MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed To Be University U/S 3 OF UGC ACT, 1956)
12, Vembuliamman Koil Street, West K.K. Nagar, Chennai – 600 078

MEENAKSHI MEDICAL COLLEGE HOSPITAL AND RESEARCH INSTITUTE,
ENATHUR, KANCHIPURAM

MASTER OF BIOCHEMISTRY –M.D

FACULTY OF MEDICINE

REGULATIONS AND SYLLABUS (REGULATIONS – 2019)

Effective from the Academic Year 2020-2021

Dr. URSULA SAMPSON, M.D.,
PROFESSOR IN BIOCHEMISTRY
MMCH, RI

DEAN

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MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH

MASTER OF BIOCHEMISTRY

REGULATIONS -2019

I.VISION AND MISSION OF MAHER

VISION

To be a world-class institution, transforming society through value-based diverse programs and healthcare advancements, leading to the all-around development of human resources, knowledge, innovation, entrepreneurship, and research.

MISSION

To become an institute of eminence by developing world-class professionals in the field of healthcare, science, liberal arts, technology and research with a focus on the societal good.

To create an enabling state-of-the-art infrastructure, intellectual capital and provide best-in- class learning experience with a freedom to innovate and invent.

To foster values and ethics so as to develop students and learners into responsible citizens of the Nation and the world.

MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH

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II.VISION AND MISSION OF MMCHRI

VISION

To provide global leadership in human development, excellence in education and quality health care.

MISSION

To train competent, compassionate and caring physicians through excellence in teaching, patient care and medical research

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REGULATIONS -2019

III. VISION AND MISSION – DEPARTMENT OF BIOCHEMISTRY

VISION:

- Improving Teaching-Learning methods, through e-learning and promoting a high level of Multi-disciplinary research

MISSION:

- To Improve learning and education of Biochemistry in an integrative manner with basic medical science. In addition, enhancement of and improvement of research activities are target aim of the staff members in the department

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REGULATIONS -2019

IV. PROGRAM OUTCOMES (PO's)

PO 1 Acquisition of knowledge: The student will be able to explain clearly concepts and principles of general, systemic and applied Physiology.

PO 2 Teaching and training: The student will be able to effectively teach undergraduate students in medicine (MBBS) and allied health science courses (Dentistry and Nursing) so that they become competent healthcare professionals and able to contribute to training of postgraduate trainees.

PO 3 Research: The student will be able to carry out a research project (both basic and clinical) 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 and eventually be able to guide postgraduates in their thesis work

PO 4 Skill: Acquire skills in conducting collaborative research in the field of biochemistry and allied sciences.

V. COURSE OUTCOMES

CO1: Demonstrate knowledge of all aspects of general, systemic and applied physiology.

CO2: Demonstrate the skills of clinical examination of human subjects.

CO3: Apply the knowledge of physiology in various clinical settings to solve diagnostic and therapeutic problems.

CO4: Demonstrate knowledge of general principles of medical education and select appropriate educational techniques.

CO5: Search, acquire and critically evaluate published scientific literature using print and digital resources.

CO6: Teach effectively the basic physiological mechanisms of human body and apply this knowledge with reference to pathogenesis of diseases (Pathophysiology) affecting various organ systems and the physiological basis of their management.

CO7: Demonstrate competence in basic concepts of research methodology, effective use of statistical methods and write a scientific paper on the lines accepted by standard scientific journals.

CO8: Develop a research protocol and conduct relevant clinical / experimental research with significant bearing on human health.

CO9: Acquire administrative skills to set up concerned department / laboratories and initiate procedure to procure necessary items for running such department / laboratories.

CO10 [illegible]

SAMPSON, M.D.,
IN BIOCHEMISTRY

DEAN

CO11: Demonstrate adequate knowledge and practice professional ethics and responsibilities of a teacher, researcher and a doctor.

VI.PROGRAM SPECIFIC OUTCOMES (PSO's)

PSO 1: Understand and deal with all aspects of general and systemic biochemistry.

PSO 2: Effectively teach undergraduate medical, paramedical and all other basic science students, the basic physiological mechanisms of the human body, with reference to their implications in the pathogenesis of diseases affecting the various organ systems and the biochemical basis of their management.

PSO 3: Be able to demonstrate to the students how the knowledge of biochemistry can effectively be used in a variety of clinical settings to solve diagnostic andtherapeutic problems.

PSO 4: Interact with the allied departments by rendering services in advanced laboratory investigations and giving relevant opinion.

PSO 5: Participate and present scientific material in various workshops/seminars etc. in Biochemistry as well as allied departments.

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MEENAKSHI MEDICAL COLLEGE HOSPITAL AND RESEARCH INSTITUTE

FACULTY OF MEDICINE

MASTER OF BIOCHEMISTRY

VII. REGULATIONS -2019

In exercise of the powers conferred by the Board of Management, Meenakshi academy of higher education and research, deemed to be University, Chennai hereby makes the following regulations:

1. SHORT TITLE

These Regulations shall be called "THE REGULATIONS FOR THE MASTER OF BIOCHEMISTRY PROGRAM OF MEENAKSHI ACADEMY OF HIGHER EDUCATION AND RESEARCH" deemed to be University.

2. COMMENCEMENT

They shall come into force from the academic year 2020-2021 onwards.

The Regulations and the Syllabus are subject to modification by the Academic council and board of studies from time to time.

3. TITLE OF THE PROGRAM

It shall be called Master of Biochemistry

4. SYLLABUS

The syllabus is as prescribed according to the norms given by NMC and finalised with board of studies management by the university

5. ELIGIBILITY FOR ADMISSION

1) Candidates who have obtained minimum eligibility in qualifying exam
2) The reservation of seats and relaxation in the qualifying marks for SC/ST/OBC and other categories shall be as per the rules of the Central Government/State Government, whichever is applicable.

6. CRITERIA FOR SELECTION

Students for M.D BIOCHEMISTRY Degree Program shall be admitted based on performance at the Competitive Examinations held by the government.

7. ADMISSION PROCEDURE

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BIOCHEMISTRY

Medical College & Research Institute
DEAN

8. ELIGIBILITY CERTIFICATE

No candidate shall be admitted to the MD BIOCHEMISTRY Program unless the candidate has obtained and produced an Eligibility Certificate issued by this University. The candidate has to make an application to the University with the Original and Xerox copies of the following documents along with the prescribed fee:

1) 10^{th} and Higher Secondary or equivalent Examination Mark Sheets.
2) Transfer Certificate
3) MBBS Under graduate degree certificate and mark sheets.
4) Candidates should obtain an Eligibility Certificate before the last date for admission as notified by the University.

9. REGISTRATION

A candidate admitted to the M.D BIOCHEMISTRY Program of this University shall register by remitting the prescribed fees along with the application form for registration duly filled-in and forwarded to this University through the Head of the Institution within the stipulated date.

10. DURATION OF THE PROGRAM

The programme shall be of duration of three academic years.

11. FEES

The institution shall change only such a fee as prescribed by the university

12. COMMENCEMENT OF THE PROGRAM

The program shall commence from 1stMay of the Academic year.

13. CUT-OFF DATES FOR ADMISSION TO EXAMINATION

The candidates admitted from 1st May to 30th September of the academic year will be registered to take up their Final examination in May at the completion of 3rd year.

There will not be any admission after 30th September for the academic year.

14. LEAVE DAYS IN AN ACADEMIC YEAR

There shall be maximum of 15 days in a year exclusive of the period of admission and examination

15. ATTENDANCE REQUIRED FOR ADMISSION TO EXAMINATIONS

a) No candidate shall be permitted to write any one of the papers of M.D BIOCHEMISTRY examination unless he/ she has attended all the courses in the subject for the prescribed period and produces the necessary certificates of study and attendance from the Head of the Institution.
b) A candidate is required to put in a minimum of 80% of attendance in both theory and clinical separately in each year before admission to the examination.
c) A candidate who has not completed the program and not submitted the dissertation signed by

d) Attendance earned by the student should be displayed on the Notice Board of the department every month and a copy of the same sent to the University for computerization and parents shall be informed regarding the shortage of attendance of their wards through email (if available) or by post by the Institution.

16. SUBMISSION OF LOG BOOK

a. At the time of practical examination each candidate shall submit to the Examiners his / her log book duly certified by the Head of the Department as a bonafide record of the work done by the candidate.
b. The log book shall be evaluated by the concerned member of the faculty and the external examiner (Internal and external Evaluation) the practical record marks shall be submitted to the University prior to the commencement of the theory examinations.

17. COMMENCEMENT OF THE EXAMINATIONS

a. There shall be examinations at the end of 3rd year in the month of April/May. A candidate who does not pass the examination in any of the 4 papers shall be permitted to appear in all the final year papers in the subsequent examinations to be held in September or April/May.
b. Candidates should get enrolled/register for the first semester examination. If enrolment/registration is not possible owing to shortage of attendance beyond condition limit/rules prescribed OR belated joining OR on medical grounds, such candidates shall redo the lost academic days in the subsequent term of shall be admitted to appear for exams, if he/she has successfully kept the term in first year or the university rules are followed.

18. EVALUATION

Attendance shall be taken as a component of continuous assessment. The students should have a minimum 80% attendance in each year. In addition to the continuous evaluation component, the end of program examination, which will be a written type examination of at least 3 hours duration, would also form an integral component of the evaluation. The evaluation of practical work will be at end of the program.

19. REVALUATION OF ANSWER SCRIPTS

There shall be no revaluation of answer papers of failed candidates in the examination

However re-totallingof answer papers is allowed once upon request by the students.

20. RE-ADMISSION AFTER BREAK OF STUDY

1) The calculation of the break of study of the candidate for re-admission shall be calculated from the date of first discontinuance of the program instead of from the date of admission.
2) Candidates having break of study shall be considered for re-admission provided, they are not subjected to any disciplinary action and no charges are pending or contemplated against them.
3) All readmissions of candidates are subject to the approval of the Vice-Chancellor.
4) A candidate having a break of study of less than 6 months shall apply for re-admission for condonation to the Academic Officer of this University. The candidate may be re-admitted in the corresponding program of study. The candidate has to fulfil the attendance requirements of the

5) A candidate having a break of study of more than 6 months but less than 2 years shall apply for re-admission for condonation to the Academic Officer of this University. The candidate may be re-admitted to the beginning of the academic year of the program. The candidate has to fulfil the attendance requirements of the University
6) A candidate having a break of study of more than 2 years and up to 5 years shall apply for the re-admission for condonation to the Academic Officer of this University. The candidates may be re-admitted in the corresponding program of study. The candidate has to fulfil the attendancerequirements of the University and shall not be granted exemption in the subjects he has already passed.
7) Candidates having a break of study of 5 years and above from the date of discontinuance and more than two spells of break will not be considered for re-admission.

SPECIFIC LEARNING OBJECTIVES

At the end of the MD training programme in Biochemistry, the post graduate student should have acquired competencies in the following areas, as detailed below.

1. Acquisition of knowledge

The student should be able to explain clearly concepts and principles of biochemistry and cell biology, including correlations of these with cellular and molecular processes involved in health and disease.

2. Teaching and training

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 postgraduate post graduate students.

3. Diagnostic services

The student should be able to set up/supervise/manage a diagnostic laboratory in Biochemistry in a hospital, ensuring quality control, and providing a reliable support service. The student should be able to provide clinicians with consultation services for diagnostic tests in biochemistry and in interpretation of laboratory results.

4. Research

The student 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 and to eventually be able to guide postgraduates in their thesis work.

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SUBJECT SPECIFIC COMPETENCIES

The student during the training programme should acquire the following competencies:

A. Cognitive domain

1. Describe and apply biochemical principles to explain the normal state, abnormal disease conditions and mechanism of action used in the perception, diagnosis and treatment of diseases.
2. Explain energy transactions in a living system, and describe importance of biomolecules in sustaining the life process.
3. Describe pathways of the intermediary metabolism along with their individual and integrated regulation and apply that in understanding the functioning of the body.
4. Describe and apply the concept of nutrition in health and disease, micro- and macronutrition and essential nutrients, and interlinks of nutrients with metabolism and functions of a living system.
5. Apply and integrate knowledge of molecular and metabolic conditions in normal and disease states for clinical problem solving and research
6. Acquire knowledge on application of various aspects of genetic engineering in medicine
7. Acquire knowledge and apply the principle of statistics, biostatistics and epidemiology to the evaluation and interpretation of molecular and metabolic disease states.
8. Evaluate, analyze and monitor disease states by applying relevant biochemical investigations and interpreting the clinical and laboratory data.
9. Able to integrate principles of immunology in biochemistry.
10. Demonstrate knowledge of basics of research methodology, develop a research protocol, analyse data using currently available statistical software, interpret results and disseminate these results and to have the potential ability to pursue further specializations and eventually be competent to guide students.
11. Describe the principles of teaching - learning technology towards application and take interactive classroom lectures, prepare modules for PBL, organize and conduct PBLs, case discussions, small group discussions, Seminars, Journal club and research presentations
12. Demonstrate knowledge of principles of Instrumentation.
13. Demonstrate knowledge about recent advances and trends in research in the field of clinical biochemistry.

B. Affective domain

1. Effectively explain to patients from a variety of backgrounds, the molecular and metabolic basis

SAMPSON, MD
BIOCHEMISTRY

DEAN

2. Communicate biochemical reasoning effectively with peers, staff and faculty, and other members of the health care team.

3. Demonstrate empathy and respect towards patients regardless of the biochemical nature of their disease.

4. Demonstrate respect in interactions with patients, families, peers, and other healthcare professionals.

5. Demonstrate ethical behaviour and integrity in one's work.

6. Demonstrate effective use of nutrition, lifestyle and genetic counseling.

7. Be aware of the cost of diagnostic tests and economic status of patients.

8. Acquire skills for self-directed learning to keep up with developments in the field and to continuously build to improve on skills and expertise

C. Psychomotor domain

1. Able to select, justify, and interpret the results of clinical tests in biochemistry.
2. Develop differential diagnoses for molecular and metabolic causes of diseases.
3. Suggest preventive, curative, and/or palliative strategies for the management of disease.
4. Predict effectiveness and adverse effects associated with disease intervention.
5. Demonstrate skills for clinical diagnosis, testing, understanding of biochemical conditions and diagnostic service.
6. Perform important biochemical, immunological and molecular biology techniques.
7. Observed working of important advanced techniques.
8. Demonstrate standard operating procedures of various methods and techniques used in clinical biochemistry.
9. Determination of enzyme activity and study of enzyme kinetics. Ideally it should be accompanied by purification (partial) of the enzyme from a crude homogenate to emphasise the concepts of specific activity, yield and fold purification
10. Demonstrate and report routine investigations in hematology and microbiology
11. Demonstrate presentation skills at academic meetings and publications.

By the end of the course, the post graduate student should have acquired practical skills in the following:

- Performance of reactions of carbohydrates, amino acids and proteins, and lipids
- Experiments to demonstrate constituents of milk
- Experiments to demonstrate normal and abnormal constituents of urine
- Determination of iodine number and saponification number of fats
- Estimation of ammonia and amino acids by Sorenson formal titration
- Estimation of nitrogen estimation in a given amino acid solution by micro
- Kjeldahl method
- Estimation of phosphorus by Fiske Subbarao method

DEAN

- Estimation of calcium content in milk
- Estimation of proteins by Folin's method and dye binding method.
- Two-dimensional paper chromatography for separation of amino acids
- Preparation and estimation of starch, glycogen, cholesterol, casein (phosphorus in casein) and hemoglobin from biological samples Determination of enzyme activity and study of enzyme kinetics, using any 2 suitable enzymes (eg, catalase from rat liver and acid phosphatase from potatoes).
- Estimation of clinical analytes as detailed below:
- blood glucose, glycated haemoglobin; performance of glucose tolerance test electrolytes, arterial blood gas analysis
- cholesterol, triglycerides, free fatty acids, phospholipids, Lp (a), urea, creatinine, uric acid, ammonia, microalbuminuria
- parameters of liver function tests (bilirubin, hepato-biliary enzymes such as AST, ALT, ALP, GGT, serum proteins/albumin and prothrombin time)
- Calcium, magnesium, copper (and ceruloplasmin), serum iron, TIBC and ferritin
- markers of myocardial damage (CK, CK MB, troponins, LDH)
- other enzymes of diagnostic relevance (eg. phosphatases, amylase etc)
- vitamins D and B12 and folate
- Electrophoresis of serum proteins
- Electrophoresis of lipoprotein (Optional)
- Electrophoretic separation of LDH isozymes or any other isoenzymes
- Clearance tests
- CSF analysis
- Thyroid function tests and other hormone assays by ELISA/RIA
- Preparation of buffers.

Clinical Laboratory

- Taking any one parameter, students should prepare a Levy Jennings chart and plot inter-assay and intra-assay variation for the laboratory.
- Implementation of Westgard rules.

Optional:

- Determination of reference values for any one parameter for the clinical Laboratory

In addition, all efforts should be made to ensure that students at least see a demonstration of the following techniques.

- Separation of peripheral blood lymphocytes using Ficoll Hypaque
- Subcellular fractionation/marker enzymes for organelles to demonstrate

- Ultracentrifugation
- Isolation of high molecular weight DNA from tissues/blood
- Isolation of RNA; synthesis of cDNA by reverse transcription; PCR (both conventional and real-time)
- Isolation of plasmids and agarose gel electrophoresis for proteins and nucleic acids
- Basic techniques in cell culture
- High performance liquid chromatography (HPLC)

Syllabus

COURSE CONTENTS:

Paper I

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

Biomolecules:

Properties of water

Concept of an acid, a base, pH, pK, buffer and buffering capacity

Classification, structure and functions of amino acids and peptides

Structural organization of proteins and relationship with their functions

o primary, secondary, tertiary and quarternary structure of proteins

o protein folding and denaturation

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

Classification, functions, properties and reactions of carbohydrates

Classification, properties and importance of lipids

o Fatty acids-nomenclature, classification, properties, reactions

o Mono, di-and triacylglycerols

o Trans fats

o Cholesterol – structure, properties and functions

o Phospholipids- definition, tupes, properties, sa and importance

o Glycolipids- definition, types, functions, examples.

o Lipoproteins - definition, structure, types, functions, role of apoproteins, importance in health and disease.

o Biological membranes - structure, function, properties and importance.

o Micelles and liposomes

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Nucleotides and nucleic acids

o Purine and pyrimidine bases in DNA RNA

o Nucleosides and nucleotides

o Physiologically important nucleotides

o Synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents (anti-cancer durgs, anti –viral drugs)

o Watson and crick model of DNA structure

o Structure and functions of different types of RNA.

Cell biology

• Structure of the cell and different subcellular organelles

• Structure and functions of cell membrane, solute transport across biological membranes

• Intracellular traffic and sorting of proteins

- Intracellular signalling pathwasy, membrane receptors and second messengers Extracellular matrix: composition, importance and biomedical importance, and biomedical importance, cellular adhesion molecules and intercellular communication
- Cytoskeleton, muscle contraction and cell motility
- Cell cycle, mitosis, meiosis and mechanisms of cell death
- Red and white blood cells

Analytical techniques in biochemistry

□ Spectrophotometry (UV and visible spectrophotometry)

□ atomic absorption spectrophotometry

□ Flame photometry

□ Fluorometry

□ Turbidimetry and nephelometry

□ Gravimetry

□ EElectrochemistry (pH electrodes, ion-selective electrodes, gas-sensing electrodes)

□ Chemiluminescence

□ Water testing

□ Electrophoresis (principle, types, applications; isoelectric focusing capillary electrophoresis; 2-D electrophoresis)

□ Chromatography (principle, types [including high performance liquid

□ 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

Biostatistics and research methodology

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

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.

Environmental Biochemistry: Health and pollution.

Paper II:

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

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.

Biological oxidation
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; cytochrome P450 system

Respiratory chain and oxidative phosphorylation

- Components, complexes and functioning of the respiratory chain
- Process of oxidative phosphorylation
- Mechanisms of ATP synthesis and regulation

- Inhibitors, uncouplers and ionophores
- OXPHOS diseases

Overview of metabolism and intermediary metabolism
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
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
Metabolism of amino acids and proteins
• Digestion and absorption
• Pathways of amino acid degradation - transamination, oxidative deamination
• Transport and metabolism of ammonia
• Metabolism of individual amino acids.
• Plasma proteins
Metabolism of nucleotides

De novo synthesis of purine nucleotides
• Salvage pathway for purines
• Degradation of purines
• De novo synthesis of pyrimidine nucleotides
• Degradation of pyrimidine
• Synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents
Metabolism of haem
• Biosynthesis of heme and associated disorders
• Degradation of heme and associated disorders
Metabolism in individual tissues and in the fed and fasting states
Liver, adipose tissue, brain, RBCs
Nutrition
• Principal food components
• General nutritional requirements

• 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

Classification, biochemical role, sources, RDA and deficiency state of each vitamin (including diagnostic tests for deficiency and treatment)

Minerals

Classification, biochemical role, sources, requirement and deficiency state of each mineral (including diagnostic tests for deficiency and treatment)

Metabolism of xenobiotics

Free radicals and anti-oxidant defence systems in the bodyand associations with disease Processes

Paper III:

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

Structure and organization of chromosomes and chromiatin re-modelling DNA replication

DNA replication in prokaryotes and eukaryotes (including important differences between the two):

• Roles of DNA polymerase, helicase, primase, topoisomerase and DNA ligase
• Replication fork
• Okazaki fragments and its importance in replication.
• 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
• DNA recombination

Transcription

• Structure of a gene - exons and introns, promoter, enhancers/repressors and response elements.
• Process of transcription in prokaryotes and eukaryotes – initiation, elongation and termination (including important differences).
• Post-transcriptional processing – capping, tailing and splicing.

Genetic code and mutations

• Characteristics of the genetic code
• Molecular basis of degeneracy of the genetic code (Wobble hypothesis)
• Mutagens- examples of physical, chemical and biological mutagens.
• Types of mutations – point mutations and chromosomal mutations
• Relationship of mutations with specific diseases

Translation

• Basic structure of prokaryotic and eukaryotic ribosomes.
• Structure of tRNA (diagram of clover leaf model of tRNA structure) and its function in protein synthesis.
• Function of aminoacyl tRNA synthase.
• Process of protein synthesis (translation) – initiation, elongation and termination (including important differences between prokaryotic and eukarvotic translation).

SAMPSON, M.D
BIOCHEMISTRY

Meenakshi Medical College & Research Institute
DEAN

• Post-translational modifications

Regulation of gene expression in prokaryotes and eukaryotes

The operon concept in prokaryotes

• Role of general and gene specific transcription factors

• Small interference RNA (siRNA) and micro RNA (miRNA).

• Other modes of regulation of gene expression: alternative splicing, alternative promoter usage, DNA methylation, Histone acet ylation / deacetylation, RNA editing, alterations of RNA stability

Recombinant DNA technology and its applications in modern medicine

• Concepts of recombinant DNA, genetic engineering, biotechnology and cloning.

• Restriction endonucleases.

• Vectors for cloning – plasmids and phages.

• Genomic and cDNA libraries.

• Applications of recombinant DNA technology in medicine.

• Gene therapy

□ Diagnosis of genetic diseases and genetic counseling

• DNA fingerprinting

• DNA sequencing

• Microarrays

• Fluorescent in situ hybridization (FISH)

• DNA vaccines

• Transgenic animals

• Application of molecular techniques in forensic investigation and medicolegal cases

Overview of Human Genome Project

Basics of bioinformatics

Principles of human genetics

□ Alleles, genotypes and phenotypes

□ Patterns of inheritance: monogenic and polygenic inheritance

□ Population genetics

□ Genetic factors in causation of diseases

□ Types of genetic diseases: Chromosomal, monogenic and polygenic disorders, mitochondrial disorders, nucleotide repeat expansion disorders, imprinting disorders

□ Screening for genetic diseases and prenatal testing

□ Ethical and legal issues related to medical genetics

Stem cells in clinical medicine

□ Basic concepts regarding stem cell

□ Types of stem cells: embryonic and induced pleuripotent stem cells (IPSC)

□ Potential applications in the clinical medicine

□ Ethical and legal issues related to use of stem cells in medicine

Cancer

□ Carcinogens: physical, chemical and biological

□ 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: cell cycle abnormalities, telomerase activity, proliferative capacity and decreased apoptosis

□ Metastasis

SAMPSON, M.D.,
IN BIOCHEMISTRY

Meenakshi Medical College & Research Institute
DEAN

□ Biochemical basis of cancer chemotherapy and drug resistance
□ New methods of anti- cancer therapy: targeted cancer therapy, cancer immunotherapy.

Immunology

Innate and acquired immunity
• Humoral and cell-mediated immunity
• Cells and organs of the immune system - T and B cells, macrophages, dendritic cells, NK cells, granulocytes
• 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 processing and presentation,
• T cell and B cell receptor, toll like receptors
• T cell maturation/activation/differentiation
• B cell generation/activation/differentiation
• Cytokines
• Complement system, cell
• Immune response to infections
• Hypersensitivity reactions
• Vaccines
• Immuno-deficiency syndromes
□ Autoimmunity
□ Transplantation immunology
□ Caner and immune system,
□ Immunodiagnostics
□ Immunotherapy

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

Basic principles and practice of clinical biochemistry
Units of measure, reagents, clinical laboratory supplies, basic separation techniques, 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, c1inical laboratory informatics

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,

Clinical correlates and analytical procedures
• Amino acids, peptides and proteins; non-protein nitrogenous compounds
• enzymes
• carbohydrates
• lipids, lipoproteins and apolipoproteins and other cardiovascular risk factors
• electrolytes
• blood gases and pH
• hormones and associated disorders
• catecholamines and serotonin
• vitamins: trace and toxic elements

 Prophyrins and associated disorders
 Bone and mineral metabolism
 Tumour markers
 Assessment of organ functions 9hypothalamus and pituitary, adrenal glands, fonads, thyroid, parathyroid, liver, kidney heart, stomach, pancreas, intesting, etc0 and associated disorders
 pregnancy and maternal and fetal health
 reproduction related disorders – infertility
 newborn screening
 inborn errors of metabolism
 hemostasis
 therapeutic drug monitoring
 clinical toxicology
 molecular diagnostics
 body fluid analyses

Regulation of fluid and electrolyte balance and associated disorders

Regulations of acid-base balance and associated disorders

Biochemistry of the endocrine system

Classification and general mechanism of action of hormones

• Biosynthesis, secretion, regulation, transport and mode of action of hypothalamic peptides, adenohypophyseal and neurohypophyseal hormones, thyroid and parathyroid hormones, calcitonin, pancreatic hormones, adrenocortical and medullar y hormones, gonadal hormones, gastrointestinal hormones, opioid peptides, parahormones.
• Biochemistry of conception, reproduction and contraception
• Endocrine interrelationship and their involvement in metabolic regulation
• Neuro-modulators and their mechanism of action and physiological significance
• Biochemical aspects of diagnosis and treatment of endocrinal disorders:

Hematopoietic disorders

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

Hemostasis and thrombosis

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

Cardiovascular system

Atherosclerosis - pathogenesis, risk factors, prevention and treatment

Cardiac failure, acute coronary syndrome, cardiac biomarkers

Respiratory system

Gaseous exchange in lungs - physiological features and disturbances, arterial blood gases

Pathogenesis of cystic emphysema, alpha-1 anti-trypsin deficiency

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.

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

Liver

 Liver function tests
• Hyperbilirubinemias
• Viral hepatitis
• Serologic/virologic markers
• Alcoholic liver disease, fatty liver, chronic liver disease, cirrhosis and its complications
• Pathogenesis of ascites
• Hepatic encephalopathy
• Metabolic diseases affecting liver
• Reye's syndrome
• Diseases of gall bladder/bile ducts - pathogenesis of gallstones
• Pancreas - acute and chronic pancreatitis, cystic fibrosis, pancreatic function tests.

Bone and mineral metabolism

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

Nervous system
• Neurotransmitters and their receptors
• Ion channels and channelopathies
• Neurotrophic factors
• Protein aggregation and neurodegeneration
 Alzheimer's disease, Parkinson's disease, Huntington's disease, multiple sclerosis
• Prions and prion diseases
• Guillain-Barre syndrome – immunopathogenesis
• Myasthenia gravis – pathophysiology
• Hereditary myopathies - Duchenne muscular dystrophy
• Inherited disorders of muscle energy metabolism
• Mitochondrial myopathies
• Pathophysiology of psychiatric disorders such as anxiety, depression and schizophrenia

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TEACHING AND LEARNING METHODS

Teaching methodology

Active and interactive learning should be the mainstay of the program. The following methods are to be used to facilitate learning by and training of MD students.

1. Interactive lectures, tutorials, problem-based learning, case discussions, seminars, guest lectures, E-learning

The above teaching learning methods should be employed for the post graduate students to acquire updated knowledge on various aspects of basic and clinical biochemistry, immunology and molecular biology, and their application in modern medicine and also to learn to communicate effectively.

2. Journal club

Journal club sessions should be used by post graduate students to learn to search medical literature, to learn how scientific data is to be disseminated, to develop skills in presentation of research papers, to critically analyse and evaluate data, to become familiar with research methodologies, to keep oneself updated on new developments/emerging trends in biochemistry and to learn to communicate effectively

3. Practical exercises

These exercises should be used by post graduate students to equip themselves with knowledge and hand-on skills in various techniques used for laboratory bench-work in biochemistry and molecular biology and in a diagnostic laboratory, and to learn to analyze and interpret data obtained.

4. Thesis

Under the supervision of a Professor or Associate Professor in the Department of Biochemistry, each PG student is expected to generate a hypothesis/research question and design a research protocol to test/answer it. The protocol should have clearly defined objectives and a work plan. The post graduate student will carry out the experimental research work proposed, analyze data, interpret results and write athesis/dissertation based on the work done and results obtained.

5. Presentation of work done on thesis to peers

A post graduate student of a postgraduate degree course in broad specialities/super specialities would be required to present one poster presentation, to read one paper at a national/state conference and to present one research paper which should be published/accepted for publication/sent for publication during the period of his postgraduate studies so as to make him eligible to appear at the postgraduate degree examination

6. Teaching of undergraduates

Postgraduate students in Biochemistry shall be required to participate in teaching and training programmes of undergraduate students. They should learn how to organize, conduct and co-ordinate UG laboratory teaching in practical classes, to participate inj 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. They should learn how to work as part of a team and to facilitate learning by students.

7. Horizontal and vertical integration of teaching of Biochemistry with other preclinical, para-clinical and clinical departments

The post graduate students should take part in integrated teaching of undergraduates by participation in joint teaching sessions and seminars with different departments, participation in clinical rounds for discussing cases of interest and by small group discussions ofcase-based problems.

8. . Training in the basics of medical education and technology

The post graduate students may be provided with training in the basics of medical education and technology through workshops at the departmental and/or institutional level.

9. Development of communication skills

presentations at seminars and journal club sessions and by teaching undergraduates.

10. 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.

11. 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. 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),
Pediatrics (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.

12. Log Book:

All post graduate students should maintain a log book that documents all the work that they have done during their years of training. This log book should be checked and assessed periodically by the faculty members involved in the training programme.

13. Department should encourage e-learning activities.

During the training programme, patient safety is of paramount importance, therefore skills are to be learnt initially on the models, later to be performed under supervision followed by performing independently; for this purpose, provision of skills laboratories in medical colleges is mandatory.

ASSESSMENT

Formative assessment during the training

FORMATIVE ASSESSMENT, ie., during the training

General Principles

Internal Assessment should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills. The Internal Assessment should be conducted in theory and practical/clinical examination.

Quarterly assessment during the MD training should be based on:

1. Journal based / recent advances learning
2. Patient based /Laboratory or Skill based learning
3. Self directed learning and teaching
4. Departmental and interdepartmental learning activity
5. External and Outreach Activities / CMEs

The student to be assessed periodically as per categories listed in postgraduate student appraisal form (Annexure I).

SUMMATIVE ASSESSMENT at the end of training

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DEAN

POSTGRADUATE MEDICAL EDUCATION REGULATIONS, 2000.

The postgraduate examination shall be in three parts.

1. Thesis

Every post graduate student shall carry out work on an assigned research project under the guidance of a recognized post-graduate teacher. The results of the work done shall be written up and submitted in the form of a thesis. The aim of doing a thesis is to contribute to development of aspirit of enquiry, to familiarize the post graduate students with research methodology, literature searches, laboratory techniques, analysis of data, interpretation of results and skills in scientific writing.

The thesis shall be submitted at least six months before the theory and clinical / practical examination. The thesis shall be examined by a minimum of three examiners; one internal and two external examiners, who shall not be the examiners for theory and clinical examinations. A post graduate student shall be allowed to appear for the theory and practical/clinical examination only after the acceptance of the thesis by the examiners

2. Theory examination

The examinations shall be organized on the basis of a 'Grading'or 'Marking' system to evaluate and certify a post graduate student's level of knowledge, skills and competence at the end of the training. Obtaining a minimum of 50% marks in 'Theory' and 'Practical' examinations separately shall be mandatory for passing the examination as a whole. The examination for MD/MS shall be held at the end of the 3rd academic year.

There shall be 4 theory papers each of three hours duration:

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

Paper II: Enzymes, bioenergetics, biological oxidation, metabolism of bio molecules, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

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

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

3. Practical and oral/viva voce examination:

This should be held over two days.

Practical examination

The practical examinations 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. Identification the carbohydrate/amino acid provided and confirm of its identity by paper chromatography, Urine analysis.

C. Performance of an electrophoresis for serum proteins and discussion of electrophoretic pattern.

D. Quality Control, its interpretation and Method validation

Viva-voce Examination

E. Thesis presentation (of about 15 mins duration)

F. Pedagogy (20 mins duration plus 10 mins for questions)

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Suggested reading material:

Books (latest edition)

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox. W H Freeman & Co (Sd).
2. Biochemistry (Stryer), Jeremy M. Berg , John L. Tymoczko , Lubert Stryer, W. H. Freeman.
3.Biochemistry (Voet & Voet), Donald Voet , Judith G. Voet, John Wiley & Sons Inc.
4. Textbook of Biochemistry with Clinical Correlations, Thomas M. Devlin, John Wiley & Sons.
5. Kuby Immunology, Judy Owen, Jenni Punt , Sharon Stranford, W. H. Freeman.
6. Clinical Chemistry: Principles, Techniques, and Correlations, Michael L Bishop, Edward P Fody, Larry E Schoeff, Lippincott Williams and Wilkins.
7. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Carl A. Burtis, Edward R. Ashwood , Saunders.
8. Harpers Illustrated Biochemistry, Victor W. Rodwell , David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil , McGraw-Hill Education / Medical.
9. Biochemistry (Lippincott's Illustrated Reviews), Denise R Ferrier , Lippincott Williams and Wilkins.
10. Harrison's Principles of Internal Medicine, Dennis L. Kasper, Anthony S. Fauci, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Joseph Loscalzo, McGraw-Hill Education / Medical.
11. Davidson's Principles and Practice of Medicine, Walker, Elsevier Health Sciences – UK.
12. Clinical Biochemistry: Metabolic and Clinical Aspects, William J. Marshall & Márta Lapsley & Andrew Day & Ruth Ayling, Imprint - Churchill Livingstone.
13. Biochemistry: A Case-oriented Approach, Rex Montgomery, Thomas W. Conway, Arthur A. Spector, David Chappell, Mosby.
14. Interpretation of Diagnostic tests, Jacques Wallach, Lippincott Williams & Wilkins.

Journals

03-05 international Journals and 02 national (all indexed) journals

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