SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY, TRIVANDRUM

COURSE WORK FOR PhD PROGRAM

M Phil Course Modules Selected for Ph.D Course Work

(offered at the BMT Wing)

PhD students' core course on "Research Methodology" consists of 6 course modules of M.Phil. Programme titled (1) Statistics -1 credit , (2)Development of Work Culture Development – 1 credit, (3) Ethics in Research – 1 credit, (4) Use of Laboratory Animals in Biomedical Research -1 credit, (5) Computer Applications - 1 credit and (6) Assignments on Development of hypothesis and Designing Experimental approach.

Part I –A. Research Methodology (Compulsory) Courses

Module I. Biostatistics (1 credit)
Course Outline: This is planned as an introduction to the principles of statistics as it applies to the understanding and interpretation of the biomedical literature. The emphasis of this course is on the application of statistical tests commonly employed in biomedical research and the interpretation of their results. Topics which will be covered include: probability, principles of inference, hypothesis testing, parametric and non-parametric tests, principles of epidemiology, statistical vs. clinical significance, and quasi-statistical methods (e.g., meta-analysis, decision analysis).

Module II. Work Culture Development (1 credit)
Course Outline: The course covers study design, preparation of proposals and manuscripts, peer review, authorship, allegations of misconduct, and intellectual property. Also discussed are mentoring relationships, inter-personal relationship in working atmosphere, conflict of interest, and work culture and career options.

Module III. Ethics in Research (1 credit)
Course Outline: This course explores techniques for recognizing, analyzing, and resolving ethical dilemmas facing healthcare professionals and biomedical researchers in today's highly regulated environment. Use of humans and animals in research, data acquisition and management, protection of human subjects/animals involved in research programs. Will include case studies, interactive small group discussions, and role-playing simulations.

Module IV. Use of Laboratory Animals in Biomedical Research (1 credit)
Course Outline: Duties of the research team and the governmental organizations involved in regulating biomedical research, basic considerations of experimental design.
Laws that govern biomedical research, the function of the institutional animal care and use committee, principles of the "three R's" of biomedical research, benefits of biomedical research, understanding research environment including: facilities, cages, feeding and

watering devices, animal sources, and administrative responsibilities. Identify and describe anatomic and physiologic characteristics, breeding systems used, behavior aspects, procedures for husbandry, housing, and nutrition, restraint and handling procedures, medication administration and blood collection, common diseases, and methods of euthanasia of the following animals: rats, mice, guinea pigs, rabbits.

Module V. Computer Applications (1 credit)

Module VI. Develop hypothesis, Design Experimental approach and submit a proposal - Assignments (1 credit)

Part II - Teaching Courses

B.Biology Courses

Module I Basics of Cell Biology (2 credit)
Course Outline Introduction to cell biology, cell-cell interaction, cell-ECM interaction. Cytokines and growth factors in cell regulation, cell cycle, cell signaling, cell proliferation/migration, Apoptosis. molecular biology, nucleic acid, protein synthesis: Translation and Transcription. Current concepts in Immunology Stem Cell Biology & Cancer Biology.

Module II Neuro Biology (1 credit)
Course Outline: Introduction to neuroscience. Brain structure and its origins - Brain and cognation - Neuronal basis of learning and memory - Cellular neurobiology - Neurological diseases

Module III: Bone Biology: (1 credit)
Course Outline: Structure and development of bone; the Osteoblast and Osteoclast lineage and signal transduction; Biomechanics of Bone; Cytokines, Proteins and Growth factors in bone; Estrogen and thyroid hormones in bone development and homeostasis; Joints; and Metabolic bone diseases.

Module IV: Experimental Pathology: (2 credits)
Course Outline: Introduction to pathology: definitions and basic terminology; Reversible cell injury; Irreversible cell injury; Ultrastructural pathology; Chronic cell-injury and cell adaptation; Disorders of cell metabolism: intracellular and extra-cellular accumulations; Tissue response to injury-1: Acute inflammation; Tissue response to injury-2: Chronic inflammation; Vascular response to injury;Immunopathology-1: Hypersensitivity; Immunopathology-2: Immunosuppression; Neoplasia; Stem cell pathology; Molecular pathology; Essential laboratory animal pathology for experimental pathologists; Experimental pathology for toxicologists; Experimental pathology for biomaterial specialists; Experimental pathology for tissue engineers

Module V. Microbiology: (1 credit)
Course Outline: Analysis of fundamental problems in bacteria, bacteriophage, viruses, and yeast. Detection of microbial contamination, cellular responses to stress and production of shock proteins, material surface-bacterial interactions and role of structure-function aspects of proteins, Issues involved in infection control. Microbiology tests for testing biomedical products; viral transmission of diseases from bio therapeutics, bacterial contamination of therapeutics and medical devices and methods of prevention and testing.

Module VI. Stem Cells & Regenerative Medicine (2 credits)

Course Outline: Introduction to Regenerative Medicine, Biology of Regeneration, Strategies of Regenerative Medicine, Current and Future Perspectives of Regenerative Medicine, Basis of Regenerative Medicine, Cells and Tissue Development, Stem Cells as source in regeneration of tissues, Therapeutic Applications: Tissue Therapy, Research Issues in Regenerative Medicine, Bioethical Issues and Challenges.

C.Materials Science Courses

Module I Introduction to Biomaterials - bulk & surface properties of materials and materials processing (2 credits)

Course Outline: An introduction to materials used in medicine - Metals, ceramics, glasses and polymers; Bulk properties of materials; Microstructure; Bonding in materials - ionic, covalent, metallic and other weak interactions; Introduction to atomic structure; Mechanical properties of materials - elastic and plastic behaviour, stress and strain, tension and compression, shear, elastic constants, isotropy, elasticity, brittle fracture, plastic deformation, creep and viscous flow, fatigue and toughness; Mechanical testing – techniques in general; Fabrication techniques – a general introduction; Examples of biomaterials applications - heart valve prostheses, artificial hip joints, intraocular lenses and left ventricular assist devices

Module II Polymeric Biomaterials (4 credits)

Course Outline: An introduction to polymer science and technology with relevance to biomaterials science is taught in this course. The topic covers introduction to polymers – natural and synthetic polymers, copolymers; Polymer synthesis – bulk, solution, emulsion, Zeiglar-Natta catalysts, metallocene catalysts, modern techniques of polymerisation; Characterization of polymers - molecular weight, tacticity, crystallinity, viscoelasticity, mechanical properties, thermal properties, dynamic mechanical properties, surface properties; Structure property relationships; Composites; Hydrogels; Smart or intelligent polymers; Bioresorbable and bioerodible polymers - process of biodegradation, currently available degradable polymers, application of synthetic degradable polymers as biomaterials, process of bioerosion, mechanism of chemical degradation, factors that affect the rate of bioerosion; Storage stability; Sterilization and packaging; Disposable polymeric medical devices and implants - gloves, catheters; Fabrication and processing of polymeric biomaterials.

Module III: Introduction to Biomaterials Part II-Metallic and Ceramic materials (1 credit)

Course Outline Introduction to metals and ceramics, steps in fabrication of metallic implants, microstructure and properties, stainless steels, cobalt based alloys, titanium based alloys, characteristics and processing of bioceramics, nearly inert crystalline ceramics, porous ceramics, bioactive glasses and glass ceramics, calcium phosphate ceramics, calcium phosphate coatings, resorbable calcium phosphates, clinical applications of hydroxyapatite, pyrolytic carbon.

Module IV: Dental Materials (1 credit)

Course Outline The course will comprise of basic concepts of dental materials, current status of dental research, Indian scenario, introduction to dental materials, applications of dental materials, physico-chemical, mechanical, toxicological and in vitro clinical performance of dental materials, dental implants, polymers, metals and ceramics in dentistry, chemistry of synthetic resins, guided tissue regeneration and various aspects of technology transfer of dental materials.

Module V: Biomaterials and Nanomaterials in drug delivery and gene therapy, Biomedical sensors (2 credits)

Course Outline The course is designed to provide an overall understanding on polymers and nanomaterials as drug carriers, nano particles based oral peptide delivery systems, physico-chemical and biological characterisation, conjugates and gene delivery systems, passive or active targeting, targeting tumor cells, polymer-protein conjugates, polymer drug-conjugates, compounds in clinical stage, combination of polymer therapeutics.
Introduction to biomedical sensors. Emphasis will be given to polymers in the design of sensors along with analytical tools used for quantification of the analytes. The course materials also include the preparation and characterization of metallic nano particles and functionalized nano particles for sensing of clinically relevant molecules.

Module VI: Biomaterial Scaffolds in tissue engineering (2 credits)
Course Outline This course is an introduction to the basic concepts of scaffolds in tissue engineering. The criteria for using different scaffolds in a variety of application areas will be discussed. These include micro and macro encapsulation of cells, in situ polymerizing and injectable gels, micro and macro porous scaffolds, and the delivery of bioactive molecules. The course will also cover some scaffold materials – natural and synthetic or combinations and processing techniques such as solvent casting and particulate leaching, fiber bonding, compression molding, extrusion, freeze drying, phase separation, gas foaming, solid freeform fabrication, self-assembled materials etc and the characterization of processed scaffolds.

D.Inter-disciplinary Courses

1. Biomaterials & Biocompatibility (2 credits)
Course Outline: This course is an introduction to the principles of biomaterials (Synthetic and Natural) and cell biology with reference to the design of medical implants and matrices for tissue engineering. Topics include methods for biomaterials characterization and changes in the biological milieu both from biomaterial and biological perspective (Case studies may presented) It also covers mechanisms of underlying wound healing and remodeling following implantation in various organs. Other areas include design of implants and prosthesis based on control of biomaterial- tissue interaction, comparative analysis of degrading and non degrading implants. Exposure to various standard methods of testing for evaluation of biocompatibility

Module II. Toxicology (2 credits)
Course Outline Topics covered include: mechanisms of drug action, dose-response relations, pharmacokinetics, drug delivery systems, drug metabolism, toxicity of pharmacological agents, drug interaction and substance abuse Immuno-toxcity, genotoxicty. Selected agents and classes of agents are examined in detail, Material toxicity, methods in toxicity evaluation.

Module III. *In Vivo* models (2 credits)
Course Outline: This course is on preclinical testing for safety and efficacy medical implantable. This course covers basic concepts in design, conduct and interpretation of large animal studies for assessing medical device safety and performance. Identification of device failure modes for different devices and selection of suitable animal models for demonstrating these will be discussed.

(B) Course Modules for Ph.D Course work (offered at Hospital Wing)

I Cardiac Sciences

Module I. Cardiac Anatomy and Physiology (1 credit)

INTRODUCTORY LECTURE – (1 hour)- Objectives of the training in cardiology.Introduction to heart diseases.

CARDIAC ANATOMY – (2 hours) -Anatomy of Heart- Surface anatomy, gross anatomy, cardiac chambers, valves,

Blood vessels. Arteries, Veins, Lymphatics, Coronary circulation and coronary venous drainage

Conduction System of Heart

CARDIAC PHYSIOLOGY – (3 hours) Normal Cardiac Cycle

Cardiac Cycle, Circulation, Tissue Perfusion – Unified Concept

Circulation in Health and Disease: Cardiac Output, Blood Pressure, Heart Rate / Pulse.

Blood pressure- Measurement of Blood Pressure :Technique : Sphygmomanometer

Heart Sounds, Murmurs, Stethescope,phonocardiography.

Oxygen Saturations: Physiology of Oxygen Transport

Blood Gases – Technique and Various Parameters

CARDIAC PATHOLOGY / PATHO PHYSIOLOGY **(1 credit)**

Cardiac Pathology – (2 hrs)

Cardiac Pathophysiology – (2hrs)

Atherosclerosis, Coronary artery disease and Myocardial Infarction

Valvular Heart Disease including Rheumatic Heart Disease

Congenital Heart Disease: Acyanotic and cyanotic , Shunts, R-L,L-R

Pathophysiology of Heart Disease in General : Myocardial Failure, Pump Failure, Circulatory Failure,Impact on other organ systems- Eg. Kidney

DIAGNOSIS OF HEART DISEASES – (3hrs)

Electrocardiography

Echocardiography

Cathlabs – Angiography

Exercise testing

CT, MRI, Electrophysiology studies.

Module II Molecular and Cellular Cardiology– 12 Hours – 2 Credits

Myocardial regeneration

Mechanisms of hypertrophy, cell death and wound healing in the heart

Cardiac energetics and oxidative metabolism in the heart

Genetics and the cardiovascular system

Atherosclerosis – From Bench to bedside

- Molecular and cellular aspects
- Clinical application of cellular and molecular level knowledge
- Future prospects and possible advancements in therapeutics based on cellular and molecular level knowledge.

Module III- Overview of medical and surgical treatments- (1 credit)

MONITORING PATIENTS WITH HEART DISEASE – (2Hrs)

Clinical Monitoring gadgets

Invasive Monitoring- CVP, Intra Arterial BP, PA Wedge Pressure, Cardiac Output

TREATMENT OF HEART DISEASES - (3 hrs)
Coronary heart disease

Congenital heart disease

Treatment of electrical disorders – Radiofrequency ablation, Pacemakers

Cardiac Arrest and cardiac Resuscitation

CARDIAC SURGERY – (2 hours)

Introduction

Cardiopulmonary bypass surgery

Surgical treatment of common heart diseases

Congenital Heart Diseases

Coronary Heart Disease – CABG

PREVENTIVE CARDIOLOGY – (2 hrs)
Primary Prevention
Secondary prevention

II NEUROSCIENCES

Module 1: Neuroanatomy & Neuroimaging – 1 credit

NEUROANATOMY – (4 hours)
Gross Anatomy, Lobar anatomy, Gyrii in Brain, Deep Grey nuclei, Structural Organization- Cortex & Fiber tracts
Gross functional areas in brain and spinal cord
Brain stem & Cerebellum, Spinal Cord, Autonomic system, Peripheral Nerves, sensors & effectors
Cellular histology of Brain, Neuronal Architecture, Neuronal pool's organization- system level organizations, Synapse & Dendrites

NEUROIMAGING (4 hours)

Introduction to Ultrasound, Doppler, computed tomography, magnetic Resonance Imaging, Positron Emission Tomography (PET), Single Photon Emission Computed Tomography (SPECT), Near Infrared Spectroscopy (NIRS), Magnetoencephalography (MEG). Magnetic Resonance Spectroscopy (MRS), Picture archival and communication system

Group Discussion with visit to department -Topic: Radiation and MRI safety

MRI Physics: MR signal generation, MR signal formation, contrast mechanisms, pulse sequences and emerging MR compatible contrast agents.

Advanced Neuroimaging methods: Diffusion Tensor Imaging (DTI), Fiber Tractography, BOLD fMRI, spatial and temporal properties of fMRI, multimodality imaging, Combined fMRI -EEG/MEG data, Perfusion Imaging, Arterial Spin Labelling (ASL), Ktrans (Permeability Transfer constant), voxel based morhometry. Introduction to Softwares for Image Processing- Matlab Basics, Statistical Parametric Mapping, DTIstudio, Brain Voyager, FSL.

Pre clinical neuroimaging, Molecular imaging with specific Application in the MR, optical and Ultrasound imaging,
Nanoprobes for imaging neurological disorders under emerging contrast materials

Module II Neurobiology – 1 credit (8 hrs) Brain structure and its origins; Brain and cognition: Neuronal basis of learning and memory; Cellular neurobiology

Module III- Neurophysiology – 2 credits (20 hrs)

Lectures

- Introduction to the Neurophysiological approach to understand brain function
- Resting membrane potential: Electrical principles of neuronal function
- Action potential
- Skeletal muscle and neuromuscular contraction
- Functional organization of nervous system
- Somatic sensations
- Special senses – Lecture 1 (vision and hearing)
- Special senses – Lecture 2 (olfaction and taste)
- Motor functions of spinal cord and reflexes
- Control of motor movements by cortex and basal ganglia
- Control of motor movement by cerebellum and brainstem
- Limbic system including hypothalamus
- Sleep and wakefulness
- Autonomic nervous system
- Intellectual functions of the brain, learning and memory
- Plasticity in the nervous system

Student seminars: Each student one seminar

Practical/Demonstration sessions: Exposure to the neuropsychological techniques

Module IV : Clinical Neurosciences – 1 CREDIT (8 HRS)

NEUROLOGICAL DISEASES (3 hour) (including demonstrating clinical examination)

An overview of various neurological diseases

Epilepsy, Movement Disorders

Cognitive Neuroscience, Stroke

NEUROSURGERY (1 hour) (including visit to Neurosurgery Operation Theater)

Introduction, Methods, Surgical treatment of neurological diseases

NEUROIMMUNOLOGY: (1 hr)

Immunoglobulins(Structure and function) and Antigen antibody interactions, Autoimmunity- Characteristics of autoimmune diseases, mechanism of action of autoantibodies, autoimmunity in relation to ion channels and epilepsy

NEUROPATHOLOGY (3 hrs)

Neuroinfections, Tumors, Neuromuscular diseases

Module V: Physics of Medical Imaging - (16 hours)- 2 credits

RADIOGRAPHY (2hrs)

Electromagnetic Radiation – x-ray production –x-ray tubes – Different factors influencing the x-ray spectrum– interaction of radiation with matter– x-ray image formation – scattered radiation and contrast – film image recording and processing – digital radiographic system – radiographic detail – mammography – fluoroscopy imaging system

RADIONUCLEOTIDE IMAGING (1hr)

Radioactive isotopes – gamma camera functions and imaging – image quality characteristics –SPECT – PET –radionucleotide dose consideration

RADIATION PROTECTION (1hr)

Radiation protection principles – effects of radiation – cardinal principles of radiation protection –dose limits – AERB regulations – personnel monitoring - patient and personnel protection

COMPUTED TOMOGRAPHY (2hrs)

Computed Tomography image formation – image quality characteristics – Spiral CT – multi detector CT – cardiac CT – radiation dose and image qualities – artifacts

ULTRASOUND IMAGING (1.5hrs)

Ultrasound probes – different modes of display – Image characteristics – controls – Doppler physics – echo – artifacts

MRI AND FUNCTIONAL MRI (8hrs)

Magnetic resonance imaging system components – tissue magnetization and relaxation – imaging process and K-space – SE and GE sequences – spatial characteristics of the MR image – image detail, noise, acquisition time and procedure optimization – MR vascular imaging

Functional MR imaging – diffusion and perfusion weighted images – BOLD fMRI – HRF – understanding SNR in fMRI – pre-processing of fMRI data – experimental design – statistical analysis – software packages – SPM and Brainvoyager – applications of fMRI – advanced fMRI methods – MR image artifacts and safety.

GENERAL MEDICAL IMAGING TOPICS (0.5hrs)

Digital image structure and characteristics – digital image storage and archiving – digital image distribution and networks

Module VI. Biophotonics-Biomedical Applications (2 credits -16 hrs)

Medical Lasers-Laser illumination,surgical lasers, laser for dermatology,cosmetic lasers,dental lasers,wound care lasers, laser for low level laser therapy(LLLT), Hyperplasia

Interaction between biological system and photons

Physics underlying biophotonic based therapeutic and diagnostic techniques

Light to image, detect and manipulate biological materials

Biophotonic approaches towards cancer detection and diagnosis

Medical therapeutics-Biophotonic approaches towards cancer therapy-PDT,PTT,LLLT and Radiation

Nanobiophotonics for molecular imaging -Contrast agents and molecular probes for biomedical imaging

Advanced biophotonic imaging and spectroscopy-Bioluminescence, Fluorescence, Fluorescence life time, Optical Coherence tomography, Infrared, Raman, SERS and CARS.

Biomaterials for photonics and Bionanophotonics

(C) MPH Course Modules Selected for PhD Course Work (offered at AMCHSS)

Course 1: BASIC BIOSTATISTICS (Compulsory course – 4 credits)
Course 2: INTRODUCTION TO EPIDEMIOLOGY (3 credits)
Course 3: HEALTH AND DEVELOPMENT (3 credits)
Course 4: HEALTH AND ENVIRONMENT (3 credits)
Course 5: BASIC HEALTH ECONOMICS (2 credits)
Course 6: GENDER ISSUES IN HEALTH (2 credits)
Course 7: ETHICS IN PUBLIC HEALTH (2 credits)
Course 8: HEALTH POLICY ANALYSIS 1 (2 credits)
Course 9: HEALTH CARE SYSTEM IN INDIA (2 credits)
Course 10: HEALTH MANAGEMENT (4 credits)
Course 11: QUANTITATIVE RESEARCH METHODS (2 credits)
Course 12: ANTHROPOLOGICAL PERSPECTIVES IN HEALTH (1 credit)
For details of MPH Course Modules, visit website – http://www.sctimst.ac.in /amchss/

(D) ADDITIONAL INSTRUCTIONS

(1) PhD research scholars at BMT Wing & Medical Complex are recommended to take the Statistics and Research Methodology Course offered at BMT Wing as the course is designed suitable for their purpose.
(2) PhD researchers working on public health are recommended to take the Basic Biostatistics Course offered at AMCHSS.
(3) PhD Course Work will be offered at the BMT Wing August to December and in AMCHSS between January to November every year.
(4) Regular attendance and pass in the final examination is a mandatory requirement.