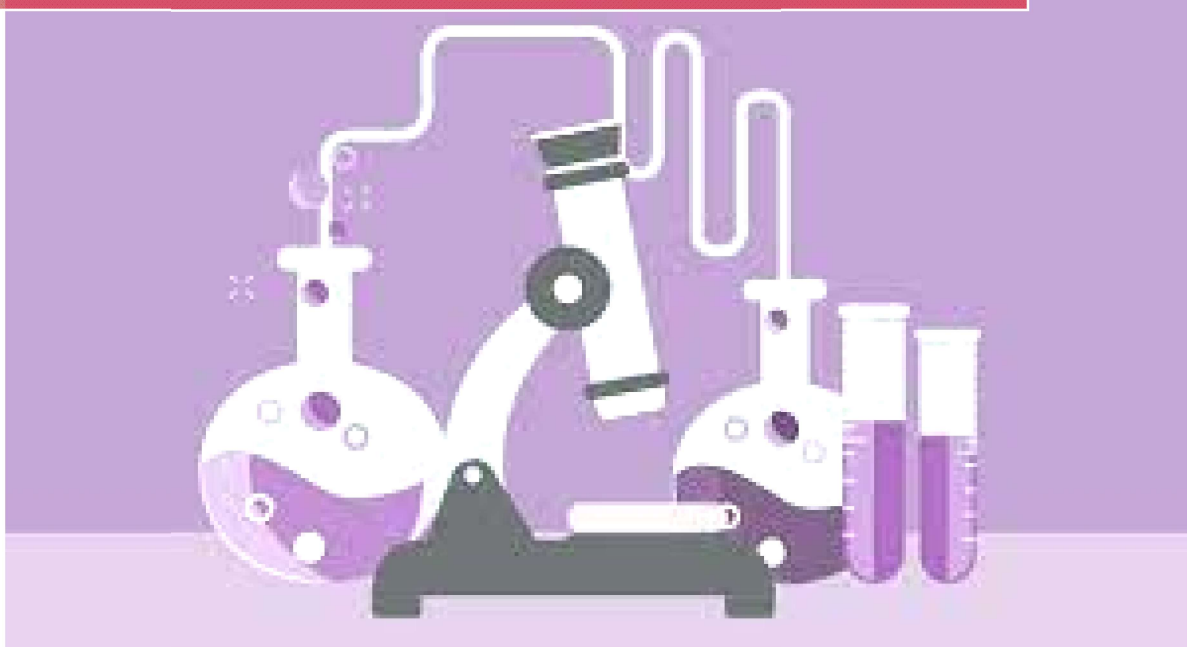


2021

SYLLABUS (CBCS) M.Sc. BIOMEDICAL SCIENCE KUMAUN UNIVERSITY, NAINITAL, UTTARAKHAND.



Department of Forensic Sciences

Faculty of Biomedical Sciences

8/12/2021

SYLLABUS (CBCS) M.Sc. BIOMEDICAL SCIENCE

KUMAUN UNIVERSITY, NAINITAL, UTTARAKHAND.

1.	Name of the Programme	M.Sc. Biomedical Science
2.	Type of Course (U.G/P.G)	Post Graduate
3.	Duration of Course	4 Semester (2 Year course) CBCS
4.	Objectives of Course	<ul style="list-style-type: none"> ➤ To enhance career opportunities and develop knowledge and skills of life sciences focusing on human health, disease pathophysiology, emerging diagnostics, therapeutics and state-of-the-art research. ➤ To explore contemporary understanding of disease pathophysiology, current and emerging diagnostic procedures and aspects of therapy. ➤ To create an ideal progression route for graduates of the Biomedical Science BMC or other bioscience disciplines to wards relevant industries and organisations.
5.	Outcome of Course	<ul style="list-style-type: none"> ➤ Trained employable professionals for Institutions of Biomedical Sciences ➤ Enables Health and Care Professionals to increase their opportunities for progression within pathology services. ➤ Development in terms of conjunction with local health units and practitioner-based academic staff ensuring use of relevant current practices.
	Number of Proposed seats (Intake)	20 (Twenty)

M. Sc. in Biomedical Science

FIRST SEMESTER (ODD SEMESTER)

Course Code	Course Type	COURSE (PAPER/SUBJECTS)	Credits	Maximum Marks		
				Internal	External	Total
BSC	CCC	Biochemistry	4	20	80	100
BSC	CCC	Cell Biology and Human Genetics	4	20	80	100
BSC	CCC	Medical Biotechnology	4	20	80	100
BSC	CCC	Techniques and Instrumentation	4	20	80	100
BSC	LAB	Lab (Lab Course 1)	4	20	80	100
Minimum credits in complete semester it would be 20			Total: 20			

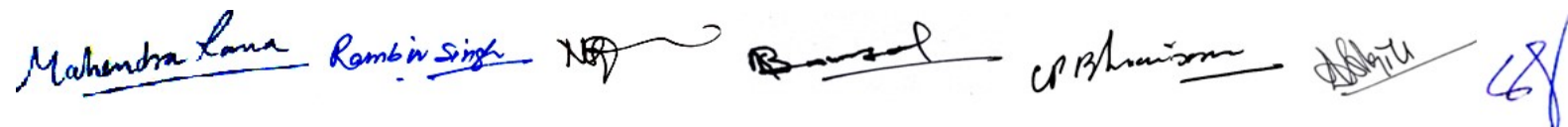
The M.Sc. program will be divided into four semesters each being of six months duration. Each semester comprises of compulsory core courses (CCC) Lab course (LC) will be based on CCC. Each theoretical course will be divided into Internal Assessment of 20 marks and semester end examination of 80 marks.

Duration of Theoretical and Practical Examination Time: 03 Hours

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M.Sc. BIOMEDICAL SCIENCE		I SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: BIOCHEMISTRY			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM. : 80 CCA: 20	
UNIT-1 18 Hours	<p>Protein Structure: Protein folding, Secondary and tertiary structure of protein: a helix, β sheets, examples of proteins, Ramachandran plot. Factors effecting secondary and tertiary structure (disulphide bonds, heat, organic solvents, detergents). Concept of Motiff and examples of some common structural motifs in proteins. Domains, structural diversity of different domains with appropriate examples, domain swapping with examples, Protein Dynamics: concept of macro states & ensembles, how dynamics affects protein function. Intrinsically disordered proteins, structure and function of alpha, beta and kappa casein, functional and evolutionary significances, role in different multi-protein complexes. Structure and function of hemoglobin: conformational studies, binding of oxygen and it's release, oxygen saturation curves. Structural proteins: structure of collagen, keratin and other fibrous proteins. Disorder of amino acid and protein metabolism.</p>		
	UNIT-2 18 Hours	<p>Enzymology: Introduction: General characteristics of enzymes, definition of coenzyme, holo- enzyme, prosthetic groups, classification. Enzyme Kinetics: Substrate, active site, transition state, activation energy, equilibrium constant K_m, V_{max}, specificity, Michaelis-Menten equation. Reaction Mechanism: Acid-base catalysis and covalent catalysis (giving examples). Regulation of enzyme activity: Reversible and irreversible inhibition (non- competitive, uncompetitive) and their effects on K_m and V_{max}, effect of pH, heat, PMSF and other inhibitors. Models to explain their kinetic behavior. Problems on enzyme kinetics: Determination of active sites and turnover number, factors affecting enzyme functions Bi- substrate enzyme kinetics: ping-pong and sequential mechanism.</p>	

UNIT-3 18 Hours	<p>Protein purification, physical separation & Analysis: Methods of protein production, isolation, purification strategies, concept of inclusion body. Chromatography (ion exchange, affinity, size exclusion), Dialysis, molecular sieving, PAGE, electrofocussing, FPLC. Methods of protein sequencing: N and C-terminal analysis, Edman degradation.</p> <p>Regulation of protein function: Concept of Structural allostery, examples of self-inhibited proteins, limited proteolysis, Post-translational modifications: enzymatic and non-enzymatic, Protein quality control system: ubiquitination, proteosomal and lysosomal- mediated degradation, Molecular chaperones (structure and functional mechanisms of Hsp90, Hsp70, Hsp60 & Hsp40), Chaperonin (structure of GroEL & GroES).</p>
UNIT-4 18 Hours	<p>DNA REPLICATION IN PROKARYOTES AND EUKARYOTES: Concept of origin of replication, experimental evidence for bidirectional and semiconservative replication. Mechanism of DNA Replication: Structure and function of DNA polymerases. Experimental approach to differentiate and identify replication proteins. Role of helicase, primase, gyrase, topoisomerase and other proteins in DNA replication in E.coli. Replication mechanism in viruses, mitochondrial DNA replication (D loop). Replication in eukaryotes, differences from prokaryote, Initiation of replication, proteins involved, their functions, Inhibitors of replication. Elongation and termination of DNA synthesis in prokaryotes and eukaryotes.</p> <p>Translation in Prokaryotes-initiation:activation of amino acid, role of 30s and 50s ribosomal subunits. role of 30s and 50s ribosomal subunits, initiation factors, Elongation factors, peptidyl transferase termination signal, release factors. Inhibition of protein synthesis - by antibiotics and inhibitors of eukaryotic translation. Methods to determine Half-life of protein.</p>



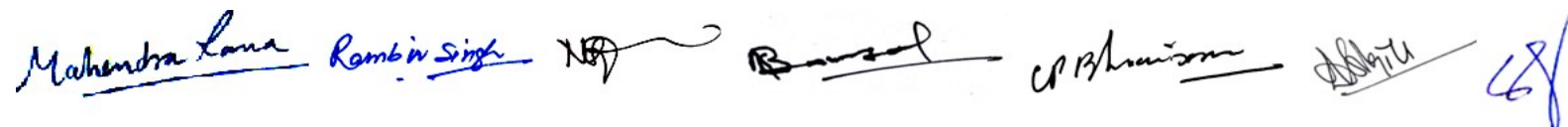
**SUGGESTED
READINGS**

1. Proteins: Structure and Function; David Whitford; 1st Ed; Wiley, 2005.
2. Biochemistry by Donald Voet and Judith G. Voet; Ed. 4th ; Wiley; 2010.
3. Lehninger principles of biochemistry by David L. Nelson and Michael M. Cox; Ed. 6th ; W.H. Freeman, 2012.
4. Biochemistry by Christopher K. Mathews and Kensal E. van Holde and Kevin G. Ahern; Ed. 3rd ; Prentice Hall, 1999.
5. Biochemistry by Jeremy M. Berg and John L. Tymoczko and Lubert-Stryer; Ed. 6th ; W.H. Freeman, 2008.
6. Fundamentals of Protein structure and function, Buxbaum Engelberg; Springer, 2015.

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M.Sc. BIOMEDICAL SCIENCE		I SEMESTER
COURSE CODE: BSC		COURSE TYPE: CCC
COURSE TITLE: CELL BIOLOGY AND HUMAN GENETIC		
CREDIT: 04	TEACHING HOURS: 90	
MARKS: 100	THEORY EXAM: 80	CCA: 20

UNIT-1 18 Hours	<p>Biomembranes: Basic structure, lipid and protein composition and their basic functions Transport of molecules across membranes. Passive and active transport across membranes. Factors regulating them, ion channels, ABC pumps of bacteria.</p> <p>Organelles of eukaryotic cells: Introduction basic structure and function of various organelles, ER, golgi bodies, chloroplasts, mitochondria endosomes, lysosomes etc. separation and visualization methods of various cell organelles. Muscle & Nerve Cells.</p> <p>Nucleus and Chromosome Structure: Introduction: Prokaryotic and Eukaryotic genome and its organization, eukaryotic chromosome. Basic structure of DNA; hairpins and cruciform, Z-DNA, triple helix. DNA Supercoiling: Histones, nonhistone proteins, topoisomerases and telomerase and their functions in chromatin structure.</p>
UNIT-2 18 Hours	<p>Cytoskeleton proteins, and Cell motility and shape, protein sorting, Transport of proteins. Microfilaments and actin filaments, Cell-cell interaction, Cell junctions, Adhesion proteins, Cell matrix interaction, Integrins, Functional role of adhesion proteins. Cell cycle and its control: Loss of cell regulation by viral infection, checkpoints in cell cycle regulation.</p> <p>Introduction to cell surface receptors, and concept of receptors. G-protein mediated signaling, camp, receptors tyrosine kinases, second messengers. Apoptosis, Necrosis, Proapoptotic and Antiapoptotic proteins mechanism of action Autophagy, Senescence, Cell death mechanisms in health and diseases. Cell Differentiation. Stress response proteins and pathways, Post translational modifications in stress response, General responses to hyperthermia nutritional deprivation and other stressors.</p>



UNIT-3 18 Hours	<p>Genes, Hereditary traits, Genetic Disease, Mutations and polymorphisms, Human Genome Project. Repetitive DNA in Human Genome, Simple sequence repeat loci; Intron, exon, UTR, regulatory sequence, non-coding RNAs, mitochondrial genome</p> <p>Methods of Genetic Study in Human a) Mendelian pedigree pattern and analysis, Penetrance and Expressivity b) Chromosomal Basis of Genetic Disorders: Chromosomal Analysis, Karyotypes and identification of chromosome variation; Nucleic Acid Hybridization Assays, cytogenetic mapping c) Single gene disorders: Genetic mapping and LOD score; Physical mapping, d) Complex diseases and association study</p>
UNIT-4 16 Hours	<p>Genetic Factors in common Diseases and techniques needed to decipher those: a) Congenital defects: Coronary heart disease; Late onset disease: diabetes, mental diseases, Defects in membrane Transport: Cystic Fibrosis; Defects in structural proteins: DMD and BMD; collagen disorders: Osteogenesis Imperfecta; b) Locus Heterogeneity; Inter-allelic and intra-allelic heterogeneity; phenotypic heterogeneity c) Genetics of triplet repeat disorders</p> <p>Transition from Genetics to Genomics: Structural, Functional and Comparative Genomics; Need to study whole genome [1 lecture hour]. Cancer Genetics: Somatic Mutations and affected pathways, Oncogenes and TSGs, LOH, Control of Cell Cycle, Epithelial mesenchymal transition; Control of Genome stability, methods to study alterations of gene expression in cancer (through Microarray)</p>
SUGGESTED READINGS	<ol style="list-style-type: none"> 1. Molecular biology of the cell by Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff; Ed. 5th; Garland Science; 2008. 2. Molecular biology of the cell: the problem book by John Wilson and Tim Hunt; Ed. 5th; Garland Science; 2008. 3. Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6th; W H Freeman and Company; New York; 2008. 4. Cell: molecular approach by Geoffrey M. Cooper and Robert E. Hausman; Ed. 4th; ASM Press; 2007. 5. Cell biology by Thomas D. Pollard and William C. Earnshaw; Ed. 2nd; Saunders; 2008. Topley and Wilson's Microbiology and Microbial Infections by Leslie Collier and Albert Balows and Max Sussman; Ed. 9th; 6-Volume Set; A Hodder Arnold Publication, 2000. 6. Human Molecular Genetics, Strachan T and Read AP – Garland Science



7. Genomes, Brown TA – Wiley Liss
8. Human Genetics and Genomics, Korf BR - Wiley
9. The Book of Genes and Genomes, Willard and Haga, - Springer
10. Modern Genetic Analysis, Griffiths AJF, Gelbart WM, Miller JH et al., - Freeman
11. An Introduction to Genetic Analysis, Griffiths AJF, Miller JH, Suzuki DT et al., - Freeman

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M.Sc. BIOMEDICAL SCIENCE		I SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: MEDICAL BIOTECHNOLOGY			
CREDIT: 04		THEORY HOURS: 90	
MARKS: 100		THEORY EXAM: 80	CCA: 20
UNIT-1 20 Hours	Prokaryotic Restriction Modification system, Types of Restriction endonucleases & restriction maps, Endonucleases produces 3' Overhang and 5' Overhang, Producing new restriction endonuclease sites. Various RDT enzymes such as S1 nuclease, Alkaline phosphatases, polynucleotide kinase, mung bean nuclease their mechanism and application, Vectors-Origin of cloning vectors and various modified versions of vectors, Bacterial, yeast expression vectors, mammalian expression vector		
UNIT-2 20 Hours	Cloning vectors, Tetracycline regulated vectors, shuttle vectors, YAC & BAC. Principles of selection of gene cloning, preparation of probes, Blue white selection, insertional inactivation, LacZ application, luciferase reporter system. Detection and identification of cloned DNA sequencing, methods of DNA sequencing, pyrosequencing, nanopore sequencing,		
UNIT-3 15 Hours	Next generation sequencing. Application and principles of Polymerase Chain Reaction, RFLP analysis, real time PCR, Disease diagnostics eg: genetic diseases (cystic fibrosis, sickle cell anemia, hemophilia etc), detection of pathogenic strain, single nucleotide polymorphism in disease diagnosis. (Gene Mutagenesis-Different methods used to generate recombinant mutants (deletion and point mutations), exonucleases, S1 nuclease, Genome editing system using ZFN, CRISPR, TALEN.		
UNIT-4 20 Hours	Application of recombinant DNA technology, DNA fingerprinting in forensic sciences. Biotechnology towards therapeutics, Gene therapy (Viral on non-Viral), Adenoviral vectors or retroviral based gene therapy, stem cell based disease diagnosis and therapies. Introduction to the concept of Regenerative Medicine, Advance Pleuripotent stem cell derived therapies, Induced pleuripotent stem cell,		

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mesenchymal stem cell. Exosomes: Biomarkers, Cancer diagnosis, Tissue repair
Bio-safety and ethics for recombinant DNA technology ,

**SUGGESTED
READINGS**

1. *Principles of Gene manipulation (Primrose), 7th Edition*
2. *Molecular Cloning (A laboratory manual), Vol 1, Vol 2, Vol 3*
3. *Molecular Cell Biology (Lodish), 7th Edition*
4. *Review articles from: Nature Reviews (Journals)*

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M.Sc. BIOMEDICAL SCIENCE		I SEMESTER
COURSE CODE: BSC		COURSE TYPE: CCC
COURSE TITLE: TECHNIQUES AND INSTRUMENTATION		
CREDIT: 04	TEACHING HOURS: 90	
MARKS: 100	THEORY EXAM : 80	CCA: 20
UNIT-1 15 Hours	<p>Selecting an analytical method and developing a new Analytical Technique.</p> <p>Ultraviolet. Visible molecular absorption spectroscopy, Theoretical basis, transitions, Lambert's Beers Law, factors affecting Absorption, Fluorescence and Phosphorescence (principle Jablonski diagram), Fluorescence quenching (dynamic, static, Stern volmer constant, FRET with examples from Biomedical field.</p> <p>Biomolecular interactions using spectroscopic methods,. Infrared – vibrational spectroscopy introduction, Functional group identification, Effects of various factors on IR frequencies and biomedical application. Concept of circularly polarized light and principles of CD. CD instrumentation, concepts of band width, slit width, scan speed, and other factors in getting proper resolution of bands. Application of CD in macromolecular structure determination, binding studies and other applications.</p>	
UNIT-2 15 Hours	<p>An introduction to chromatographic separation, Gas Chromatography, Pressure Liquid Chromatography and FPLC, Supercritical fluid chromatography. Theory of NMR: Quantum description, Classical description – Procellional motion, Larmour frequency, Relaxation processes, T1 and T2 and their measurement. Fourier Transform NMR: Pulsed excitation, FID, Types of NMR Spectra – Wild line and high. - resolution spectra. NMR Spectrometers: Instrumentation.</p> <p>Introduction to ¹³C NMR: Proton decoupling: Broad band, off-resonance, Pulsed decoupling, NOE, application to structure determination.</p> <p>The concept of MRI, BOLD imaging, fMRI, Application in Muscle Physiology, functional mapping of brain. Other nuclei : ³¹P, ¹⁹F, ²³Na, ¹⁵N, metabolomics studies using NMR</p>	
UNIT-3 20 Hours	<p>Introduction to mass Spectrometry. Forming charged particles: Electron impact (EI) and Chemical Ionization(CI), Fast Atom Bombardment (FAB), Field Desorption (FD), Electrospray Ionization, Matrix Assisted Laser Desorption Ionization (MALDI).</p> <p>Mass Analyzers: Magnetic sector mass spectrometers, Double focusing mas spectrometers, Quadrupole pole mass spectrometers, ion cyclotron resonance, Time of Flight mass analyzers.</p>	

	Combine the mass spectrometer with Gas Chromatography
UNIT-4 20 Hours	Introduction to flow cytometer: Need and versatility of FACS. Fluidics and Optics in FACS. Filters and detectors in FACS: choosing the right fluorochromes, compensation of overlapping emissions. Plotting of data in various formats (Histograms/dot plots/contour plots) Gating, Principles of cell Sorting by FACS and MACS. Confocal Microscopy: Applications in Cell Biology, Electron Microscopy, Tracer Techniques in Biology: tumor diagnosis and imaging, infectious diseases such as tuberculosis. Biomolecular Structure determination techniques: X-Ray crystallography.
SUGGESTED READINGS	<ol style="list-style-type: none"> 1 Spectrometric identification of organic compounds by Robert M. Silverstein and Francis X. Webster; Ed. 6th; John Wiley; 1997. 2 Principles of instrumental analysis by Douglas Skoog and F. James Holler and Timothy A. Nieman; Ed. 5th; Saunders; 1998. 3 Contemporary instrumental analysis by Kenneth A. Rubinson and Judith F. Rubinson; Prentice Hall 2000. 4 Organic spectroscopy by William Kemp; Ed. 3rd; Palgrave; 1991. 5 Basic one and two dimensional NMR spectroscopy by Horst Friebolin; Ed.3rd; Wiley- VCH; 1998. 6 Principles of Fluorescence Spectroscopy by Lacowicz, 3rd Ed. 2006, Springer US. 7 NMR and its applications to living systems by David G. Gadian; Ed. 2nd; Oxford; 1995. 8 Structure determination of organic compounds: tables of spectral data by E. Pretsch and P. Buhlmann and C. Affolter; Springer; 2005. 9 MRI principles by Donald G. Mitchell; W S Saunders; 1999. 10 HPLC: a practical user's guide; Ed.2nd by Marvin C. McMaster; Wiley-Interscience; 2007.

M.Sc. BIOMEDICAL SCIENCE

I SEMESTER

COURSE CODE: BSC

COURSE TYPE: PRACTICAL

COURSE TITLE: LAB (Lab Course 1)

CREDIT: 04

PRACTICAL HOURS: 90

MARKS: 100

LABORATORY WORK

1. Preparation of buffers and other solutions
2. Salting in and salting out of proteins.
3. Void Volume estimation
4. Desalting of proteins by dialysis
5. Desalting of proteins by Sephadex G-25
6. Protein estimation by Lowrys & Bradford methods.
7. Protein estimation by Lamberts & beer law
8. Ion-exchange chromatography.
9. Affinity chromatography for protein:
 - (i) protein induction & binding to affinity column
 - (ii) running gel & analysis
10. To check purity of protein & subunit structure by SDS page silver staining
 - (i) reducing Gel (ii) non reducing Gel
11. (i) Running Western blot of a specific protein:
 - (i) SDS, transfer & blocking and (ii) probing with antibodies & analysis of result
12. To run Native Gel of a protein/Far western blot.
13. Protein & Nucleic Acid blots, Clustal W and sequence alignment etc.
14. Measurement of Enzyme activity parameters
15. Measurement of Enzyme inhibition mechanisms
16. Recrystallization and Melting Determination
17. Thin Layer Chromatography (mixture of 2 compounds)
18. Thin Layer chromatography (mixture of 3 compounds)
19. Claisen Schmidt reactions
20. Infrared spectroscopy (instrumentation and spectra analysis)
21. Cannizarro reaction
22. Optical activity by polarimetry of known optically active compound of known concentration and hence to determine concentration of unknown sample
23. Column chromatography

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24. Aldol condensation
- 25 Schotten Baumann reaction
- 26 Demonstration of sterilization techniques related equipments and use of aseptic techniques for preparation of pure cultures.
- 27 Demonstration of differential staining techniques like Gram's staining, AFB staining, spore staining etc. Differentiation of flagellate vs nonflagellate bacteria.
- 28 Differential diagnosis of bacteria based on biochemical tests.
- 29 Spread plate technique and antibiotic sensitivity assay.
- 30 Identification of medically important fungi.

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M. Sc. in Biomedical Science

SECOND SEMESTER (EVEN SEMESTER)

Course Code	Course Type	COURSE (PAPER/SUBJECTS)	Credits	Maximum Marks		
				Internal	External	Total
BSC	CCC	Human Physiology-I	4	20	80	100
BSC	CCC	Medical Microbiology	4	20	80	100
BSC	CCC	Immunology	4	20	80	100
BSC	CCC	Molecular Biology	4	20	80	100
BSC	LAB	Lab (Lab Course 2)	4	20	80	100
Minimum credits in complete semester it would be 20			Total: 20			

The M.Sc. program will be divided into four semesters each being of six months duration. Each semester comprises of compulsory core courses (CCC) Lab course (LC) will be based on CCC. Each theoretical course will be divided into Internal Assessment of 20 marks and semester end examination of 80 marks.

Duration of Theoretical and Practical Examination Time: 03 Hours

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M.Sc. BIOMEDICAL SCIENCE		II SEMESTER
COURSE CODE: BSC		COURSE TYPE: CCC
COURSE TITLE: HUMAN PHYSIOLOGY-1		
CREDIT: 04	TEACHING HOURS: 90	
MARKS: 100	THEORY EXAM: 80	CCA: 20
UNIT-1 18 Hours	Fluid mosaic model of the membrane, Fluidity, Transport of ions and molecules through cell membrane: diffusion and active transport. <i>Concept of Membrane potentials</i> : types of membrane potential, resting membrane potential, graded and action potentials, methods to record and observe membrane potential. Physiologic anatomy of skeletal muscle, neuromuscular transmission and excitation-contraction coupling, Molecular mechanisms of muscle contraction, Energetics of muscle contraction, muscle fatigue, motor unit recruitment, size principle, muscle mechanics, and Electromyogram.	
UNIT-2 18 Hours	Respiratory system: Anatomy and Functions of respiratory passageways, pulmonary circulation, pulmonary edema and pleural fluid. Pulmonary ventilation: mechanisms of pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation. Physical principles of gas exchange, Diffusion of gases through respiratory membrane, Transport of oxygen and carbon dioxide in blood and body fluids. Regulation of respiration: respiratory center, peripheral chemoreceptor system, central chemoreceptor system and their regulatory function. Respiratory Adjustments in Health & Disease: Effects of Exercise, Other Forms of Hypoxia, Oxygen Treatment, Hypercapnia & Hypocapnia, Effects of Increased Barometric Pressure, Artificial Respiration, Respiratory acidosis and alkalosis, Regulation of acid-base balance.	
UNIT-3 18 Hours	Body fluid and excretory system: <i>Body fluid compartments</i> : Basic principles of osmosis and osmotic pressure: Extracellular and intracellular fluids, Interstitial fluid and edema with its etiology. Urine formation by kidneys: renal blood flow and their control, Glomerular filtration, Determinants of glomerular filtration rate, Tubular processing of glomerular filtrate, Reabsorption and secretion along different parts of nephron, Regulation of tubular reabsorption, Functions of kidneys in homeostasis, Diuretics, Micturition and disorders of Non-excretory function of kidney, Integration of renal mechanisms for control of blood volume and extracellular fluid volume. Regulation of extracellular fluid	

UNIT-4
16 Hours

osmolarity and sodium concentration, Role of thirst in controlling extracellular fluid osmolarity and sodium concentration, Renal regulation of potassium, calcium, phosphate and magnesium.

Gastrointestinal system: General principles of gastrointestinal function - motility, nervous control, and blood circulation, Transport and mixing of food in the entire alimentary tract, sphincters of gastrointestinal tract. Ingestion of food, vomiting, motor functions of stomach, Defecation and its control. Secretory functions of alimentary tract: Secretion of saliva, Gastric secretion, pancreatic secretion, Secretion of bile by liver, Secretions of small and large intestine. Digestion and absorption in gastrointestinal tract, Digestion of various foods, Neuronal regulation of feeding, obesity and starvation.

Reproductive system: Anatomical and functional aspects of human genital system, Sex Differentiation & Development, Aberrant Sexual Differentiation, Embryology of the Human Reproductive System, defects of reproductive system, Puberty: Precocious & Delayed Puberty, Menopause, Male: Gametogenesis, Development structure and function of testis with Ejaculation, Control of Testicular Function, Abnormalities of Testicular Function, Female: Gametogenesis Development structure and function of ovary The Menstrual Cycle, Control of Ovarian Function, Abnormalities of Ovarian Function, Pregnancy: conception, fetal development, placenta, parturition, Lactation, fertility and infertility, Physiological concepts for a planned family

Endocrine system: Anatomy and structure, formation, secretion and regulation of hormones, hypo- and hyper secretions. Diseases of the following glands Thyroid, Adrenal, Parathyroid, Pituitary Thyroid Anatomic Considerations, Formation & Secretion of Thyroid Hormones, Transport of Thyroid Hormones, Effects of Thyroid Hormones, Regulation of Thyroid Secretion, Clinical Correlates. Adrenal Medulla, Structure & Function of Medullary Hormones: Regulation of Adrenal Medullary Secretion, Adrenal Cortex Structure & Biosynthesis of Adrenocortical Hormones. Effects of Adrenal Androgens & Estrogens, Physiologic, Pharmacologic & Pathologic considerations. Effects of Glucocorticoids, Regulation of Glucocorticoid Secretion, Effects of Mineralocorticoids, Regulation of Aldosterone Secretion, Summary of the effects of Adrenocortical Hyper & Hypofunction in Humans. The Parathyroid Glands, Calcitonin, Effects of Other Hormones & Humoral Agents on Calcium Metabolism

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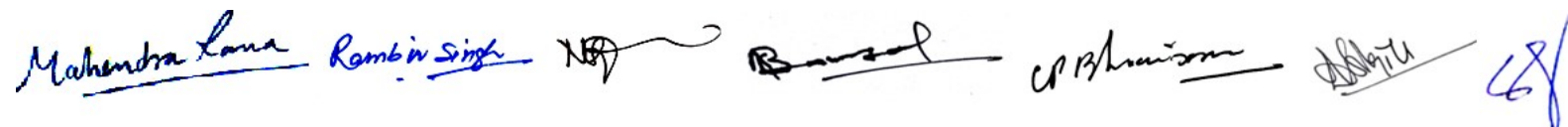
**SUGGESTED
READINGS**

1. *Textbook of medical physiology by Arthur C. Guyton and John E. Hall; Ed.13th & 14th.*
2. *Review of medical physiology by William F. Ganong; Ed. 23nd; McGraw Hill; 2010.*
3. *Essential medical physiology by Leonard R. Johnson and Ed. 3rd; ELSEVIER; 2003.*
4. *Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.15th; John Wiley; 2016.*
5. *Hole's Human Anatomy & Physiology, McGraw-Hill Education; 14th edition, 2015*
6. *Medical Physiology: A cellular and molecular approach by Walter F. Boron and Emile L. Boulpaep; Saunders; Ed. 3rd, 2017.*
7. *Physiology by Robert M. Berne and Matthew N. Levy; Mosby; ELSEVIER, Ed.7th 2018.*
8. *Essentials of Anatomy & Physiology Plus Mastering A&P with Pearson (7th Edition) 2016*

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M.Sc. BIOMEDICAL SCIENCE		II SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: MEDICAL MICROBIOLOGY			
CREDIT: 04		THEORY HOURS: 90	
MARKS: 100		THEORY EXAM: 80	CCA: 20
UNIT-1 20 Hours	<p>Bacterial morphology: detailed structural features of gram positive and gram negative bacteria, Staining techniques for identification of bacteria. Detailed structure and functions of various bacterial organelles, cell wall, cell membrane, ribosomes, flagella, spores, capsules, storage components, quorum sensing. Techniques to study morphology of bacteria, Nutrition and condition requirements of bacteria: Macro and micronutrients, growth of bacteria , temperature, moisture and dessication, oxygen and carbon dioxide requirements of bacteria. Multiplication and bacterial growth and methods to study growth patterns in bacteria. Aseptic techniques, methods for pure culture isolation. Cultivation methods for bacteria. Types of Nutrient media for bacteria. Aerobic and anaerobic culture methods.</p> <p>Identification of bacteria using biochemical methods. Disinfection and sterilization: definition, importance, Physical agents: autoclave, hot air sterilization, incinerators, pasteurisation, tyndallisation, methods of quality check. Normal flora of human body and their significance. Nosocomial infections.</p>		
	UNIT-2 20 Hours	<p>Bacterial and Phage genetics: Transformation, transduction, Conjugation, genetic map construction in <i>E.coli</i>. Phage genetics, fine structure of rII region, work of Seymour Benzer., highlighting the design of experiment and choice of the experimental model.</p> <p>Genetic Variation; transposition and its application in genetic studies. Extra chromosomal inheritance, chloroplast and mitochondrial inheritance, mitochondrial mutations in yeast, human genetic disorders related to mitochondrial inheritance.</p>	
UNIT-3 15 Hours	<p>GI tract infections: Salmonella, Shigella, Staphylococcus, E. coli, Helicobater pylori. Microbial pathogenicity, virulence factors and their effect on pathogenesis. Chemotherapy: structure and mechanism of action of Cell wall inhibitors, antimetabolites. Antimicrobial chemotherapy, protein synthesis inhibitors, Nucleic acid inhibitors. Methods for estimation of antimicrobial activity. Mechanisms of Antibiotic resistance. Literature for new emerging antibiotics. Urinary tract infections.</p>		

	<p>New and re-emerging diseases. infections of the respiratory system: commensals vs infectious organisms, Diagnosis and prevalence of <i>Corynebacterium diphtheriae</i> in India and the world. Virulence factors of <i>Corynebacterium diphtheria</i>, Treatment and management of <i>Corynebacterium diphtheria</i></p>
<p>UNIT-4 20 Hours</p>	<p>Spore formation in fungi, Economic importance of fungi. Mycoses, <i>Tinea Versicolor</i>, White Piedra, Black Piedra. Dermatophytes, Dermatophytidid, Candidiasis, Cryptococcosis. Opportunistic Fungi, Ostomycosis. Fungal Contaminants. Medical parasitology overview and classification of medically important parasites.</p> <p>Shapes and structure of viruses, classification of viruses. Life cycle of various viruses as per Baltimore system of classification. Arboviruses, their genetics, pathogenesis, epidemiology, diagnosis and clinical features with emphasis on hepatitis, Dengue, Zika and Chikungunya viruses</p>
<p>SUGGESTED READINGS</p>	<ol style="list-style-type: none"> 1. <i>Medical Microbiology</i> by Geo. Brooks and Karen C. Carroll and Janet Butel and Stephen Morse; Ed. 24th; McGraw-Hill Medical, 2007. 2. <i>Microbiology</i> by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th; McGraw-Hill Science, 2004. 3. <i>Medical microbiology: a guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control</i> by David Greenwood and Richard C. B. Slack and John F. Peuthere, ed. 17th Ed. Churchill Livingstone; 2007. 4. <i>Fundamental Virology: Fields and Knipe</i>, ed. Raven Press, 1991. 5. Strauss, E. G. and Strauss, J. H., “<i>Viruses and Human Disease</i>”, Academic Press, 2002. 6. Flint, S.J., Enquest, L.W., Krug, R. M., Racaniello, V. R., and Skalka, A. M., “<i>Principles of Virology: Molecular Biology, Pathogenesis and Control</i>”, ASM Press. 2000.



M.Sc. BIOMEDICAL SCIENCE		II SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: IMMUNOLOGY			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM: 80	CCA: 20
UNIT-1 15 Hours	History and scope of Immunology: Introduction to Immune System, concepts of Innate and acquired Immune responses, Active and passive Immunity , Natural and artificial immunity, primary and secondary immune responses. Lymphoid System- overview . Lymphatic system and lymphocyte traffic. .Lymphoid Tissue: Primary and Secondary Lymphoid organs. Anatomy and functional significance of Thymus, Bone marrow, Anatomy and functional significance of spleen, various lymph nodes, MALT, GALT, NALT, ILT, Cells involved in the Immune Response: Structural and functional features of cells involved in immune responses and their relative significance. Lymphocytes (B&T lymphocytes), NK Cells. Mononuclear Phagocytes, Antigen- presenting cells, Polymorphonuclear cells, eosinophils, basophils and mast cells, Cluster designation Ag specific receptors (comparison of Human and Mouse Lineages)		
	UNIT-2 15 Hours	Dendritic cells: discovery types and functions: DC 1 vs DC2 vs Follicular DC. Antigen recognition processing, presentation and cross-presentation of antigens by DC subsets. DC priming of T independent antigens, DCs as immunotherapeutics. Innate immune system: overview. Cells and receptors of the innate immune system. Diversity in Antigen recognition receptors of innate immunity, Signaling from Toll Like Receptors. Cell surface and intracellular antigen/pathogen recognition systems: NOD/NLR/TLR9. Secretory receptors of innate immune system and their functions. Innate memory and danger hypothesis. Macrophages: types, location and function. Neutrophils and NK cells: mode of action and neutralization of pathogens	
		UNIT-3 20 Hours	Antibody Generation, structure and Function : Over View of Humoral immunity, Clonal Selection Theory, Immunoglobulins classes and their functions , Antibody Structure and Function. Antibody Effector Mechanisms, Antibody Receptors, Basis of Antibody Diversity, Mechanisms of Immunoglobulin Gene Recombination, and B cell development. Mechanism and Effect of Somatic Mutations on the Antibody Diversity, Mechanism of Ab Class switching. Antibody Responses in vivo, Enhanced Secondary

	<p>Responses , significance Isotype switching, Affinity Maturation and development of Memory responses. Major Histocompatibility Complex overview and significance. Structure of MHC Class I Molecules, Structure of MHC Class II Molecules, Genomic Organisation of the MHC locus in Mice and Humans, Diversity of MHC molecules and their effect of immune response modulation.</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">UNIT-4 20 Hours</p>	<p>Cell Mediated Immune Response Overview, T lymphocyte classification, lineage and Mechanisms of development of T cells in thymus. Structure of T cell receptors , Mechanisms of recombination and diversity of TCR genes, self tolerance mechanisms. Regulation of innate and humoral responses by T cells. T cell APC interactions and modulation of Immune responses.</p> <p>Regulation of Immune Response: Antigens, classification of antigens based on their interaction and functions. Superantigens, interaction of Antigens with Antigen Presenting Cells, Antibody, Lymphocytes</p> <p>Immunopathology: overview Rh- blood groupings, Autoimmune Diseases, Basis of breach of central and peripheral tolerance.</p> <p>Immuno-deficiencies, Genetic disorders congenital and acquired.</p> <p>Hypersensitivity Reactions (type I and type IV), Role of IgE, Mast cells, Genetic basis of Allergic Response and pathogenesis.</p> <p>Immune Tolerance overview: Self Tolerance, Transplantation and Rejection mechanisms</p> <p>Mechanism of Antigen-Antibody Interaction, Experiment based evidence to calculate antigen binding sites, avidity, affinity. Immunological Techniques: Principles, significance and methods; Agglutination(Direct/Indirect), Precipitation(Radial and double immunodiffusion) and Radioimmunoassays.</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">SUGGESTED READINGS</p>	<ol style="list-style-type: none"> 1. <i>Fundamental Immunology William Paul (Ed) 2017. Lippincott Williams & Wilkins.</i> 2. <i>Kuby Immunology by Thomas Kindt and Richard A. Goldsby and Barbara A. th Osborne; Ed. 6 edition. W.H. Freeman and Company, New York; 2007</i> 3. <i>Cellular and molecular immunology by Abul K. Abbas and Andrew H. Lichtman and Shiv Pillai; Ed. 6th; Saunders, 2007.</i> 4. <i>Immunology; Ed.7th by David Male and Jonathan Brastoff and David B. Both and Ivan Roitt; Mosby Elsevier; 2006.</i> 5. <i>Immunobiology: the immune system in health and disease by Charles A. Janeway and Paul Travers and Mark Walport and Mark J. Shlomchik; 7th Ed; Garland Science; 2008.</i> 6. <i>Immunology of infection diseases by Stefan H. E. Kaufmann and Alan Sher and Rafi Ahmed; ASM Press, Washington; 2002.</i> 7. <i>Essentials of immunology & serology by Jacqueline H. Stanley; DELMAR; Australia; 2002.</i>

M.Sc. BIOMEDICAL SCIENCE		II SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: Molecular Biology			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM: 80 CCA: 20	
UNIT-1 15 Hours	Molecules and macromolecules in BIOMEDICAL systems, Amino acids, peptides and proteins, Structure and Functions of proteins Formation of peptide bonds, Protecting groups and peptide bond formation, protein degradation and sequencing of amino acids, DNA and RNA bases, nucleosides and nucleotides, phosphodiester, formation of N- and C- glycosides, conformation and configuration of 5 carbon and 6-carbon sugars, maltose, sucrose and lactose, Synthetic macromolecules and polymers in biology, Building of macromolecules and molecular frameworks and their biomedical applications.		
	UNIT-2 15 Hours	Synthetic strategies for artificial systems that mimic BIOMEDICAL entities, applications of supramolecular principles to molecular diagnosis, therapeutic applications of supramolecular chemistry. Nanotechnology and its applications in drug delivery and other biomedical applications, Mechanisms in BIOMEDICAL Chemistry, Active methylene groups, aldol and retroaldol reactions, schiff bases and enamine reactions, nitrogen, phosphorus and sulfur ylides. Umpolung reaction, Michael addition, Polymer supported organic reactions, phase transfer catalysis, Equivalence of these reactions in BIOMEDICAL system, Enzyme and Coenzyme systems: Enzyme classifications, Inhibitors, Mechanisms of Enzymes. Mechanism of coenzyme catalysis, Coenzyme A, NAD ⁺ and NADPH, FMN and FAD, biotin, PLP, TPP, lipoic acid, tetrahydrofolate, ascorbic acid, cyanocobalamin and cytochrome P-450 Hammett and Taft equation, Steric and solvent effects, role of pH, role of reaction media on certain reactions	
		UNIT-3 20 Hours	TRANSCRIPTION IN PROKARYOTES & EUKARYOTES: Basic concepts of transcription in prokaryotes using E-coli as an example, Structure & function of RNA polymerases. Transcription initiation, proteins involved in initiation, Experimental

evidence to check their function. Transcription elongation and termination. Transcription in eukaryotes- differences and similarities, inhibitors of transcription Structure of TFIID, and other general transcription factors. Methods to identify the subunits of complexes. Post transcriptional regulation of transcription (polyadenylation, capping), mechanism and their role in transcription, Transcription regulation by methylation, acetylation of histones.

Inhibitors of transcription in prokaryotes and eukaryotes, Determining the mRNA half life of mRNA. Promoter structure and Transcription by RNA polymerase , Structure of Promoter and Transcription by RNA polymerase III,

Regulation of gene expression in Prokaryotes: Coordinated control of clustered genes-operon model, with example of inducible systems like Lac– Operon. Experimental proof for the operon, use of mutants of I gene, O^c mutants in understanding operon function. Role of cyclic AMP, catabolite repression and regulation by glucose.Repressible systems like Trp operon. Concept of attenuation. Trp operon cond. Arabinose operon concepts of dual role of regulatory protein, Arabinose operon contd. Identification and understanding the role of sRNA in gene regulation in prokaryotes. Other regulatory pathways in prokaryotes

Regulation of Gene expression in Eukaryotes: Introduction-Organization of genes in eukaryotic DNA Repetitive DNA sequences, multiple regulatory sequences, activators, coactivators, repressors, Activators contd, enhancers. Modular structure of transactivators (Zn fingers, HLH, HTH etc). Repressor complexes, mechanism of their function in gene regulation. Regulation of gene expression by hormone receptors. Concept of half-site. Methods used to study protein-DNA interactions EMSA controls, supershift etc. DNA foot printing, reporter assays to prove binding.

Homodimers and heterodimers in differential gene regulation with examples. Diseases linked with altered gene expression. Methods used to study protein-protein interactions (i) yeast two hybrid, controls, library screening to identify new interacting partners.

(ii) Concept of co-Immunoprecipitation, uses, advantages and disadvantages of two techniques. Alternate splicing in gene regulation, mechanism. Alternate splicing contd. splicing factors etc, gene editing. Ribozymes–Structure and mechanism of action. microRNA and its role in gene regulation (in brief).

Chromatin remodeling:Introduction to chromatin remodeling concepts and factors involved. Role of various remodeling proteins such as NURF, ACF,Role of DNA and histone methylation and histone acetylation in chromatin remodeling and gene regulation. Concept of insulators, nuclear matrix in gene regulation, Methods to

understand chromatin remodeling.

**SUGGESTED
READINGS**

1. *Biomedical Chemistry: Applying Chemical Principles to the Understanding and Treatment of Disease* edited by Paul F. Torrence.
2. *Molecular Biology of Gene*, Watson James D., Baker Tania A., Bell Stephen P., Gann Alexander, Levine Michael, Losick Richard .
3. *Karp's Cell and Molecular Biology: Concepts and Experiments, Binder Ready Version, 8th Edition.*

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*

M.Sc. BIOMEDICAL SCIENCE

II SEMESTER

COURSE CODE: BSC

COURSE TYPE: PRACTICAL

COURSE TITLE: Lab Course 2

CREDIT: 04

PRACTICAL HOURS: 90

MARKS: 100

LABORATORY WORK

Primer designing for gene amplification using PCR, and other types of primers for real time PCR based detection or analysis

Preparation of Various solutions and Buffers, cell culture LB (Luria-Bertani) media preparation, LB-Agar Plates, Ampicillin Antibiotics preparation, autoclaving, sterilized surface, laminar flow operation.

Adopting calcium chloride methodology for Competent cells preparation

Polymerase Chain Reaction based gene amplification and recombinant formation using cloning vector

Recombinant plasmid isolation and preparation

Recombinant restriction digestion of DNA and excision of DNA from Agarose gel

Heat shock methodology based recombinant transformation, competent efficiency calculation and Blue white colony screening

Application of Polymerase Chain Reaction based infectious or non-infectious disease diagnosis

Loop mediated isothermal amplification assay

Concept of cell culture (Demonstration)

To demonstrate that activation of peritoneal macrophages/ myeloid lineage cells by lipopolysaccharides results in reactive oxygen production (RNS) and reactive nitrogen species production. Estimation will be done by flowcytometry, Colorimetry and microscopy assays.

The antigen antibody interaction mechanisms will be demonstrated by precipitation and agglutination assays (octerlony, mancini methods and indirect agglutination tests)

The T cell and B cell separation and their proliferation will be done using MACS and FACS

Pro-inflammatory cytokine expression will be demonstrated in activated cells by ELISA or immunofluorescence.

Mahendra Lona *Rambin Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*

M. Sc. in Biomedical Science

THIRD SEMESTER (ODD SEMESTER)

Course Code	Course Type	COURSE (PAPER/SUBJECTS)	Credits	Maximum Marks		
				Internal	External	Total
BSC	CCC	Human Physiology II	4	20	80	100
BSC	CCC	Principles of Medicinal Chemistry	4	20	80	100
BSC	CCC	Pharmacology & Toxicology	4	20	80	100
BSC	CCC	Bio informatics, Computational Biology and Drug Design	4	20	80	100
BSC	LAB	Lab (Lab Course 3)	4	20	80	100
Minimum credits in complete semester it would be 20			Total: 20			

The M.Sc. program will be divided into four semesters each being of six months duration. Each semester comprises of compulsory core courses (CCC) Lab course (LC) will be based on CCC. Each theoretical course will be divided into Internal Assessment of 20 marks and semester end examination of 80 marks.

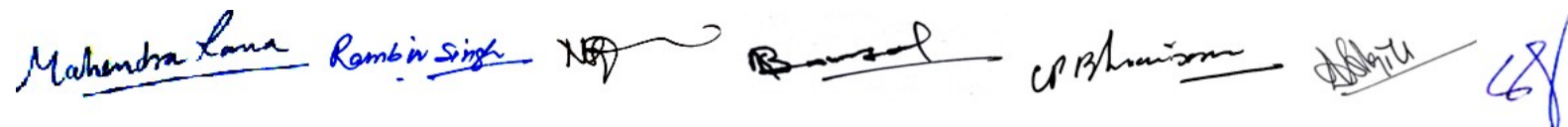
Duration of Theoretical and Practical Examination Time: 03 Hours

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*

M.Sc. BIOMEDICAL SCIENCE		III SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: HUMAN PHYSIOLOGY II			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM: 80 CCA: 20	
UNIT-1 18 Hours	<p>Cardiovascular system: Physiology of cardiac muscle (contractile and auto-rhythmic myocytes), Cardiac Cycle Control and Regulation of excitation, contraction and conduction of heart pumping, Heart sounds, Characteristics of normal electrocardiogram, analysis of ECG for various myopathies, Cardiac arrhythmias, Physical characteristics and basic theory of circulation, Vascular dispensability and functions of arterial and venous systems, Microcirculation and lymphatic system, Capillary fluid exchange, interstitial fluid and lymph flow, Local control of blood flow by tissues and humoral regulation, Nervous regulation of circulation, Cardiac output, venous return and their regulation, coronary circulation. Blood and circulation: blood corpuscles, haemotopoiesis and formed elements, plasma function, Hemostasis and blood coagulation, Blood banking, blood groups, and Transfusion.</p> <p>Overview of the Nervous System: Neuron and classification of nerve cell, nerve fibers, nerve, intracellular trafficking of neuron, Resting membrane potential of nerves, Nerve action potential, neurotransmitters: synthesis, models of exocytosis of synaptic vesicles and its inhibitors, synapse: types, pre and post synaptic regulation.</p> <p>Anatomical and functional division of nervous system, Spinal cord and cranial nerve, Blood-Brain barrier, Cerebral Blood Flow, Regulation of Cerebral Circulation.</p>		
	UNIT-2 18 Hours	<p>Motor System: Motor Units, Motor neurons types and characteristic of upper and lower motor neuron, lesions of upper and lower motor neuron. Muscle Receptors, Posture: Neural Systems Controlling Postural Orientation and Stability, Automatic Postural Reactions, Postural Reflexes: Infant to Adult, Spinal Reflexes. Grouping of Motor pathways: direct and indirect pathways, Cortical and brain stem control of motor function.</p> <p>Cognitive System: Neural Basis of Instinctual Behavior & Emotions: Limbic Functions: behavior, Sexual Behavior, Fear & Rage, Motivation</p>	



<p style="text-align: center;">UNIT-3 18 Hours</p>	<p>Learning and Memory: Cerebral Cortex: Intellectual functions of brain, learning and memory, Physiologic anatomy of cerebral cortex, Functions of specific cortical areas, Association areas, Function of brain in communication - language input and output, Function of corpus callosum and anterior commissure. Thoughts, consciousness and memory: Memory formation, types of memory, molecular pathway of memory formation, Activating-driving systems of brain, Functional anatomy and functions of limbic system and hypothalamus, States of brain activity, Brain waves, Origin in brain of brain waves (EEG). Sleep: Slow-wave sleep, REM sleep, Basic theories of sleep and awake, Physiological Mechanisms of Sleep and Waking, dreams sleep deprivation, Epilepsy, Psychotic behavior and dementia - roles of specific neurotransmitter systems.</p> <p>Sensory Physiology: Neuronal circuits for processing information, “Coding” of Sensory Information, Electrical & Ionic Events in Receptors. Somatic sensations: Tactile and position senses, Sensory pathways for transmission of somatic signals into the central nervous system, Sensory receptors, Transmission in dorsal column – medial lemniscal system. Pain and thermal sensations: Pain receptors and their stimulation, Dual transmission of pain signals into the central nervous system, Types of pain.</p>
<p style="text-align: center;">UNIT-4 18 Hours</p>	<p>Special Senses: Eye: The Image-Forming Mechanism (accommodation and visual acuity), Receptor and Photochemistry of vision, Neural function of retina. Visual Pathways and effects of lesions of these pathways. Hearing and equilibrium: Tympanic membrane and ossicular system, Cochlea, Central auditory mechanisms, directionality of sound, Vestibular sensations and maintenance of equilibrium, auditory and vestibular reflexes, oculo-vestibular system. Taste and smell: Anatomical aspects of olfaction and gustation, Receptors and sensory transduction of olfaction and gustation & Neuronal Pathways of olfaction and gestation</p> <p>The Autonomic Nervous: System Introduction Anatomic Organization of Autonomic Outflow Chemical Transmission at autonomic Junctions Responses of Effector Organs to Autonomic Nerve Impulses Cholinergic and Adrenergic Discharge.</p> <p>Central Regulation of Visceral Function: Hypothalamic Function: Autonomic Function, Cyclic Phenomena and circadian rhythm, Hunger Thirst Control of Posterior Pituitary Secretion Control of Anterior pituitary Secretion Temperature Regulation, fever.</p>



**SUGGESTED
READINGS**

1. *Textbook of medical physiology* by Arthur C. Guyton and John E. Hall; Ed. 13th & 14th.
2. *Review of medical physiology* by William F. Ganong; Ed. 23rd ; McGraw Hill; 2010.
3. *Essential medical physiology* by Leonard R. Johnson and Ed. 3rd; ELSEVIER; 2003.
4. *Principles of anatomy and physiology* by Gerard J. Tortora and Bryan Derrickson; Ed. 15th; John Wiley; 2016.
5. *Hole's Human Anatomy & Physiology* , McGraw-Hill Education; 14 edition, 2015
6. *Medical Physiology: A cellular and molecular approach* by Walter F. Boron and Emile L. Boulpaep; Saunders; Ed. 3rd , 2017.
7. *Physiology* by Robert M. Berne and Matthew N. Levy; Mosby; ELSEVIER, Ed. 7th 2018.
8. *Principles of Neural Science*, (Kandel) 5th Edition, 2013.
9. *Fundamental Neuroscience*, ELSEVIER 4th Edition, 2012
10. *Neuroscience Online, an Open-Access Neuroscience Electronic Textbook*
<https://nba.uth.tmc.edu/neuroscience/>

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*

M.Sc. BIOMEDICAL SCIENCE		III SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: Principles of Medicinal Chemistry			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM: 80 CCA: 20	
UNIT-1 18 ours	<p>Role of Medicinal Chemistry in discovery of drugs: Introduction to medicinal chemistry as a strategy to the design of new drug candidates for the human pathologies.</p> <p>Drug Design: Discovery of lead compound- Serendipous, Random and Non-random screening, drug metabolism studies, clinical observations, Rational approaches to lead discovery- Homologation, chain branching, ring-chain transformations, bioisosterism.</p> <p>Lead modifications: Conventional drug screening and structural modifications, concept of isosteres and bioisosteres, structure activity relationship, Quantitative structure activity relationships- Electronic effects: Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation, mathematical method for denovo design, Manual stepwise scheme 2DQSAR; 3D-QSAR examples, CoMFA</p> <p>Introduction to molecular modeling and molecular graphics, pharmacophore descriptors: The classical mechanics model (e.g., MM1, MM2), Quantum chemical methods semi-empirical and ab initio methods. Molecular graphics: View and manipulate molecular structures. Pharmacophore descriptors: Based on Genetic Algorithms--Partial Least Squares (GA-PLS) and K- Nearest Neighbors (KNN) to achieve a robust QSAR model characterized by the highest value of cross- validated R² (q²).</p>		
	UNIT-2 18 Hours	<p>Receptors: Chemical nature of receptors - Covalent, ion-ion, ion-dipole, Hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, Van der Waals interactions and the associated energies, Chirality and receptor binding.</p> <p>Drug receptor interactions- Occupancy Theory, Rate Theory, Induced Fit Theory, Macromolecular perturbation theory, Activation-Aggregation theory. Classification of receptors and receptor subtypes, Neurotransmitters and their receptors, Receptor modulation and mimics, Receptor sites. Chirality and receptor binding, Signal transduction</p>	

	and second messenger systems. Active transport, affinity and efficacy, antagonism, partial antagonism, inverse agonism, allosteric binding sites.
UNIT-3 18 Hours	Introduction of various classes of drugs based on their interaction with target site. With suitable examples, the drugs interacting with Receptors-Rational design of agonist/antagonist Enzymes Mechanisms of enzyme catalysis, Electrostatic catalysis and desolvation. Covalent catalysis, Acid-base catalysis, Strain / distortion in enzyme catalysis. Coenzyme catalysis. Enzyme Inhibition-Reversible and irreversible, rational design of various enzyme inhibitors, Adverse drug reactions, Drugs acting on cell wall, Fungal membrane and Nuclear membrane, Drugs inhibiting protein synthesis. DNA- NA as targets for drug action. NA-interactive agents. Classes of drugs that interact with nucleic acids. Intercalation, NA-alkylation, NA-strand breaking and their importance in drug action, Carbohydrates- development of glyco-conjugates in cancer models
UNIT-4 16 Hours	Structure activity relationship illustrated with examples from, Sulphonamides, b-lactams, Quinolones, Nucleosides and Alkaloids. Drug Metabolism: Biotransformations and their Mechanisms, Phase I and Phase II metabolism, Oxidation, Reduction, Hydrolysis, Deamination and Conjugation (GSH, Sulfate, Glucuronide and Amino acids), Role of non-specific enzymes: Oxidases, Mono-oxygenases, Di-oxygenases and Peroxidases, Biotransformations illustrated by suitable examples of commonly used drugs, Chirality and drug metabolism.
SUGGESTED READINGS	<p>1. <i>Organic chemistry of drug design and drug action</i> by Richard B. Silverman; Ed. 2nd; ELSEVIER; 2004.</p> <p>2. <i>Foye's Principles of Medicinal Chemistry</i> by Thomas L Lemke and David A Williams; Ed. 6th; Lippincott Williams & Wilkins; 2007.</p> <p>3. <i>Medicinal chemistry: principles and practice</i> by Frank D. King; Ed. 2nd; The Royal Society of Chemistry; 2002.</p> <p>4. <i>Introduction to Medicinal chemistry</i> by Graham L. Patrick; Ed. 3rd; Oxford; 2006.</p>

M.Sc. BIOMEDICAL SCIENCE		III SEMESTER	
COURSE CODE: BSC		COURSE TYPE: CCC	
COURSE TITLE: PHARMACOLOGY & TOXICOLOGY			
CREDIT: 04		TEACHING HOURS: 90	
MARKS: 100		THEORY EXAM: 80 CCA: 20	
UNIT-1 19 Hours	<p>Introduction to pharmacology: Scope of pharmacology: Introductory class to define pharmacology, historical background and limitations</p> <p>Pharmacokinetics: Absorption- Routes of administration of drugs, their advantages and disadvantages. Various processes of absorption of drugs and the factors affecting them</p> <p>Metabolism: Microsomal and non-microsomal mechanisms ii) Effect of Enzyme induction and inhibition on drug metabolism and the factors influencing them. Distribution - distribution of drugs and the factors affecting them Loading and maintenance doses Excretion of drugs- zero order, first order and steady state kinetics and half life of drugs, Numerical problems Pharmacodynamics: General mechanism of drug action and the factors, which modify drug action. : Dose response relationship curves and different types of antagonisms</p>		
	UNIT-2 18 Hours	<p>Pharmacodynamics: General mechanism of drug action and the factors, which modify drug action (signal transduction mechanisms in general. Dose-response relationship curves and different types of antagonisms. Drug receptor interaction and Theories. Pharmacological classification of drugs; the brief introduction of drugs should emphasize the ADME profile of following systems: Drugs acting on the central nervous system: Anesthetics- History, theory, mechanism and stages of anesthesia, Drug classification based on mechanism of action of anesthesia, Inhalation and general anesthesia; Local anaesthetics-classification and mechanism of local anesthesia, adverse reactions of Anesthesia, Pshychopharmacological agents: Sedatives, Hypnotics, anxiolytics, anti-mannaic, antidepressants, Drugs acting on the autonomic nervous system: Cholinergic drugs, anticholinergic drugs, anticholinesterase drugs, dopaminergic drugs, Adrenergic drugs and adrenergic receptor blockers, Neuron blockers and ganglion blockers, Neuromuscular blockers, drugs used in myasthenia gravis. Cardiovascular drugs, cardiotonics, antianginal</p>	

	<p>agents, antihypertensive agents, peripheral vasodilators and drugs used in atherosclerosis, coagulants and anticoagulants. Drugs acting on the respiratory system, Expectorants and antitussive agents, Drugs acting on the digestive system, Drug acting on Renal system, Coagulants and anticoagulants, Analgesics- Opioid analgesics (Morphine) and NSAIDs (Brufen), Hormones and hormone antagonists (Classification of hormones based on their pharmacological and physiological action), Mechanism of hormonal action (Hypothalamopituitary adrenal / thyroid axis).</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">UNIT-3 18 Hours</p>	<p>Principles of Toxicology: Definition, scope and different branches of toxicology. A brief review of toxic substances: Synthetic organic compounds: Chemical additives in food, Chemicals in the work place, Solvents, Pesticides, Cosmetics, Drugs of abuse. Inorganic chemicals: Industrial and chemical environmental inorganic toxicants polluting air/ water/ food. Naturally occurring poisons: Mycotoxins, Bacterial toxins, Plant toxins and Animal toxins.</p> <p>Types of toxicity and its measurement: Acute, Sub-acute or Chronic and its manifestations. Acute toxicity: Mode of application/ administration/ exposure, in-vitro tests, Dose response relationship, Measurement of TD 50/ TC 50 and LD 50/ LC50. Sub-acute and chronic toxicity. Risk and safety analysis: Margin of safety, Therapeutic index, Ideal therapeutic index. Inter-species extrapolation of dose-response data, NOEL, ADI, TLV, WHO standards. Special toxicity studies: Carcinogenicity, teratogenicity, in-vitro mutagenicity tests.</p> <p>Epidemiology of toxicity: Cohort study, Retrospect study, Case-control study, Cross-sectional study, Confounding.</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">UNIT-4 16 Hours</p>	<p>Pharmacokinetic aspects of toxicants: Site of metabolism, Metabolizing enzymes of liver, kidney, lung, GI tract, skin and their role in activation and detoxification of drugs and chemicals. Physiological (route of exposure, species, sex and age), Nutritional and environmental (temperature, altitude and circadian rhythms related) factors affecting metabolism, detoxification and toxic responses of drugs and chemicals.</p> <p>Organ toxicities: Hepatotoxicity: A brief description of morphological and functional aspects of liver with special reference to hepatotoxicity, various hepatotoxic agents, types of liver injuries- Fatty liver formation, Necrosis, Cholestasis, Hepatitis, Fibrosis, Cirrhosis, Carcinogenesis. Nephrotoxicity: A brief description of morphological and functional aspects of kidney in relation of nephrotoxicity, nephrotoxic agents, detailed mechanisms of chemical induced nephrotoxicity. Cardiovascular toxicity: A brief description of mechanisms of cardiovascular toxicity and cardiotoxic agents- subcellular</p>

and biochemical mechanisms. Neurotoxicity: A brief description neurotoxic agents and types of neurotoxic effects- Axonopathy, Nerveopathy, Neuronopathy, Myelinopathy. Broncho-pulmonary (inhalation) toxicity. Gastro-intestinal toxicity. Skin toxicity/ photosensitivity.

Tests for evaluation of toxicities in different organs: Therapeutic aspects: General measures and treatment of poisoning cases, Specific antidotes, Agents of first choice, Contraindications.

1. *Essential of medical pharmacology; 6th Ed. By K.D. Tripathi; Jaypee Brothers; New Delhi; 2008.*
2. *Goodman & Gilman's the pharmacological basis of therapeutics by Laurence Brunton and John Lazo and Keith Parker; Ed. 11th; McGraw-Hill Professional; 2005.*
3. *Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed. 5th; Churchill Livingstone, 2003.*
4. *Integrated Pharmacology: With Student Consult Access by Clive P. Page and M.J. Curtis and M.C. Sutter and M.J. Walker and B.B. Hoffman; Ed. 3rd; Mosby; 2006.*
5. *Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed. 2nd; CRC Press; 2006.*
6. *Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed. 5th; Informa Healthcare; 2009.*
7. *Casarett and Dull's toxicology: the basic science of poisons by Curtis D. Klaassen; Ed. 7th; McGraw Hill; New York; 2007.*
8. *Toxicology by Hans Marquardt and S.G. Schafer and R.D. McClellan and Academic Press; 1999.*
9. *Principles and practice of toxicology in public health by Ira R. Richards; Jones and Bartlett Publishers; 2007.*
10. *Handbook of human toxicology by E.J. Massaro; CRC Press; 1997.*

M.Sc. BIOMEDICAL SCIENCE		III SEMESTER
COURSE CODE: BSC		COURSE TYPE: CCC
COURSE TITLE: BIO INFORMATICS, COMPUTATIONAL BIOLOGY AND DRUG DESIGN		
CREDIT: 04	TEACHING HOURS: 90	
MARKS: 100	THEORY EXAM: 80	CCA: 20
UNIT-1 18 Hours	Basics of Bioinformatics, Basic commands of Windows, Unix and Linux operating systems, Sequence Analysis: Biological background for sequence analysis; Sequence alignment: Global, Local, Pairwise and Multiple sequence analysis; Algorithm for alignments	
	Database Searching; Tools for Sequence alignment. Biological Databases, Introduction to Data types and source; Protein Sequence and Structural Databases; Nucleic acid databases; Genome databases; Specialized Databases; Carbohydrate Databases; Clinically relevant drugdrug interactions databases; Information retrieval from Biological databases: Entrez system, TCGA data bases, Biportal Cheminformatics: Introduction; Cheminformatics tools; Chemical structure representation (SMILES and SMARTS); Chemical Databases: CSD, ACD, WDI, Chembank, PUBCHEM, Chemical Structure file formats; Structural Isomers; Structure visualization	
	Biosimilars: Introduction to biosimilars, Definition, Examples of Biosimilars Genetically engineered products of biosimilars, Molecular Complexity of biosimilars. Critical manufacturing parameters of biosimilars and Challenges-Modifications linked to the process, conversion and formulation. Concept of expression cassette and vector, Host cell and expression system. Non Clinical and Clinical Aspects of Biosimilars Preclinical approach and Clinical approach. Introduction to Computational Biology: Nature and scope of Computational Biology, Alignment definition, Pairwise sequence alignment, biological interpretation of the alignment problem, scoring alignment	
UNIT-2 18 Hours		
UNIT-3 18 Hours	Global alignment, local alignment, overlap alignment, banded alignment, normalized local alignment, maximizing Vs minimizing score, similarity and distance measures, PAM matrices, BLOSUM matrices, comparison between PAM and BLOSUM matrices, Application of substitution matrices. Pairwise sequence matching analysis: Sequence	

UNIT-4
18 Hours

matching method- Dot plot visualization method, Dynamic programming method, Word method, Bayesian method, progressive method, Markov chain model, Hidden Markov Models and Kernel methods Advances of Computational Biology: Synthetic biology- Ethical issues of Synthetic Biology, Computational Synthetic biology, Codon optimization, AND gate and OR gate in biology, Operons, Switches and clocks, Repressilator. Computational Quantum Mechanics- One electron atoms, Polyelectron atoms and molecules, Molecular orbitals, Hartree-Fock Equations, Molecular Properties using ab initio methods, Semi-empirical methods, Huckel Theory

Molecular modeling and Virtual Screening: Energy minimization and optimization, conformational analysis, global and local minima; Bioactive vs. global minimum conformations; Automated methods of conformational search; Molecular graphics; Computer methodologies behind molecular modeling, High throughput virtual Screening; Shape based virtual screening; Structure similarity searching; ADME/T Property prediction; Structural Fingerprint search. Pharmacophore: Concept of Pharmacophore generation and analysis, pharmacophore mapping, methods of conformational search used in pharmacophore mapping; Comparison between the popular pharmacophore methods like catalyst, HipHop, DiscoTech, GASP, etc. with practical examples. Structure based and Energy based pharmacophore models. Quantitative Structure Activity relationship (QSAR): QSAR Methodology, QSPR, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors.

Linearity versus non-linearity, importance of biological activity; Regression analysis, 2D-QSAR, 3D QSAR with case studies. CoMFA and CoMSIA; Tools for QSAR studies . Molecular Docking and Molecular Dynamics Simulations: Different types of molecular docking; Rigid docking; flexible docking; Protein Protein docking. Induced fit docking with case studies. QM/MM docking; Constraints and restraints in Molecular Docking. Significance of partial charges in molecular docking. Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Solvent effects in Molecular Dynamics; Conformational changes in Molecular Dynamics. Biomolecular Simulations; Free energy Calculations; Restraint Potentials, Importance of Force Field in Dynamics, Conformational Sampling: Energy Minimization, Monte Carlo Simulations, Membrane Simulation, Metadynamics

Mahendra Lona Rabin Singh NDA Bansal CP Bhargava Ashmita

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. & Watson, J.D. (1991). *Molecular Biology of the cell*. Oxford (3rd ed.). Garland publishers.
2. De Robertis, E. D., & De Robertis, E. M. (1987). *Cell and molecular biology*. Lea & Febiger.
3. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2004). *Overhead Transparency Set for Lehninger Principles of Biochemistry (4th ed.)*. WH Freeman.
4. Aluru, S. (2005). *Handbook of computational molecular biology*. Chapman and Hall/CRC.
5. Gutka, H. J., Yang, H., & Kakar, S. (Eds.). (2018). *Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development (Vol. 34)*. Springer.
6. Haubold, B., & Wiehe, T. (2006). *Introduction to computational biology: an evolutionary approach*. Springer Science & Business Media
7. Najarian, K., Najarian, S., Gharibzadeh, S., & Eichelberger, C. N. (2009). *Systems biology and bioinformatics: a computational approach*. CRC Press.
8. Prugnaud, J. L., & Trouvin, J. H. (Eds.). (2012). *Biosimilars: A New Generation of Biologics*. Springer Science & Business Media.
9. Ramachandran, K. I., Deepa, G., & Namboori, K. (2008). *Computational chemistry and molecular modeling: principles and applications*. Springer Science & Business Media.
10. Cavasotto, C. N. (Ed.). (2015). *In silico drug discovery and design: theory, methods, challenges, and applications*. CRC Press.
11. Gore, M., & Jagtap, U. B. (Eds.). (2018). *Computational drug discovery and design*. Humana Press. Grover, A. (2017). *Drug Design: Principles and Applications*. Singapore: Springer Nature Singapore Pte Ltd.
12. Marx, D., & Hutter, J. (2012). *Ab initio molecular dynamics: basic theory and advanced methods*. Cambridge University Press.

M. Sc. in Biomedical Science

FOURTH SEMESTER (EVEN SEMESTER)

Course Code	Course Type	COURSE (PAPER/SUBJECTS)	Credits	Maximum Marks		
				Internal	External	Total
BSC	Theory	Research Methodology and Intellectual Property Rights (IPR)	4	20	80	100
BSC	Practical	Dissertation Work	16	200*	200	400
Minimum credits in complete semester it would be 20			Total: 20			

The M.Sc. program will be divided into four semesters each being of six months duration. Each semester comprises of compulsory core courses (CCC) Lab course (LC) will be based on CCC. Each theoretical course will be divided into Internal Assessment of 20 marks and semester end examination of 80 marks. Duration of Theoretical and Practical Examination Time: 03 Hours.

The Dissertation will be of 16 credits and a total of 400 marks. The students would be assessed externally as per the following criteria.

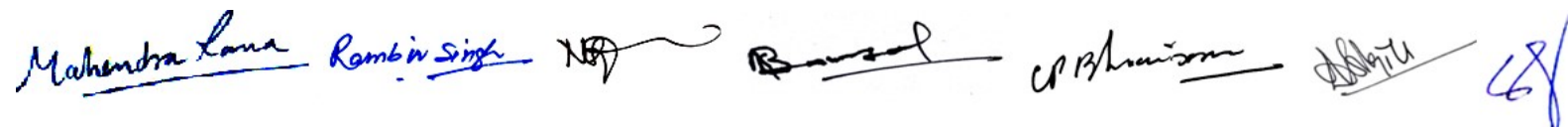
- i) Presentation and Viva-voce: 100 Marks
- ii) Dissertation Report/Thesis: 100 Marks

*Internal marks for dissertation work would be assessed as per following criteria

- i) Regularity and attendance : 50 Marks
- ii) Research concept and hypothesis: 50 Marks
- iii) Field and Lab work: 100 Marks

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhambhani* *Sharma* *CS*

M.Sc. BIOMEDICAL SCIENCE		IV SEMESTER									
COURSE CODE: BSC		COURSE TYPE: CCC									
COURSE TITLE: Research Methodology and Intellectual Property Rights (IPR)											
CREDIT: 04		THEORY HOURS: 90									
MARKS: 100		THEORY EXAM: 80	CCA: 20								
<table border="1"> <tr> <td style="background-color: #800000; color: white; text-align: center; vertical-align: middle;">UNIT-1 20 Hours</td> <td>Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question, Qualitative and Quantitative Research, Interpretation of Data and Academic Writing, Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism</td> </tr> <tr> <td style="background-color: #800000; color: white; text-align: center; vertical-align: middle;">UNIT-2 20 Hours</td> <td>Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance, Research Design: Exploratory Research Design, Descriptive Research Designs and Experimental Design. Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Sample types, Concept of Independent & Dependent variables, Levels of measurement – Nominal, Ordinal, Interval and Ratio. Data Analysis, Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.</td> </tr> <tr> <td style="background-color: #800000; color: white; text-align: center; vertical-align: middle;">UNIT-3 15 Hours</td> <td>Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs, Basics of patents (Types, patent application and Specifications), concept of Prior Art and patent filling procedures, Process patent vs product patent.</td> </tr> <tr> <td style="background-color: #800000; color: white; text-align: center; vertical-align: middle;">UNIT-4 20 Hours</td> <td>Introduction to General Agreement on Tariffs and Trade (GATT), World Trade Organization (WTO), World Intellectual Property Organization (WIPO) and Trade Related Intellectual, Property Rights (TRIPS), Indian Patent Act.</td> </tr> </table>				UNIT-1 20 Hours	Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question, Qualitative and Quantitative Research, Interpretation of Data and Academic Writing, Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	UNIT-2 20 Hours	Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance, Research Design: Exploratory Research Design, Descriptive Research Designs and Experimental Design. Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Sample types, Concept of Independent & Dependent variables, Levels of measurement – Nominal, Ordinal, Interval and Ratio. Data Analysis, Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	UNIT-3 15 Hours	Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs, Basics of patents (Types, patent application and Specifications), concept of Prior Art and patent filling procedures, Process patent vs product patent.	UNIT-4 20 Hours	Introduction to General Agreement on Tariffs and Trade (GATT), World Trade Organization (WTO), World Intellectual Property Organization (WIPO) and Trade Related Intellectual, Property Rights (TRIPS), Indian Patent Act.
UNIT-1 20 Hours	Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question, Qualitative and Quantitative Research, Interpretation of Data and Academic Writing, Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism										
UNIT-2 20 Hours	Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance, Research Design: Exploratory Research Design, Descriptive Research Designs and Experimental Design. Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Sample types, Concept of Independent & Dependent variables, Levels of measurement – Nominal, Ordinal, Interval and Ratio. Data Analysis, Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.										
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**SUGGESTED
READINGS**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Intellectual Propert Rights in India (2015) 2nd edition, V.K Ahuja .
5. Intellectual Propert Rights (2014), Neeraj Pandey and Dharni Khushdeep, PHI Larning Pvt Ltd.

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*

M. Sc. in Biomedical Science

FOURTH SEMESTER (EVEN SEMESTER)

M.Sc. BIOMEDICAL SCIENCE		IV SEMESTER
COURSE CODE: BSC		COURSE TYPE: PRACTICAL
COURSE TITLE: Dissertation Work (Major)		
CREDIT: 16	PRACTICAL HOURS: 90	
MARKS: 400		

Mahendra Lona *Rambir Singh* *NSD* *Bansal* *CP Bhargava* *Sharma* *CS*