (WPBA), multisource feedback (MSF) and eportfolio. A great emphasis is given on monitoring the progress in acquisition of knowledge, skill and attitude through various appraisal forms including e-portfolios during three years of residency period.

Prof. M. Ravishankar
Director eLearning,
I/C refining CoBaLT

Prof. Seetesh Ghose
Dean I/C, MGMCRI
Prof. Sugumaran Annamalai
Dean, SSSMCRI

Forward

This course book for MD biochemistry is competency based medical education introduced by Medical Council of India for post-graduate education to recognize provision of high quality in specialty health care services and advancement in the research and medical education. Biochemistry is essentially the application of chemistry to the study of biological processes at molecular and cellular level which enlightens upon the basis of a disease process.

This curriculum enlists the strategies and details of holistic approach to health care practice. This serves to ensure practical and real-time learning of theoretical concepts and their applicative aspects. There is a phased approach in the acquisition of knowledge, integration with clinical relevance and real-life practice of the learner under the supervision of experienced specialist. The methods to gauge the progress of a student and to acquire competence are carefully designed to provide a comprehensive learning experience to be an efficient clinical biochemist, teacher and a researcher.

Emphasis is laid on formative assessment where in assessments are for learning, as learning instead of traditional assessment of learning. This curriculum provides details, methods of achieving and ensuring of attainment and assessment methods in a very systematic, specific and clear manner. To facilitate this entrustable professional activities (EPAs) have been incorporated for residency completion. EPAs integrate all of the competencies, subcompetencies, and their specific milestones. Competencies and sub competencies have been formulated to equip MD Biochemistry students to achieve optimum training. There are six domains of competence: patient care, medical knowledge, systems-based practice, interpersonal and communications skills, and practice-based learning and improvement. Competencies are further divided into sub competencies and meaningful milestones to be achieved which provides vital observable behaviours of the residents.

A considerable attempt has been made in the competency driven postgraduate curriculum to provide the orientation and the skills necessary for life-long learning and that which conforms to global trends.

Dr. Sumathi S,
HOD Dept. Of Biochemistry
MGMCRI

List of contributors

1. Dr. Sumathi S; Professor and head, Dept. of Biochemistry, MGMCRI, SBV
2. Dr. Reeta R; Professor, Dept. of Biochemistry, MGMCRI, SBV
3. Dr. Sweta Kulkarni, Associate Professor, Dept. of Biochemistry, MGMCRI, SBV
4. Dr. Revathy G; Assistant Professor, Dept. of Biochemistry, MGMCRI, SBV

We would like to express our great appreciation to the external experts Dr. Nagendran Professor and head Dept. of Biochemistry Sree Mookambika institute of medical sciences, Nagercoil, TN and Dr Ramesh R, Professor, JIPMER, Puducherry for their valuable and constructive suggestions.

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1 List of Abbreviations and Acronyms

PEO	Programme Educational Objective
PO	Programme Outcome
CO	Course outcome
EPA	Entrustable Professional Activity
MK	Medical Knowledge
PC	Patient Care
SBP	System Based Practice
PBLI	Practice Based Learning and Improvement
IPCS	Interpersonal Communication Skills
P	Professionalism

Sri Balaji Vidyapeeth

Post - Graduate Programme, MD Biochemistry

2 Preamble

The competency-based curriculum should take into account the needs of the society, both local and global. It needs to outline the demand for the present day as well as future. The curriculum needs to be reviewed at least every five years to address the trending needs, as new knowledge is evolving and communication of the same is seamless. Accordingly, the competencies need to meet the societal needs detailing the cognitive, psychomotor and affective domain development for attaining these competencies.

The curriculum indicates to the candidate the knowledge, basic skills and attitudes required to become a MD Biochemist. It disciplines the thinking habits for problem solving and discovery of new knowledge in the field of Biochemistry. It defines the Teaching - Learning methods adopted for the resident to achieve the goals of the, and the methods of assessment performed throughout the training period and at the completion of training. The purpose of this document is to provide teachers and learners illustrative guidelines to achieve defined outcomes through learning and assessment.

3 Programme Educational Objective (PEO)

Programme Educational Objectives are broad statements that describe what graduates are expected to attain within few years of completing their programme. These are based on the needs of the society as analysed and outlined by the regulatory body. So as defined by Medical Council of India (MCI), the PEO for MD Biochemistry are as follows:

- PEO1.** Specialist who can provide comprehensive care related to Diagnostic services in biochemistry over and above the physician of first contact
- PEO2.** Be a leader and team member who understands health care system and act to provide safe patient care with accountability and responsibility.
- PEO3.** Communicator possessing adequate communication skill to convey required information in an appropriate manner in various health care setting.
- PEO4.** Lifelong learner keen on updating oneself regarding the advancement in the health care field and able to perform the role of researcher and teacher.
- PEO5.** Professional who understands biomedical research and follows the principle of bio - ethics / ethics related to health care system.

4 Programme Outcome (PO)

PO's represent broad statements that incorporate many areas of inter - related knowledge and skills developed over the duration of the programme through a wide range of courses and experiences. They represent the big picture and describe broad aspects of knowledge, skill and attitude development. They encompass multiple learning experiences.

After a period of 3 years, the resident should be able to attain the following PO's:

- ✓ **PO1:** Able to explain clearly concepts and principles of biochemistry regarding Biomolecules human nutrition, metabolism, metabolic interrelationships, metabolic homeostasis, molecular and cell biology, body Défense against xenobiotics and pathogens, including correlations of these with cellular and molecular processes involved in health and disease.
- ✓ **PO2:** Biochemistry of principles of various laboratory estimations, instrumentations and rationale underlying biochemical laboratory investigations and interpreting the data.
- ✓ **PO3:** To set up/supervise/manage a diagnostic laboratory in Biochemistry in a hospital including modern laboratory techniques, ensuring total quality assurance in clinical biochemistry, and providing a reliable support service.
- ✓ **PO4:** Provide clinicians with consultation services for diagnostic tests in biochemistry and in interpretation of laboratory results.
- ✓ **PO5:** The student should be able to effectively teach undergraduate students in medicine and allied health science courses so they become competent health care professionals and able to contribute to training of undergraduate and post graduate students.
- ✓ **PO6:** Communicate with stake holders of the health care system
- ✓ **PO7:** Should be able to carry out a research project from planning to publication and be able to pursue academic interests and continue life-long learning to become more experienced in all the above areas.
- ✓ **PO8:** Effectual use of nutrition, lifestyle, cost of diagnostic tests and genetic counselling and exhibits shared responsibility.

5 Course and Course Outcomes (CO)

CO's describe the learning that will take place across the curriculum through concise statements, made in specific and measurable terms, of what students will know and /or be able to do after successful completion of each course.

There are four courses for MD *Biochemistry*:

1. Course 1 (C1) *Biomolecules, cell biology, biochemical techniques, biostatistics and research methodology, basics of medical education in teaching and assessment of biochemistry*
2. Course 2 (C2) *Enzymes, bioenergetics, biological oxidation, metabolism of biomolecules, intermediary metabolism and regulation, inborn errors of metabolism and nutrition*
3. Course 3 (C3) *Molecular and cancer biology, immunology and effects of environmental pollutants on the body*
4. Course 4 (C4) *Clinical biochemistry and molecular diagnostics related to different body systems/organs, endocrinology, and recent advances in biochemistry*

5.1 Course 1 (C1): Biomolecules, cell biology, biochemical techniques, biostatistics and research methodology, basics of medical education in teaching and assessment of biochemistry

- C1.1. Explain the importance of biomolecules in sustaining the life process, describe and apply biochemical principles to explain the normal state, abnormal disease conditions pertaining to Biomolecules, cell biology
- C1.2. Describe the working principle, instrumentation and uses of Analytical techniques in a clinical biochemistry laboratory including Nanotechnology and microfabrication Techniques to study in vivo metabolism - NMR, SPECT, PET scans, radioisotope-based techniques and its applications etc.
- C1.3. Demonstrate ability to apply basic concepts of biostatistics as applied to health science and to Carry out & conduct various research problems both at basic and applied level
- C1.4. Perform Critical appraisal of medical literature

- C1.5. Demonstrate principles of adult learning, taxonomy of learning, educational objectives, principles of assessment and question paper setting, methods of assessing knowledge, appropriate use of media, microteaching,
- C1.6. Take interactive classroom lectures, prepare modules for PBL, organize and conduct PBLs, case discussions, small group teaching, Seminars, Journal club and research methodology

5.2 Course 2 (C2): Enzymes, bioenergetics, biological oxidation, metabolism of biomolecules, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

- C2.1. Explain the principles and mechanisms of enzymatic catalysis, enzyme kinetics, regulation of enzyme activity and principles of bioenergetics, electron transport chain and oxidative phosphorylation.
- C2.2. Describe pathways of the intermediary metabolism along with their individual and integrated regulation and apply that in understanding the functioning of the body
- C2.3. Describe and apply the concept of nutrition in health and disease, essential nutrients, and interlinks of nutrients with metabolism and functions of a living system.
- C2.4. Apply and integrate knowledge of molecular and metabolic conditions in normal and disease states for clinical problem solving and research

5.3 Course 3 (C3): Molecular and cancer biology, immunology and effects of environmental pollutants on the body

- C3.1. Able to explain Structure and organization of chromosomes and chromatin re-modelling DNA replication, Transcription, Genetic code, mutations, Translation and Regulation of gene expression
- C3.2. Describe human Genome Project, basics of bioinformatics, Principles of human genetics and stem cells in clinical medicine
- C3.3. Integrate principles of immunology in biochemistry
- C3.4. Perform important biochemical, immunological and molecular biology techniques.

C3.5. Acquire knowledge on application of various aspects of genetic engineering in medicine

C3.6. Application of molecular techniques in forensic investigation and medicolegal cases

5.4 Course 4 (C4): Clinical biochemistry and molecular diagnostics related to different body systems/organs, endocrinology, and recent advances in biochemistry

C4.1. Perform sample collection, quality control methods, setting up of a clinical biochemistry laboratory, specialized assays and statistical analysis of data.

C4.2. Explain principles of basic techniques and instrumentation used in a clinical biochemistry laboratory and to Clinically correlate these to analytical procedures

C4.3. Describe regulation of fluid and electrolyte balance and associated disorders, regulation of acid-base balance and associated disorders

C4.4. Explain biochemistry of the endocrine system and biochemical aspects of diagnosis and treatment of endocrine disorders including conception, reproduction and contraception.

C4.5. Explain biochemical basis of hematopoietic disorders transfusion biology, hemostasis and thrombosis related laboratory tests, antiplatelet/ anticoagulant/ fibrinolytic therapy

C4.6. Explain the biochemistry of Atherosclerosis - pathogenesis, risk factors, prevention and treatment Cardiac failure, acute coronary syndrome, cardiac biomarkers

C4.7. Suggest, evaluate, monitor disease states, interpret biochemical investigation in a given clinical situation and apply knowledge in clinical problems

C4.8. Suggest, evaluate and interpret regarding the analysis of biological fluids for its chemical constituents & correlating the same in health & disease

C4.9. Update about recent advances and trends in research in the field of clinical biochemistry and implement important advanced techniques.

C4.10. Show empathy and respect towards patients, interactions with patients, families, peers and healthcare professionals with ethical behaviour and integrity

5.5 Mapping of PEO, PO and CO

Programme mapping facilitates the alignment of course - level outcomes with programme outcomes. It allows faculty to create a visual map of a programme. It is also used to explore how students are meeting program - level outcomes at the course level. Outcome's mapping focuses on student learning also.

Table1. Mapping of PEO, PO and CO

	PEO 1		PEO2	PEO3			PEO4	PEO5
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
C1	Y	Y			Y	Y	Y	
C2	Y							Y
C3		Y	Y					Y
C4		Y	Y	Y		Y		

All courses run concurrently for 3 years, with a summative assessment at the end.

6 Competencies, Sub - competencies and milestones

The post graduate programme is competency based, consisting of six domains of competency. Sub - competencies under these domains, specific to the speciality, have been mentioned in general terms. The progression through the curriculum is detailed in sub - competency milestone levels, that directs the prescribed syllabus. These sub - competency milestones are mapped to the Entrustable Professional Activities (EPAs), identified as essential for a specialist. Formative assessment includes EPA assessment, and is carried out every quarter using appropriate tools, for identifying eligibility for transfer of trust, to the resident.

6.1 Domain of Competencies

1. **Medical Knowledge (MK)** – Acquiring Knowledge of established and evolving biomedical, clinical, epidemiological, and social - behavioural sciences, and the application of this knowledge to patient care.
2. **Patient Care/Procedural Skill (PC/PS)** – Demonstrate ability to provide patient - centred care/ demonstrate skills required for teaching and conducting research.
3. **System Based Practise (SBP)** - Demonstrate the ability to follow the standard operating procedures relevant to practices of the organisations for patient care, inculcating quality and economical practices.
4. **Practice Based Learning and improvement (PBLI)** - Demonstrate the commitment to learn by literature search, feedback, practice and improve upon their ability.
5. **Interpersonal Communication skills (IPCS)** - Demonstrate behaviour and skills that result in the effective communication, exchange of information and cooperation with patients, their families, and health professionals
6. **Professionalism (P)** - Demonstrate a commitment to carrying out professional responsibilities and an adherence to ethical principles.

6.2 Sub - competencies

6.2.1 Medical Knowledge (MK)

- MK1. Knowledge and importance of biomolecules and cell biology in sustaining the life process, in health and disease
- MK2. Knowledge and application of the concept of nutrition in health and disease, essential nutrients, and interlinks of nutrients with metabolism and functions of a living system.
- MK3. Knowledge regarding the working principle, instrumentation and uses of routine and advanced analytical techniques in a clinical biochemistry laboratory including application of various aspects of genetic engineering in medicine and molecular techniques in forensic investigation and medicolegal cases
- MK4. Knowledge of research and biostatistics to evaluate and interpret identify molecular and metabolic disease states, develops polices, evidence-based practice guidelines for testing and participates in assay development. knowledge about recent advances and trends in research in the field of clinical biochemistry
- MK5. Knowledge of pathogenesis, diagnostic techniques, and prognostic factors in disease processes in general, including hematology and microbiology.
- MK6. Knowledge on medical educational technology, pedagogy, andragogy heutagogy

6.2.2 Patient Care/ Procedural skill (PC/PS)

- PC/PS.1. Understands principles of analysis and methodology of biochemical analytes
Able to perform, interpret, and report routine and less commonly used biochemical tests and correlate with laboratory data.
- PC/PS.2. Able to suggest an evidence-based diagnosis based on laboratory and clinical findings, interaction with other health care teams to discuss test results and make recommendations, Able to infer the role of the consultant in Biochemistry.
- PC/PS.3. Provide health care services in diagnostics for screening, diagnosing and monitoring health problems with commitment to patients by applying best practices and adhering to high ethical standards
- PC/PS.4. Analyses results of IQC and proficiency tests, identifies problems, and suggests corrective action and preventive action so as to release reliable reports.

6.2.3 System Based Practice

- SBP1. Leads a quality improvement project to improve quality of care or access to resources (E.g., case presentation, consultation, test selection guidance) in health care team
- SBP2. Actively participates in, or performs, inspections of laboratory so as to establish total quality management
- SBP3. Lab Management: Resource Utilization (personnel and finance) Perform administrative role, practice management responsibilities for resource utilisation (Personnel and finance)

6.2.4 Practice based learning and improvement

- PBLI.1. Demonstrates Evidence-based Utilization by self-directed learning
- PBLI.2. Demonstrates Reflective Practice and Commitment to Personal Growth

6.2.5 Interpersonal communication skills

- IPCS.1. Appropriate use of language and nonverbal behavior to demonstrate respect and establish rapport. Identifies common barriers to effective communication (e.g., language, disability) while accurately communicating own role within the health care system
- IPCS.2. Communicate effectively with students, colleagues within specialty, other health professionals, and health-related agencies (Vendors and management) as applicable.
- IPCS.3. Executes appropriate personnel management and conflict resolution

6.2.6 Professionalism

- P1. Demonstrates Reflective Practice and Commitment to Personal Growth
- P2. Accountability and Responsiveness to the Needs of Patients, Society, and the Profession

6.3 Milestone Levels for Sub – competencies

6.3.1 Medical Knowledge

MK 1: Knowledge and importance of biomolecules and cell biology in sustaining the life process, in health and disease				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Demonstrates knowledge and importance of biomolecules in sustaining the life process, able to describe and apply biochemical principles to explain the normal state, pertaining to Biomolecules and cell biology</p>	<p>Able to Describe importance of biomolecules in sustaining the life process, able to describe and apply biochemical principles to explain the abnormal disease conditions pertaining to Biomolecules and cell biology</p>	<p>Applies a broad base and in-depth knowledge in clinical and biomedical sciences relevant to a given clinical condition. Able to Apply knowledge of general concepts related to the human genome, human genes, and inheritance of DNA</p>	<p>Applies the knowledge of Biochemistry for interpreting the findings in correlation with clinical features. (knowledge)</p>	<p>Expands understanding and publishes results of molecular and metabolic basis of pathogenicity or treatment of a disease or metabolic pathway</p>

MK 2: Knowledge and application of the concept of nutrition in health and disease, essential nutrients, and interlinks of nutrients with metabolism and functions of a living system.				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Demonstrates basic medical knowledge of cellular, and molecular systems and its interrelation to nutrition in health and disease</p> <p>Applies knowledge of molecular and metabolic pathogenesis of disease to diagnosis and treatment recognizes signs and symptoms of inborn errors of metabolism, including these disease groups</p> <ul style="list-style-type: none"> -amino- acidopathies carbohydrate metabolism -fatty acid oxidation disorders -lysosomal storage diseases -mitochondrial disorders -organic acidurias -urea cycle disorders 	<p>Applies cellular, and molecular knowledge to identify pathologic processes, selects and recommends diagnostic studies including IBEM</p>	<p>Applies advanced knowledge of cellular, and molecular basis to common diagnoses</p> <p>Selects and orders confirmatory laboratory studies. Demonstrates knowledge of triage for individuals with abnormal tests and NBS results</p>	<p>Able to Integrate advanced knowledge of cellular, and molecular pathology to common and uncommon diagnoses</p> <p>Independently interprets and applies the information obtained from testing and also generates a differential diagnosis based on NBS results</p>	<p>Recognized as an expert so able to teach others the integration of cellular, and molecular pathology knowledge to disease</p> <p>Participates in state, regional, or national New Born Screening program/ development or evaluation projects and contributes to generalizable medical knowledge and diagnosis</p>

MK 3: Knowledge regarding the working principle, instrumentation and uses of routine and advanced analytical techniques in a clinical biochemistry laboratory including application of various aspects of genetic engineering in

medicine and molecular techniques in forensic investigation and medicolegal cases				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
Describe the working principle, instrumentation and uses of routine Analytical techniques in a clinical biochemistry laboratory	Able to explain the technology and utilization of diagnostic testing	Describe the working principle, instrumentation and uses of Analytical techniques such as Nanotechnology and microfabrication Techniques to study in vivo metabolism - NMR, SPECT, PET scans, radioisotope-based techniques and its applications	Identifies trouble shoot and resolves equipment related issues. Identifies best methods for diagnosis and subsequent laboratory monitoring	Develops polices or practice guidelines for testing and participates in assay development

MK 4: Knowledge of research and biostatistics to evaluate and interpret identify molecular and metabolic disease states, develops polices, evidence-based practice guidelines for testing and participates in assay development. knowledge about recent advances and trends in research in the field of clinical biochemistry				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
Acquire knowledge on the basics of research methodology and biostatistics	Able to write a research protocol with guidance	Carry out research work under guidance and draw inferences from the study. Critically appraise articles and provide feedback	Present the findings in scientific forums and defend the work	Able to carry out research independently and guide others (peers and students)

MK 6: Knowledge on medical educational technology, pedagogy, andragogy heutagogy

MK 5: Knowledge of pathogenesis, diagnostic techniques, and prognostic factors in disease processes in general, including hematology and microbiology.				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
Explains the need for knowledge of pathogenesis, diagnostic techniques, and prognostic factors in disease processes including hematology and microbiology	Demonstrates the application of basic textbook-level knowledge as it applies to clinical problems in medical microbiology and hematology	Applies medical knowledge to interpret and report routine investigations in hematology and microbiology under supervision	Independently applies medical knowledge to interpret and report routine investigations in hematology and microbiology with clinical correlation	Participates in interdepartmental presentations

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Demonstrates background content knowledge in Biochemistry.</p> <p>Participates in active learning</p>	<p>Understands and begins to acquire the skills needed for effective teaching.</p> <p>Able to teach undergraduates with guidance</p>	<p>Demonstrates the knowledge of pedagogical principles and teaching-learning tools in micro teaching session. Teaches peers as needed</p>	<p>Apply the content and pedagogical knowledge while teaching students in practical classes and theory classes</p>	<p>Create teaching- learning lesson plans based on content and pedagogical knowledge.</p> <p>Models teaching across departments and at all levels, including for clinicians, patients, and families.</p>

6.3.2 Patient Care/Procedural Skill – PC/PS

PC1: Understands principles of analysis and methodology of biochemical analytes Able to perform, interpret, and report routine and less commonly used biochemical tests and correlate with laboratory data				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Explain the indications for ordering specific tests and interpretation of commonly used biochemical tests.</p>	<p>Describe the principles of analysis and methodology of biochemical analytes Able to perform, interpret, and report less commonly used biochemical tests.</p> <p>Able to analyse with the test characteristics for less commonly used tests, and understands how these affect the establishment of a definitive diagnosis</p>	<p>Able to describe the utility and methodology of currently outsourced biochemical tests and assists with strengths and limitations of all test</p> <p>Observes and assists with interaction with other health care teams to discuss test results and make recommendations</p> <p>Able to significantly narrow a differential diagnosis using laboratory and clinical findings</p>	<p>Analyse the most complex test platforms, methodology, and test indications. Effectively teaches the salient features of chemistry testing, including the utility, and the strengths and limitations of the various methods of testing.</p> <p>Interacts with other health care teams to discuss test results and make recommendations</p>	<p>Proficient in Biochemical investigations during emergency situations such as pandemics.</p>

PC 2: Able to suggest an evidence-based diagnosis based on laboratory and clinical findings, interaction with other health care teams to discuss test results and make recommendations, Able to infer the role of the consultant in Biochemistry.				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5

<p>Able to infer the role of the consultant in Biochemistry. Observes and assists in the consultation Able to use the electronic medical record (EMR) and other electronic resources to obtain clinical and disease information</p>	<p>Performs clinically useful consultation in a timely manner. Prepares full and complete consultative reports with faculty member guidance</p>	<p>Effectively communicates consultative recommendations and action plans and maintains a portfolio, independently prepares full and complete consultative reports</p>	<p>Independently performs consultation during regular working hours and while on call and effectively teaches consultation skills</p>	<p>Proficient in Biochemical consultations, including those involving complex clinical scenarios and patient evaluation</p>
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<p>PC 3: Provide health care services in diagnostics for screening, diagnosing and monitoring health problems with commitment to patients by applying best practices and adhering to high ethical standards</p>				
<p>Milestone Level 1</p>	<p>Milestone Level 2</p>	<p>Milestone Level 3</p>	<p>Milestone Level 4</p>	<p>Milestone Level 5</p>

<p>Able to suggest disease-specific tests for diagnosis, screening and monitoring health problems.</p>	<p>Along with level one able to provide Dietary and supportive, management, offers and provides disease modifying therapy (e.g., solid organ transplant, enzyme replacement therapy, cell-based therapy), screens and provides referral for neurodevelopmental disorders, orders disease-specific monitoring and referrals for further evaluations</p>	<p>Able to assimilate information regarding complex test platforms, methodology, and test indications.</p> <p>Computes the utility and methodology of currently outsourced chemistry tests</p>	<p>Effectively teaches the salient features of chemistry testing, including the utility, and the strengths and limitations of the various methods of testing</p>	<p>Interacts with other health care teams to discuss test results and make recommendations</p>
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<p>PC 4: Analyses results of IQC and proficiency tests, identifies problems, and suggests corrective action and preventive action so as to release reliable reports.</p>				
<p>Milestone Level 1</p>	<p>Milestone Level 2</p>	<p>Milestone Level 3</p>	<p>Milestone Level 4</p>	<p>Milestone Level 5</p>

<p>Becomes familiar with the test characteristics [e.g., sensitivity, specificity, and positive and negative predictive values (PPV and NPV)] for tests commonly used in Biochemistry, and appreciates how these affect the establishment of a definitive diagnosis</p>	<p>Prepares a differential diagnosis for abnormal test results or finding. Identifies the strengths and limitations of tests commonly used.</p>	<p>Justifies for additional testing. Identifies the strengths and limitations of all tests used in biochemistry including those sent to a reference laboratory</p>	<p>Able to suggest an evidence-based solution to outliers in IQC based on laboratory data</p>	<p>Analysis results of proficiency tests, identifies problems, and suggests corrective action Demonstrates expertise at the level expected of a clinical biochemist</p>
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6.3.3 System based practice

SBP 1: Leads a quality improvement project to improve quality of care or access to resources (e.g., case presentation, consultation, test selection guidance) in health care team

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Recognises the importance of the role a clinical biochemist in the health care team</p> <p>Acquire knowledge on the teaching learning methods and modalities of assessment</p>	<p>Observes the role of clinical biochemist in the health care team (e.g., case presentation, consultation, test selection guidance)</p> <p>Identify the pros and cons of various teaching-learning sessions</p>	<p>Takes part in the role of a biochemist in the health care team (e.g., case presentation, consultation, test selection guidance)</p> <p>Incorporates multiple TL methods during seminars, journal club and UG teaching</p>	<p>Independently participates as a part of a health care team.</p> <p>Evaluate the teaching learning sessions and assessment critically for improvement</p>	<p>Effectively plays a lead role in the health care team</p> <p>Works with peers to create teaching-learning lesson plans keeping in mind the system errors, and assessment strategies</p> <p>Coaches junior postgraduates on following systems-based practice</p>

SBP 2: Actively participates in, or performs, inspections of laboratory so as to establish total quality management				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Able to associate that laboratories are regulated by professional bodies.</p> <p>Demonstrates compliance with national regulations for patient privacy and confidentiality</p>	<p>Explains the basics of quality assurance according to (NABL, NABH and ISO 15189) guidelines</p>	<p>Reviews IQC and proficiency testing results.</p> <p>Able to implement corrective and preventive action based on IQC and proficiency testing results</p>	<p>Participates as a team member in mock or actual inspection of a laboratory, or equivalent</p>	<p>Actively participates in, or performs, inspections of a laboratory at an outside facility</p> <p>Able to lead an inspection of a laboratory</p>

SBP 3: Lab Management: Resource Utilization (personnel and finance) Perform administrative role, practice management responsibilities for resource utilisation (Personnel and finance)				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Aware of the role of a biochemist in managing personnel</p> <p>Interprets an organizational chart</p> <p>Recognizes different budget types (i.e., capital vs. operating budget) Recognizes how health care systems influence individual practice and patient care</p> <p>Sensitive to cost-effective care</p>	<p>Well informed about the personnel and lines of reporting in the laboratory</p> <p>Describes the elements of a budget. Functions effectively within different systems of the health care system</p>	<p>Describes the process of personnel management and employment laws</p> <p>Advocates for laboratory services to enhance cost-effective care</p> <p>Implements state, national, and professional organizations' standards, or elements of checklists in the laboratory</p>	<p>Participates in employee interviews /performance evaluation (real or simulated experiences)</p> <p>participates in budgeting of a lab. Manages the variation in access to laboratory services.</p>	<p>Manages personnel effectively and able to develop a budget.</p> <p>Leads a quality improvement project to improve quality of care or access to resources</p>

6.3.4 Practice based learning and improvement

PBL1 1: Demonstrates Evidence-based Utilization by self-directed learning				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Demonstrates how to access and select applicable evidence</p> <p>Aware of the need for patient privacy, autonomy, and consent as applied to clinical research.</p> <p>Demonstrates the importance of evidence-based utilization of laboratory tests and results</p>	<p>Identifies and applies the best available evidence to guide diagnostic workup of simple cases</p> <p>Develops knowledge of the basic principles of research (demographics, Institutional Review Board, human subjects), including how research is evaluated, explained to patients, and applied to patient care</p>	<p>Identifies and applies the best available evidence to guide diagnostic work-up of complex cases</p> <p>Applies knowledge of the basic principles of research such as informed consent and research protocols to clinical practice, with assistance including laboratory tests and results</p>	<p>Critically appraises and applies evidence to guide care, even in the face of conflicting data</p> <p>Proactively and consistently applies knowledge of the basic principles of research such as informed consent and research protocols to clinical practice.</p> <p>Independently performs a critical review of the literature addressing evidence-based utilization of laboratory tests and results, and designs utilization guidelines</p>	<p>Teaches others to critically appraise and apply evidence for complex cases; and/or participates in the development of guidelines</p> <p>Suggest improvements to research regulations and/or substantially contributes to the primary literature through basic, translational, or clinical research.</p> <p>Implements institutional utilization guidelines for laboratory tests and results</p>

PBL1 2: Demonstrates Reflective Practice and Commitment to Personal Growth

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Acknowledges gaps in knowledge and expertise in his own knowledge of biochemistry.</p> <p>Accepts responsibility for personal and professional development by establishing goals</p> <p>Identifies the gap(s) between expectations and actual performance</p> <p>Actively seeks opportunities to improve</p>	<p>Incorporates feedback for improving his knowledge and skills in the gap. Demonstrates openness to receiving performance data and feedback in order to inform goals</p> <p>Analyzes and reflects on the factors which contribute to gap(s) between expectations and actual performance</p> <p>Designs and implements a learning plan, with assistance</p>	<p>Develops a learning plan based on the knowledge and expertise gap and the obtained feedback.</p> <p>Seeks performance data and feedback with humility</p> <p>Institutes behavioral change(s) to narrow the gap(s) between expectations and actual performance</p> <p>Independently creates and implements a learning plan</p>	<p>Implements the learning plan to bridge the gap.</p> <p>Actively and consistently seeks performance data and feedback with humility</p> <p>Critically evaluates the effectiveness of behavioral changes in narrowing the gap(s) between expectations and actual performance</p> <p>Uses performance data to measure the effectiveness of the learning plan and improves it when necessary</p>	<p>Applies the principles of self-directed learning in identifying and correcting the knowledge and expertise, gaps in knowledge in general</p> <p>Models seeking performance data with humility</p> <p>Teaches others reflective practice</p> <p>Facilitates the design and implementing learning plans for others</p>

6.3.5 Interpersonal communication skills

ICS 1: Appropriate use of language and nonverbal behavior to demonstrate respect and establish rapport. Identifies common barriers to effective communication (e.g., language, disability) while accurately communicating own role within the health care system				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Uses language and nonverbal behavior to demonstrate respect and establish rapport.</p> <p>Identifies common barriers to effective communication (e.g., language, disability) while accurately communicating own role within the health care system</p>	<p>Demonstrates usage of active listening and clear language</p>	<p>Establishes rapport in challenging patient encounters, as appropriate.</p> <p>Communicates to the patients the preparatory requirements for the test while overcoming the barriers to communication under supervision</p>	<p>Independently, sensitively, and compassionately delivers medical information, elicits patient/family values, goals and preferences, and acknowledges uncertainty and conflict</p>	<p>Mentors others in situational awareness and critical self-reflection to consistently develop positive therapeutic relationships</p>

ICS 2: Communicate effectively with students, colleagues within specialty, other health professionals, and health-related agencies (Vendors and management) as applicable.

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Recognises the importance of timely and effective communication with students, health care providers, families, and patients (as applicable). Conforms to the fact that the written report is a form of communication that must be clear and understandable. Effectively utilizes the electronic medical record</p>	<p>Communicates/Provides timely and effective communication with health care providers, families, and patients (as applicable) with guidance Produces a clear and understandable written report information effectively</p>	<p>Uses active listening to adapt communication style to fit needs. Independently communicates with healthcare team. Produces a clear and understandable written report effectively.</p>	<p>Effectively communicates complex, difficult, or challenging information (e.g., errors, complications, adverse events, and bad news) Independently and consistently produces a clear and understandable written report. Coordinates recommendations from different members of the team to optimize patient care.</p>	<p>Serves as a role model for effective and professional communication to student's health care providers, families, and patients (as applicable)</p>

ICS 3: Executes appropriate personnel management and conflict resolution

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Explains the importance of conflict and complaint resolution</p>	<p>Observes how conflict and complaints are resolved</p>	<p>Independently manages conflicts and complaints</p>	<p>Anticipates, mitigates, and manages potential conflicts and complaints</p>	<p>Models' flexible communication strategies that value input from all health care team members, resolving conflict when needed.</p>

6.3.6 Professionalism

P 1: Demonstrates Reflective Practice and Commitment to Personal Growth				
Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Demonstrates knowledge of the ethical principles underlying informed consent, surrogate decision making, advance directives, confidentiality, error disclosure, stewardship of limited resources</p> <p>Describes when and how to appropriately report professionalism lapses, including strategies for addressing common barriers; identifies and describes potential triggers for professionalism lapses</p>	<p>Analyzes straight forward situations using ethical principles</p> <p>Demonstrates insight into professional behaviors in routine situations; takes responsibility for own professionalism lapses</p>	<p>Recognizes the need and uses appropriate resources to seek help in managing and resolving complex ethical situations</p> <p>Demonstrates professional behavior in complex or stressful situations</p>	<p>Independently resolves and manages complex ethical situations</p> <p>Recognizes situations that may trigger professionalism lapses and intervenes to prevent lapses in self and others</p>	<p>Identifies and seeks to address system-level factors that induce or exacerbate ethical problems or impede their resolution</p> <p>Coaches others when their behavior fails to meet professional expectation</p>

P 2: Accountability and Responsiveness to the Needs of Patients, Society, and the Profession

Milestone Level 1	Milestone Level 2	Milestone Level 3	Milestone Level 4	Milestone Level 5
<p>Responds promptly to instructions, requests, or reminders to complete tasks and responsibilities</p> <p>Understands that physicians are accountable to patients, society, and the profession Acts with honesty and truthfulness</p>	<p>Takes appropriate ownership and performs tasks and responsibilities in a timely manner with attention to detail</p> <p>Consistently punctual for laboratory assignments and responsive to requests for assistance; completes administrative duties (e.g., medical records, reports) on time and without reminders</p> <p>Understands the signs and symptoms of fatigue, stress, and substance abuse</p>	<p>Recognizes situations that may impact own ability to complete tasks and responsibilities in a timely manner and describes the impact on team</p> <p>Serves as an example for others in punctuality, responsiveness, and timely completion of duties</p> <p>Recognizes signs and symptoms of fatigue, stress, and substance abuse</p>	<p>Anticipates and intervenes in situations that may impact others' ability to complete tasks and responsibilities in a timely manner</p> <p>Coaches others to improve punctuality and responsiveness; offers assistance to ensure patient care duties are completed in a timely fashion</p> <p>Demonstrates self-awareness of fatigue and stress, and mitigates the effects</p>	<p>Takes ownership of system outcomes</p> <p>Designs new strategies to ensure that the needs of patients, teams, and systems are met</p> <p>Participates in institutional or community peer counselling related to professionalism</p>

7 Syllabus

7.1 Course 1 (C1) (Biomolecules, Cell Biology, Biochemical Techniques, Biostatistics and Research Methodology, Basics Of Medical Education In Teaching And Assessment Of Biochemistry)

7.1.1 Biomolecules:

- a. Properties of water
- b. Concept of an acid, a base, pH, pK, buffer and buffering capacity
- c. Classification, structure and functions of amino acids and peptides
- d. Structural organization of proteins and relationship with their functions
- e. primary, secondary, tertiary and quaternary structure of proteins
- f. protein folding and denaturation
- g. Structure-function relationship of proteins
 - o Structure and functions of hemoglobin and myoglobin
 - o Structure and function of collagen
 - o Structure and function of immunoglobulins
- h. Classification, functions, properties and reactions of carbohydrates
- i. Classification, properties and importance of lipids
 - Fatty acids - nomenclature, classification, properties, reactions
 - Mono, di- and triacylglycerols
 - Trans fats
 - Cholesterol - structure, properties and functions
 - Phospholipids - definition, types, properties, s and importance
 - Glycolipids - definition, types, functions, examples.
 - Lipoproteins - definition, structure, types, functions, role of apoproteins, importance in health and disease.
 - Biological membranes - structure, function, properties and importance.
 - Micelles and liposomes
- j. **Nucleotides and nucleic acids**
 - purine and pyrimidine bases in DNA and RNA
 - nucleosides and nucleotides
 - physiologically important nucleotides
 - synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents

(anti-cancer drugs, anti-viral drugs)

· Watson and Crick model of DNA structure

· Structure and functions of different types of RNA.

7.1.2 Cell biology

- a.** Structure of the cell and different subcellular organelles
- b.** Structure and functions of cell membrane, solute transport across biological membranes
- c.** Intracellular traffic and sorting of proteins
- d.** Intracellular signalling pathways, membrane receptors and second messengers
- e.** Extracellular matrix: composition, importance and biomedical importance, cellular adhesion molecules and intercellular communication
- f.** Cytoskeleton, muscle contraction and cell motility
- g.** Cell cycle, mitosis, meiosis and mechanisms of cell death
- h.** Red and white blood cell

7.1.3 Analytical techniques in biochemistry

- a.** Spectrophotometry (UV and visible spectrophotometry),
- b.** Atomic absorption spectrophotometry
- c.** Flame photometry
- d.** Fluorometry
- e.** Turbidimetry and nephelometry
- f.** Gravimetry
- g.** Electrochemistry (pH electrodes, ion-selective electrodes, gas-sensing electrodes)
- h.** Chemiluminescence
- i.** Water testing
- j.** Electrophoresis (principle, types, applications; isoelectric focusing capillary electrophoresis; 2-D electrophoresis)
- k.** Chromatography (principle, types [including high performance liquid chromatography and gas chromatography])
- l.** Techniques in molecular biology: Blotting techniques, polymerase chain reaction (PCR), DNA and protein sequencing, microarrays and DNA chip technology, cloning techniques, genomics, proteomics and metabolomics
- m.** Nanotechnology and microfabrication

- n.** Techniques to study in vivo metabolism - NMR, SPECT, PET scans, etc
Radioisotope-based techniques and its applications

7.1.4 Biostatistics and research methodology

- a.** Basic concepts of biostatistics as applied to health science
- b.** Statistical tests: t-test, analysis of variance, chi-square test, non-parametric tests, correlation and regression
- c.** Statistical methods of validation of diagnostic tests
- d.** Basics of epidemiological study designs and sampling methodologies
- e.** Meta-analysis and systematic reviews

7.1.5 Bioethics

To list the ethical guidelines for laboratory medicine given by various national and international councils

7.1.6 Basics of medical education in teaching and assessment of biochemistry

- a.** Principles of adult learning, taxonomy of learning, educational objectives
- b.** Principles of assessment and question paper setting, methods of assessing knowledge, appropriate use of media, microteaching, small group teaching.

7.2 Course 2 (C2) (Enzymes, Bioenergetics, Biological Oxidation, Intermediary Metabolism and Regulation, Inborn Errors of Metabolism and Nutrition)

7.2.1 Enzymes

Properties, classification, mechanism of action, coenzymes and cofactors, kinetics of enzyme activity, regulation of enzyme activity, isoenzymes, diagnostic and therapeutic enzymes, principles of assays of enzymes, enzymes as therapeutic targets of drugs.

7.2.2 Biological oxidation

- a.** Basic concepts of thermodynamics and its laws, as applied to living systems,
- b.** Exergonic and endergonic reactions and coupled reactions, redox potential and High energy compounds
- c.** Classification and role of oxidoreductases
- d.** Cytochromes; cytochrome P450 system
- e.** Respiratory chain and oxidative phosphorylation
 - Components, complexes and functioning of the respiratory chain
 - Process of oxidative phosphorylation
 - Mechanisms of ATP synthesis and regulation
 - Mitochondrial transport systems and shuttles
 - Inhibitors, uncouplers and ionophores
 - OXPHOS diseases

7.2.3 Overview of metabolism and intermediary metabolism

- a.** *Metabolism of carbohydrates*
 - Digestion and absorption
 - Glycolysis and TCA cycle, including regulation
 - Glycogen metabolism and its regulation
 - Cori cycle, gluconeogenesis and control of blood glucose
 - Metabolism of fructose and galactose
 - Pentose phosphate and uronic acid pathways and their significance
 - Polyol pathway
 - Regulation of blood glucose levels
 - Diabetes mellitus (including gestational diabetes mellitus) – classification, pathogenesis, metabolic abnormalities, diagnostic criteria, principles of treatment, pathogenesis of

complications, laboratory tests

- Metabolism of ethanol

b. *Metabolism of lipids*

- Digestion and absorption, including role of bile salts
- Biosynthesis and oxidation of fatty acids
- Ketone bodies – formation, utilisation and regulation
- Metabolism of unsaturated fatty acids and eicosanoids
- Metabolism of triacylglycerol; storage and mobilisation of fats
- Metabolism of cholesterol
- Metabolism of lipoproteins
- Metabolism in adipose tissue
- Role of liver in lipid metabolism
- Role of lipids in atherogenesis
- Metabolism of phospholipids and associated disorders

c. *Metabolism of amino acids and proteins*

- i.** Digestion and absorption
- ii.** Pathways of amino acid degradation - transamination, oxidative deamination
- iii.** Transport and metabolism of ammonia
- iv.** Metabolism of individual amino acids.
- v.** Plasma proteins

d. *Metabolism of nucleotides*

- i.** De novo synthesis of purine nucleotides
- ii.** Salvage pathway for purines
- iii.** Degradation of purines
- iv.** De novo synthesis of pyrimidine nucleotides
- v.** Degradation of pyrimidine
- vi.** Synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents

e. *Metabolism of haem*

- i.** Biosynthesis of heme and associated disorders
- ii.** Degradation of heme and associated disorders

f. *Metabolism in individual tissues and in the fed and fasting states*

Liver, adipose tissue, brain, RBCs

7.2.4 Nutrition

- a. Principal food components
- b. General nutritional requirements
- c. Energy requirements
- d. Biological value of proteins
- e. Thermogenic effect of food
- f. Balanced diet, diet formulations in health and disease, mixed diet
- g. Nutritional supplements
- h. Food toxins and additives
- i. Parenteral nutrition
- j. Disorders of nutrition, obesity, protein and protein energy malnutrition, dietary fibers, under-nutrition, laboratory diagnosis of nutritional disorders
- k. National Nutrition Programme.
- l. ***Vitamins***
Classification, biochemical role, sources, RDA and deficiency state of each vitamin
(including diagnostic tests for deficiency and treatment)
- m. ***Minerals***
Classification, biochemical role, sources, requirement and deficiency state of each mineral
(including diagnostic tests for deficiency and treatment)
- n. ***Metabolism of xenobiotics***
- o. ***Free radicals and anti-oxidant defence systems in the body and associations with disease processes***

7.3 Course 3 (C3) (Molecular Biology, Molecular and Genetic Aspects Of Cancer, Immunology and Effects of Environmental Pollutants on the Body)

7.3.1 Molecular Biology

- a.** Structure and organization of chromosomes and chromatin re-modelling
- b.** DNA replication
 - i. DNA replication in prokaryotes and eukaryotes (including important differences between the two): Roles of DNA polymerase, helicase, primase, topoisomerase and DNA ligase
 - ii. Replication fork
 - iii. Okazaki fragments and its importance in replication.
 - iv. Overview of role of major DNA repair mechanisms – mismatch repair, base excision repair, nucleotide excision repair and double strand break repair.
Diseases associated with abnormalities of DNA repair systems
 - v. DNA recombination
- c.** Transcription
 - i. Structure of a gene - exons and introns, promoter, enhancers/repressors and response elements.
 - ii. Process of transcription in prokaryotes and eukaryotes – initiation, elongation and termination (including important differences).
 - iii. Post-transcriptional processing – capping, tailing and splicing.
- d.** Genetic code and mutations
 - i. Characteristics of the genetic code
 - ii. Molecular basis of degeneracy of the genetic code (Wobble hypothesis)
 - iii. Mutagens- examples of physical, chemical and biological mutagens.
 - iv. Types of mutations – point mutations and chromosomal mutations
 - v. Relationship of mutations with specific diseases
- e.** Translation
 - i. Basic structure of prokaryotic and eukaryotic ribosomes.
 - ii. Structure of tRNA (diagram of clover leaf model of tRNA structure) and its function in protein synthesis.
 - iii. Function of aminoacyl tRNA synthase.

- iv. Process of protein synthesis (translation) – initiation, elongation and termination (including important differences between prokaryotic and eukaryotic translation).
- v. Inhibition of prokaryotic translation by antibiotics.
- vi. Post-translational modifications
- f.** Regulation of gene expression in prokaryotes and eukaryotes
 - i. The operon concept in prokaryotes
 - ii. Role of general and gene specific transcription factors
 - iii. Small interference RNA (siRNA) and micro-RNA (miRNA).
 - iv. Other modes of regulation of gene expression: alternative splicing, alternative promoter usage, DNA methylation, Histone acetylation / deacetylation, RNA editing, alterations of RNA stability
- g.** Recombinant DNA technology and its applications in modern medicine
 - i. Concepts of recombinant DNA, genetic engineering, biotechnology and cloning.
 - ii. Restriction endonucleases.
 - iii. Vectors for cloning – plasmids and phage's.
 - iv. Genomic and cDNA libraries.
 - v. Applications of recombinant DNA technology in medicine.
 - vi. Gene therapy
- h.** Diagnosis of genetic diseases and genetic counselling
 - i. DNA fingerprinting
 - ii. DNA sequencing
 - iii. Microarrays
 - iv. Fluorescent in situ hybridization (FISH)
 - v. DNA vaccines
 - vi. Transgenic animals
 - vii. Application of molecular techniques in forensic investigation and medicolegal cases
- i.** Overview of Human Genome Project
- j.** Basics of bioinformatics
- k.** Principles of human genetics
 - i. Alleles, genotypes and phenotypes
 - ii. Patterns of inheritance: monogenic and polygenic inheritance

- iii. Population genetics
- iv. Genetic factors in causation of diseases
- v. Types of genetic diseases: Chromosomal, monogenic and polygenic disorders, mitochondrial disorders, nucleotide repeat expansion disorders, imprinting disorders
- vi. Screening for genetic diseases and prenatal testing
- vii. Ethical and legal issues related to medical genetics
- l. Stem cells in clinical medicine**
 - i. Basic concepts regarding stem cells
 - ii. Types of stem cells: embryonic and induced pluripotent stem cells (iPSC)
 - iii. Potential applications in the clinical medicine
 - iv. Ethical and legal issues related to use of stem cells in medicine

7.3.2 Cancer

- a.** Carcinogens: physical, chemical and biological
- b.** Clonal origin of cancers
- c.** Genetic basis of carcinogenesis
- d.** Role of oncogenes and tumour suppressor genes
- e.** Familial cancer syndromes
- f.** Cancer stem cells
- g.** Epigenetic regulation in cancer
- h.** Gene expression profiling in cancer
- i.** Cancer cell biology: cell cycle abnormalities, telomerase activity, proliferative capacity and decreased apoptosis
- j.** Metastasis
- k.** Tumor markers
- l.** Biochemical basis of cancer chemotherapy and drug resistance
- m.** New methods of anti-cancer therapy: targeted cancer therapy, cancer immunotherapy.

7.3.3 Immunology

- a.** Innate and acquired immunity
- b.** Humoral and cell-mediated immunity

Cells and organs of the immune system - T and B cells, macrophages, dendritic cells, NK cells, granulocytes

- c.** Antigens, epitopes and haptens
- d.** Immunoglobulin classes, isotypes, allotypes, idiotypes, monoclonal antibodies, organization and expression of immunoglobulin genes, immunoglobulin gene rearrangement, class switching
- e.** Antigen-antibody interaction - immunochemical techniques
- f.** Major histocompatibility complex, antigen processing and presentation,
- g.** T cell and B cell receptor, toll like receptors
- h.** T cell maturation/activation/differentiation
- i.** B cell generation/activation/differentiation
- j.** Cytokines
- k.** Complement system, cell
- l.** Immune response to infections
- m.** Hypersensitivity reactions
- n.** Vaccines
- o.** Immuno-deficiency syndromes
- p.** Autoimmunity
- q.** Transplantation immunology
- r.** Cancer and immune system,
- s.** Immunodiagnostics
- t.** Immunotherapy

7.3.4 Environmental pollution

7.4 Course 4 (C4) (Clinical biochemistry and Molecular diagnostics related to different body systems/organs, endocrinology, and Recent advances in biochemistry)

7.4.1 Basic principles and practice of clinical biochemistry

- a.** Units of measure, reagents, clinical laboratory supplies, basic separation techniques,
- b.** laboratory calculations, specimen collection and processing, safety in the laboratory, clinical utility of laboratory tests (including sensitivity, specificity, ROC curves, etc), analysis in the laboratory, selection and evaluation of methods (including statistical techniques), evidence-based laboratory medicine, establishment and use of reference values, pre-analytical variables and biological variations, quality management, clinical laboratory informatics.
- c.** Analytical techniques and instrumentation
Principles of basic techniques used in a clinical biochemistry laboratory (spectrophotometry, electrochemistry, electrophoresis, osmometry, chromatography, mass spectrometry, immunochemical techniques, molecular techniques, automation, point of care testing

7.4.2 Clinical correlates and analytical procedures

- a.** Amino acids, peptides and proteins; non-protein nitrogenous compound
- b.** Enzymes
- c.** Carbohydrates
- d.** lipids, lipoproteins and apolipoproteins and other cardiovascular risk factors
- e.** electrolytes
- f.** blood gases and pH
- g.** hormones and associated disorders
- h.** catecholamines and serotonin
- i.** vitamins; trace and toxic elements
- j.** Hemoglobin, and bilirubin, porphyrins and associated disorders
- k.** Bone and mineral metabolism
- l.** Tumour markers
- m.** Assessment of organ functions (hypothalamus and pituitary, adrenal glands, gonads, thyroid, parathyroid, liver, kidney, heart, stomach, pancreas, intestine, etc) and associated disorders
- n.** pregnancy and maternal and fetal health

- o.** reproduction related disorders – infertility
- p.** New born screening
- q.** Inborn errors of metabolism
- r.** Hemostasis
- s.** Therapeutic drug monitoring
- t.** Clinical toxicology
- u.** Molecular diagnostics
- v.** Body fluid analyses

7.4.3 Regulation of fluid and electrolyte balance and associated disorders

7.4.4 Regulation of acid-base balance and associated disorders

7.4.5 Biochemistry of the endocrine system

- a.** Classification and general mechanism of action of hormones
 - Biosynthesis, secretion, regulation, transport and mode of action of hypothalamic peptides, adenohipophyseal and neurohipophyseal hormones, thyroid and parathyroid hormones, calcitonin, pancreatic hormones, adrenocortical and medullary hormones, gonadal hormones, gastrointestinal hormones, opioid peptides, parahormones.
- b.** Biochemistry of conception, reproduction and contraception
- c.** Endocrine interrelationship and their involvement in metabolic regulation
- d.** Neuro-modulators and their mechanism of action and physiological significance
- e.** Biochemical aspects of diagnosis and treatment of endocrinal disorders:

7.4.6 Hematopoietic disorders

- a.** Iron deficiency and other hypoproliferative anaemias - iron metabolism, laboratory tests of iron status, iron therapy
- b.** Anaemia of chronic disease, anaemia of renal disease
- c.** Hemoglobinopathies - sickle cell anaemia, methaemoglobinemias, thalassemia syndromes, Megaloblastic anaemia
- d.** RBC membrane and metabolism
- e.** Hemolytic anaemia - inherited defects in RBC membrane and enzymes (G6PD deficiency), immunologic causes of hemolysis
- f.** ABO blood group system - biochemical basis, transfusion biology.
- g.** Plasma cell disorders - multiple myeloma.

h. Hemostasis and thrombosis

- Biochemical mechanisms, related laboratory tests, antiplatelet/anticoagulant/fibrinolytic therapy

7.4.7 Cardiovascular system

- a.** Atherosclerosis - pathogenesis, risk factors, prevention and treatment, Cardiac failure, acute coronary syndrome, cardiac biomarkers

7.4.8 Respiratory system

- a.** Gaseous exchange in lungs - physiological features and disturbances, arterial blood gases
- b.** Pathogenesis of cystic emphysema, alpha-1 anti-trypsin deficiency

7.4.9 Kidney

Kidney function tests; pathophysiology, biochemistry, laboratory findings and management in acute kidney injury and chronic kidney disease; estimation of GFR; glomerular diseases - pathogenesis and mechanisms of glomerular injury, nephrotic syndrome, diabetic nephropathy; tubular disorders - renal tubular acidosis, proteinuria, nephrolithiasis, kidney transplant; biochemical aspects of renal stones.

7.4.10 Gastrointestinal system

- a.** Gastric physiology
- b.** Pathophysiology of peptic ulcer disease, including role of *H. pylori*; gastric function tests; Zollinger-Ellison syndrome
- c.** Digestion and absorption of nutrients; evaluation of malabsorption (steatorrhea, lactose intolerance)
- d.** Celiac disease
- e.** Inflammatory bowel disease
- f.** Protein losing enteropathy
- g.** Regulatory peptides in the gut
- h.** Neuroendocrine tumours

7.4.11 Liver

- a.** Liver function tests
- b.** Hyperbilirubinemias
- c.** Viral hepatitis
- d.** Serologic/virologic markers

- e. Alcoholic liver disease, fatty liver, chronic liver disease, cirrhosis and its complications
- f. Pathogenesis of ascites
- g. Hepatic encephalopathy
- h. Metabolic diseases affecting liver
- i. Reye's syndrome
- j. Diseases of gall bladder/bile ducts - pathogenesis of gallstones
- k. Pancreas - acute and chronic pancreatitis, cystic fibrosis, pancreatic function tests.

7.4.12 Bone and mineral metabolism

- a. Bone structure and metabolism; metabolism of calcium, phosphate and magnesium; regulation and abnormalities of bone metabolism; vitamin D; parathyroid hormone; calcitonin; parathyroid hormone-related (PTHrP); osteoporosis – pathophysiology; markers of bone turnover

7.4.13 Nervous system

- a. Neurotransmitters and their receptors
- b. Ion channels and channelopathies
- c. Neurotrophic factors
- d. Protein aggregation and neurodegeneration
- e. Alzheimer's disease, Parkinson's disease, Huntington's disease, multiple sclerosis
- f. Prions and prion diseases
- g. Guillain-Barre syndrome – immunopathogenesis
- h. Myasthenia gravis – pathophysiology
- i. Hereditary myopathies - Duchenne muscular dystrophy
- j. Inherited disorders of muscle energy metabolism
- k. Mitochondrial myopathies
- l. Pathophysiology of psychiatric disorders such as anxiety, depression and schizophrenia

7.5 Practical's

7.5.1 PART – I: GENERAL BIOCHEMISTRY PRACTICALS

1. Reactions of carbohydrates, lipids, proteins and amino acids
2. Reactions of haemoglobin and its derivatives – detection by spectroscope
3. Analysis of normal Urine
4. Analysis of abnormal Urine
5. Separation of sugars and amino acids by chromatography (paper/TLC)
6. Separation of proteins in serum / plasma by electrophoresis (paper / agarose)
7. Preparation of buffers and determination of pH using pH meter.
8. Assay of antioxidant capacity and lipid peroxidation
9. Isolation and assessment of the purity of the extracted DNA
10. Blotting techniques
11. Gene amplification techniques and identification of SNPs
12. Ion exchange chromatography
13. Estimation of ethyl alcohol in blood and urine
14. Estimation of vitamin A, E & C
15. Planning and organization of biochemical experiments in the laboratory
16. Method validation.
17. Basic Trouble shooting of an auto analyser.
18. To do Precision and accuracy checks.
19. Basic criteria for selecting instruments.
20. Basic maintenance of Electrolytes, Hormone and ABG analyser.
21. To prepare a workflow chart for clinical biochemistry lab.
22. To interpret internal and external quality control charts.
23. To prepare and discuss Monthly Lab audit report.
24. Interpretation of basic biochemistry reports.
25. Interpretation of ABG reports

7.5.2 PART – II: CLINICAL BIOCHEMISTRY PRACTICALS

1. Estimation of glucose in blood
2. Glucose tolerance test
3. Estimation of glycosylated hemoglobin
4. Estimation of lipid profile
 - a. Cholesterol
 - b. Triacylglycerol (Triglycerides)
 - c. LDL,
 - d. VLDL,
 - e. HDL

5. Estimation of Renal profile
 - a. Urea
 - b. Creatinine
 - c. Uric acid
 - d. Ammonia
5. Estimation of protein, albumin and A/G ratio in serum
6. Separation of proteins by polyacrylamide gel electrophoresis (PAGE)
7. Separation of lipoproteins by electrophoresis
8. Separation of normal and abnormal hemoglobins by electrophoresis
9. Separation of Isoenzymes of LDH and CPK by PAGE
10. Immunoelectrophoresis
11. Estimation of calcium and phosphorus in blood
12. Estimation of Bilirubin (Total, Direct and indirect Bilirubin) in serum or plasma
13. Estimation of electrolytes (Sodium, potassium and chloride) in blood and urine using ion selective electrodes / flame photometer.
14. Estimation of blood gases (ABG): pO₂, pCO₂, pH, etc
15. Estimation of trace elements in blood
 - a. Iron
 - b. Iron binding capacity
 - c. Copper
 - d. Ceruloplasmin
 - e. Magnesium
 - f. Lithium
16. Estimation of hormones by non-isotopic assays (ELISA / Chemiluminescence)
 - a. T₃, T₄, TSH
 - b. Insulin
 - c. LH & FSH
 - d. Steroid hormones
17. Analysis of bio fluids and interpretation of reports
 - a. CSF
 - b. Ascitic acid
 - c. Plural fluid
 - d. Peritoneal fluid
18. Estimation of Lp (a)
19. Estimation of troponin, myoglobin, microalbumin
20. Analysis of renal and biliary calculi
21. Coagulation profile
22. Estimation of urine proteins
23. Detection of Bence –Jones proteins in urine
24. Estimation of 17 keto steroids, VMA, 5HIAA in urine
25. Interpretation of laboratory data on biochemical parameters and correlation with clinical profile related to the liver function, renal function, gastric function and thyroid function.
26. Method validation
27. Preparation and interpretation of quality charts and application of six sigma for clinical chemistry laboratory
28. Trouble shooting of instruments
29. Conducting internal audits, writing SOPs and quality manual for NABL accreditation

8 Teaching and Learning Method

The trainee will undergo a graded training over a period of three years.

○ Orientation

At the beginning of the course each resident should be given an orientation to the department and subject. The candidate shall be assigned dissertation guides so as to help them prepare protocols

8.1 Theory (Knowledge/ Cognitive Domain)

The teaching learning methods does not totally depend on didactic lectures. Only the introductory lectures by faculty are in this format.

8.1.1 Introductory lectures

These will be conducted at the beginning of the course by a faculty and are aimed to familiarize the resident with the

- a. Routine working of the department and the central laboratory
- b. Patient evaluation, work flow in the laboratory and interpretation of laboratory investigation
- c. Role of residents as teachers
- d. Residents will be taught to search literature and write a dissertation protocol.
- e. Significance of documentation in the laboratory
- f. The residents are encouraged to ask questions and request consultations when necessary

8.1.2 Teaching programme

This will include theory topics and will ensure participation of the resident in the form of:

1. Seminars, group discussions and symposia. These should be regularly organized in the department.
2. Problem case discussion, before and after the conduct of the case should form part of training.
3. Journal club presentation and discussion
4. Interdepartmental programmes with clinical departments
5. Simulation based training involving - Weekly 2hrs class on simulation:
 - a) Learning and practicing basic skills and competencies
 - b) Problem solving and decision-making skills/ Interpersonal and communications skills or team - based competencies, Deliberate practice with feedback, Exposure to uncommon events and Assessment of learners

8.1.3 Structured Graded Training – Year wise Knowledge / cognitive domain

First Year Objectives:

1. Understand the concept of Biochemistry regarding Biomolecules Carbohydrates, proteins, lipids, Nucleic acids, Enzymes, Minerals.
2. Acquire knowledge of intermediary metabolism of the above & regulation of individual metabolism.
3. Attain the knowledge of the impairment of metabolism including inborn errors of metabolism.
4. Understand the role of nutrition in health& disease.
5. Relevant basic science knowledge in clinical biochemistry, immunology and molecular biology
6. Apply biochemical knowledge in physiological states
7. Computers, Utility, computer assisted learning and data storage.

Second Year Objectives

1. Working principle, instrumentation and uses of routine analytical techniques in a clinical biochemistry laboratory
2. Clinical competence in the diagnosis and clinical management of patients with conditions characterized by the need for clinical biochemistry assessment and/or monitoring, which may include but is not limited to diabetes mellitus, cardiovascular disease prevention and nutritional deficiency or excess
3. Medical statistics relevant to data collection, analysis, comparison and estimation of significance
4. Working principles and limitations of general and special analyses currently used in clinical biochemistry laboratories
5. Organize, conduct and co-ordinate UG laboratory teaching in practical classes, to participate in clinical case-based teaching sessions and small group discussions (as part of a team that includes faculty members and senior residents of the department), to develop skills of self-directed learning, effective communication and leadership
6. Utility of assays used in medical biochemistry and provide proper interpretation of results for medical and surgical patients in adult, paediatric, and women's health environments

Third Year Objectives:

1. Supervise the technical performance, interpretation and reporting of results
2. Apply biochemical knowledge in pathological states of diseases in clinical biochemistry, immunology and molecular biology
3. Conduct a personal practice audit
4. Access and interpret the relevant evidence
5. Principles of learning relevant to medical education
6. Identify collaboratively the learning needs and desired learning outcomes of others
7. Select effective teaching strategies and content to facilitate others' learning
8. Demonstrate effective lectures or presentations
9. Principles of human resources and material management in the laboratory.
10. Supervise pre-analytical, analytical and postanalytical aspects of laboratory procedures relevant to medical biochemistry

8.2 Practical skills training (psychomotor domain)

8.2.1 Resident Rotations

Training in clinical Biochemistry: The post graduate students should receive hands-on training in a diagnostic laboratory in Biochemistry; such training should be extensive and rigorous enough for each post graduate student to acquire adequate skills and expertise to manage and supervise such a laboratory. The post graduate students should be posted in all sections of the laboratory in the institution, starting from sample collection and processing. They should become proficient in working with the autoanalysers in the laboratory, in quality control methods, setting up of a clinical biochemistry laboratory, specialized assays and statistical analysis of data. It would also be desirable for them to acquire experience in running a 24-hours diagnostic laboratory; towards this end, it would help if they are posted in the laboratory out of regular hours as well.

Rotation in clinical departments

It would be desirable for the post graduate students to be posted in clinical departments after their training period in the diagnostic laboratory, for up to 3 months of the course. The students would be posted in the clinical departments at the beginning of the 2nd year of postgraduation. A log of everyday activities such as patient care, procedures performed and academic sessions attended will be entered by resident into an e - portfolio, a link of which will be sent to the respective consultant in - charge for review and comments.

Suggested departments and durations of postings are as follows:

General medicine (1 month which includes endocrinology and intensive care units),
Hematology (1 month),
Routine Microbiology (1 month),
Paediatrics (10 days).

These postings will help post graduate students get a better perspective on diagnostic tests in clinical practice and will enable them to contribute more effectively to patient care.

8.2.2 Structured Graded Training –Year - wise Practical training objectives

First Year Objectives:

- The resident should be able to perform and interpret the qualitative experiments in biochemistry including electrophoresis and chromatography.
- They will observe the work flow in the clinical biochemistry laboratory and gradually learn the working principles of the instruments.

Second Year Objectives

- The resident should be able to perform and interpret the quantitative experiments in clinical biochemistry including operating principles of manual and automated analytical instruments.
- The resident should be able to analyse data and write a dissertation.
- Should be able to present scientific data.

Third Year Objectives:

- Demonstrate ability to supervise pre-analytical, analytical and postanalytical aspects of laboratory procedures relevant to medical biochemistry
- Demonstrate the ability to establish proper reference ranges
- Demonstrate effective, appropriate, and timely performance of diagnostic procedures relevant to Medical Biochemistry
- The resident should be able to establish a quality control plan appropriate to the biochemical parameters
- Able to interpret the internal quality control value and perform a root cause analysis for outliers in the IQC and external quality assurance.
- Able to take appropriate corrective and preventive action.
- Able to verify and validate methods
- Attend audit meetings.

E - portfolio

It is an electronic portfolio to be maintained by the resident to record their day to day academic and patient care activities under the following sections:

- Entrustable Professional Activity assessment

- Daily log
- Patient care
- Procedure
- Dissertation
- Academic activities (Seminar, symposium, case presentation, journal club)
- Co - curricular activities (Conference, CME, Workshop),
- Teaching Assignments,
- Awards and achievements
- Outreach activities.

E - portfolio will be monitored and endorsed periodically by the faculty supervisors. This will enable faculty to monitor residents progress, attainment of milestones and impart the training accordingly.

9 Assessment

Assessment will have 2 components Formative and Summative

9.1 Formative assessment

9.1.1 Cognitive Assessment

- Assessment in Cognitive Domain
- Schedule of theory tests
 - 1st year – 2 papers consisting of syllabus from Course 1
 - 2nd year – 2 papers consisting of syllabus from Course 2 and 3
 - 3rd year – one paper consisting of syllabus from Course 4
 - 3rd year – Mock exams one month prior to University examination, consisting of 4 papers, including syllabus from all the four courses.

9.1.2 EPA Assessment

- Assessment of Entrustable Professional Activities (EPA) done during the clinical central laboratory posting and also during clinical posting by the consultant in - charge. EPA assessment will be done once by the end of the 1st week of the posting and then again at the end of the posting, for monitoring of resident progress.

List of EPA's

General

- EPA1. Prioritizing a differential diagnosis based on history, physical examination and biochemical analysis
- EPA2. Recommending and interpreting common screening and diagnostic tests and data
- EPA3. Giving the necessary instructions to the patients related to biochemical investigations
- EPA4. Obtain informed consent for investigations and for academic research
- EPA5. Collaborate as a member of an interprofessional team
- EPA6. Form clinical questions and retrieve evidence to advance patient care

Clinical Biochemistry

- EPA7. Evaluate and report clinical laboratory testing including critical values and special investigations
- EPA8. Provide guidance for the resolution of preanalytical, analytical and post analytical testing issues
- EPA9. Provide biochemistry support for interdisciplinary presentations/clinicopathological meet
- EPA10. Provide patient care consultations
- EPA11. Optimize test utilization

- EPA12. Improve quality and patient safety
- EPA13. Evaluate and choose a new test/assay or instrument
- EPA14. Perform a laboratory audit

Research methodology

- EPA15. Should be able to write a scientific protocol for clinical research
- EPA16. Reporting and communication of scientific research

Teaching

- EPA17. Select and demonstrate competency in a range of teaching methods
- EPA18. Select a learning outcome and design and develop an appropriate assessment method
- EPA19. Solicit feedback on one's leadership and teaching from multiple observers & critically reflect on it

9.1.3 EPA Descriptions (Enter all the EPA and their descriptions)

EPA1. General

Prioritizing a differential diagnosis based on history, physical examination and biochemical analysis			
Description for the activity	Residents should be able to perform complete history taking and physical examination in an organized manner without supervision and with respect for the patient. The history and physical examination should be tailored to the clinical situation and specific patient encounter. This data gathering and patient interaction activity serves as the basis for clinical work and as the building block for patient evaluation.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	1,2	1- L4; 2- L4
	PC/PS	1,2	1- L4; 2- L3
	SBP		
	IPCS	1	1- L4
	P	1	1- L3
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in clinical posting 		

EPA2. General

Recommending and interpreting common screening and diagnostic tests and data			
Description for the activity	Residents should be able to integrate patient data to formulate an assessment, develop a list of potential diagnoses that can be prioritized and lead to selection of a working diagnosis based on the lab data		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	2	2- L4
	PC/PS	3	3- L4
	SBP		
	IPCS	1	1- L4
	P	1	1- L3
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS, SBP & PBLI assessment will be done by the faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in central laboratory 		

EPA3. General

Giving the necessary instructions to the patients, related to biochemical investigations			
Description for the activity	Residents should be able to define the clinical question posed by the consultation request. Evaluate patient clinical history, signs and symptoms, ancillary findings, and laboratory tests pertinent to the consult request and provide necessary instructions required for the biochemical evaluation.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	1,2	1-L4,2-L4
	PC/PS	2,3	2-L4,3-L4
	SBP		
	IPCS	1	1-L4
	P	1	1-L3
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done in clinical posting 		

EPA4. General

Obtain informed consent for investigations and for academic research			
Description for the activity	Residents should be able to obtain informed consent for investigations that have been ordered or for research purposes and also that which depends on the socioeconomic status of the patients		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK		
	PC/PS	2	2-L3
	SBP		
	IPCS	4	4-L4
	P	3	3-L3
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done in clinical posting and laboratory 		

EPA5. General

Collaborate as a member of an interprofessional team			
Description for the activity	Effective teamwork is necessary to achieve the Institute of Medicine competencies for care that is safe, timely, effective, efficient, and equitable. Introduction to the roles, responsibilities, and contributions of individual team members early in professional development is critical to fully embrace the value that teamwork adds to patient care outcomes.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	5	5-L5
	PC/PS	2	2-L3
	SBP	1	1-L4
	IPCS	2	2-L3
P	2	2-L3	
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in the department and clinical postings 		

EPA6. General

Form clinical questions and retrieve evidence to advance patient care			
Description for the activity	Residents should be able to identify key clinical questions in caring for patients, identify information resources, and retrieve information and evidence that will be used to address those questions. Residents should have basic skill in critiquing the quality of the evidence and assessing applicability to their patients and the clinical context. Underlying the skill set of practicing evidence-based medicine is the foundational knowledge an individual has and the self-awareness to identify gaps and fill them.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK		
	PC/PS	1	1-L4
	SBP		
	IPCS	2	2-L4
P	2	2-L4	
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in clinical laboratory postings 		

EPA7.Clinical Biochemistry

Evaluate and report clinical laboratory testing of critical values and special investigations			
Description for the activity	Residents should be able to perform an accurate complete or focused evaluation and reporting of the clinical laboratory test in a prioritized, organized manner without supervision. The report should clinically correlate with the patient details. Identification of critical values must be made promptly without delay and communicated to the treating clinician in an organised manner and documented. This interpretation and reporting of a laboratory test serve as the basis for clinical work and as the building block for patient evaluation and management.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	1,2	1-L4,2-L4
	PC/PS	1,3	1-L4,3-L4
	SBP	2	2-L3
	IPCS	2	2-L4
	P	1	1-L3
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done in 		

EPA8. Clinical Biochemistry

Provide guidance for the resolution of preanalytical, analytical and post analytical testing issues			
Description for the activity	The resident should have knowledge of the various preanalytical, analytical and post analytical factors that could interfere with the analysis of a biochemical investigation and its interpretation. The resident should also have knowledge about the technical know-how for detecting them and appropriately communicating to the concerned clinician about the measures required to be taken to prevent such factors and thus promote safe, optimum and reliable patient care services.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	3	3-L4
	PC/PS	1,4	1-L4,4-L4
	SBP	1	1-L4
	IPCS	1	1-L4
	P	1	1-L3
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done in central lab 		

EPA9. Clinical Biochemistry

Provide biochemistry support for interdisciplinary conferences			
Description for the activity	Residents should be able to correlate biochemical aspects with other basic sciences and clinical sciences and should be able to provide in-depth biochemistry support to interdisciplinary conferences, clinicopathological meetings including active participation and guidance regarding biochemical aspects.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK		
	PC/PS	3	3-L4
	SBP	3	3-L3
	IPCS	1	1-L4
	P	2	2-L4
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done during clinicopathological meetings 		

EPA10. Clinical Biochemistry

Provide patient care consultations			
Description for the activity	Residents should be able to describe various disease states, the biochemical alterations that can be expected in such situations. This is required to correlate the biochemical reports of patients and provide appropriate guidance in its interpretation and suggest further evidence-based Investigations that may be needed for the management of the patient in a timely manner.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK		
	PC/PS	2	2-L3
	SBP	1	1-L4
	IPCS	1,2	1-L4,2-L3
	P	1,2	1-L3,2-L4
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 4. Assessment done in the central laboratory 		

EPA11. Clinical Biochemistry

Optimize test utilization			
Description for the activity	Resident should be able to compute the availability of resources, know the indications of the routine and special tests performed, so as to be able to identify unnecessary tests ordered and guide clinicians on the appropriate requisitions for laboratory testing		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	3	3-L4
	PC/PS	1	1-L4
	SBP	3	3-L3
	IPCS	2	2-L4
	P	1	1-L3
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in central lab 		

EPA12. Clinical Biochemistry

Improve quality and patient safety in laboratory			
Description for the activity	The resident must be able to contribute to a culture that promotes patient safety, analyze patient safety incidents to enhance systems of care. Contribute to quality management in laboratory, the formulation and execution of a quality plan of action, and the assessment of that plan.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	3,5	3-L4, 5-L5
	PC/PS	2,3,4	2-L3, 3-L4, 4-L4
	SBP	2,3	2-L3, 3-L3
	IPCS	2	2-L3
	P	2	2-L4
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in central lab 		

EPA13. Clinical Biochemistry

Evaluate and choose a new test/assay or instrument			
Description for the activity	The resident must be able to analyse the need of the community, hospital or population and appropriately choose a test/assay and the type of instrument needed for the laboratory to provide health care services.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	3,5	3-L3, 5-L5
	PC/PS	1,3,4	1-L4, 3-L4, 4-L4
	SBP	1,3	1-L3, 3-L3
	IPCS	1,2	1-L4, 2-L3
	P	2	2-L4
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS, SBP & PBLI assessment will be done by the faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in central lab 		

EPA14. Clinical Biochemistry

Perform a laboratory Audit			
Description for the activity	The resident must be able to make statement of facts and observations made after an investigation or inspection of a laboratory, clinic, or facility where research is carried out. A laboratory audit program is critical to ensuring the institution meets applicable requirements		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	3	3-L4
	PC/PS	4	4-L4
	SBP	2,3	2-L3, 3-L3
	IPCS	2	2-L3
	P	1,2	1-L3, 2-L4
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS, SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. Assessment done in the central laboratory 		

EPA15. Research Methodology

Should be able to write a scientific protocol for clinical research			
Description for the activity	Resident should be able to formulate a research question, derive objectives, design methodology and write up a comprehensive, clear and complete scientific protocol for clinical research for betterment of patient care services. This would entail improvement of scientific writing and communication skills besides identifying a solution to a research question for patient care		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	4	4-L4
	PC/PS	4	4-L4
	SBP	3	3-L3
	IPCS	1,2	1-L4, 2-L3
P	2	2-L4	
Method of Assessment	<ol style="list-style-type: none"> PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. 		

EPA16. Research Methodology

Reporting and communication of scientific research			
Description for the activity	Resident should be able to systematically collect, organise, analyse the data to derive meaningful conclusions and suggest translational value of the research work. The resident should further be able to communicate the findings in a clear, comprehensive and scientific way along with evidences supporting or refuting the research work.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	4	4-L4
	PC/PS	4	4-L4
	SBP	3	3-L3
	IPCS	1,2	1-L4; 2-L3
P	2	2-L4	
Method of Assessment	<ol style="list-style-type: none"> MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. Communication skills & Professionalism will be assessed by Multisource feedback. 		

EPA17. Teaching

Select and demonstrate competency in a range of teaching methods			
Description for the activity	Resident should be able to identify the type of teaching method most appropriate to the learning objective and be able to adapt the teaching method in such a way to bring out clear presentation of concepts in a systematic and appropriate manner so as to generate interest and understanding in the students		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	6	6-L5
	PC/PS	2	2-L3
	SBP	1	1-L4
	IPCS	1,2,3	1-L4; 2-L3; 3-L3
P	1	1-L3	
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 		

EPA18. Teaching

Select a learning outcome, design and develop an appropriate assessment method			
Description for the activity	The resident must be able to compose measurable learning objectives for individual classes design a lesson plan and develop an appropriate method for assessment pertaining to the objective both for theory and practical		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	6	6-L5
	PC/PS		
	SBP	1	1-L4
	IPCS	1,2,3	1-L4; 2-L3; 3-L3
P	1,2	1-L3; 2-L4	
Method of Assessment	<ol style="list-style-type: none"> 1. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 2. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 3. Communication skills & Professionalism will be assessed by Multisource feedback. 		

Solicit feedback on one's leadership and teaching from multiple observers & critically reflect on it			
Description for the activity	The resident must be able to compose measurable learning objectives for individual classes design a lesson plan and develop an appropriate method for assessment both theory and practical, seek feedback from senior professionals, peers and students, work on the negative comments to improve on one's own skills.		
Resident will be entrustable when these subcompetency Milestone Levels are attained	Relevant domains of competency	Subcompetencies within each domain	Milestone level (L) in subcompetency
	MK	6	6-L5
	PC/PS		
	SBP	1	1-L1
	IPCS	3	3-L3
Method of Assessment	P 1,2 1-L3; 2-L4		
Method of Assessment	4. MK assessment will be done by the faculty either by direct interaction, written exam or eportfolio 5. PC/PS,SBP & PBLI assessment will be done by the Faculty at the workplace and eportfolio. 6. Communication skills & Professionalism will be assessed by Multisource feedback.		

9.1.4 Mapping of EPA to Programme Outcomes (PO)

Table 4 showing mapping of the EPA's to the Programme outcomes

	PO1.	PO2.	PO3.	PO4.	PO5.	PO6.	PO7.	PO8.
EPA1.	✓	✓		✓		✓		
EPA2.	✓	✓	✓	✓		✓		
EPA3.	✓	✓	✓	✓				
EPA4.	✓	✓	✓	✓		✓		
EPA5.	✓	✓		✓	✓	✓		
EPA6.	✓	✓	✓	✓		✓	✓	✓
EPA7.	✓	✓	✓	✓				
EPA8.	✓	✓	✓	✓		✓		✓
EPA9.						✓		
EPA10.	✓	✓	✓	✓		✓		✓
EPA11.	✓	✓	✓	✓		✓		✓
EPA12.			✓	✓		✓		
EPA13.		✓	✓			✓		✓
EPA14.		✓	✓			✓		✓
EPA15.							✓	
EPA16.							✓	
EPA17.					✓	✓		
EPA18.					✓	✓		
EPA19.					✓	✓		

9.2 Summative assessment

9.2.1 Dissertation

Objectives

1. The student should be able to demonstrate capability in research by planning and conducting systematic scientific inquiry & data analysis and deriving conclusion.
2. Communicate scientific information for health planning.

Guide for dissertation

1. Chief guide will be allocated from the Department of Biochemistry.
2. Co - guides can be selected from within the department or from other disciplines related to the dissertation topic.

Submission of dissertation protocol

It should be submitted at the end of six months after admission in the course, in the format prescribed by the institute:

1. Protocol in essence should consist of:
 - a) Introduction and objectives of the research project.
 - b) Brief review of literature
 - c) Suggested materials and methods, and (scheme of work)
 - d) Statistician should be consulted at the time of selection of groups, number of cases and method of study. He should also be consulted during the study.
 - e) Bibliography
2. The protocol must be presented in the Department of Biochemistry before being forwarded to the Institutional Research Committee (IRC) for review.
3. Protocol must be approved by the research committee, which is appointed by the Dean / Principal to scrutinize the dissertation protocol in references to its feasibility, statistical validity, ethical aspects, etc.
4. Once approved by the IRC, the protocol will be forwarded to the Institutional Human Ethics Committee (IHEC) for review.
5. After presentation and approval of the protocol by the IHEC, the dissertation must be registered in the Clinical Trial Registry of India - <http://ctri.nic.in>, following which data collection may be initiated.

Submission of dissertation

1. The dissertation shall relate to the candidates own work on a specific research problem or a series of clinical case studies in accordance with the approved plan.

2. The dissertation shall be written in English, printed or typed double line spacing, on white bond paper 22x28 cm with a margin of 3.5 cm, bearing the matter on one side of paper only and neatly bound with the title, the name of the College and University printed on the front cover.
3. The dissertation shall contain: Introduction, review of literature, material and methods, observations, discussion, conclusion and summary and reference as per index medicus.
4. Each candidate shall submit to the Dean four copies of dissertation, through their respective Heads of the Department not later than six months prior to the date of commencement of theory examination in the subject.

Evaluation of Dissertation:

1. The dissertation shall be referred by the University for Evaluation, to External Examiners appointed by the University. The examiners will evaluate and report independently to the Controller of Examinations using Proforma for Dissertation Evaluation Form and recommend whether the dissertation
 - a. Accepted as submitted
 - b. Accepted pending modification as suggested
 - c. Not Accepted for reasons specified
2. The dissertation shall be deemed to be accepted when it has been approved by at least two external examiners, who will allocate marks from which an average will be taken.
3. If the dissertation is rejected by one of the external examiners it shall be referred to another external examiner (other than the one appointed for initial evaluation) whose judgment shall be final for purposes of acceptance or otherwise of the dissertation.
4. Where improvements have been suggested by the external examiners, the candidate shall be required to re - submit the dissertation, after making the required improvements for evaluation.
5. When a dissertation is rejected by the examiners, it shall be returned to the candidate who shall have to rewrite it. The second version of the dissertation, as and when submitted shall be treated as a fresh dissertation and processed.
6. Acceptance of dissertation submitted by the candidate is a pre - condition for his / her admission to the written, oral and practical / clinical part of the examination.
 - a. Provided that under special circumstances if the report from one or more examiners is not received by the time the Post - Graduate examination is due, the candidate may be permitted provisionally to sit for the examination but the result be withheld till the receipt of the report, subject to the condition that if the dissertation is rejected then the candidate in addition to writing a fresh dissertation, shall have to reappear for the examination.

7. A candidate whose dissertation stands approved by the examiners but fails in the examination, shall not be required to submit a fresh one if he/she appears in the examination in the same branch on a subsequent occasion.

9.2.2 Eligibility Criteria

- Candidates will be eligible to appear for the university examinations after completion of 3 years and when following criteria are fulfilled:
 1. Attendance of 80%
 2. Submission of dissertation and acceptance by external examiner
 3. One research Publication based on the Dissertation
 4. One poster and one Podium presentation at National or Regional conferences, recognised by Theory (Subject contents already outlined in syllabus)

9.2.3 Theory

- Final Theory Papers: 4 papers
- All papers should have 10 short answer questions.
- Question papers are prepared based on the prescribed blueprint described later (see blueprint section)
- Model question paper is attached for ready reference.

9.2.4 Practical

- The practical examination will be held over 2 days; one day will be mainly for the practical exercises and the second day for the oral/ viva voce. The practical examinations will have the following components: -
 - a) A clinical case for which an actual patient or a paper-based case may be used, as per the facilities available in each institution running the course. The clinical features of the patient and relevant laboratory investigation of biochemical abnormalities present will be discussed
 - b) Quantitative assays for the given parameters one in autoanalyzer and one by standardisation graph and calculation
 - c) Performance of an electrophoresis for serum proteins and discussion of electrophoretic pattern. Quality Control, its interpretation and Method validation, Calculation of TAE, CV, bias, sigma metrics and selecting the appropriate QC rules and Interpretation of results of PCR
 - d) Identification the carbohydrate/amino acid provided and confirm of its identity by paper chromatography, Urine analysis.
 - e) **Viva-voce Examination**
 - i. Thesis presentation (of about 15 mins duration)
 - ii. Pedagogy (20 mins duration plus 10 mins for questions)

Viva voce shall comprise Theoretical and Practical knowledge of the candidate related to Biochemistry wherein in-depth knowledge can be assessed. This includes the discussion on case presentation as well as the Dissertation work carried out by the candidate.

f) Pedagogy (seminar)

The candidate will be given a choice of at least two topics in biochemistry on 1st day of the examination of which one topic will have to be presented by the candidate to the examiner in the form of class room teaching for a period of 10-15 minutes in the 2nd day

- Total Marks allotted:

Segment	Total Marks
Theory (Papers 1 - 4)	400
Practical	200
Viva Voce (e+f)	100
Grand Total	700

- Recommendations for passing:
 1. The candidate will be required to secure minimum 50% marks in theory and 50% marks in clinicals and viva - voce separately, which is mandatory for passing the whole examination.
 2. There will be enough gap between theory and practical examination as recommended by MCI rules.
 3. There university practical examination will be conducted by 2 external and 2 internal examiners.

10 Blueprint of Theory exam paper

Insert text with Normal style

Paper 1 : Biomolecules, cell biology, biochemical techniques, biostatistics and research methodology, basics of medical education in teaching and assessment of biochemistry

Sl.No	Discipline	Topics	Weightage	Marks Allotted	No. of Question
1	Biomolecules	Water, Buffer system, Basic chemistry, Structure function relationships of biomolecules (Carbohydrates, amino acids, proteins, hemoglobin, enzymes, immunoglobulins, collagen, lipids, nucleotides & nucleic acids), Biological membranes	30	30	3
2	Cell biology	Structure of cell, sub-cellular organelles including cell membrane, Transport mechanisms across cell, intracellular traffic and sorting of proteins, extracellular matrix, cellular adhesion molecules, Cell cycle, cell division, cell death, cytoskeleton, muscle contraction, cell motility, red and white blood cell	10	10	1
3	Biochemical techniques	Photometry (colorimetry, spectrophotometry, Reflectance, flame photometry, absorption spectroscopy and fluorimetry, mass spectrometry, fluorescence and Chemiluminescence, spectroscopy), Ion selective electrodes, Centrifugation, Electrophoresis (including isoelectric focusing, isotachopheresis,	40	40	4

		immunoelectrophoresis), Radioactivity, Chromatography (paper, column, affinity, ion exchange, adsorption and partition, GLC, TLC, HPLC, Gel filtration), Turbidimetry and nephelometry, Gravimetry, Water testing, Techniques in molecular biology: Blotting techniques, polymerase chain reaction (PCR), DNA and protein sequencing, microarrays and DNA chip technology, cloning techniques, genomics, proteomics and metabolomics, Nanotechnology and microfabrication, Techniques to study in vivo metabolism - NMR, SPECT, PET scans, etc, Radioisotope-based techniques and its applications			
4	Biostatistics and research methodology	Basic concepts of biostatistics as applied to health science, Statistical tests, Statistical methods of validation of diagnostic tests, Basics of epidemiological study designs and sampling methodologies, Meta- analysis and systematic reviews	10	10	1
5	Basics of medical education in teaching and assessment of biochemistry	Principles of adult learning, taxonomy of learning, educational objectives, principles of assessment and question paper setting, methods of assessing knowledge, appropriate use of media, microteaching, small group teaching.	10	10	1

Paper 2: Enzymes, bioenergetics, biological oxidation, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

Sl.No	Discipline	Topics	Weightage	Marks Allotted	No. of Question
1	Enzymes	Properties, classification, mechanism of action, coenzymes and cofactors, kinetics of enzyme activity, regulation of enzyme activity, isoenzymes, diagnostic and therapeutic enzymes, principles of assays of enzymes, enzymes as therapeutic targets of drugs.	20	20	2
2	Bioenergetics	Basic concepts of thermodynamics and its laws, as applied to living systems, Exergonic and endergonic reactions and coupled reactions, redox potential, High energy compounds, Classification and role of oxidoreductases, Cytochromes	10	10	1
3	Biological oxidation	Components, complexes and functioning of the respiratory chain, Process of oxidative phosphorylation, Mechanisms of ATP synthesis and regulation, Mitochondrial transport systems and shuttles, Inhibitors, uncouplers and ionophores, OXPHOS diseases	10	10	1
4	Intermediary metabolism and regulation	Metabolism of carbohydrates, lipids, amino acids and proteins, nucleic acids, heme and in specialised tissues, starvation and fed state. Inborn errors of metabolism.	30	30	3
5	Nutrition	Principal food components, General nutritional requirements, Energy requirements, Biological value of proteins, Thermogenic effect of food, Balanced diet, diet formulations in health and disease, mixed diet, Nutritional supplements, Food toxins and additives, Parenteral nutrition, Disorders of nutrition, obesity, protein and protein energy malnutrition, dietary fibers, under-nutrition, laboratory diagnosis of nutritional disorders, National Nutrition Programme, Vitamins, Minerals, Metabolism of xenobiotics, Free radicals and anti-oxidant	30	30	3

		defence systems in the body and associations with disease processes			
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Paper 3: Molecular biology, molecular and genetic aspects of cancer, immunology and effects of environmental pollutants on the body

Sl.No	Discipline	Topics	Weightage	Marks Allotted	No. of Question
1	Molecular biology	Structure and organization of chromosomes and chromatin re-modelling, DNA replication, Transcription, Genetic code and mutations, Translation, Regulation of gene expression in prokaryotes and eukaryotes, Recombinant DNA technology and its applications in modern medicine, Diagnosis of genetic diseases and genetic counseling, Overview of Human Genome Project, Basics of bioinformatics, Principles of human genetics, Stem cells in clinical medicine	40	40	4
2	Molecular and genetic aspects of cancer	Carcinogens, Clonal origin of cancers, Genetic basis of carcinogenesis, Role of oncogenes and tumour suppressor genes, Familial cancer syndromes, Cancer stem cells, Epigenetic regulation in cancer, Gene expression profiling in cancer, Cancer cell biology, Metastasis, Tumor markers, Biochemical basis of cancer chemotherapy and drug resistance, new methods of anti-cancer therapy: targeted cancer therapy, cancer immunotherapy.	10	10	1
3	Immunology	Innate and acquired immunity, Humoral and cell-mediated immunity, Cells and organs of the immune system, Antigens, epitopes and haptens, Immunoglobulin classes, isotypes, allotypes, idiotypes, monoclonal antibodies, organization and expression of immunoglobulin genes, immunoglobulin gene rearrangement, class switching, Antigen-antibody interaction - immunochemical techniques, Major histocompatibility complex, antigen	40	40	4

		processing and presentation, T cell and B cell receptor, toll like receptors, B and T cell generation/ activation/ differentiation, Cytokines, Complement system, cell, Immune response to infections, Hypersensitivity reactions, Vaccines, Immuno-deficiency syndromes, Autoimmunity, Transplantation immunology, Cancer and immune system, Immunodiagnostics, Immunotherapy			
4	Environmental pollutants	Environmental pollutants and their effects on the body	10	10	1

Paper 4: Clinical biochemistry and molecular diagnostics related to different body systems/organs, endocrinology, and recent advances in biochemistry

Sl.No	Discipline	Topics	Weightage	Marks Allotted	No. of Question
1	Clinical biochemistry and molecular diagnostics related to different body systems/organs	Basic Principles and practice of clinical biochemistry, Analytical techniques and instrumentation, Clinical correlates and analytical procedures, Regulation of fluid and electrolyte balance and associated disorders, Regulation of acid -base balance and associated disorders , Hematopoietic disorders, Hemostasis and thrombosis Cardiovascular system, Respiratory system, Kidney, Gastrointestinal system, Liver Gall bladder/bile ducts, Pancreas, Bone and mineral metabolism, Nervous system	60	60	6
2	Endocrinology	Classification and general mechanism of action of hormones. Biogenesis, secretion, regulation, transport, mode of action and disorders of hormones (hypothalamic peptides, adenohipophyseal and neurohipophyseal hormones, thyroid hormones, parathyroid	30	30	3

		hormones, calcitonin, pancreatic hormones, adenocortical and medullary hormones, gonadal hormones, gastrointestinal hormones, opioid peptides, Endorphins and encephalins), Conception, reproduction and contraception.			
3	Recent advances in biochemistry	Recent biochemical concepts in health and disease, Newer analytical methods	10	10	1

Practical's

		Marks Allocation
I	a. Clinical examination of a patient making of a provisional diagnosis and giving differential diagnosis with relevant investigations and interpretation with case discussion	30
	b. Quantitative assays for the given parameters one in autoanalyzer and one by standardisation graph and calculation	30 and 40
II	c. Two Clinical Biochemistry experiments (any 2 will be chosen by lot) <ul style="list-style-type: none"> i. Method validation (30 marks) ii. Interpretation of westgard rule (30 marks) iii. Calculation of TAE,CV,bias, sigma metrics and selecting the appropriate QC rules (30 marks) 	60

	iv. Linearity experiments (30 marks)	
	v. Interpretation of results of PCR) including separation of proteins by electrophoresis. (30 marks)	
	d. One qualitative identification of a carbohydrate or an amino acid and confirmation by Chromatography	40
<i>Total (I + II)</i>		200
III	a) General Viva-Voce	80
	b) Pedagogy	20
<i>Total (a+b)</i>		100
GRAND TOTAL		300

11 Model Question Paper

PAPER I Biomolecules, cell biology, biochemical techniques, Biostatistics and research methodology, basics of medical Education in teaching and assessment of biochemistry

3 Hours

(10 x 10 = 100 marks)

ANSWER ALL QUESTIONS

(Draw labelled diagram wherever required)

1. Describe the structure, composition, synthesis, functions and significance of Phospholipids.
2. Describe the types, principle and clinical applications of PCR.
3. Describe Bloom's taxonomy of learning domains.
4. Explain the structure function relationship of hemoglobin molecule.
5. Describe the basic instrumentation of mass spectrometry. Add a note on its applications
6. Explain the fluid mosaic model of membrane.
7. Describe the principle, instrumentation and clinical applications of capillary electrophoresis.
8. Describe the evaluation of a new diagnostic test.
9. Describe the levels of organisation of protein structure.
10. Describe the principle, instrumentation and clinical applications of HPLC.

PAPER II Enzymes, bioenergetics, biological oxidation, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

3 Hours

(10X10=100 marks)

(Draw labelled diagram wherever required)

ANSWER ALL QUESTIONS

1. Describe the sources, RDA, metabolism, functions and deficiency of Vitamin B12.
2. Discuss the mechanisms of enzyme action with suitable examples.
3. Describe the characteristics of Cytochrome P450.
4. Discuss the metabolism in fasting and fed state.
5. Discuss the causes, clinical features and laboratory diagnosis of Iron deficiency.
6. Explain therapeutic enzymes with suitable examples.
7. Explain the chemiosmotic theory.
8. Explain the regulation of calcium and phosphate in the body.
9. Explain how phenylalanine is both ketogenic and glucogenic. Add a note on phenylketonuria
10. Discuss the reverse cholesterol transport.

PAPER III Molecular biology, molecular and genetic aspects of cancer, immunology and effects of environmental pollutants on the body

3 Hours

(10 x 10 = 100 marks)

ANSWER ALL QUESTIONS

- 1) a. Discuss the various DNA binding motifs seen in protein DNA interactions.
b. What is the role of cyclins and cyclin dependent kinases in the cell cycle?
- 2) A. What is post translational modification of proteins? Explain with the help of an example.
b. Mention the role of vitamins in their modification.
- 3) Types of stem cells and their therapeutic potential
- 4) a. RT-PCR
b. Antisense therapy
- 5) Tumor markers their role in diagnosis, prognosis and therapy of cancers.
- 6) Monoclonal antibody, their uses and related clinical aspects. 6+4
- 7) Immunological tests for thyroid functions
- 8) Describe the structure of an immunoglobulin. List the different types of immunoglobulin along with their functions
- 9) Transplant immunology
- 10) Pollution and cancer

PAPER IV Clinical biochemistry and molecular diagnostics related to different body systems/organs, endocrinology, and recent advances in biochemistry

3 Hours

(10 x 10 = 100 marks)

ANSWER ALL QUESTIONS

1. Total quality management
2. How is the reference range of a laboratory parameter established?
3. What is anion gap? What is its clinical significance?
4. What type of lipid profile is seen in diabetes mellitus (D.M.) patients? What is the biochemical basis for it?
5. Biochemical basis and clinical features of Gout. Add a note on investigations and different treatment modalities
6. POCT
7. Peptide hormones regulating food intake
8. How can primary, secondary and tertiary thyroid dysfunctions be differentiated by using laboratory tests?
9. Classify hormones on the basis of their mechanism of action. Write about the hormones that are transported by plasma proteins
10. Diagnostic utility of saliva

12 Recommended reading

12.1 List of recommended books

S. No	Name of the book	Author name
1	Devlin's Textbook of Biochemistry with clinical correlations	Paslow G.P and Wood E.J.
2	Lehninger's Principles of Biochemistry	David L. Nelson and Michael M. Cox
3	Harper's Illustrated Biochemistry	Robert K. Murray et al.
4	Biochemistry	Donald Voet and Judith Voet
5	Lippincott's illustrated reviews of Biochemistry	Parnela C. Champe et al
6	Biochemistry	Zubay
7	Biochemistry	Lubert Stryer and Jeremy M. Berg
8	Textbook of Biochemistry	West and Todd
9	Medical Biochemistry	Baynes
10	Marks Essentials of Medical Biochemistry – A clinical approach	Liebermann et al
11	Will's Biochemical basis of Medicine	Gillham
12	Tietz Text book of Clinical Chemistry and Molecular Diagnostics	Burtis et al.
13	Clinical chemistry	Bishop
14	Clinical chemistry	Kaplan
15	Clinical Biochemistry	Marshall
16	Lecture notes in Clinical Biochemistry	Beckett et al
17	Zilva's Clinical chemistry in diagnosis and Treatment	Mayne
18	Biochemistry – A case oriental approach	Montgomery
19	Clinical Biochemistry – A Pictorial manual	Allan Gaw
20	Metabolic and Molecular basis of diseases	Scriver et al.
21	Molecular cell biology	Lodsh H and Baltimore
22	Genes – VIII	Levin
23	Molecular Biology of the cell	Alberts.B et al
24	William's Textbook of Endocrinology	Reed Larsen et al
25	Modern nutrition in health and disease	Maurina E. Shilb and Mosby
26	Human nutrition and dietetics	Garrow

27	Duncan's Diseases of Metabolism	Bondy etal
28	Text book of Biochemistry	Chatterjee and Shinde
29	Text book of Biochemistry – A clinically oriented approach	Dinesh Puri
30	Principles and techniques of Biochemistry and Molecular biology	Keith Wilson and John Walker
31	Varley's Practical Biochemistry	Allen Gowenlock
32	Clinical diagnosis and management by laboratory methods	Todd etal
33	Immunogy	Roitt
34	Harrison's principles of internal Medicine	Dennis L. Hasper etal.
35	Methods in Biostatistics	Mahajan

12.2 List of recommended journals

S. No	Name of the Journal
1	Clinical chemistry
2	Clinical Biochemistry
3	Clinical Chemical Acta
4	Biochemical Journal
5	Journal of Endocrinology
6	European Journal of Molecular Biology
7	American Journal of Clinical Nutrition
8	Food and Nutrition
9	Clinical chemistry reviews
10	Journal of Laboratory investigation
11	Trends in Biochemical sciences
12	Annual Review of Biochemistry
13	Indian Journal of biochemistry and Biophysics
14	Indian Journal of Clinical Biochemistry
15	Indian Journal of Medical Research
16	Recent advances in Endocrinology and metabolism
17	Recent advances in clinical chemistry
18	Nature
19	Science
20	British Medical Journal

13 Annexures - Assessment and Feedback forms

Annexure 1 – Multisource Evaluation sheet

MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE

PILLAIYARKUPPAM, PUDUCHERRY – 607 402

Evaluation sheet for postgraduate clinical work

(To be completed by respective Unit Head/Peers/HCPs/Patient relatives)

Name of the Resident: UIN No.:

.....

Name of the Faculty/Peers/HCPs/Patient relatives:

.....

Date:

Sl. No.	Criteria to be assessed	Score		
		Below par (0)	At par (1)	Above par (2)
INTERPERSONAL COMMUNICATION SKILLS (IPCS)				
1.	Ability to gather the needed information during History taking and physical examination in a respectful manner.			
2.	Ability to give the necessary information regarding choice of investigation and further management and guide the patient/attenders to make appropriate decisions.			
3.	Ability to communicate the risks involved for patient care, in an understandable language without making the patient/attenders apprehensive, allowing 2-way communication.			
4.	Ability to be caring and respectful with patients during any procedure.			
5.	Ability to convey the required information clearly to the consultants, peers and other health care workers.			
PROFESSIONALISM (P)				
1.	Ability to be regular and punctual			
2.	Demonstrate respectfulness and obedience to consultants, peers and other health care workers.			
3.	Ability to accept and follow constructive feedback from consultants, peers and other health care workers.			
4.	Ability to maintain emotional balance during triggering situations, people and environment.			
5.	Makes their presence respectful, with their physical appearance and wearing appropriate attire.			
IPCS Total score: IPCS Final score= IPCS Total score*10				
Milestone Level: IPCS=1 0 - 20%, IPCS=2 20 - 40%, IPCS=3 40 - 60%, IPCS=4 60 - 80%, IPCS=5 80 - 100%,				
P Total score: P Final score= P Total score*10				
Milestone Level: 0 - 20%, P=1. 20 - 40%, P=2. 40 - 60%, P=3. 60 - 80%, P=4. 80 - 100%, P=5				
Signature:				

Annexure 2 – Seminar

MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE
PILLAIYARKUPPAM, PUDUCHERRY – 607 402

Evaluation sheet for postgraduate seminar

(To be marked individually by each faculty)

Name of the Resident:

UIN No

Name of the Faculty:

Date:

S. No.	Criteria to be assessed	*Score (1 – 10)
1	Introduction of subject and its importance / Objectives	
2	Completeness of presentation	
3	Cogency of presentation	
4	Consulted all relevant literature	
5	Use of audio - visual aids	
6	Understanding of subject	
7	Summary and take-home message	
8	Cites appropriate references / suggests further reading	
9	Time management	
10	Overall performance – relevant answers to questions, attitude during presentation and confidence	

***Score interpretation – 1-3->Needs improvement; 4-6->Meets expectations; 7-9->Exceeds expectation; 10->Outstanding.**

General Comments:

Highlights in performance (strengths)

Possible suggested areas for improvement (weakness)

Signature

Annexure 3 – Journal Club

MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE
PILLAIYARKUPPAM, PUDUCHERRY – 607 402

Evaluation sheet for postgraduate journal club
(To be marked individually by each faculty)

Name of the Resident:

UIN No

Name of the Faculty:

Date:

S. No.	Criteria to be assessed	*Score(1-10)
1	Relevance of article chosen	
2	Identifies the problem addressed in the paper	
3	Completeness of presentation	
4	Analyses and gives comments on methodology and statistics	
5	Brief summary of results	
6	Comparison of work with other published work	
7	Merits and demerits of the paper	
8	Summary and take home message	
9	Time management	
10	Overall performance – relevant answers to questions, attitude during presentation and confidence	

***Score interpretation – 1-3->Needs improvement; 4-6->Meets expectations; 7-9->Exceeds expectation; 10->Outstanding.**

General Comments:

Highlights in performance (strengths)

Possible suggested areas for improvement (weakness)

Signature:

Annexure 4 - Case Presentation

MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE
PILLAIYARKUPPAM, PUDUCHERRY – 607 402

Evaluation sheet for postgraduate case presentation

(To be marked individually by each faculty)

Name of the Resident:

UIN No

Name of the Faculty:

Date:

S. No.	Criteria to be assessed	*Score (1-10)
1	Logical order in presentation (History taking)	
2	Cogency of presentation	
3	Accuracy and completeness of general and local physical examination	
4	Other systemic examination	
5	Summarizes the case and analyses the appropriate differential diagnoses	
6	Whether the diagnosis follows logically from history and findings	
7	Investigations required : Completeness of list, relevant order, interpretation of investigations	
8	Management principles and details	
9	Time management	
10	Overall performance – relevant answers to questions, attitude during presentation and confidence	

***Score interpretation – 1-3->Needs improvement; 4-6->Meets expectations; 7-9->Exceeds expectation; 10->Outstanding.**

General Comments:
Highlights in performance (strengths)
Possible suggested areas for improvement (weakness)
Signature:

Annexure 5 - EPA Assessment Form

MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE
DEPARTMENT OF ANAESTHESIOLOGY
Entrustable professional activity assessment form

STUDENT NAME:

UIN No:

PGY:

ASSESSMENT No:

FACULTY:

DATE:

Upper half for
self-assessment

Lower half for
Faculty
assessment

EPA	Marking of Subcompetencies							
1. Prioritizing a differential diagnosis based on history, physical examination and biochemical analysis	MK1	MK	PC1	ICS1	SBP1			
	L3	2	L1	L1	L1			
		L2						
2. Recommending and interpreting common screening and diagnostic tests and data	MK1	MK2	MK5	PC1	PC2	ICS1	P2	
	L4	L3	L2	L2	L1	L2	L2	
3. Giving the necessary instructions to the patients related to biochemical investigations	MK1	MK2	PC1	PC3	ICS1	PBL1	P1	P2
	L4	L3	L2	L1	L4	L4	L3	L2
4. Obtain informed consent for investigations and for academic research	ICS1	P1						
	L4	L3						
5. Collaborate as a member of an interprofessional team	MK5	PC2	ICS1					
	L5	L3	L2					
6. Form clinical questions and retrieve evidence to advance patient care	PC1	PBL1	ICS2	P2				
	L4	L4	L3	L4				
7. Evaluate and report clinical laboratory testing including critical values	MK1	MK2	PC1	PC3	ICS2	SBP2	PBL1	P1
	L4	L4	L4	L4	L4	L3	L4	L3
8. Provide guidance for the resolution of preanalytical, analytical and post analytical testing issues	MK3	PC1	PC4	ICS1	SBP1	PBL1	P1	
	L4	L4	L4	L4	L4	L4	L3	
9. Provide biochemistry support for interdisciplinary presentations/ clinicopathological meet	PC3	ICS1	SBP3	PBL1	P2			
	L4	L4	L3	L4	L4			
10. Provide patient care consultations	PC2	ICS1	ICS2	PBL1	P1	P2		
	L3	L4	L3	L4	L3	L4		

11. Optimize test utilization	MK3 L4	PC1 L4	ICS2 L3	SBP3 L3	PBLI2 L5	P1 L3					
12. Improve quality and patient safety	MK3 L4	MK5 L5	PC2 L3	PC3 L4	PC4 L4	ICS2 L3	SBP2 L3	SBP3 L3	PBLI1 L4	P2 L4	
13. Evaluate and choose a new test/assay or instrument	MK3 L3	MK5 L5	PC1 L4	PC3 L4	PC4 L4	ICS1 L4	ICS2 L3	SBP2 L3	SBP3 L3	PBLI1 L4	P2 L4
14. Perform a laboratory Audit	MK3 L4	PC4 L4	ICS2 L3	SBP2 L3	SBP3 L3	PBLI1 L3	P2 L4				
15. Should be able to write a scientific protocol for clinical research	MK4 L4	PC4 L4	ICS1 L4	ICS2 L3	SBP3 L3	PBLI1 L4	PBLI2 L5	P2 L4			
16. Reporting and communication of scientific research	MK4 L4	PC4 L4	ICS1 L4	ICS2 L3	SBP3 L3	PBLI1 L4	PBLI2 L5	P2 L4			
17. Select and demonstrate competency in a range of teaching methods	MK6 L5	PC2 L3	ICS1 L4	ICS2 L3	ICS3 L3	SBP1 L4	PBLI2 L5	P1 L3			
18. Select a learning outcome and design and develop an appropriate assessment method	MK6 L5	PC2 L3	ICS1 L4	ICS2 L3	ICS3 L3	SBP1 L4	PBLI2 L5	P1 L3	P2 L4		
19. Solicit feedback on one's leadership and teaching from multiple observers & critically reflect on it	MK6 L5	ICS3 L3	SBP1 L4	PBLI2 L5	P1 L4	P2 L4					

Key for assigning Grade of entrustability

EPA	Grade of Entrustability
EPA1.	
EPA2.	
EPA3.	
EPA4.	
EPA5.	
EPA6.	
EPA7.	
EPA8.	
EPA9.	
EPA10.	
EPA11.	
EPA12.	
EPA13.	
EPA14.	
EPA15.	
EPA16.	
EPA17.	
EPA18.	
EPA19.	
EPA20.	
EPA21.	

Signatures	
Resident	
Faculty	
Head of the Department	

Grade	1	2	3	4	5
Entrustability	Can observe and assist	Can perform with strict supervision	Can perform with loose supervision	Can perform independently	Expert

Comments

Annexure 7 – Dissertation evaluation form

**MAHATMA GANDHI MEDICAL COLLEGE AND RESEARCH INSTITUTE
PILLAIYARKUPPAM, PUDUCHERRY – 607 402
Proforma for evaluation of Dissertation**

UIN:

Topic of the study :

DISSERTATION COMPONENTS	Grade		
TITLE			
Title appropriate and clear	A	B	C
INTRODUCTION			
Purpose of the Study	A	B	C
Hypothesis/Research Question	A	B	C
Aims & Objectives	A	B	C
REVIEW OF LITERATURE			
Appropriate	A	B	C
Complete and current	A	B	C
METHODS			
Study subjects, controls, Inclusion and Exclusion criteria	A	B	C
Materials/Apparatus/Cases	A	B	C
Methodology used	A	B	C
Procedure for data collection	A	B	C
Appropriate statistical methods employed	A	B	C
Handling of ethical issues	A	B	C
RESULTS			
Logical organization of data	A	B	C
Appropriate use of charts, tables, Graphs, figures, etc.	A	B	C
Statistical/Clinical interpretation	A	B	C
DISCUSSION			
Appropriate to data	A	B	C
Discussion and implication of results	A	B	C
Comparison with other studies	A	B	C
Satisfactory explanation of deviations if any	A	B	C
Limitations of the study	A	B	C
Recommendation for future studies	A	B	C
CONCLUSION			
Relevance, are they in line with aims	A	B	C
SUMMARY			
Clear and Concise	A	B	C
REFERENCES			
Vancouver Format and appropriately cited in text.	A	B	C

Key for grading – A – Exceeds expectation, B – Meets expectation, C – Needs Improvement

Overall Impression

(Please Check the appropriate box)

- Accepted as submitted
- Accepted pending modification as suggested below
- Not Accepted for reasons specified below

Remarks:

Signature of the examiner with date