



# **Syllabus** **M Sc / M Biotech** **at the AIIMS**



**All India Institute of Medical Sciences**  
**Ansari Nagar, New Delhi-110029**

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M Sc / M Biotech  
at the  
AIIMS



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All India Institute of Medical Sciences

New Delhi - 110 029

## **Academic Affairs Concerned Officials**

- Dr. P. Venugopal – Dean (Acad.)
- Dr. Y.K. Joshi -- Sub-Dean (Acad.)
- Dr. K.K. Deepak – Sub-Dean (Exam.)
- Shri V.P. Gupta – Registrar

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## PREAMBLE

The Health Survey and Development Committee, popularly known as the Bhore Committee, in its report published in 1946, recommended very strongly the establishment of a national medical center at Delhi which will concentrate on training of highly qualified teachers and research workers in order that a steady stream of these could be maintained to meet the needs of the rapidly expanding health activities throughout the country. After the attainment of independence the Union Ministry of Health proceeded to implement this challenging idea and a magnificent grant of one million pounds by the Government of New Zealand through the Colombo Plan helped to translate the idea into reality. An act of Parliament in 1956 established the All India Institute of Medical Sciences as an autonomous institution of National importance and defined its objectives and functions.

The prime concern of the Institute is to develop patterns of teaching in undergraduate and postgraduate medical education in all the branches so as to demonstrate a high standard of medical education to all medical colleges and other allied institutions in India. This educational experience is imparted in an atmosphere of research.

By virtue of the Act, the Institute grants its own medical degrees and other academic distinctions. The degrees granted by the Institute under the All India Institute of Medical Sciences Act are recognized medical qualifications for the purpose of the Indian Medical Council Act and, notwithstanding anything contained therein, are deemed to be included in the first schedule of that Act, entitling the holders to the same privileges as those attached to the equivalent awards from the recognized University of India respectively.

The AIIMS imparts postgraduate degrees in major specialities of M Sc sciences i.e.

### **M Sc (Master of Science)**

1. Anatomy
2. Biochemistry
3. Biophysics
4. Pharmacology
5. Physiology
6. M Biotech (Master of Biotechnology)
7. Perfusion Technology
8. Nuclear Medicine Technology
9. Urology Technology

The syllabus has been developed in consultation with the faculty of the concerned departments and further scrutinized by the Academic Section under the supervision of the Dean.

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# ANATOMY — M Sc

## OBJECTIVES

At the end of the two years of training programme in Master of Science in Anatomy the student should be able to:-

1. Acquire comprehensive knowledge of structure and functions of human body, ontogeny of human development and genetic mechanisms involved in normal and abnormal development, knowledge of light microscopic and ultrastructure of human body. Knowledge of structure and functional correlation of nervous system and be able to communicate the same clearly and with precision.
2. Inculcate habit of scientific enquiry and be able to identify lacunae in the existing knowledge in a given area. Acquire knowledge of modern research techniques and be familiar with the recent advances in human biology.

## Learning Activities, Training And Evaluation

During the course students have formal teaching and are trained for teaching and research

### I. Didactic teaching:

Topics in gross anatomy, microanatomy, embryology, neuroanatomy, histochemistry, and genetics, along with related practical sessions.

### II Training

Communication skills – journal club, seminars

Hands on experience – techniques in micro, neuro, gross anatomy, embryology, histochemistry, genetics, electron and confocal microscopy.

Teaching experience – taking UG classes : demonstrations and practicals for one semesters (six months)

Educational technology – preparation of AV aids for teaching, posters/manuscripts for presentation in conferences/workshops and publication in journals. Setting objective questions – SAQs, MCQs and OSPE. Prepare teaching modules & museum specimens, casts. Participation in organization of symposia/workshops.



### III. Research

Thesis – progress monitoring every semester.

Presenting paper/poster at conferences/Preparing manuscripts for documentation.

Thesis work presentation at regular intervals.

Thesis submission at the end of 1 & 1/2 yrs.

### IV. Evaluation of training

Written/practical assessment every semester. Feedback on teaching/training programme.

## M.Sc. Anatomy Examinations

Final examination at the end of the course has theory, practical and viva-voce.

### Theory

Paper-I : Gross Anatomy with evolution and Comparative Anatomy. Gross Anatomy will include functional Anatomy. (**Section-1**)

Paper-II : Microscopic Anatomy, Developmental Anatomy and Genetics. (**Section-2**)

Paper-III : Neuroanatomy including development and microscopic structure (**Section-3**)

### Practical and Viva

1. Histological techniques, identification light and electron microscopic structure of tissues of body.
2. Slides, specimens of developmental anatomy, genetics, neuroanatomy to assess comprehensive knowledge in these areas.

Viva-voce on gross anatomy, living anatomy, sectional anatomy and neuroanatomy, developmental anatomy and genetics.

## SECTION – 1

### *GROSS ANATOMY*

### COURSE CONTENT

Structure of whole human body in detail, including functional, sectional and radiological anatomy.

### PRACTICAL

Dissection of entire body. Preparation of museum specimens, casts, plastination, fixation and preservations of human body.

## SECTION – 2

### *HISTOLOGY AND HITOCEMISTRY*

### COURSE CONTENT

1. Cell Biology: Cytoplasm – Cytoplasmic matrix, cell membrane, cell organelles, cytoskeleton, cell inclusions, cilia and flagella.

Nucleus – nuclear envelope, nuclear matrix, DNA and other components of chromatin, protein synthesis, nucleolus, nuclear changes indicating cell death.

Cell cycle, mitosis, meiosis, cell renewal. Cellular differentiation and proliferation.

2. Tissues of Body: Light and electron microscopic details and structural basis of function, regeneration and degeneration.
3. The systems/organs of body – Cellular organization, light and electron microscopic features, structure-function correlation, and cellular organization.

## **PRACTICAL**

Preparation of histological sections, light microscopy and its applications, electron microscopy and its applications, confocal microscopy, histological staining -routine and special stains, identification of normal and abnormal organelles in electron micrographs, three dimensional interpretation, artifacts identification.

## ***GENETICS***

### **COURSE CONTENT**

Normal and abnormal chromosomes, Molecular genetics, developmental genetics, immunogenetics, population genetics and genetic counselling.

1. Human Chromosomes - Structure, number and classification, methods of chromosome preparation, banding patterns. Chromosome abnormalities, Autosomal abnormalities – syndromes, Sex chromosomal abnormalities – syndromes, Molecular and Cytogenetics.
2. Single gene pattern inheritance, Autosomal and Sex chromosomal patterns of inheritance, Intermediate pattern and multiple alleles, Mutations, Non Mendelian inheritance, Mitochondrial inheritance, Genomic imprinting, parental disomy.
3. Multifactorial pattern of inheritance: Criteria for multifactorial inheritance, Teratology, Structure of gene, Molecular Screening, Cancer Genetics – Haematological malignancies, Cancer Genetics, Pharmacogenetics.
4. Reproduction Genetics- Male infertility, Female Infertility, assisted reproduction, Preimplantation genetics, Prenatal diagnosis, Genetic Counselling Ethics and Genetics.

## **PRACTICAL**

DNA Isolation from peripheral blood lymphocytes, Polymerase Chain Reaction (PCR), Fluorescence In-Situ Hybridization (FISH), Chromosomal Analysis

## ***DEVELOPMENTAL ANATOMY***

### **COURSE CONTENT**

Gametogenesis, early human development, general and systemic embryology, environmental and genetic influences on normal growth and development, teratogenesis.

## **PRACTICAL**

Models, specimens of early human development and slides of chick and pig embryos to correlate avian and mammalian early development with human development. Specimens of congenital malformations.

## **IMMUNOLOGY**

### **COURSE CONTENT**

Immune system and the cell types involved in defense mechanisms of the body. Gross features, cytoarchitecture, functions, development and histogenesis of various primary and secondary lymphoid organs in the body. Biological and clinical significance of the major histocompatibility complex of man including its role in transplantation, disease susceptibility/resistance and genetic control of the immune response. Common techniques employed in cellular immunology and histocompatibility testing. Molecular hybridization and PCR technology in immunology research particularly mechanism of antigen presentation, structural and functional relevance of the T cell receptor, genetic control of the immune response, molecular basis of susceptibility to disease.

### **PRACTICAL**

Techniques of DNA preparation, electrophoresis and southern blot hybridization.

## **SECTION – 3**

## **NEUROANATOMY**

### **COURSE CONTENT**

Brain and its environment, Development of the nervous system, Neuron and Neuroglia, Somatic sensory system, Olfactory and optic pathways, Cochleovestibular and gustatory pathways, Motor pathways, Central autonomic pathways, Hypothalamo-hypophyseal system, Cross sectional anatomy of brain and spinal cord.

### **PRACTICAL**

Identification of structures in sections of brain stem and spinal cord at different levels. Staining nervous tissue using Nissl's staining and other special stains.

### **RECOMMENDED BOOKS**

- |                                                                                                  |                                                   |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1. Gray's Anatomy 38 <sup>th</sup> edition, 1995 reprint in 2000<br>Churchill Livingstone        | Williams et al                                    |
| 2. Wheaters Functional Histology 4 <sup>th</sup> ed.(2000)<br>Churchill Livingstone              | B. Young and J.Heath<br>www.med.uc.edu.embryology |
| 3. Histology: A text & atlas 3 <sup>rd</sup> edition (1995)<br>Williams & Wilkins                | M.H.Ross, E.& L.J.                                |
| 4. Medical Embryology 8 <sup>th</sup> edition<br>William and Wilkins                             | Jan Langman                                       |
| 5. Genetics in medicine 6 <sup>th</sup> edition, 2001<br>W.B. Saunders & Co.Philadelphia, London | J.S.Thompson &<br>M.W. Thompson                   |
| 6. Human Neuroanatomy 9 <sup>th</sup> edition, 1996                                              | Stuin J and Carpenter MB                          |
| 7. Clinical Neuroanatomy for Medical Students<br>Willian and Wilkins                             | Richard S. Snell                                  |

# BIOCHEMISTRY — M Sc

## Goal

The program is designed to enable a student acquire sound knowledge in the subject and develop practical skills to contribute effectively in academics and health sciences research.

## OBJECTIVES

1. At the end of the 2 years training in Biochemistry, the PG student is expected to demonstrate sound knowledge of general concepts and principles of Biochemistry. Evolutionary perspectives of biomolecules, cell organelles and diversity provided at the molecular level, discuss various aspects of nutrition and metabolism under different physiological conditions, explain the occurrence, regulation and interrelationship of metabolic events, identify the molecular/metabolic basis of a disease, explain concepts of body defense/immunology and detoxification, molecular and cell biology, describe the principles of various biochemical techniques and instrumentations and analyze and interpret the data.
2. Plan & conduct lecture, practical demonstrations & tutorial classes.
3. Critically review & comment on research papers
4. Prepare research protocols to conduct experimental studies, analyse, interpret diseases, experimental results of generate hypothesis.
5. Be familiar with literature survey / computer skills, basic knowledge of biostatistics.

## METHODOLOGY

Following methods are used to facilitate learning and training of the students.

### A. Theory

1. **Tutorials:** will be held for 1 hour duration, at least twice a month. The objective is to provide an opportunity to the students to have interaction with the teachers and gain maximum coordinated information on the subject.

2. **Seminars:** will be held once a month. The topics will be chosen from the latest advances in the subject and also from areas of general biological / biochemical interest. One student will take up a topic for one seminar, prepare and speak on it. Presentation and discussion will be for 1 hour. By this exercise, the students will know the advanced developments in the fields & also learn, comprehend and explain the information they have obtained.
3. **Journal club:** To develop a) skills of analysis, evaluation and presentation of research papers b) familiarity with approaches and methodologies of research and c) to update on new development/emerging trends in biochemistry.
4. **Invited lectures:** to gain access to recent work by an expert in an area and opportunity for free interactions with scientists of eminence.
5. Relevant lectures in biotechnology

## B. Practicals

Core- Biochemistry.

These will include some of the Biochemistry practicals from the undergraduate course.

Advanced practicals- Biochemistry, cell biology, molecular biology, immunology.

Some of the biochemistry practicals from the undergraduate course and from cell biology and immunology. Students will attend this weekly biochemistry practicals. Other practicals will be arranged in the Deptt. laboratories.

Advanced : Biochemistry, cell biology, molecular biology, immunology.

1. **Study of the cell** – (i) Cell culture, lymphocyte isolation & culture, growth rate studies, staining techniques (ii) Cell fractionation, homogenization of the tissue, centrifugation, marker enzyme assays (iii) Microscopy and microphotography.
2. **Quantitative assays** – (i) Enzyme assays (ii) RIA (iii) ELISA (iv) DNA, RNA & proteins
3. **Protein fractionation** – (i) Salting in and out, gel filtration, electrophoretic separation (ii) Gel filtration affinity based techniques (iii) SDS-PAGE (iv) Electrophoretic separation of LDH isoenzymes
4. **Enzymology** – purification of enzyme & its kinetics
5. **DNA** – (i) Genomic and plasmid DNA isolation (ii) Restriction enzyme digestion (iii) Electrophoresis (iv) PCR (v) RT-PCR
6. Southern blotting
7. Western blotting
8. Tissue culture
9. Absorption & fluorescence spectroscopy
10. Chromatographic techniques – HPLC, Gel filtration, ion exchange, affinity chromatography

These practicals will give an exposure to the students on the basic techniques as well as advanced techniques. A researcher uses in his/her studies.

## C. Thesis

A small topic based on-going work will well established / standardized parameters.

**Oral examination**

1. Thesis work presentation and discussion.
2. General viva voce and practical bench viva.

**Paper I:** Essentials of biochemistry and advances in intermediary metabolism. Duration- 3 hrs, Marks-100.

(Section 1)

**Paper II:** Nutrition, vitamins, hormones and immunology. Duration- 3 hrs, Marks-100.

(Section 2)

**Paper III:** Molecular biology, Biostatistics, Clinical Biochemistry and techniques in Biochemistry. Duration- 3 hrs, Marks-100.

(Section 3)

**Practicals: Duration- 2 days, Marks-300.**

**SECTION 1**

**PAPER I :** Biomolecular, chemical bonding, structure and function of carbohydrates, proteins and lipid, water and its properties, cell composition, architecture and function, enzymes coenzymes, metabolism of carbohydrate, amino acids and lipids, in born of metabolism. Principles of thermodynamics, Bioenergetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids – pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.

**SECTION 2**

**PAPER II :** Hormones – chemistry, mechanism of action and physiological effects. Nutrition and food assimilation, macronutrients and micronutrients, vitamins and trace elements, chemistry and metabolism of purines and pyrimidines. Immunology.

**SECTION 3**

**PAPER III :** Nucleic acids - structure synthesis, regulation. Molecular biology and recombinant DNA technology, genomics and proteomics, DNA microarrays, biochemical genetics, environmental biochemistry. Oncogenes, group factors, biochemistry of cancer, clinical biochemistry. Experimental techniques in biochemical research and study of cell. Current topics, biostatistics and its application in research and clinical chemistry, Journal club seminars.

**Books recommended**

1. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York.
2. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishers and distributors.
3. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stamford, Connecticut.
4. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin. Wiley-Liss Publishers.

5. Genes VI. Ed Benjamin Lewin. Oxford University Press.
6. Tietz Textbook of Clinical Chemistry. Ed Burtis and Ashwood. W.B. Saunders Company.
7. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press.
8. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc.
9. Molecular Cloning- A Laboratory Manual. J. Sambrook, E.F.Fritsch and T.Maniatis. Cold Spring Harbor Laboratory Press.
10. Molecular Cell Biology, H. Lodish, A. Berk, S.L.Zipursky, P. Matsudaira, D. Baltimore, J. Darnell

# **BIOPHYSICS — M Sc**

- I. Molecular Biology, Radiation Biophysics, Electronics and Dynamics of Nonlinear Processes
- II. Molecular Biophysics: X-ray Crystallography, Spectroscopy, Proteins, Viruses, Nucleic Acids And Membranes.
- III. Mathematical Methods, Quantum Chemistry, Theoretical Modeling And Microscopy.
- IV. Laboratory Experiments.

## **PAPER – I**

### ***MOLECULAR BIOLOGY, RADIATION BIOPHYSICS, ELECTRONICS AND DYNAMICS OF NONLINEAR PROCESSES***

#### **CELL AND MOLECULAR BIOLOGY**

Central Dogma, Genetic code, gene and operon, Structure of DNA and RNA, extrachromal elements, plasmids, selectable markers, gel electrophoresis, polymerase chain reaction (PCR), cloning PCR products, expression vectors, DNA sequence analysis, cDNA libraries, genomic libraries, applications of molecular biology methods, using internet resources in molecular biology

#### **RADIATION BIOPHYSICS**

Interaction of radiation with matter, ionizing radiation, nonionizing radiation, free radicals, ion pairs, radiation units and dosimetry, dose effect graphs and target theory, direct and indirect radiation action, radiation on proteins, nucleic acids, carbohydrates, cell and whole organism, genetic effects of radiation, repair of radiation induced damage, radiation in diagnosis and therapeutics, protection from radiation.

#### **ELECTRONICS**

Passive circuit components, series and parallel circuits, circuit theory, power supplies, amplifiers, emitter followers, oscillators and basic digital circuits.



## DYNAMICS OF NONLINEAR PROCESSES

Physico-mathematical foundations of the dynamics of nonlinear processes, phase plane method, different modes of excitations, nearly sinusoidal oscillations, building up of oscillations, effect of third harmonic distortion, Liapounov criteria of stability, limit cycles.

### PAPER II

## MOLECULAR BIOPHYSICS (X-RAY CRYSTALLOGRAPHY, SPECTROSCOPY, PROTEINS, VIRUSES, NUCLEIC ACIDS AND MEMBRANES)

### X-RAY CRYSTALLOGRAPHY

#### *X-ray Diffraction*

Structure factor expression, electron density equation, phase problems, Patterson function, molecular replacement method, heavy atom method, isomorphous replacement method, refinement procedure and interpretation of results.

#### *Data Collection*

Methods of data collection of crystal containing small molecule and large molecule, factors affecting the measurement of integrated intensities, photographic methods, diffractometers, area detectors and image plates.

### SPECTROSCOPY

UV, IR, Raman ORD and CD, spectroscopy, basic principles, instrumentation and use. NMR/ESR: classical description of magnetic resonance in terms of precession moments, relaxation process, Bloch equation for line width and shape, spin Hamiltonian, ESR spectrometer, spin labelling in biological molecules, NMR: spectrometer instrumentation, pulsed and Fourier transformed NMR, scalar and dipolar broadening, line multiplicity, ring current shifts factors affecting relaxation time, Karplus equation and use of NMR for conformational study, Mössbauer spectroscopy, resonance absorption in biological samples. Line shape, line width, chemical shifts, quadruple and magnetic splitting in Mössbauer spectra of biological molecules.

### PROTEINS

*Stability of protein structures:* flexibility, reversible folding and unfolding, pH titration, chemical denaturation, thermal denaturation solvent perturbation and chemical modification

*Prediction of protein structures:* circular dichroism, NMR Methods, Structure-function relationship, catalysis, Study of three dimensional structures of Trypsin, Trypsinogen, Antibody molecules.

### NUCLEIC ACIDS

Introduction of nucleic acids, definition of terms for nucleic acids, old nomenclature, IUPAC-IUB nomenclature. Basis of Watson Cricks original model Different, base- pairing schemes Unsatisfactory

nature of Hoogsteen and other base pairing schemes, biological implication of Watson Crick base pairing scheme refinement of Watson-Crick model by linked-atom least squares, fiber X-ray diffraction studies, single crystal X-ray diffraction, and NMR studies on mono- and oligo-nucleotides, DNA polymorphism, parameters for A-, B-, C-, D- and Z-DNA, definitions of roll, tilt and propeller twist, spectroscopic study of DNA polymorphism, interaction of DNA with proteins, drugs, dyes and carcinogens, experimental and theoretical studies on base stacking, hydrogen bonding interactions, structure of RNA, basic differences between DNA and RNA structures, structure of yeast phenylalanine tRNA.

## **MEMBRANES**

Lipid structure and their organization, phase transitions in lipids, polysaccharides, molecular shapes and the conformation, comparison between different membrane models, diffusions and permeability, carrier transport, ion transport, active and passive transport, ion pumps, water transport, use of liposomes for membrane models and drug delivery systems.

## **PAPER III**

### **MATHEMATICAL METHODS, QUANTUM BIOLOGY AND MICROSCOPY**

#### **MATHEMATICAL METHODS**

Review of Fourier Series, Laplace transforms, transforms of derivatives, properties of Laplace transform, solution of linear ordinary differential equation with Laplace transforms, Fourier transforms, solution of partial differential equation with method of separation of variables.

#### **QUANTUM CHEMISTRY**

Atomic orbital models, the wave equation, molecular orbitals, the LCAO method the overlap, Coulomb and resonance integrals, the hydrogen molecule, charge distributions, approximate methods.

##### ***Theoretical modeling***

Basic principle of modeling, Modeling by energy minimization technique, Concept of rotation about bonds, Energy minimization basic technique for small molecules. Ramachandran plot, Torsional space minimization. Energy minimization in Cartesian space. Molecular mechanics basic principle. Molecular dynamics basic principles.

#### **MICROSCOPY**

##### ***Optical Microscopy***

Theory and use of light, fluorescence, phase and polarising microscopes, selection of suitable samples, and observation in different optical systems, study of living cells, principle and techniques of photomicroscopy, applications and limitations of optical microscopy.

##### ***Electron Microscopy***

Principle of electron microscopes, preparation of samples, interpretation of ultrastructure and cell function, confocal microscopy, atomic force microscopy.

**LABORATORY EXPERIMENTS**

1. Study of peptide/ligand DNA interaction
2. The determination of unit cell constants and space group of a given Crystal using Weissenberg method.
3. The determination of unit cell constants and space group of given crystal by precession method using a layer line screened photograph.
4. Crystallization of Lysozyme and examination of its crystals in the polarizing microscope.
5. Urea Denaturation of protein
6. (a) Conformational energy plot for tripeptide or dinucleotide monophosphates and obtain lowest energy conformation.  
(b) Determine the geometric parameters for the obtained conformation.
7. Molecular weight determination by SDS PAGE.
8. Plasmid isolation.
9. DNA Electrophoresis
10. PCR

# PHARMACOLOGY — M Sc

## OBJECTIVES

The following self-learning sessions for PG students;

- Post graduate lectures in **systemic pharmacology** to update various aspects basic pharmacology and applied therapeutics
- **Therapeutic club:** To critically analyze the day to day development in new drugs
- **Journal club:** To familiarize research methodologies and application of statistics in experiments
- **Seminars:** To update newer developments in pharmacology/emerging trends/ novel mechanisms of drug action etc.
- **Practical exercises:** Once in a week, under the supervision of a faculty, with/without the help of animals, various principles/ mode of drug action/ screening of drugs/ drug analysis using various techniques should be performed to develop practical skills to conduct similar experiments in future.
- **Thesis:** Each PG student will carry out research work under the supervision of a faculty member of the Pharmacology Department. The thesis will be submitted to AIIMS and will be analysed by suitable experts in that field. The acceptance of the thesis by the institute will be a prerequisite for the candidate to be allowed to appear in the written/practical examination.

## MSc EXAMINATION

### Theory examination

#### Paper- I

General pharmacological principles and allied sciences (**section -1**)

#### Paper-II

Systemic pharmacology, chemotherapy and therapeutics (**section-2**)

#### Paper-III

Experimental pharmacology, bioassay, statistics, pharmacokinetics and recent advances (**section-3**)

**Practical examination ( 2 days)**

- (1) One exercise on intact animal\*\*
- (2) One exercise on isolated organ\*\*
- (3) One chemical pharmacology exercise

**Oral examination**

- (1) Thesis presentation and discussion
- (2) General viva voce

**SECTION 1****1.a. GENERAL PHARMACOLOGICAL PRINCIPLES AND APPLIED SCIENCES****1.b. TOXICOLOGY**

Antidotes in the management of poisoning. Applied analytical toxicology and toxicovigilance.

**1.c. MOLECULAR BIOLOGY IN PHARMACOLOGY**

Gene expression, Pharmacogenomics, Proteomics, techniques involved in studying receptor dynamics. PCR, Northern blot, Southern blot and Western blot. Protein purification. Mono, poly clonal antibodies. Molecular biology in receptor identification. Antisense oligonucleotides, molecular targets of drug action.

**1.d. ISOLATION OF COMPOUNDS FROM HERBAL SOURCES**

Basic constituents of plants (chemical classification). Isolation of active constituent from plant materials. Percolation and maceration. Qualitative constituent characterisation techniques. Utilisation of HPTLC for the constituent analysis. Estimation of marker compound in biological fluid after crude plant material administration.

**Practical skills:** Isolation of active principles from medicinal plants

**1.e. WONDER DISCOVERIES IN PHARMACOLOGY**

Nobel laureates in Pharmacology and their revolutionary discoveries

**SECTION 2****SYSTEMIC PHARMACOLOGY**

**Autonomic nervous system**

**Central nervous system**

**Autocoids**

**Drugs affecting kidney function and Cardiovascular system**

**Drugs affecting gastrointestinal and respiratory system**

**Drugs affecting uterine motility**

**Chemotherapy of parasite infections**

**Chemotherapy of microbial diseases****Antineoplastic agents****Immunomodulators****Drugs acting on blood and blood forming organs****Hormones****Miscellaneous**

Vitamins (water soluble and fat soluble vitamins). Heavy metals and heavy metal antagonists. Ocular and dermato-pharmacology. Recent developments in Pharmacology time to time. Gene therapy. Therapeutic gases. Free radical biology and antioxidants, pharmacology of biophosphonates, melatonin-therapeutic potential. Pharmacotherapy of migraine, Drug therapy in Alzheimer's disease and male sexual dysfunction. Hormone replacement therapy.

**SECTION 3****3.a. EXPERIMENTAL PHARMACOLOGY, BIOASSAY AND STATISTICS AND RECENT ADVANCEMENTS**

Experimental methodologies involved in the discovery of drugs (*in vivo*, *in vitro*, *ex vivo*). Animal handling and animal care. Methods of anaesthetising animals and methods of euthanasia. Restraining and blood collecting methods. Drug screening methods involved in the evaluation of anti-ulcer, antidepressant, antianginal, antihypertensive, antiarrhythmic, antidiabetic, anticataract, anti-platelet, anticancer, anti-inflammatory, antidiarrhoeal, antiepileptic, analgesic, antithyroid, antipyretic, antiglaucoma, antihyperlipidemic antiasthmatics drugs and cough suppressants. Drug screening methods used in screening antifungal, antihelminthic, antibacterial, antiviral agents, drugs for heart failure, posterior pituitary, adrenal steroid (gluco & mineralo corticoids), testicular, parathyroid, ovarian, thyroid hormones, Methods involved in testing teratogenicity, carcinogenicity and organ toxicities in animals.

**Practical Skills\*\*:** Effect of antiinflammatory agents on caragennan induced rat paw edema. Evaluation of analgesic activity of morphine using tail flick latency test. Evaluation of cardiotoxic drugs on isolated rabbit heart (Langendorff isolated heart preparation). Demonstration of Dale's vasomotor reversal and nicotinic effect of acetylcholine on dog blood pressure. Effect of autonomic drugs on rabbit intestine. Demonstration of bronchodilation on guinea pig tracheal chain. Effect of sedatives on rodents (rotarod test).

Four point assay of histamine and acetylcholine on guinea pig ileum. Four point assay of 5HT on rat uterus. Estimation of  $PA_2$  value of atropine. Identification of unknown by evaluating its action on dog haemodynamic parameters. Assay of acetylcholine using rat fundus. Estimation of pressor agents on rat blood pressure.

**3.b. INSTRUMENTATION IN DRUG ANALYSIS**

Qualitative testing, titrimetric analysis. Beer and Lambert's law. Basis and working principle of colorimeter, ultraviolet, atomic absorption spectrometers, Fluorescence spectroscopy, NMR and Mass Spectroscopy. Basics of Chromatography. Partition, adsorption and ionexchange chromatography. column chromatography, thin layer chromatography, paper chromatography, immunoabsorbant chromatography, high performance thin layer chromatography, high performance liquid chromatography and gas

Chromatography. Radio immunoassay. Processing of biological materials for drug analysis. Calculations in drug analysis. Good laboratory practice. Validation of analytical procedure.

**Practical skills:** Spectrophoto & fluorimetric estimations of drugs in biological fluids.

### 3.c. BIOSTATISTICS

Calculation of basic statistical parameters (mean, median, mode, standard deviation, standard error etc.). Null hypothesis, parametric and non parametric tests (Student 't' test, Wilcoxon, ANOVA etc.). Metaanalysis.

**Practical skills:** Calculation for statistical significance in the given data for Student paired and unpaired 't' test. Applying ANOVA to the given set of concentration vs time data of two drug formulations to comment about their bio-equivalence.

### 3.d. PHARMACOKINETICS

Basics of pharmacokinetics, calculation of pharmacokinetic estimates (C-max, Tmax, T<sub>1/2</sub>, AUC<sub>(0-n)</sub>, AUC<sub>(0-∞)</sub>, V<sub>d</sub>, K<sub>e</sub>, K<sub>a</sub> etc.) Compartment models used in pharmacokinetics (oral and intravenous). Compartment fitting (one comp & two comp). Pharmacodynamic /pharmacokinetic (PK/PD) correlation.

**Practical skills:** Calculation of Pharmacokinetic estimates from given concentration vs time data

### 3.e. DRUG REGULATIONS

Drugs and Cosmetics Act, Drug Price Control order, Application for Investigational New Drug (IND), Application for New Drug Discovery (NDD) according to Indian Control Authority & USFDA guidelines. Conducting bio-equivalence studies. Ethical considerations in utilizing human subjects for drug discovery process. Helsinki's declaration. ICH-GCP Guidelines. Ethical guidelines in utilising animals for experimental purposes.

**Practical skills:** Draft an IND and NDD application for the approval of a numbered compound.

### 3.f. DRUG DEVELOPMENT PROCESS

Methods involved in the development of new drugs. Preclinical toxicological studies. Calculation of LD<sub>50</sub> & ED<sub>50</sub>. Acute, subacute and chronic toxicity studies. Irwin profile test, Pre-clinical pharmacokinetic and dynamic studies. Lipinski's rule for drug like molecule, High throughput screening (*invitro and invivo*) for pre-clinical pharmacokinetic and pharmacodynamic studies.

### 3.g. DRUG DEVELOPMENT PROCESS

Methods involved in the development of new drugs. Preclinical toxicological studies. Calculation of LD<sub>50</sub> & ED<sub>50</sub>. Acute, subacute and chronic toxicity studies. Irwin profile test, Pre-clinical pharmacokinetic and dynamic studies. Lipinski's rule for drug like molecule, High throughput screening (*invitro and invivo*) for pre-clinical pharmacokinetic and pharmacodynamic studies.

### 3.h. THERAPEUTIC DRUG MONITORING

Basic principles of TDM. Therapeutic index. Trough level monitoring and dosage adjustments.

**Drug delivery systems:** sustained release, enteric coated formulations and liposome etc.

**Pharmacovigilance, Pharmacoeconomics, Pharmacogenetics And Drug Information**

**Books recommended**

1. Goodman Gillman's The Pharmacological basis of therapeutics. (2001) Ed. Hardman JG, Limbird LE (Tenth Edition) McGraw Hill press New York.
2. Applied biopharmaceutics and pharmacokinetics (1999) Ed. Sargel L. (IV Edition) Prentice-Hall International, London.
3. Fundamentals of experimental pharmacology. (1984) Ed. Ghosh MN. Scientific book agency, Calcutta.
4. Text book of receptor pharmacology. Eds. Forman JC, Johansen TJ CRC Press, New York 1996.
5. Drug Discovery and Evaluation –Pharmacological assays. (1997) Ed. Vogel HG & Vogel WH. Springer- New York.

**Journals to be referred**

Trends in Pharmacological Sciences, Annual Review of Pharmacology, Pharmacological Reviews, Indian Journal of pharmacology, Indian Journal of Physiology and Pharmacology, Annals of Pharmacotherapy, Pharmacology and Experimental Therapeutics, Journal of Ethnopharmacology, Nature, Science, European Journal of Clinical Pharmacology, BJCP and other pharmacology related journals

**\*\*PRACTICAL EXERCISE USING ANIMAL EXPERIMENTS IS SUBJECT TO ETHICAL APPROVAL**



# PHYSIOLOGY — M Sc

## OBJECTIVES

The M.Sc. (Physiology) program has the following broad and intermediate objectives:

### Broad Objectives

The candidate qualifying for the award of M.Sc. (Physiology) should be able to:

1. demonstrate comprehensive understanding of physiology as well as that of the applied disciplines;
2. demonstrate adequate knowledge of the current developments in medical sciences as related to physiology;
3. teach undergraduates and postgraduates in physiology;
4. plan and conduct research;
5. plan educational programs in physiology utilizing modern methods of teaching and evaluation; and
6. organize and equip physiology laboratories.

### Intermediate Objectives

The candidate qualifying for the award of M.Sc. (Physiology) should be able to:

1. demonstrate comprehensive understanding of the structure, function and development of the human body as related to physiology,
2. demonstrate elementary understanding of the clinical applications of physiology,
3. critically evaluate the impact of the recent information on the genesis of current concepts related to various topics of physiology;
4. recapitulate the information imparted to the undergraduate students in physiology;
5. perform and critically evaluate the practical exercises done by undergraduate students;
6. identify a research problem which could be basic, fundamental or applied in nature; define the objectives of the problem and give a fair assessment as to what is expected to be achieved at the completion of the project; design and carry out technical procedures required for the study; record accurately and systematically the observations and analyze them objectively; effectively use statistical

methods for analyzing the data; interpret the observations in the light of existing knowledge and highlight in what way his observations have advanced scientific knowledge; write a scientific paper on the lines accepted by standard scientific journals;

7. design, fabricate and use indigenous gadgets for experimental purposes;
8. demonstrate familiarity with the principles of medical education including definitions of objectives, curriculum construction, merits and demerits of various tools used in the teaching-learning process; use of learning aids and learning settings, and methods of evaluation;
9. share learning experiences with the undergraduate and postgraduate students using appropriate pedagogical skills and methods;
10. draw out meaningful curricula for teaching medical and paramedical courses; give lucid, interactive lectures, presenting the information in a logical, simple and comprehensive manner; generate interest and curiosity amongst the students during lectures; give practical demonstrations;
11. organize the laboratories for various practical exercises, substitute and fabricate some of the simpler equipment for teaching purposes; and
12. handle and order for stores, draw up lists of equipment required to equip physiology laboratories

## **TEACHING PROGRAMME**

To achieve the above objectives in three years, we have the following structured programme.

### **Semester 1**

1. Orientation to the department
2. Choosing the subject of thesis and guide
3. Writing the protocol
4. Recapitulation of undergraduate physiology through attending UG lectures

### **Semester 2**

1. Physiology: theory & practical
2. Thesis work
3. Recapitulation of undergraduate physiology through attending UG lectures

### **Semester 3**

1. Physiology: theory & practical
2. Thesis work

### **Semester 4**

1. Physiology: theory & practical
2. Submission of thesis

## **Physiology: theory & practical**

The theory and practical syllabus is completed in four semesters. The department conducts the semester-wise programme in a cyclic fashion so that no matter at what point a student joins the programme,

he completes the course in two years. The semester-wise programme is as follows:

- I. (a) General & Cellular Physiology
  - (b) Hematology
  - (c) Renal Physiology & Fluid Balance
- II. (a) Cardio-vascular Physiology
  - (b) Respiration
  - (c) Environmental Physiology
- III. (a) Nerve & Muscle Physiology
  - (b) General, Sensory & Motor Physiology
  - (c) Special Senses
  - (d) Limbic System and Higher Nervous System
- IV. (a) Nutrition & Metabolism
  - (b) Gastro-intestinal System
  - (c) Endocrines & Reproduction

## Themes and topics

### ***Semester I***

#### *(a) General & Cellular Physiology*

- Cell as the living unit of the body
- The internal environment
- Homeostasis
- Control systems
- Organization of a cell
- Physical structure of a cell
- Transport across cell membranes
- Functional systems in the cells
- Genetic code, its expression, and regulation of gene expression
- Cell cycle and its regulation

#### *(b) Hematology*

- Erythrocytes
  - erythropoiesis
  - structure & function of RBCs
  - formation of hemoglobin
  - destruction & fate of RBCs
  - anemias
  - polycythemias

- Leucocytes
  - general characteristics
  - genesis & life span of WBCs
  - classification & functions of each type of WBC
  - leukopenia
  - leukemias
- Blood groups
  - classification
  - antigenicity
  - agglutination
  - blood typing
  - principles of transfusion medicine
- Hemostasis
  - components of hemostasis
  - mechanisms of coagulation
  - coagulation tests
  - anticoagulants
- Immunity
  - Innate immunity
  - Acquired immunity
  - Allergy, hypersensitivity and immunodeficiency
  - Psychoneuroimmunology

(c) *Renal Physiology & Fluid Balance*

- Body fluid compartments
- Water balance; regulation of fluid balance
- Urine formation
- Regulation of extracellular sodium & osmolarity
- Renal mechanisms for the control of blood volume, blood pressure & ionic composition
- Regulation of acid-base balance
- Micturition
- Diuretics
- Renal failure

**Semester II***(a) Cardio-vascular Physiology*

- Properties of cardiac muscle
- Cardiac cycle
- Heart as a pump
- Cardiac output
- Nutrition & metabolism of heart
- Specialized tissues of the heart
- Generation & conduction of cardiac impulse
- Control of excitation & conduction
- Electrocardiogram
- Arrhythmias
- Principles of Hemodynamics
- Neurohumoral regulation of cardiovascular function
- Microcirculation & lymphatic system
- Regional circulations
- Cardiac failure
- Circulatory shock

*(b) Respiration*

- Functional anatomy of respiratory system
- Pulmonary ventilation
- Alveolar ventilation
- Mechanics of respiration
- Pulmonary circulation
- Pleural fluid
- Lung edema
- Principles of gas exchange
- Oxygen & carbon-dioxide transport
- Regulation of respiration
- Hypoxia
- Oxygen therapy & toxicity
- Artificial respiration

*(c) Environmental Physiology*

- Physiology of hot environment
- Physiology of cold environment
- High altitude
- Aviation physiology
- Space physiology
- Deep sea diving & hyperbaric conditions

**Semester III***(a) Nerve & Muscle Physiology*

- Resting membrane potential
- Action potential
- Classification of nerve fibres
- Nerve conduction
- Degeneration and regeneration in nerves
- Functional anatomy of skeletal muscle
- Neuro-muscular transmission and blockers
- Excitation-contraction coupling
- Mechanisms of muscle contraction
- Smooth muscle

*(b) General, Sensory & Motor Physiology*

- General design of nervous system
- Interneuronal communication
- Classification of somatic senses
- Sensory receptors
- Sensory transduction
- Information processing
- Dorsal column & medial lemniscal system
- Thalamus
- Somatosensory cortex
- Somatosensory association areas
- Pain
- Organization of spinal cord for motor function
- Reflexes & reflex arc
- Brain stem & cortical control of motor function
- Cerebellum
- Basal ganglia
- Maintenance of posture and equilibrium
- Motor cortex

*(c) Special Senses*

- Optics of vision
- Receptors & neural functions of retina
- Colour vision
- Perimetry

- Visual pathways
- Cortical visual function
- Functions of external and middle ear
- Cochlea
- Semicircular canals
- Auditory pathways
- Cortical auditory function
- Deafness & hearing aids
- Primary taste sensations
- Taste buds
- Transduction & transmission of taste signals
- Perception of taste
- Peripheral olfactory mechanisms
- Olfactory pathways
- Olfactory perception

*(d) Limbic System and Higher Nervous System*

- Autonomic nervous system
- Limbic system and hypothalamus
- EEG
- Sleep
- Emotions & Behaviour
- Learning & Memory
- Yoga

## **Semester IV**

*(a) Nutrition & Metabolism*

- Carbohydrates
- Fats
- Proteins
- Minerals
- Vitamins
- Dietary fibre
- Recommended Dietary Allowances
- Balanced diet
- Diet for infants, children, pregnant & lactating mothers, and the elderly
- Energy metabolism
- Obesity & Starvation

*(b) Gastro-intestinal System*

- General principles of G-I function
- Mastication & swallowing
- Esophageal motility
- Salivary secretion
- Gastric mucosal barrier
- Pancreatic & biliary secretion
- Gastrointestinal motility
- Digestion & absorption
- Functions of Colon
- Pathophysiology of peptic ulcer and diarrheal disease
- Liver functions

*(c) Endocrines & Reproduction*

- Classification of Hormones
- Mechanism of Hormone action
- Measurement of hormones in Blood
- Endocrine functions of the hypothalamus
- Pituitary
- Thyroid
- Adrenals
- The endocrine pancreas
- Pathophysiology of diabetes
- Parathyroid, calcitonin, Vit D & calcium metabolism
- Pineal gland
- Testosterone & male sex hormones
- Spermatogenesis
- Hyper & hypogonadism
- Menstrual cycle
- Female sex hormones
- Pregnancy & Lactation
- Functions of Placenta
- Parturition
- Lactation



Apart from the above topics in general and systemic physiology, the students are introduced to:

1. Biophysics
2. Biochemistry
3. Biostatistics
4. Molecular Biology
5. Medical Education
6. History of Medicine

The above topics are covered through a mix of self-learning and structured program. The structured program consists of:

### **1. Seminars every Saturday**

The seminars are on a topic belonging to a system scheduled for the semester. The topic is presented in depth appropriate for postgraduates by one of the M.Sc or M.D. students and moderated by a faculty member.

The seminars represent only a small and somewhat arbitrary selection of topics. They are not intended to cover an entire system. Their aims are to:

- (a) introduce the system
- (b) tune the students to the system
- (c) cover recent advances
- (d) give students practice in the art of oral presentation

### **2. Journal clubs and Faculty presentations, every Tuesday**

The journal clubs are on an article belonging to a system scheduled for the semester. The article is presented by an M.Sc./M.D./Ph.D. student or senior demonstrator, and moderated by a faculty member. The aims of journal clubs are to:

- (a) highlight recent advances
- (b) discuss classical papers
- (c) inculcate the faculty of critical appreciation of a research article
- (d) give students and senior demonstrators practice in the art of oral presentation
- (e) Faculty presentations are usually on:
  - (f) medical education
  - (g) research methodology
  - (h) an area of research in which the faculty member is involved

### **3. Practicals**

About 8-10 practical exercises are conducted every semester exclusively for M.Sc. (and M.D.) students on systems scheduled for the semester. The results obtained in these exercises are presented in teaching meetings (see below).

Besides specially designed P.G. practicals, M.Sc. students perform all undergraduate practicals and also teach a few of these practicals to the undergraduates.

#### 4. Teaching meetings, every Saturday

Since M.Sc. students might opt for a teaching career, they are occasionally involved in teaching undergraduates. In the teaching meetings, the forthcoming practical exercises are discussed, and feedback on recently held exercises is obtained. These discussions are designed to tune the M.Sc. students to teaching and related administrative responsibilities. In addition, teaching meetings are also utilized for discussion of P.G. practicals, research protocols of new P.G. students, presentation of thesis work by P.G. students prior to submission of the thesis, and any other items of interest to the teaching and research staff of the department.

#### ASSESSMENT

In the first three semesters, an end-semester theory, practical and oral examination is conducted by the department on the systems scheduled for the semester, and a record of the internal assessment maintained. In the last (4<sup>th</sup>) semester, the students take the final M.Sc. examination conducted by the examination section.

#### SUMMARY

A summary of the M.Sc. (Physiology) program has been given in Fig. 1.

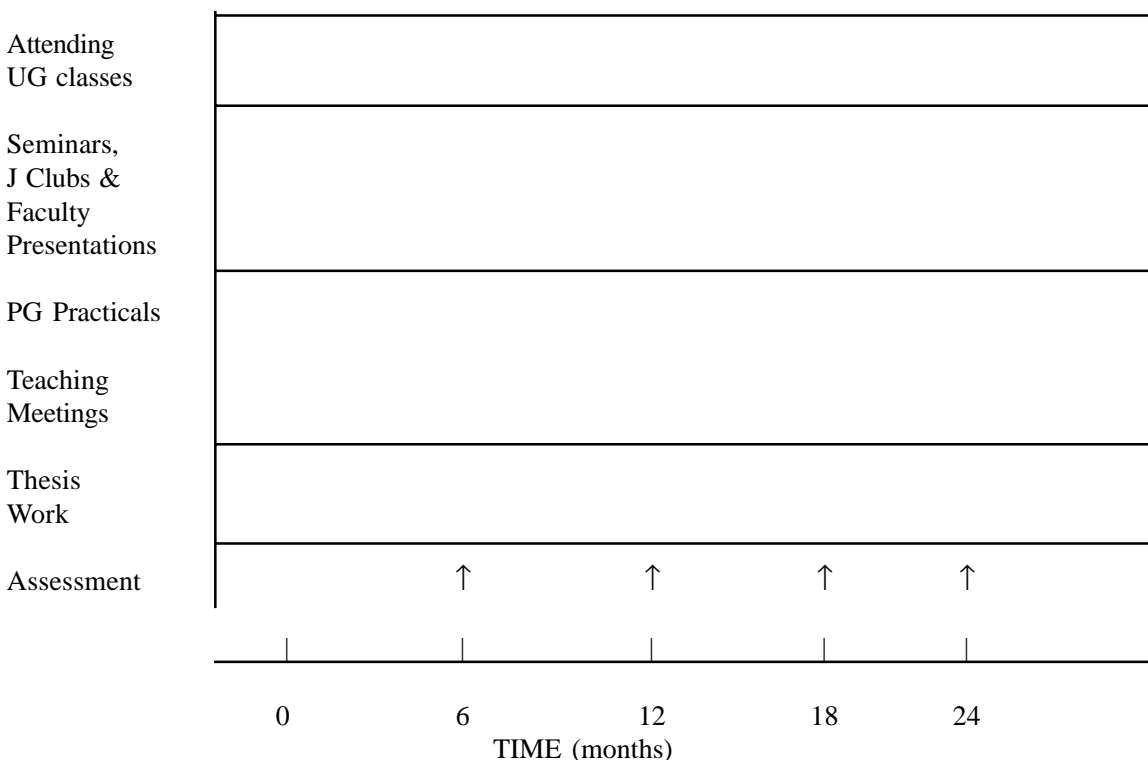


Fig.1. The M.Sc. (Physiology) program of AIIMS. Light arrows, internal (formative) assessment; dark arrow, final (summative) assessment.

# M BIOTECH (MASTER OF BIOTECHNOLOGY)

<b>Course No.</b>	<b>Subjects</b>
Course 1	Techniques: Instrumentation & Principles
Course 2	Cell Biology
Course 3	Biochemistry
Course 4	Immunology
Course 5	Molecular Biology
Course 6	Computers
Course 7	Structural Biology
Course 8	Dissertation
Course 9	Biostatistics
Course 10	Applied Biotechnology
Course 11	Seminar Series
(I)	Immunology Seminars
(II)	Mol. Biology, Recombinant DNA technology Seminars

## **COURSE – 1**

### **TECHNIQUES: INSTRUMENTATION AND PRINCIPLES**

#### **THEORY**

**Hours - 25**

Spectrophotometry and Colorimetry; Electrophoretic techniques: Proteins Carbohydrates and Electrophoretic techniques: Nucleic Acids; Adsorption chromatography partition chromatography & Affinity chromatography; Ion-exchange chromatography, Gel filtration chromatography and High performance (Pressure) Liquid chromatography; Radioisotope techniques – Nature of radioactivity, detection, measurements counters and safety aspects; Laser Confocal Microscopy and Digital Image Analysis; Centrifugation & Ultracentrifugation; Biosensors in Diagnostics; Animal Tissue Culture;

Decontamination, Sterilization and disinfection; Radioimmunoassay; Chemical synthesis of nucleic acids; Enzyme purification and assay techniques; Techniques in cytogenetics; DNA sequencing; PCR Human Genome Project; DNA microarray; Proteomics; Nanotechnology; Cell separation techniques; Immobilized enzymes

## **COURSE – 2**

### **CELL BIOLOGY**

#### **THEORY**

**Hours - 16**

Protein synthesis; Protein sorting, transport and secretion; Cell to cell communication: Hormones and receptors; Transport across membranes; Endocytosis and Protein trafficking-I; Cell Structure, Function and subcellular compartments; cells to molecules to atoms; the inter-disciplinary approach; Cell-interaction: growth factors, transformation and oncogenes; Energy oriented organelles; mitochondria, cytoplasmic matrix and cytoskeleton; Endocytosis & protein trafficking-II; Cell fusion, cellular dynamics, Movements of macromolecules, organelles and whole cells; Biophysical methods of study; Endocytosis & protein trafficking-III

#### **PRACTICALS**

**Hours - 30**

Sample preparation for TEM; Fixation dehydration infiltration embedding and block making; Preparation of glass knife, Block-trimming and ultramicrotomy; Preparation of coated grids, negative staining and viewing; Staining of ultrathin sections and TEM viewing; Sample preparation for SEM; Critical point drying of SEM samples; Sputter coating of SEM samples; SEM viewing; Immunoelectron Microscopy

## **COURSE – 3**

### **BIOCHEMISTRY**

#### **THEORY**

**Hours - 24**

Thermodynamics: concept of free energy, entropy, High energy Molecules and their significance; Structure and function of Biomembranes; Liposomes and their applications; Chemistry, biosynthesis and catabolism of purines; Chemistry, biosynthesis and catabolism of pyrimidines; Transport mechanisms; Cytoskeleton-structure and function; Kinetics of reactions and factors that determine that rate of reactions; Protein structure & function; Factors determining that rate of enzyme catalyzed reactions; Inhibitors and activators of enzyme catalyzed reactions; Enzyme Kinetics; Methods of regulation of enzyme activity; Regulation of carbohydrate metabolism; Regulation of Lipid Metabolism; Regulation of Amino acid metabolism and inborn errors of metabolism; Metabolic Interrelationship; Inborn errors of metabolism clinical disorders associated with purine and pyrimidine metabolism; Environmental pollution

## **COURSE 4**

### **IMMUNOLOGY**

#### **THEORY**

**Hours - 60**

Innate immunity, cell, CD nomenclature; Experimental Systems used in the Immunology; Acquired immunity, T-cells, B-cells; Immunoglobulins, class, sub-class and structure; Super Antigens and T-Cell

Activation; Antibody combining sites, conformational changes; H.L.A. Part I; Immunoglobulin superfamily, affinity, avidity; Complement Part I; Antigenicity, Antigenicity & Immunogenicity; Complement Part II; Antigen Processing & Presentation; Cell-cell interaction, adhesion molecules; Antigen Processing & Presentation (Contd.); B-cell activation and differentiation – generation of humoral response; Antibody mediated Effector mechanisms; Cell mediated Effector mechanism; Immunization strategies; Cytokines, characteristics and function; Monoclonal antibody production; Antibody screening Assays; Cytokine classes and their biological activities; Characterization of monoclonal antibodies; Human Monoclonal Antibodies; Cytokine Receptor and Network; T-cell Hybridomas; Chemokines and chemokine receptor; Cytokine assays-I; Immunoglobulin gene organization; Immunoglobulin gene rearrangement and expression; T-cell receptors: molecular structure & gene organization of CD2, CD3, CD4 & CD8; MHC gene organization; New generation antibodies; MHC gene expression and regulation; Immunoregulation and Apoptosis; Flowcytometry: Principle & Instrumentation; Applications of Flowcytometry; Cell migration and Homing; Mucosal Immunity; Tumour Immunity; Immunity to Bacteria; Immunity to viruses; Transplantation Immunity; Immunity to Parasites; Autoimmunity; Strategies of vaccine development

## **PRACTICALS**

**Hours - 120**

Hybridoma Technology; Antibody Purification & Conjugation; Immunofluorescence and Flowcytometry; CMI; Gel Techniques; ELISA; SDS PAGE/Western blot

## **COURSE 5**

### **MOLECULAR BIOLOGY**

#### **THEORY**

**Hours - 30**

mRNA structure and relation to function; Mechanisms of DNA replication; tRNA structure and relation to function; DNA Repair; Ribosomes and rRNA; Prokaryotic transcription-initiation mechanisms and sigma factors; Mutations and mutants; Prokaryotic Regulation of gene expression in prokaryotes-I transcription-elongation and termination mechanisms; Transcription initiation in Eukaryotes-protein coding genes; Regulation of gene expression in prokaryotes-II; Protein biosynthesis, genetic code; Eukaryotic transcription of tRNA and rRNA genes; Post transcriptional processing of rRNA; Post transcriptional processing of tRNA; Components of Translation; Post transcriptional processing of nuclear RNA; Mechanism of translation

### **RECOMBINANT DNA TECHNOLOGY**

#### **THEORY**

**Hours - 30**

Eukaryotic vectors- C3 1 lifecycle and gene regulation; Post-translational modifications; Comparison of transcription in Prokaryotes, Eukaryotes and Archaea; Introduction of recombinant DNA technology; Attenuation and Antitermination mechanisms in Bacteria; Enzymes used in recombinant technology I; Bacterial plasmids; Bacteriophage lambda-I structure & assay; Plasmids: replication and copy number control; Bacteriophage lambda-II life cycle and gene regulation; Plasmid and Cosmid vectors; Restriction modification systems in Bacteria; F factor and conjugation; Transformation; Viruses-I; Generalized and Specialized transduction; Bacteriophage lambda vectors; M-13 based vector; Transposable elements; Yeast Vectors; *E.coli* expression systems; Cloning Strategies I; Viruses-II; Cloning Strategies II; Strategies for Screening DNA libraries; Analysis of Recombinants Part I; Viruses III; Gene Therapy Pt. II; Analysis

of Recombinants Part II; Molecular genetics in clinical practice; Genetic Counselling

## **PRACTICALS**

**Hours - 120**

1.a. Preparation of buffers, reagents and media etc.; b. Laboratory equipment handling and safety guidelines, Radiation safety guidelines; 2.a. Isolation and characterization of genomic DNA for E.Coli; b. Unit determination of restriction enzyme activity; 3.a. Cutting of DNA and clean up of DNA for ligation; b. Setting up ligation; c. Preparation of culture media, pouring Plates and streaking of E.Coli; d. Evaluation of transformants and preparation of glycerol stocks; e. Demonstration of electroporation; 4.a. Preparation of radiolabelled DNA probe (random primer labeling); b. Hybridization, washing & autoradiography (Cleaning and monitoring work bench for radioactive spill); 5. Induction of Lac operon; 6. Demonstration of PCR; a. Setting up PCR reaction; b. Analysis of amplified product; 7.a. Minipreparation & digestion of plasmid DNA; b. Southern transfer of plasmid DNA digest & baking of membrane; 8.a. Phage unification, titration and preparation of stocks; b. Isolation of phage DNA; 9. Demonstration of DNA sequencing; a. Setting up sequencing reactions; b. Casting sequencing gel; c. Gel electrophoresis & autoradiography. d. Reading sequencing from X-ray film

## **COURSE 6**

### **COMPUTERS**

#### **THEORY**

**Hours - 24**

Introduction to Computers Science; Introduction to Data-Base; Introduction to Windows; Windows Application (Word, Excel, PowerPoint and Multimedia); Introduction to INTERNET & use of Electronic Mail; Introduction to Medical Informatics & use of Statistical Package; Introduction to UNIX & C; Computer Aided Teaching & testing

#### **PRACTICALS**

**Hours - 30**

Medline, Medlar Search; Usage of statistics for data analysis; Creation of DataBase; Slide Presentation; Computer Aided Learning

## **COURSE 7**

### **STRUCTURAL BIOLOGY**

#### **THEORY**

**Hours - 24**

Introduction to DNA-Structure of Historic and current view; Polymorphism of DNA; Basic principles of NMR-Vector description; Structural feature of protein; Structural features of protein-DNA and drug-DNA complexes; Pulse Fourier NMR & relaxation Phenomena; Peptide bonds, non covalent forces in proteins; Chemical shift and coupling constraints; Chemistry of building blocks, various structural organization in proteins; Introduction to protein structure: Principle of folding; Hydrophilicity, hydrophobicity & amphipathicity in proteins; Building blocks: amino acids-L and D configurations; Peptide bonds, conformation and dihedral angles; Secondary structures of proteins: b pleated sheets and helical structures; b-turns/hairpin loops/-blends and other non repetitive structures; Tertiary structure with one example of a globular protein; Basic principles of 2D NMR; Applications of NMR in the study of Biomolecules; UV-VIS Absorption Spectroscopy; NMR imaging and invivo NMR spectromicroscopy

**PRACTICALS****Hours - 16**

Simulation of A, B and Z forms of DNA using packages; Simulation of a helix,  $\beta$  sheet and turn conformation of protein; Molecular dynamics simulation of a peptide fragment with known structures using AMBER; Homology-based modeling of proteins; Simulation of A, B and Z forms of DNA; Applications of NMR in the study of Biomolecules; Fluorescence Spectroscopy;

## COURSE 8

### DISSERTATION

**DURATION : One Year**

#### Topics of the thesis submitted by M.Biotech students under various guides for the batch (2000-2002)

1. Evaluation of the utility of the *Mycobacterium smegmatis* Dormancy model in the assessment of the *M.tuberculosis devR* Gene activity.
2. Studies on DevS Protein and devS gene of *Mycobacterium tuberculosis*.
3. Study of Innate immune response elicited by Natural Killer cells in tuberculosis.
4. Study of histone like protein in mycobacteria.
5. Production and characterization of monoclonal antibodies against *Plasmodium vivax* recombinant antigen PvHSP28.
6. Detection of chloroquine resistance in *Plasmodium falciparum* isolates by cg10 gene based mutation – specific polymerase chain reaction.
7. Study of cytokine protein expression in oral cancer patients.
8. The role of in-vitro nuclear magnetic resonance spectroscopy (NMR) in the study of breast cancer.
9. A pilot study for detection of CMV DNA from saliva of neonates by polymerase chain reaction.
10. Genetic Polymorphisms of drug metabolizing enzymes CYP2D6 and GST M1 in epileptic patients undergoing therapy showing idiosyncratic and adverse drug reactions.
11. Immunolocalization of transcription factors (c-Fos & c-Jun) during development of auditory brain stem nuclei in domestic chick by immunoelectronmicroscopy.

## Course 9

### Biostatistics

**THEORY****Hours - 25**

Definition of selected terms Scale of measurements Related to statistics; Methods of collecting data; Presentation of data statistical Tables; Need for reduction of data measures of averages and location; Measures of dispersion Range quartile deviation mean deviation & relative deviation; Concepts of statistical population and sample need for sampling studies; Simple procedures of random sampling; Methods of sampling; Probability : Basic concepts; Basic theorems of probability addition and multiplication theorems; Conditional probability of Bayes Theorems; Probability distribution definition & applications; Binomial distribution and its application; Poisson distribution and its application; Normal distribution and its

application; Logic of statistical standard error estimation testing of hypothesis; Tests of significance : Normal deviate tests (Ztest); Student's "t" test; Chi-Squared test; F. test and analysis of variance; Correlation concept and applications; Regression concept and application; Statistics in Genetics-; Statistics in Genetics – II

### **PRACTICALS**

**Hours - 25**

Dia-grams and graphs; Measures of averages and location; Measures of dispersion; Probability; Binominal distribution; Poisson distribution; Normal distribution; Normal deviates and students "T" test; Chi-Squared test; Analysis of variance; Correlation analysis; Regression analysis

## **COURSE 10**

### **APPLIED BIOTECHNOLOGY**

#### **SEMINAR TOPICS**

**Hours - 42**

1. Concept to Industry (Biotechnology Industry)
2. Intellectual Property Rights (Biotechnology Industry)
3. Challenging problem in Biology in the new Millenium (Bioinformatics)
4. Molecular technologies for diagnosis of genetic disorders (Clinical Disease)
5. Molecular genetics in clinical practice (Clinical Diagnosis)
6. New generation viral vectors for Gene Therapy (Clinical Therapy)
7. In vivo targeted gene delivery (Clinical Therapy)
8. Ribozymes for therapeutic use in viral infection (Clinical Therapy)
9. Biology of Nitric oxide implications in diagnosis and therapeutics (Therapy)
10. Characterization of a retrotransposable element in *Entamoeba histolytica* (Mol. Biology)
11. Designing of endothelin receptor antagonists (Mol. Biology)
12. Immuno-Gene therapy in cancer (Immunology)
13. Oncoviruses and Immunity in cervical cancer (Immunology)
14. Applications of immuno flowcytometry in cell death processes (Immunology)
15. Lymphocyte homeostasis (Immunology)
16. Molecular charaterisation of immunodominant allergens and antigens of *Aspergillus fumigatus*, an opportunistic fungal pathogen Diagnostic application (Immunology)
17. Molecular mechanism in fungal allergies (Immunology)
18. Viral induced modulation of host immune response (Immunology)
19. Immunological memory (Immunology)
20. Human leukocyte antigen (HLA) Polymorphism in health and disease (Immunology)
21. Induction and maturation of B cells (Immunology)
22. Homing & cytokine polarization in T cells of pulmonary TB patients (Immunology)
23. Phage Display for Antibody Generation-I (Immunology)



24. Phage Display for Antibody Generation-II (Immunology)
25. Molecular mechanism in mammalian fertilization (Cell Biology)
26. Ligand-Receptor Interaction (Cell Biology)
27. Molecular aspects of apoptosis (Cell Biology)
28. Erythrocyte invasion and cyto adherence by Malaria parasite (Cell Biology)
29. How are safe limits for radiation determined? (Radiation)
30. Radiation-carcinogenesis (Radiation)

**COURSE 11**  
**SEMINAR SERIES**  
***I : IMMUNOLOGY***

**SEMINAR TOPICS**

**Hours - 15**

Autoimmunity through infection/immunization; B7 superfamily of Co-stimulating molecules; Role of Toll receptors in innate immunity; Chemokine regulation of immune response; Functional regulation of lymphocytes by apoptosis; Dendritic cell regulation of Th1 - Th2 development; Genomic views of the Immune System; NK Cell Receptor Complexes & Signalling pathways; Immunological Basis of Celiac Disease; Lymphocyte Migration, Homing & Trafficking; Granulysin mediated anti-microbial activity of T cells.

***II : MOLECULAR BIOLOGY, RECOMBINANT DNA TECHNOLOGY***

**SEMINAR TOPICS**

**Hours - 15**

Malaria Genome Project; Interaction transcriptomes in the study of host pathogen interaction RNA as enzymes; Molecular basis of Cystic Fibrosis; Cancer genomics and cell cycle; DNA microarrays : Analysing genome wide expression; Single nucleotide polymorphism and future of molecular medicine; Eukaryotic transcription factors: DNA binding domains; Protein translocation; TB & Leprosy genomes; Salient features of human genome.

# **PERFUSION TECHNOLOGY — M Sc (Cardiothoracic & Vascular Surgery)**

The department of Cardiothoracic and Vascular surgery has a multifaceted programme including the Coronary Artery Bypass Surgery, Valvular heart surgery, Paediatric Cardiac surgery, cardiac Transplant programme and the aortic and peripheral vascular surgery. To support these programmes we need the services of allied specialities. Perfusionist has an important role to play and in that direction there has been a long felt need to train - up personnel in this area. The department intend to start a M. Sc. course in the perfusion Technology. The Cardio Thoracic and Vascular Surgery is a rapidly expanding speciality and the need for well trained perfusion is real.

## **M. SC. PERFUSION TECHNOLOGY**

Duration of Course	:	2 Academic Years
Basic Qualification	:	B.Sc. with Biology or B.Sc. in Perfusion Technology
Number of Candidates	:	4 students every year
Research Projects	:	Every candidate would be asked to submit the project (dissertation) on a selected research topic 6 months before final examination.

Course would consist of theory and practise of perfusion.

### **Aims & objective of course**

Impart comprehensive training of the candidate in various aspects of perfusion to enable him to function as an independent perfusionist.

### **Method of selection**

To be done on the basis of theory and viva voce assessment. Selection to be based on merit only.

## **CURRICULUM**

### **Theory**

*Anatomy :*

Heart

Blood Vessels

Lungs

Kidneys

Liver

Nervous system (Central & Autonomous)

Endocrine system

### **Physiology**

Blood, its elements & clotting system

Body volume, oncotic pressure

Circulation : Physics, factors controlling, blood supply of vital organs.

Cardiac cycle

Physics of gas diffusion

Kidney function & electrolyte balance

Acid base balance

Autonomic nervous system

Endocrine system : Catecholamines, Adrenocortical Hormone.

Hypothermia & Oxygen consumption

Liver function & renal function tests

### **Pathology**

Ischemic, congenital & valvular heart disease

Atherosclerosis, Arteritis, Aneurysm of Aorta

Tumours of heart

Cardiogenic shock

Infective endocarditis

Pulmonary hypertension

Emphysema

Pulmonary embolism

Anemias

Clotting disorders

Renal failure & acute tubular necrosis

Liver cell failure

### **Pharmacology :**

Inotropes & vasopressors

Vasodilators & hypotensive agents

Treatment of hypertension

Plasma expanders

Anti arrhythmic agents

Anesthetic agent & muscle relaxants

Anticoagulants

Drugs affecting coagulation

Thrombolytics

Steroids

Buffers

Diuretics

Insulins

Antibiotics

### **Bacteriology & Sterilization :**

Bacteriology of common gram +ve & gram -ve bacteria

### **Perfusion Technology :**

Calculation of BSA, circulating PCV, SVR

Priming solutions

Oxygenators

Tubings, reservoirs, heat exchanger, cannulae, circuits  
pumps

Cooling & rewarming on bypass

Body response to CPB & pathophysiology of CPB

Conduct of CPB

Myocardial preservation & cardioplegia

Safety devices

Complications during CPB & management

Pediatric perfusion

Preventive maintenance & sterilization

Assist devices

Blood conservation & perfusion

Organ preservation, ECMO

### **Simulation :**

Handlong of sterile components

Priming techniques

Assembly of circuit

Leakage detection

Air bubble removal

Roller pump calibration

Wet runs

Monitoring parameters

Sampling and data recording

Drug management

Equipment maintenance

Coordination with Surgeon and Anaesthetist

# NUCLEAR MEDICINE TECHNOLOGY — M Sc

Nuclear Medicine is an established clinical specialty with wide ranging diagnostic and therapeutic techniques. This is a specialized branch of medicine, and is multidisciplinary in nature. It requires skills of a trained manpower of which technologist is significantly important person. There is gross deficiency of trained technologist in our country. They are trained in the department without any formal teaching or curriculum. They lack in the basic knowledge of the specialty, radiation safety, radiopharmacy, instrumentation and clinical applications.

## Courses available in our country

Only 2 centers have organized courses for the technologists in our country, one is at Radiation Medicine Center (RMC) BARC leading to DMRIT and another is at Kidwai Memorial Hospital Bangalore. Number of student's undertakings this course is 6-8 per year and all are gainfully employed in local hospitals or various Nuclear Medicine departments. There are more than 100 Nuclear Medicine centers in the country, and need approximately 400-500 trained technologists at any given time. In view of such gross deficiency we proposed to start 2 years teaching and training course at AIIMS, leading to the degree of Msc (Nuclear Medicine Technology).

**Definition:** Nuclear medicine can be defined as embracing all applications of radioactive materials in the diagnosis and treatment of various diseases, in medical research and in the study of body function both in healthy and diseased state, with the exception of the uses of sealed radiation sources in radiotherapy (W.H.O. Technical report Series 492,1972)

**Duration** of the course leading to Msc (Nuclear Medicine Technology) 2 academic years.

**Minimum qualification** for admission to this course will be B.Sc. from a recognized university with physics, chemistry and biology as core subjects.

**Admission to Msc** course will follow the rules and regulations, which are currently in force at the AIIMS for admission to postgraduate course in specialties like Bio-technology, Lab medicine, Microbiology, Biochemistry etc and shall be applicable for admission to MSc course in Nuclear Medicine.

## Institutional Objectives

To develop patterns of teaching and training of postgraduate technologists in the specialty of Nuclear Medicine so as to demonstrate high standards of professional skills, competence/leadership qualities

arising out of such teaching and training to all the Nuclear Medicine facilities in India.

## Departmental Objectives

The postgraduate training program is aimed at producing skilled technologist in Nuclear Medicine with the following accomplishments. Upon referral of a patient for a given investigation the Nuclear Medicine technologist should be able to:

1. Obtain pertinent information from the patient and other sources as advised by the Nuclear Medicine consultant.
2. Select and carry out appropriate procedures as advised to him in a manner that is safe to both patient and staff.
3. To prepare appropriate radio-pharmaceutical in the desired dose for the particular investigation and age of the patient
4. Perform daily, weekly and monthly all the quality control procedures of the equipment..
5. Keep the record of all quality control procedure in the manner as described by various regulatory agencies.
6. To assist the consultant in-charge for maintenance of the equipment.
7. If Nuclear Medicine therapy is indicated assume full responsibility for dispensing the dose, administering the dose to the patient and monitoring.
8. Fulfilling of the Institutional objective of bringing together in one place educational facilities of the highest order for the training of personal in all important branches of health activity, and
9. Attaining self-sufficiency in postgraduate para-medical education
10. Enabling him to plan, implement and evaluate teaching program.
11. Understand the working of electronic instruments, such as pulse amplifiers, pulse height analyzers, scalars, and count rate meters. Single and dual head gamma cameras.
12. Image production and display technology including photographic principles, with special emphasis on sensitivity, resolution, contrast, latitude, and film processing.
13. Principles of quality assurance.
14. Principles and application of other imaging modalities as a correlate to Nuclear Medicine procedures.

## Following is core contents of the syllabus

### I. BASIC SCIENCES

1. Introduction to Basic Physics :
2. Mechanism of Radioactive Decay
3. Beta & Gamma emission, electron capture
4. Decay schemes and energy level diagrams
5. The laws of Radioactive Decay
6. Physical, biological and effective half lives
7. Units of activity, the Becquerel,, Curie

8. Properties of Radiation
9. Relevance in Nuclear Medicine
10. Properties of beta and gamma radiation
11. Interactions of beta and gamma radiation with matter
12. Compton scattering.
13. Radionuclide hazards.
14. Internal exposure – contamination control
15. External exposure – shielding, distance, time
16. Safe handling of radioactive sources
17. Basis of computers and logic involved
18. Filters and its use in the image processing
19. 3 D construction
20. Fusion imaging principal of DICOM, image transfer PACK technology.

## **II. INSTRUMENTATION**

1. Gamma camera. both single and dual head
2. Positron Emission Tomography scanner (both simple and Hybrid)
3. Medical Cyclotron
4. Basis of automated Radiopharmacy modules
5. Basic Quality Control Instrument uniformity, resolution
6. Daily, weekly and monthly quality control procedures for all the instruments
7. NEMA classification
8. Record keeping of quality assurance procedures.
9. Film processing
10. Film characteristics, processor QC
11. Dose calibrators – theory of operation and QC
12. Probe systems – basic components,
13. System set up and calibration.
14. Basic counting experiments
15. Single and dual SPECT Systems
16. Highlight main features and use of operational manual
17. Photo peak, energy window width
18. Collimator, distance, count-rate
19. Total counts, exposure
20. Radio-immunoassay– Theory of operation of well type counter, multi channel counter
21. Beta counter principals and operation



22. Personal computers principals and application software for Word; Data base; and Excel; Power point etc

### **III. MATHEMATICS, STATISTICS, AND COMPUTER SCIENCES**

1. Basic concepts of mathematics.
2. Probability distributions and parametric and monoparametric statistics.
3. Statistics of counting random events.
4. The mathematics of medical decision making and comparative effectiveness of tests and therapeutic procedures.
5. Basic aspects of computer structure, function, and programming.
6. Computer applications with emphasis on digital image acquisition, analysis processing and enhancement, tomographic reconstruction, display, and recordings of findings.
7. Mathematical models of physiologic systems.

### **IV. RADIATION BIOLOGY AND PROTECTION:**

1. The biological effects of radiation exposure, with emphasis on the effects of low level exposure.
2. Administrative and technical means of reducing unnecessary radiation exposure to patients, personal, and environment. Planning a laboratory in ward which will utilize radioisotope.
3. Methods of reducing patient ,technicians, General public dose
4. Immunology, molecular biology, and genetics.
5. Calculation of the radiation dose from internally administered radionuclides.
6. The diagnosis, evaluation, and treatment of radiation over-exposure in any form.
7. Governmental/BARC regulations regarding limits of radiation exposure, handling of radioactive patients, and disposal of radioactive wastes.

### **V. RADIOPHARMACEUTICALS**

#### **Radiopharmaceutical Principles**

This syllabus explores the chemical, physical and biological properties of radiopharmaceutical used in Nuclear Medicine.

1. Production of radionuclide by reactors, cyclotrons, other particle accelerators, and the use of radionuclide generators.
2. Formulation of radiopharmaceuticals considering chemical properties and quality control.
3. Physiology and pharmo-kinetics of commonly used radiopharmaceutical
4. Radionuclide and pharmaceutical requirements for clinical imaging
5. Parent – daughter relationship of radionuclide generator systems(Tc99m/Mo99, including solvent extraction
6. Mechanism of localization of various radiopharmaceutical.
7. Chemistry of Technetium

8. Radionuclide used in therapy.
9. Positron emission radiopharmaceutical.
10. Good manufacturing practice (GMP) ISO and ISI Standards in relation to radiopharmaceutical.
11. Various receptor imaging legends and labeling of molecules.

## **VI. QUALITY CONTROL**

1. Generator system, chromatography
2. Adverse reactions, drug intervention
3. Preparation of various radiopharmaceutical and quality control procedures.
4. TLC scanner and its applications
5. Radio- active HPLC
6. Quality assurance of PET pharmaceuticals

## **VII LABORATORY TECHNIQUES**

1. Dose calibration,
2. Aseptic
3. Radioactive syringe handling.
4. Principals of RIA, standard curve, data analysis
5. Methods of receptor assays , hormones, Drugs. etc
6. GFR, Red Cell Mass and survival, using Cr.

## **VIII. RADIATION SAFETY**

1. Radiation measurement – monitoring
2. Personal monitoring: TLD's film
3. Contamination monitoring:
4. Survey instruments, wipe tests
5. Safe Handling – Patients
6. Scanning and Nursing procedures
7. Activity in body fluids – urine, blood, breast, milk, etc.
8. Accidents and emergencies
9. Spills & Personnel contamination
10. Medical emergencies, including death of patient
11. Loss of radioactive sources.

## **IX. INTRODUCTION TO COMPUTERS**

1. Highlight and main features
2. Introduction to computers
3. System hardware and System software

4. Data acquisition
5. Static, dynamic
6. Data display
7. Matrix, size, threshold, grayscale, color

## **X. CLINICAL APPLICATIONS**

### **ENDOCRINOLOGY**

1. Structure and physiology of thyroid, mechanism of isotope uptake, quantitative measurements of uptake and imaging procedures.
2. Clinical topics : hyperthyroidism and cancer
3. Thyroid uptake I-131 and Tc-99m use of probe system
4. I-131 Therapy (low dose) for thyrotoxicosis
5. Thyroid imaging

Patient preparation, positioning, anatomical markers, collimation and rectifying artifacts use of rectilinear scanner & camera

### **GASTROINTESTINAL AND HEPATOBILIARY**

1. Structure and Physiology of the liver, its function and perfusion.
2. Tin Colloid, IDA Compound characteristics, mechanism of uptake
3. Gall bladder, bile ducts, bile formation and secretion.
4. Esophageal and gastro- intestinal system. Anatomy and physiology
5. Anatomical markers, views, artifacts.
6. Spleen Views for size, shape, location
7. GI Bleeding
8. Esophageal and Gastrointestinal revision Gastrointestinal Bleed, Meckles Diverticulum. Esophageal Reflux ,how and when to image, transit times and determining reflux
9. Esophageal and gastrointestinal transitory system.
10. Haemangiomas use of blood pool study.
11. Biliary when and how long to image and intervention. esophageal transit
12. Hepatobillary function

### **RESPIRATORY SYSTEM**

13. Pulmonary embolism,
14. Interrelation between alveoli and lung capillaries, ventilation and perfusion.
15. Importance of mismatching / matching in interpretation of V/P defect.
16. Segmental configuration, postural effects on pulmonary perfusion and ventilation.
17. COAD assessment

18. Mechanism of the nebulizer including BARC nebulizer system
19. Alternative ventilation imaging methods.
20. Effects of varying collimation,
21. Patients preparation, positioning, imaging
22. Perfusion MAA preparation and QC
23. Ventilation DTPA & Colloid for aerosols
24. Safety precautions with aerosols units and contamination

### **SKELETAL**

25. Bone structure, osteogenesis, tumors and infections reference to stress fractures etc.
26. Patient preparation
27. 3 phase imaging
28. Whole body imaging and spot views
29. Bone SPECT
30. I-131 whole body imaging
31. Collimators including the use of the pinhole, patient positioning and special views.
32. MDP – preparation and characteristics

### **CEREBRAL**

1. Brain Blood Flow: Arterial/Venous cerebral blood flow
2. Blood/brain barrier.
3. Head positioning and images.
4. ROI and curve processing
5. Basic image processing
6. Brain SPECT both icitel and non-ictel
7. FAN Beam Collimator

### **RENAL**

33. Structure of kidneys,
34. Renal perfusion, glomerular filtration, tubular function, absorption and secretion.
35. Pathological condition, obstructive uro-pathy, reflux, renal failure, renal transplantation. Space occupying lesions and infection.
36. Dynamic and static differential kidney function
37. Influence of lasix (diuretics)
38. Renal differential analysis
39. GFR Estimation

**CARDIOVASCULAR SYSTEM**

40. Myocardium and cardiac chambers.
41. The heart as a pump. Coronary circulation.
42. Cardiac output. Ejection Fraction and wall movement.
43. The ECG – its value and emphasis on nuclear medicine procedures.
44. Coronary disease and impaired cardiac function.
45. Myocardial perfusion: Interrelationship of blood pool, flow and function.
46. First Pass & Gated Blood Pool acquisition and analysis.
47. Computer acquisition and processing.
48. Infarct imaging (hot spot imaging).PYP – characteristics and Indications
49. In-vivo & In-vitro red cell labeling.
50. Myocardial perfusion imaging using Tl <sup>201</sup> and Tc <sup>99m</sup>-MIBI planar & circumferential analysis
51. Gated SPECT

**XI. POSITRON EMISSION TOMOGRAPHY**

52. Introduction
53. Positron Emission radio-isotopes
54. Cyclotron and basic concepts of isotope production.
55. Clinical Application in oncology, cardiology and neurology.
56. Quality Control procedures.
57. Hard Copy and development of films

**XII. ORGANIZATIONAL CONSIDERATIONS**

58. Design of laboratories or various sizes & capacity as per the norms of BARC.
59. Planning & scheduling of the patient work load.
60. Economic aspects of nuclear medicine and cost-effectiveness of nuclear medicine procedures.
61. Public relations.
62. Role of National and International Organizations like AERB, MCI, NMC, BRIT, BARC, IAEA ICRP
63. Regular participation in weekly journal club, Seminar and other periodical CME programs.

**XIII. LOG BOOK**

Each candidate should be required to maintain a log book in which following details will be entered :

64. Investigations performed by him.
65. Presentation in journal clubs along with Title & Journal & issue with title.
66. Presentation in departmental seminars.
67. Conferences attended – National/International.
68. Cases worked up for radionuclide therapy.

#### **XIV. MID TERM EVALUATION**

Each candidate shall have a midterm evaluation in terms of :

1. Presentation of work completed in Thesis.
2. Evaluation of the Log book.

#### **XV. PRE EXAMINATION EVALUATION**

Examination appearing students shall be evaluated by the faculty & observer for following :

#### **XVI. TRAINING PROGRAMME**

1. Didactic lectures in physics related in Nuclear Medicine, radiopharmacy, radioisotope techniques, instrumentation data processing and quality control.
2. Participation in the daily routine work of the department including work rounds of patients admitted for radionuclide therapy.
3. Active participation in the combined clinical meetings with other departments for case discussions.
4. Participation in Distance learning program.

#### **XVII. SUGGESTED BOOKS AND JOURNALS**

<b>Name of Book</b>	<b>Editor's Name</b>
Principles of Nuclear Medicine	Henry N. Wagner (Jr.)
Cerebral Radionuclide Angiography.	Deland F.H
Cardiovascular Nuclear Medicine	Strauss H. William
Fundamentals of Nuclear Pharmacy.	Gopal Shah
Quality Control in Nuclear Medicine Radiopharmaceutical Instrumentation & In-vitro Assays.	Rhodes Buek
Intervention Nuclear Medicine	Richard P. Spencer
Mosby's Manual of Nuclear Medicine Procedures	D. Bruce Sodes
Radiopharmaceuticals	Paul J early
Nuclear Medicine in Vitro	Subramaniam G.et. al.
Nuclear Medicine in Clinical Diagnosis and Treatment (2 <sup>nd</sup> Edition)	B. Rothfield I.P.C. Murray P.J. EII Churchill Livingstone.

Nuclear Medicine-The Requisites (2 <sup>nd</sup> Edition)	James H Thrall
An Atlas of Clinical Nuclear Medicine (2 <sup>nd</sup> Edition)	Harvey A Ziessman I.Fogelman M.N. Maisey S.E.M. Clarke
Nuclear Medicine	Robert E. Henkin Mark A. Boles
Nuclear Oncology-Diagnosis & Therapy	Iraj Khalkhali
Medical Imaging Physics	William R.Hendee Russell Ritenour
Clinical SPECT Imaging	Elissa Lipcon Kramer Joseph J. Sanger
Nuclear Cardiac Imaging Principles & Applications	A.S. Iskandrian Mario S. Verani

## **JOURNALS**

1. Indian Journal of Nuclear Medicine.
2. European Journal of nuclear medicine.
3. Annals of nuclear medicine
4. Clinical nuclear medicine
5. Seminar in Nuclear Medicine.
6. International journal of radiation application instrumentation, part B; Nuclear Medicine and Biology.
7. Journal of nuclear medicine.
8. Nuclear Medicine Communication
9. Medical Physics.
10. Journal of Nuclear Medicine Technology

# UROLOGY TECHNOLOGY — M Sc

## 1. Purpose and necessary background:

The course has been planned to upgrade the standard for the hospital urology technicians. The students, who have passed B.Sc with Science (Biology compulsory) shall receive training. At present, no other university/ hospital in our country have got this course. In our hospital, most staff members have joined as nursing orderlies or OTAs without any preliminary training in operating urology equipments. Though in course of time they are able to perform the technical work, their technical knowledge is almost negligible. The proposed training in this field will enable a student to learn systematically the theoretical and practical aspects of the operating room techniques and enable them to become trained technicians in this field. It has become essential as highly oriented equipments of different types are commonly used in the modern operation theatres and as diagnostic tools.

## 2. Objectives of the Course:

At the end of this training programme, students should acquire theoretical knowledge and skills related to the technical aspects of the functioning and maintenance of equipments used in the specialty of urology. They should be able to provide better assistance for conducting various procedures in the operation theatres and the clinics.

### Details of the objective

- To achieve greater understanding of basic anatomy, physiology, pathology and microbiology as applied to urology
- To achieve understanding of basic principles of surgery and surgical assistance
- To achieve understanding of basic urology and steps of various urological procedures, endoscopic, open, laparoscopic, microsurgery, ultrasound, ESWL and urodynamics
- To achieve competence at assisting in all urological procedures
- To achieve competence in cleaning, maintaining, and operating all technical and optical urological equipments including c-arm, ultrasound, diathermy, lasers, endoscopes, cameras, lithotrites, etc.
- To achieve competence in sterilization and disinfection of all urological equipment
- To achieve good understanding of the physics and electronics aspects of all urologic equipment



- To achieve competence in on-site trouble shooting of minor technical snags and problems

### **Instructional Objectives**

- The instructional objectives shall be as under:

### **THEORY**

- (a) To impart knowledge regarding basic human biology to enable the student to understand the relation between structure, function and disease and basis of remedial measures.
- (b) To impart knowledge regarding basic medical sciences relevant to surgery and urology such as anatomy, physiology, pharmacology, physics, microbiology etc.
- (c) To impart knowledge of Physics & electronics related to urological and sterilization equipments.
- (d) To impart knowledge about general surgery and urological disease and procedures

### **CLINICAL AND PRACTICAL**

Clinical: To provide basic understanding in clinical urology and urological procedures to be able to assist the urologist in all areas of urological practice

Practical: To impart training to develop skills in:

- (a) To lay trolley for all types of urological procedures, minor or major, open or endoscopic
- (b) To check the various components of urological equipment for its safety and working aspects
- (c) To clean, maintain and sterilize or disinfect urologic equipment
- (d) To assist in various urological procedures

### **3. Eligibility Criteria**

Successful candidates of BSc with science (Biology compulsory) or equivalent course, having minimum of 50% marks will be eligible to complete for the course. Candidates should be well versed with Hindi and English languages. Candidates have to be the citizen of India. Selection will be done for the open seats and on the basis of merit following a written competitive test followed by an interview as is done for other courses.

1. No. of position: 2 per year
2. Course duration: 2 years
3. Course fee: As per rules of AIIMS
4. Course Stipend: As per rules of AIIMS
5. Course Content:

### **THEORY**

Two 1-hour lectures per week that shall, in a structured manner over 2 years cover the following topics:

- Anatomy, Physiology and Biochemistry of the genitourinary (GU) system
- Basic Surgical pathology and microbiology, specimen fixation and transport
- Basic principles of Surgery and Urology
- Techniques of surgical assistance

- Steps of various urological procedures
- Basic life saving procedures
- Basic physics and electronics of urological equipment and diathermy and laser machines
- Basic physics and safety requirements of x-rays and fluoroscopy
- Maintenance of the all theatre equipment
- Sterilization and disinfection
- Acute and chronic renal failure
- Renal replacement theory

## **PRACTICAL**

Each candidate shall attend the Urology OT everyday from 8 am sharp till the end of the list on all urology OT days. On Thursday they will attend the general ward round till 12 noon after which they will attend the ESWL room. Once a week, by rotation, they shall also attend the urodynamic lab and urology minor OT. During this they will assist at all urological procedures in the OT under direct supervision of the consultant/senior resident of urology. In between procedures they will learn and carry out cleaning and maintenance of equipment. Over a period of 2 yrs they are expected to become proficient at:

- Assisting at endourology, open surgery and laparoscopy
- Operating C-arm and maintaining it
- Setting up endourology, laparoscopy and open surgery equipment trolleys
- Cleaning and maintenance of urologic equipment including endoscopes, laparoscopes, lithtrites, lasers, diathermy etc.
- Setting up diathermy and ultrasonic scalpel equipment and their safety precautions
- Setting up laser equipment and their safety precautions
- Setting up operating microscope, urodynamic machine and ESWL

**Dissertation:** One dissertation on a selected research topic will be mandatory in the 2 years.

## **COURSE SYALLABUS**

### **First Year**

#### **Method of Instruction**

- 2 one-hour lectures/week
- 2 (1 hr each) lecture demonstration /week
- 6 hour practical and clinical work daily

#### **First year course includes**

1. Anatomy, Physiology, Pharmacology of the GU system
2. Microbiology & Sterilization
3. Basic Pathology, Specimen fixation and transport

#### 4. Equipments

### **Anatomy and Physiology**

1. Embryology and development of the GU system
2. Blood/Body Fluids/Compartments/Components
3. Urogenital system/Endocrine system and Reproductive system

### **Pharmacology**

1. Introduction of Pharmacology related to the GU system
2. Effects of drugs on various parts of the GU system
3. Routes of administration, absorption, Metabolism and excretion of drugs, anaphylaxis reactions and complications
4. Antibiotics
5. Drugs acting on the autonomic nervous system with special emphasis on bladder and prostate
6. Preservatives of organs
7. Fluids and miscellaneous

### **Microbiology and Sterilization**

1. Microbial organisms
2. Importance of sterilization / infections
3. Sterilization techniques
4. Microbiological surveillance and sampling
5. Cultures in microbiology
6. Preparation of materials for autoclaving
7. Sterilization of rooms/equipments/CSD procedures

### **Equipments**

1. Intravenous cannulation and infusion
2. Monitoring equipments
3. Operation able management
4. Diathermy/Cautery
5. Suction machine and connections
6. Ultrasonic scalpel
7. Open surgery instruments
8. Endourology instruments and peripherals
9. Laparoscopy instruments and peripherals

**Method of Instruction**

- 2 one-hour lectures/week
- 2 (1 hour each) lecture demonstration / week
- 6 hour practical and clinical work every day

**Second year course**

- Allied and applied sciences
- Management strategies in urology
- Special techniques, equipments and recent advances
- Administration and management
- Statistics and Computers

**Allied and Applied Sciences**

- Pathology
- Computers and Statistical Methods
- Nephrology
- General Surgery

**Management Strategies in Urology**

- Common urological conditions
- Methods of diagnosis
- Treatment modalities

**Special techniques, equipments and recent advances**

- PCNL
- Laparoscopy
- Retroperitoneoscopy
- Robotics
- Telesurgery
- Laparoscopic suturing
- Microsurgery
- Ultrasonography
- Urodynamics
- ESWL
- Plalysis Techniques

**Administration and Management**

Staff relationship  
 Departmental Organization  
 Audits  
 Store keeping  
 Store accounting  
 Procedure for purchase of government goods  
 Storage  
 Taking stocks/loss etc.

### Statistics and Research

Knowledge of computers, literature search, Internet tools  
 Basic statistics, sample size, randomization, methods of presentation of data

### Examinations

- The examination shall be conducted by AIIMS as per the rules of the Institute and internal assessment
- At end of every semester (6 months) internal assessment conducted by Department of Urology
- Internal assessment 100 marks in each semester including theory, viva voce and practical
- Maintenance of logbook: All candidates have to maintain a logbook with record of their postings, evaluation remark from the faculty and technician of the work area
- Final examination at the end of 2nd year:

### THEORY

Paper	Marks	Duration	Subjects
I	100	2 hrs	Basic Sciences & equipments
II	100	2 hrs	Allied Sciences & management
III	100	2 hrs	Applied & special techniques & Management
IV	100	2 hrs	Recent advances

### PRACTICAL

Practical in OT            40 marks  
 Viva Voce                 50 marks  
 Log Book                 10 marks

- Pass marks, (50% aggregate 50% from practical)
- Students who scores less than 50% marks shall be allowed to reappear the examination after six months

## Examination Rules

- 3 Semester examinations - internal assessment
- End of 4th semester- final examination
- Semester examination and day to day assessment will be done and internal assessment & recorded in the log book
- 75% attendance of total lectures, demonstrations, and practicals is compulsory to appear in the final examination
- Date of examination & appointment of examiners will be made by the Dean on the recommendation of the coordinator of the course
- Theory paper would include short notes, one-word answers, multiple choice questions, essay type questions
- Logbook marks will be added to practical
- Logbook marks will be on the basis of day to day work
- A student will be deemed to have passed in the subject if he/she obtains a minimum of 50% marks in that subject in the theory and practical
- There will be no internal assessment or compulsory attendance for the student who has failed and is appearing in supplementary examination
- Examination fee has to be paid by the candidate
- A candidate who obtains 75% or more marks of the total marks shall be declared to have passed with distinction
- Bond of Security may be obtained from candidates as per AIIMS rules