

PRAVARA INSTITUTE OF MEDICAL SCIENCES

(Deemed to be University)

Loni Bk. 413 736, Tal. Rahata, Dist. Ahmednagar, (MS)



College of Biosciences and Technology



Course Structure & Syllabus of

M. Sc. (Medical Biotechnology)

Implemented from Academic Year 2020-21

**Revised in AC 2025 (Notification No. AC/2025(1)/D-16(i),
dated 23/06/2025)**

Pravara Institute of Medical Sciences (Deemed to be University)

University Established under section (3) of UGC Act, 1956.

NAAC Accredited with 'A' Grade (CGPA 3.17)

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- Dr. Balasaheb Vikhe Patil Rural Medical College
- Rural Dental College
- Dr. APJ Abdul Kalam College of Physiotherapy
- Smt. Sindhutai Eknathrao Vikhe Patil College of Nursing
- Centre for Bio-Technology
- School of Public Health and Social Medicine
- Dr. Vitthalrao Vikhe Patil Pravara Rural Hospital

Ref No.

Ref. No.: PIMS/R/2025/1461

Date

Date: 26/08/2025

NOTIFICATION No.: 55 / 2025

Subject: Notification regarding revision in the syllabus of the B.Sc. & M.Sc. Medical Biotechnology programmes.

Reference: Academic Council Resolution No. AC/2025(1)/D-16(i), dated 23rd June, 2025.

It is hereby notified for information to all the concerned that as per the Academic Council Resolution No. AC/2025(1)/D-16(i), dated 23rd June, 2025; it has been approved to revise the syllabi of "Enzyme Technology (BU 19302; Sem V)" course in B.Sc. Medical Biotechnology programme and "Clinical Research (BM19213A; Sem IV)" course in M. Sc. Medical Biotechnology programme.

The Director, College of Biosciences and Technology, Loni and the Dean, Faculty of Allied Health Sciences is authorised to follow & implement it from the Academic Year 2025-26.

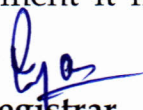


Copy for information:

1. Hon'ble Chancellor, PIMS (DU), Loni.
2. Hon'ble Vice-Chancellor, PIMS (DU), Loni.
3. Hon'ble Deputy Director Administration, PIMS (DU), Loni.

Copy for information & necessary action to:

1. Director, College of Biosciences and Technology, Loni.
2. Dean, Faculty of Allied Health Sciences.
3. Controller of Examinations, PIMS (DU), Loni.


Registrar
Registrar
Pravara Institute of Medical Sciences
(Deemed to be University)
Loni - 413736, Tal. Rahata
Dist. Ahmednagar (M.S. India)



M. Sc Medical Biotechnology

Sr. No.	Code	Name of the subject	Page No.
Semester I			
1.	BM 19101	Cell Biology	03
2.	BM 19102	Molecular Biology	05
3.	BM 19103	Human Biochemistry	07
4.	BM 19104	Human Physiology	09
Semester II			
5.	BM 19111	Medical Microbiology	11
6.	BM 19112	Immunology & Immunotechnology	13
7.	BM 19113	Cell Culture (Animal & Plant)	15
8.	BM 19114	Clinical Biochemistry	17
Semester III			
9.	BM 19201	Genetic Engineering	20
10.	BM 19202	Molecular Diagnostics	22
11.	BM 19203	Bioinformatics	24
12.	BM 19204	Research Methodology, IPR, Bioethics & Biosafety	26
Semester IV			
13.	BM 19211	Food & Industrial Biotechnology	28
14.	BM 19212	Nanobiotechnology	30
15.	BM 19213A BM 19213A	Any one of the following electives - Clinical Research - Regenerative Medicine	32
16.	BM 19214	Dissertation	35



SEMESTER I

CELL BIOLOGY (BM 19101)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19101	Core	Cell Biology	4	0	4	60	4+2=6

Objective:

The objective of the course is to familiarize the students with the fundamentals of cell biology.

Outcome:

At the end of the course, the students will be familiar with cell science and cell-cell interaction. This would help him to take further courses in biotechnology in the subsequent semesters.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Cell Structure	Introduction to Prokaryotes and eukaryotes Prokaryotic cell structure Eukaryotic cell structure	8
Unit II	Cytoskeleton	Overview of the Major Functions of Cytoskeleton. Microtubules: Structure and Composition. MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella. Microfilaments: Structure, Composition, Assembly and Disassembly. Motor Protein: Myosin. Muscle Contractility: Sliding Filament Model. Actin Binding Proteins: Examples of Non-muscle Motility. Intermediate Filaments: Structure and Composition; Assembly and Disassembly; Types and Functions.	12
Unit III	Cell Differentiation and Tissues Maintenance	Tissues with permanent cells: Renewal by simple duplication, Renewal by stem cells- epidermis, Renewal by pluripotent stem cells- blood cell formation. Quiescent stem cells – skeletal muscle, soft cells and tough matrix – growth turnover and repair in skeletal connective tissue	10
Unit IV	Cell Cycle & Signaling	Mitosis and meiosis, chromosomes- structure and organization, nucleosomes organization karyotypes and ideograms. Cytological, genetical and evolutionary significance of Mitosis and Meiosis. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor). Types of cell signaling, Signaling molecules and their receptors, functions, pathways of intracellular signal transduction.	14
Unit V	Cell –Cell Communication	Cell adhesion & cell junctions Cell –cell interaction & cell matrix interaction Extracellular matrix	6



Sr. No.	Topic	Detail of syllabus	Hrs.
Unit VI	Cancer Biology	Cellular and genetic basis of cancer, apoptosis, carcinogens, environmental and diet factors in cancer.	10

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books recommended:

Cell and Molecular Biology by De Robertis.
Molecular Biology of Cell by Bruce Alberts, 2002.
The Cell by Cooper. 2000
Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P. S Verma and VK Agarwal.
Publisher S. Chand and Comp. 2005
Cell Biology by Powar
Cell and Molecular Biology Garald Karp J. Wiley & Sons, NY
Harvey Lodish- Molecular Cell biology, 5th edition (2003), Freeman W. H. and company
Gerald Karp- Cell & molecular Biology 6th Edition 2010
Alberts- Essential Cell Biology 4th Edition 2014
Becker WM Kleinsmit, LJ, Hardin J, and Bertoni GP, 2009. The World of the Cell, seventh edition.
Pearson/Benjamin-Cummings, Boston, MA.

PRACTICAL IN CELL BIOLOGY (4 hrs. per week)

LIST OF EXPERIMENTS

1. Microscopes- Compound microscopes
2. Observation of prokaryotic and eukaryotic cells with the help of light micrographs
3. Arrest and observation of chromosomes after colchicine treatment in onion roots.
4. Different stages of Meiosis.
5. Cell fractionation
6. Buccal smear – Identification of Barr Body
7. Isolation of Mitochondria/chloroplast
8. Counting of cells using Haemocytometer



MOLECULAR BIOLOGY (BM 19102)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19102	Core	Molecular Biology	4	0	4	60	4+2=6

Objective:

The objective of the course is to familiarize the student with the fundamental's concepts and technique in molecular biology and its use in the medical research.

Outcome:

At the end of the course, it is expected that students should understood the basic genetic mechanisms such as DNA replication, DNA repair and recombination, gene expression and regulation, and how to apply molecular knowledge to solve a critical problem. It is expected that they will be more confident to develop independent research projects either for pursuing their higher education or for industrial applications.

Sr. No.	Topic	Detail of syllabus	Hrs
Unit I	Introduction	History and scope of molecular biology- Discovery of DNA-evidence for DNA as the genetic material. The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast	4
Unit II	Structure and Maintenance of Genome	Structure of DNA, types and alternatives forms of DNA. Structure of RNA. Organization of eukaryotic genome- components of eukaryotic chromatin and chromosome structure- DNA-supercoiling, linking number and satellite DNA.	7
Unit III	DNA Replication	Replication of DNA in prokaryotes, Origin of replication, types of DNA polymerases, details of DNA synthesis process. Eukaryotic DNA replication- multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication.	10
Unit IV	DNA Damage, Repair and Mutation	Different types of DNA damage. Mutation, types of mutation, spontaneous and induced mutation, Detecting mutation Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, SOS, operon, Double strand break repair, transcription coupled repair	7
Unit V	Recombination	Homologous and site-specific recombination, Models for homologous recombination. Proteins involved in recombination: RecA, B, C, D, Ruv A, B, C and Gene conversion.	8
Unit VI	Mobile DNA Elements	General features of Transposable elements, Transposable elements in prokaryotes-IS element, Retroviruses Retrotransposons- Ty elements in yeasts, SINES and LINES	5
Unit VII	Transcription	Transcription in Prokaryotes: RNA polymerase, sigma factor, Initiation, elongation, termination, Transcription in Eukaryotes:	7



Sr. No.	Topic	Detail of syllabus	Hrs
		RNA polymerases, transcription of protein coding sequences by RNA polymerase-II, post-transcriptional modification, RNA splicing and RNA editing, CpG Island and Epigenetic - Overview	
Unit VIII	Translation	Genetic code, Translation in Prokaryotes and Eukaryotes, post translational process- protein translocation	7
Unit IX	Control of Gene Expression	Gene regulation in Prokaryotes, Operon model, Gene regulation in eukaryotes, gene activators, enhancers and silencers	5

METHODOLOGY

The course would be taught through lectures, demonstrations and practical session.

Books Recommended:

1. Benjamin Lewin. (2010) Genes X, Jones and Bartlett Publishers Inc.
2. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson (2004), Molecular Biology of the Cell, 4th Edition, Garland Publishing
3. Raff, Keith Roberts, Peter Walter, (2003) Essential Cell Biology, 2nd Edition, Garland Publishing
4. Watson James D., Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick (2004) Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
5. Weaver R., (2007) Molecular Biology, 4th Edition, McGraw Hill Science.
6. Molecular Biology and Biotechnology, 3rd edition– J M Walker & E B Gingold, Panima publishing corporation, 1999.
7. Elliot, Biochemistry & Molecular Biology
8. Kleinsmith, L. J. & Kish, V.M. 1995. Principles of Cell and Molecular Biology. 2nd edn., McLaughlin, S., Trost, K., Mac Elree, E. (eds.), Harper Collins Publishers, New York.

PRACTICAL IN MOLECULAR BIOLOGY (4 hrs. per week)

LIST OF EXPERIMENTS

1. Isolation of Genomic DNA from Bacterial & Blood Samples
2. Quantitative analysis of DNA by UV Spectrophotometer
3. Qualitative analysis of DNA through Agarose Gel Electrophoresis
4. Total isolation of RNA from bacterial cells
5. Quantitative analysis of RNA by UV Spectrophotometer

REFERENCE:

J Sambrook & D. W. Russell (2001). Molecular cloning: a laboratory manual Vol 1,2 & 3, CSHL Press.



HUMAN BIOCHEMISTRY (BM 19103)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19103	Core	Human Biochemistry	4	0	4	60	4+2=6

Objective:

The objective of the course is to study the biochemical constituents, their interaction in cells, biochemical reactions and metabolic pathways occurring in human body.

Outcome:

At the end of the course, the student will have sufficient scientific understanding of the subject & have good knowledge of various biomolecules, their functions & metabolism.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Chemical Basis of Life	Composition of living matter; Water properties, pH, pKa, Buffers, Handerson-Hasselbach equations, ionization and hydrophobicity; Emergent properties of biomolecules in water; Water as a reactant.	5
Unit II	Proteins	Amino acids as building blocks of proteins and their classification, pI and pKa values, Primary, Secondary, Tertiary and Higher order structure of Proteins, Protein Sequencing, Ramchandran Plot, Conjugated proteins- Glycoproteins, Lipoproteins, Hemoproteins.	10
Unit III	Enzymes	Enzyme classification, General principles of catalysis, Quantitation of enzyme activity and efficiency, Enzyme characterization and Michaelis-Menten kinetics, Enzyme inhibition and covalent modification, enzyme regulation, - Jackob & Monod model, Ribozymes. Enzyme immobilization	10
Unit IV	Carbohydrates	Mono- Di- and Polysaccharides, Optical isomerism, Glycolysis, Gluconeogenesis, Pentose phosphate pathways, Citric acid cycle.	9
Unit V	Lipids	Classification of lipids & fatty acids and structural analysis of fatty acids, Glycerols, Waxes, Glycolipids, Phospholipids, Sphingolipids, Sterols, Lipoproteins, β -oxidation, Biosynthesis of Cholesterol & its significant, Fatty acids. Ketogenesis	9
Unit VI	Nucleic acids	Biosynthetic pathways of purines and pyrimidines, degradation pathways	8
Unit VII	Bioenergetics	Basic principles; Equilibria and concept of free energy; Group transfer, concept of Entropy, Enthalpy and free energy, Oxidation and Reduction reactions, Electron Transport Chain, Metabolic regulations including the role of hormones – Inhibitor, Michel theory	9



METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books Recommended:

Harper's Illustrated Biochemistry

A text of biochemistry, - A.V.S.S. Rama Rao 9th ed. (UBS Publisher's and Distributors Pvt. Ltd.)

Lehninger: Principles of Biochemistry, 3rd Ed. – Nelson D. et al (Worth Publishers)

Biochemistry, 5th, - Ed. Breg, J.M. Tymoczko J.L. and Stryer L. (W.H. Freeman & Co.)

Lubert Stayer (Latest) Biochemistry, II edition, W.H. Freeman and CO.NY

PRACTICALS IN BIOCHEMISTRY (4 Hrs. per Week)

LIST OF EXPERIMENT

1. Calibration of pH meter
2. Estimation of Proteins by Biuret Method
3. Estimation of Protein by Lowry Method
4. Estimation of Serum Albumin by BCG Method
5. Estimation of SGPT
6. Estimation of Serum Alkaline Phosphatase
7. Estimation of Serum Creatinine
8. Estimation of Urea Nitrogen
9. Estimation of Cholesterol by Zak's ferric Chloride Method
10. Estimation of Carbohydrates by Anthrone Method
11. Separation of Proteins by SDS-PAGE
12. Separation of serum protein by paper electrophoresis



HUMAN PHYSIOLOGY (BM 19103)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19103	Core	Human Physiology	4	0	4	60	4+2=6

Objective:

The objective of the course is to study the physiological aspects of the human systems and its role in functioning of all the major organs of the body.

Outcome:

At the end of the course, the students will be able to understand the integral mechanism operating in the human system among with regulation of each system.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Basic Concepts and Principles	Introduction and background (homeostasis, control systems), Biophysics of blood flow, Regulation of respiration, Auto regulation of renal blood flow and the concept of clearance	7
Unit II	Sensory Organs	Eye, Ear, Nose, Tongue and Skin: Functions & Disorders	5
Unit III	Digestive System	Functions & Disorders, Pharynx, Esophagus, Stomach and Intestines, Liver & Pancreas, Peritoneum	5
Unit IV	Circulation System	Heart rate and the significance, Cardiac cycle, HR factors ECG- Machine, Recording, Abnormalities types Causative Factors Reporting & Interpretation.	8
Unit V	Respiration System	Respiration, Mechanism, Inspiration, Expiration Gas exchange mechanism Lung surfactant, compliance Lung volume and capacity Respiratory Exercises, Artificial Respiration Basis & Techniques	8
Unit VI	Genito-Urinary System	Kidney, Urethra, bladder, Urethra, Female Reproductive System, Male Reproductive System	7
Unit VII	Skeletal System	Mechanism of contraction, Difference between 3 types of muscles, Electro myography & mechanical recording of muscle contraction, Locomotion, Diseases of muscles, Dystrophies,	7
Unit VIII	Nervous System	Nerve fibres, types, functions, injuries, impulses & velocity	5
Unit IX	Endocrine System	Hormones, Functions & Disorders	5
Unit X	Genetic Testing	Genetic testing, Eugenics and Aging	3

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.



Books Recommended:

Textbook of Medical Physiology by C. Guyton
Physiology by C. Chatterjee
Human Anatomy & Physiology by Tortora
Medical Physiology by Chaudhary
Anatomy and histology by Ross and Wilson
Human Anatomy and Physiology by Creager

PRACTICAL IN HUMAN PHYSIOLOGY (4 hrs. per week)

LIST OF EXPERIMENTS

1. Blood grouping
2. Haemoglobin estimation
3. Total WBC and RBC count
4. Erythrocyte sedimentation rate
5. Differential Counting of Blood
6. PVC count



SEMESTER II

MEDICAL MICROBIOLOGY (BM 19111)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19111	Core	Medical Microbiology	4	0	4	60	4+2=6

Objective:

The course provides the conceptual basis for understanding pathogenic microorganisms and their pathogenesis, clinical manifestations and control of infectious diseases.

Outcome:

After completion of this course students are expected to be able to,

- Demonstrate theory and practical skill in microscopy and their handling technique and staining procedure.
- Know various culture media and their application
- Understand physical and chemical means of sterilization
- Know various biochemical test to analyze and understand the basic concept of chemical reaction that occur in living system.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Microbiology	Scope and history of Microbiology. Classification and identification of microorganism.	3
Unit II	Microbial Nutrition and Growth	Cultivation of bacteria. Types of culture media, Preservation methods of bacterial cultures and maintenance, Growth kinetics of bacteria, and various factors on microbial growth.	4
Unit III	Structure of Bacterial Cell	Structure and function of Gram-positive and Gram-negative bacteria, Cell wall, Cell membrane, Cytoplasmic inclusions and Mesosomes, Flagella, Capsule, Ribosome, Chromosome, Plasmid, and Endosome, etc.	4
Unit IV	Normal Microbial Flora and Pathogenic Microorganisms	Normal microbial flora of the human body, collection and transport of specimens, processing of clinical specimens for microbiological examination. The host-parasite relationship, Entry, exit, and transmission.	6
Unit V	Bacteriology	Bacteria of medical importance, Gram-Positive Cocci- <i>Staphylococcus</i> , <i>Streptococcus</i> , Gram Negative - <i>Neisseria</i> Gram Positive Bacilli- <i>Bacillus anthrax</i> , <i>Clostridium</i> Gram-negative Bacilli- members of <i>Pseudomonadaceae</i> , <i>Vibrio cholerae</i> , other: <i>Mycoplasma</i> , <i>Rickettsiae</i> .	12
Unit VI	Virology, Mycology and Parasitology	General properties of viruses, classification of viruses, Laboratory diagnosis of viral infections, viral cultivation, Role of antiviral agent, structure and characteristics of fungi, differences between bacteria and fungi, culture and laboratory diagnosis, and medical importance of fungi. Parasitology: Taxonomy and classification, Transmission, clinical features, and prophylaxis of medically important Protozoa and	15



		Nematodes, Parasitic diseases- Malaria, Dengue, Laboratory diagnosis of parasites.	
Unit VII	Epidemiological Aspects	Control of infection and disease, hospital-acquired infection-prevention & control.	4
Unit VIII	The Clinical Manifestation of Infection	Respiratory tract infections, Urinary tract infections, sexually transmitted diseases, Gastrointestinal tract infections, Meningitis	12

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books Recommended:

General Microbiology: Vol. I & 2 by Powar & Dagainawala
Microbiology by Pelzer
Microbiology by Prescott
General Microbiology by Stanier
Instant notes in Microbiology by Nicklin
Medical Microbiology by Mims
Medical microbiology by C.P. Baweja
Medical microbiology by Ananthnarayanan
Parasitology by Chatterjee
Mycology by Jagdish Chander
Diagnostic Microbiology by Bailey & Scott

PRACTICAL IN MEDICAL MICROBIOLOGY (4 hrs per week)

LIST OF EXPERIMENTS

1. Preparation of culture media
2. Staining procedures: negative, gram, capsule & endospore
3. Aseptic transfer techniques: streak plate, spread plate and pour plate method
4. Biochemical tests: IMViC, Triple Sugar Iron and Carbohydrate fermentation
5. Isolation and identification of bacterial pathogen from clinical specimen: urine, pus and blood sample
6. Antibiotic sensitivity test (disc diffusion method and well diffusion method)
7. Techniques for diagnosis of viral infections: HIV & Dengue
8. Techniques for diagnosis of parasitic infections: Malaria



IMMUNOLOGY & IMMUNOTECHNOLOGY (BM 19112)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19112	Core	Immunology & Immunotechnology	4	0	2	60	4+2=6

Objective:

The objectives of this course are to learn about structural features and components of immune system as well as their functions.

Course Outcomes:

On completion of this course, students will be able to:

- Predict about nature of immune response that develops against bacterial, viral or parasitic infections.
- Apply their knowledge and design immunological experiments to demonstrate innate and humoral immunity.
- Apply their acquired knowledge in research and different pharmaceutical industries.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Antigens, Immunoglobulins Structure and Function	Overview of antigens, basic and fine structure of immunoglobulin: light chains, heavy chains and sequences, antigenic determinants on immunoglobulin: isotopic, allotypic, idiotypic, immunoglobulin super family	8
Unit II	Generation of B cell and T cell Responses	Brief introduction of antibodies, organization and expression of immunoglobulin genes, antigen-antibody interactions: principles and applications, Major Histocompatibility Complex, Antigen processing and presentation, T cell receptor, T cell maturation, activation, and differentiation B cell generation, activation, and differentiation	12
Unit III	Immune Effector Mechanisms	Cytokines, The Complement system, Cell mediated effector responses, Leukocyte migration and inflammation, Hypersensitive reactions.	8
Unit IV	Immunotechniques	Strength of antigen and antibody interactions: antibody affinity, antibody avidity and cross reactivity, precipitation reactions, agglutination reactions (Immunodiffusion and Immunoelectrophoretic technique), Radioimmunoassay, Enzyme Linked Immunosorbant Assay (ELISA), Western Blotting, Immunoprecipitation.	12
Unit V	The Immune System in Health and Disease	Immune response to infectious diseases, vaccines, AIDS and other immunodeficiencies, autoimmunity, transplantation immunology, cancer and the immune system.	10
Unit VI	CMI and Imaging Techniques	CD nomenclature, identification of immune cells; principle of Immunofluorescence Microscopy, Fluorochromes; staining techniques for live cell imaging and fixed cells; Flow cytometry instrumentation, applications: cell cytotoxicity	10



METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED:

1. Immunology – Kuby
2. Cellular Interactions and immunobiology – BIOTOL series
3. Immunology – Roitt
4. Immunobiology – Janeway Travers
5. Cellular and molecular Immunology - Abbas A.K., Lichtman A.H. and Pober, J.S.
6. Immunobiology 3rd ed. – Janeway Travers
7. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
8. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
9. Paul, W. E. (1993). Fundamental Immunology. New York: Raven Press.
10. Goding, J. W. (1986). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press

PRACTICAL IN IMMUNOLOGY & IMMUNOTECHNOLOGY (4 hrs. per week)

LIST OF EXPERIMENTS

1. Animal handling
2. Blood collection
3. Routes of drug administration
4. Dissection of mice lymphoid organ (spleen)
5. Latex agglutination method
6. Determination of Phagocytic index
7. Clinical diagnostic immunoblotting/ SDS PAGE
8. ELISA
9. Immunoassay – immuno diffusion method, rocket electrophoresis
10. ICT for malaria and HIV detection



CELL CULTURE (ANIMAL & PLANT) (BM 19113)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19113	Major	Cell Culture (Animal & Plant)	4	0	4	60	4+2=6

Objective:

To improve theoretical & practical fundamental of cell and tissue culture techniques in animals & plants. To provide the students with the ability to adopt basic cell culture procedure for various research requirements.

Outcome:

At the end of this course the student will able to understand how to initiate, grow & harvest the eukaryotic cells & their uses. They will be also able to understand the applications of *in vitro* biology for clonal propagation.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Animal Tissue Culture	Historical background, the application of tissue culture (stem cells tissue engineering, industry and research), terminology, stages in cell culture.	8
Unit II	Introduction to Plant Tissue Culture	History & development of PTC, nutrient medium, plant growth regulators: mode & mechanism of action, Incubation system & maintenance of <i>in vitro</i> culture.	6
Unit III	Outline of the key techniques of Animal Cell Culture	Setting up the laboratory, culturing cells, maintaining the culture, Quantification of cells in cell culture, Cloning and selecting cell lines, hazards and safety in the cell culture laboratory.	8
Unit VI	Animal Cell Culture Media	General cell culture media design, natural media, synthetic media, further considerations in media formulation, nutritional components of media, the role of serum in cell culture, choosing a medium for different cell type	8
Unit V	Cell Separation and Characterization of Cell Lines	Cell separation – methods of cell separation – density, antibody based, FACS, MACS technology. Cell characterization - species identification, linkage of tissue markers. Cell morphology – microscope, staining	8
Unit VI	Preservation of Animal Cell Lines	Variation and instability in cell lines, preservation of cell lines, freezing of cells, thawing of cells, quantification of cell viability, cell banks	8
Unit VII	Plant, Cell & Organ Culture	Growth & development of plant cell & tissue <i>in vitro</i> . Callus culture, cell suspension culture, organ culture, organogenesis & embryogenesis. Applications of plant tissue culture: mass propagation, synthetic seeds & disease elimination	6
Unit VIII	Large Scale Animal Cell Culture	Culture parameters, scale up of anchorage-dependent cells, culture vessels, suspension culture, perfusion techniques, bioreactors	8



METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED

Cell and Tissue Culture: Lab Procedures in Biotechnology by Alan Doyle (ed) J. Bryan Griffith (ed)
Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R Ian Freshney
Animal Cell Culture: A Practical Approach (Practical Approach Series) by John Masters
Animal Cell and Tissue Culture by Mathur Shivangi
Basic Cell Culture 2nd Edition by JM Davis Oxford University Press.2002.
Plant biotechnology by B. D. Singh, Kalyani Publication
Plant Biotechnology by Chawla H. S. Oxford & IBH
Plant tissue culture by Bhojwani & Razdan

PRACTICALS IN CELL CULTURE (ANIMAL & PLANT) (4 Hrs. per Week)

LIST OF EXPERIMENT

1. Layout of animal tissue culture laboratory
2. Washing of glasswares
3. Sterilization of glasswares
4. Preparation of culture media
5. Thawing of animal cell lines
6. Passaging of animal cell lines
7. Cell quantification and cell viability
8. Cryopreservation of cell cultures
9. Preparation of plant tissue culture media
10. *In vitro* propagation through shoot tip and nodal culture
11. Production of synthetic seeds
12. Production of callus culture
13. Transformation by *Agrobacterium* based vector systems and regulation



CLINICAL BIOCHEMISTRY (BM 19114)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19114	Core	Clinical Biochemistry	4	0	4	60	4+2=6

Objective:

The objective of this course is to provide biochemical knowledge based on biochemical pathways and immunology used in detection, diagnosis and treatment of human diseases.

Outcomes:

At the end of this course the students should be able to:

- Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.
- Understand applications of clinical biochemistry in diagnostics.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Clinical Biochemistry	Clinical specimen Considerations: processing, sample variables, chain of custody; infection control, composition and types of blood specimens, preservation, influence of nutrition, drugs, posture, anticoagulants; care of the specimens, identification, transport, storage, influence of temperature, freezing/thawing; Laboratory safety and regulations: biological, chemical, fire and radiation safety; method of evaluation and quality management, basic concepts, reference interval study, diagnostic efficiency, method evaluation, quality control and quality management.	10
Unit II	Disorders of Amino Acid and Protein Metabolism	Inborn errors of amino acids: aminoacidopathies, homocystinuria, cystinuria and cystinosis, phenyl ketonuria, alkaptonuria, albinism, and tyrosinemia. Total protein abnormalities and analysis: hypoproteinemia, hyperproteinemia, analysis of urinary and cerebrospinal fluid proteins, quantification of specific proteins, serum protein electrophoresis, and immunochemical methods. Non-protein nitrogen compounds (physiology, clinical applications, and pathophysiology): urea, uric acid, creatine, creatinine, ammonia.	10
Unit III	Clinically Important Enzymes	Enzymes of clinical significance: creatine kinase, lactate dehydrogenase, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, acid phosphatase, glutamyl transferase, amylase, lipase, glucose-6-phosphate dehydrogenase, drug-metabolizing enzymes, tumour markers, bone markers, cardiac markers, liver markers.	8
Unit IV	Diagnosis and Treatment of Carbohydrate Disorders	Blood glucose regulation: hormones influencing carbohydrate utilization (insulin, glucagon, glucocorticoids, epinephrine, and growth hormone). Carbohydrate disorders: aetiology symptoms, complications and pathophysiology of Diabetes Mellitus. Criteria for testing for prediabetes, criteria for the diagnosis of Diabetes Mellitus, hypoglycemia, hyperglycemia. Inborn errors of carbohydrate metabolism: glycogen storage diseases, fructosuria, fructose intolerance, pentosuria, galactosuria, urine screening.	12



Sr. No.	Topic	Detail of syllabus	Hrs.
Unit V	Transport Mechanism and Associated Disorders	Transport of plasma lipids, lipoprotein metabolism, lipid profile and diet, PUFA and dietary fiber. Diagnosis and conditions of lipid disorders: arteriosclerosis, hyperlipoproteinemia, hypercholesterolemia, hypertriglyceridemia, combined hyperlipoproteinemia	10
Unit VI	Assessment of Organ System Function	Introduction to hormones and pituitary function: the hypophysiotropic hormones, hypothalamic hormones, anterior pituitary hormones, pituitary function test. Liver functions: liver dysfunction disorders: jaundice, cirrhosis, tumors, hepatitis, drug- and alcohol- related disorders. Assessment of liver function tests- bilirubin test, liver enzymes analysis. Cardiac function: cardiovascular disease, diagnosis of heart disease - laboratory diagnosis of myocardial infarction, markers of congestive heart failure. Renal function: glomerular diseases, tubular diseases, urinary tract infection/obstruction, renal calculi and renal failure. Pancreatic function and gastrointestinal function: diseases of the pancreas, tests of pancreatic function, secretin/cholecystokinin test, tests of intestinal function -lactose intolerance test.	10

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED

1. Michael L. Bishop, Edward P. Fody and Larry E. Schoeff; (2013). Basic Principles and Practice of Clinical Chemistry, (7th Ed). Lippincott Williams and Wilkins.
2. Stryer, L. (2002). Biochemistry, (8th Ed). Freeman.
3. D.M. Vasudevan and Sreekumari, S, (2010). Textbook of Biochemistry for Medical Students, (6th Ed). Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar; (2010). Concise Medical Biochemistry, (3rd ed), Elsevier Health.
5. Satyanarayana and Chakrapani, (2013), Biochemistry; (4th Ed). Elsevier.
6. Clinical Biochemistry- Metabolic & Clinical aspects by William J. Marshall et al.– 3rd Edition Churchill Livingstone- Elsevier
7. Textbook of Clinical Biotechnology- Ramnik Sood, CBS publications
8. Clinical Biotechnology- Lecture notes by Walker et al, 9th edition, Wiley Blackwell
9. Clinical Biotechnology-Ahmed, Oxford
10. Clinical Chemistry-Principles, Techniques & Correlation – M.L. Bishop, Edward P. Fody, Larry E. Schoeff- 8th edition- Wolter Kluwer.
11. Text fundamental of Clinical Chemistry and Molecular Diagnostics by Carl A. Burtis & David E. Bruns, 7th edition, Elsevier publication.



PRACTICALS IN CLINICAL BIOCHEMISTRY (4 Hrs. per Week)

1. Estimation of protein by Lowry method.
2. Estimation of blood glucose by Ortho-Toluidiene method.
3. Estimation of total protein and A: G ratio.
4. Estimation of blood urea by diacetyl monoxime method.
5. Estimation of serum creatinine by Jaffe's method.
6. Estimation of serum uric acid by phosphotungstate method.
7. Estimation of serum triglycerides
8. Qualitative analysis of urine for the presence of normal and abnormal constituents.



SEMESTER III

GENETIC ENGINEERING (BM 19201)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19201	Core	Genetic Engineering	4	0	4	60	4+2=6

Objective:

To familiarize the students with recombinant DNA technology as well as to create understanding and expertise in wet lab techniques related to genetic engineering.

Outcome:

At the end of the course, the students will have sufficient scientific understanding of the subject and have good knowledge of applications of recombinant DNA techniques in research related to life sciences.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Recombinant DNA Technology- Introduction and Tools	The recombinant DNA concept, milestones in genetic engineering, tools of genetic engineering; enzymes, nuclease, the restriction endonucleases, phosphodiesterase, polynucleotide kinase, DNA ligase, DNA polymerase I, reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase	10
Unit II	Vector System	Salient features of cloning vector, types of cloning vectors- plasmids, cosmids, phages (lambda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes- YACs and MACs	10
Unit III	The Means: Constructing, Cloning, and Selecting	Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors, Techniques of gene transfer - transformation, transfection, micro injection, electroporation, lipofection and biolistics, screening cloned populations of recombinants, preparation of gene libraries and c-DNA libraries	14
Unit IV	Molecular Mapping of Genome	DNA synthesis methods-chemical and enzymatic. DNA sequencing techniques- Maxam & Gilbert method, Sanger's dideoxy chain termination method, automated DNA sequencing. Genetic and physical mapping techniques. PCR, molecular markers in genome analysis- RFLP, RAPD & AFLP analysis, molecular markers PCR based. MicroRNAs and RNA interference.	14
Unit V	Applications of Genetic Engineering	Genetic diseases- detection and diagnosis, gene therapy – <i>ex vivo</i> , <i>in vivo</i> , DNA marker technology in plants, DNA fingerprinting, genetically engineered biotherapeutics and vaccines and their manufacturing, Transgenic animals and Bio-pharming.	12

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.



BOOKS RECOMMENDED:

Molecular Biology of the gene - J. Watson
Genes VI, VII and VIII - Benjamin Lewin
Molecular Biotechnology Principles and application of recombinant DNA
Molecular Biology - Robert F. Weaver
Plant Molecular Biology: A practical approach. - C.H. Shaw (2006), Panima Pub. Corp.
Molecular cloning Vol. 1-3. Sambrook and Russel. 2001. CSH press.
Principles of gene manipulation. 1994. Old and Primrose, Blackwell Scientific Publ.
Principles and techniques of biochemistry and molecular biology, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, New York.
DNA Cloning: A practical approach D.M. Glover and D.B. Hames, R.L. Press, Oxford, 1995
Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu, D. Kim and L.J. Cseke, CRC Press Florida 1995

PRACTICALS: IN GENETIC ENGINEERING (4 hrs. per week)

List of Experiments:

1. Competent cell preparation
2. Transformation of *E.coli*.
3. Isolation of plasmid DNA by alkaline lysis mini preparation
4. Gel Elusion
5. Restriction digestion of vector DNA
6. Random Fragment Length Polymorphism
7. Random Amplified Polymorphic DNA
8. Southern hybridization
9. DNA amplification by PCR and analysis by agarose gel electrophoresis
10. Manual DNA sequencing (Demo)



MOLECULAR DIAGNOSTICS (BM 19202)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19202	Specialized	Molecular Diagnostics	4	0	4	60	4+2=6

OBJECTIVE:

The objective of the course is to aware students about the various medical diagnostic techniques and their use in diagnosing various humans disorders and also to sensitize students about recent advances in molecular medicine.

OUTCOME:

At the end of the course the student will be able to understand various molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction and History of Diagnostics	Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. Philosophy and general approach to clinical specimens.	12
Unit II	Metabolic Disorders and its causes	Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders - Identifying human disease genes. Cancer- different types of cancers, genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders- sickle cell anaemia, retinoblastoma, cystic fibrosis and sex – linked inherited disorders.	11
Unit III	Immunodiagnostics	Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases.	08
Unit IV	Molecular Diagnosis	Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, <i>In situ</i> PCR, Long-PCR, PCR-ELISA, Arbitrarily Primed PCR, Ligase Chain Reaction. Proteins and amino acids, qualitative and quantitative techniques: protein stability, denaturation; amino acid sequence analysis	12
Unit V	Hybridization Technique, DNA Sequencing and Radiation in Diagnostics	Southern, Northern, <i>in-situ</i> (including FISH), microarrays – types and applications; protein extraction and analysis (including PAGE and its variations); Western Blot, Automated DNA sequencing, advances in DNA sequencing- New Generation Sequencing methods, pyrosequencing, microarrays, basic principles of X-Rays in diagnostics, MRI, CT-scan, radio isotopes in disease and diagnostics.	12
Unit VI	Molecular Oncology	Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, and melanoma as well as matching targeted therapies with patients.	05



METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED:

1. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2007.
2. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.
3. James W Goding, Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press, 1996.
4. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition, Academic Press, 2005.
5. Lela Buchingham and Maribeth L Flawsm, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA, 2007.
6. Medical Microbiology, Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
7. Parasitology, Chatterjee K.D, Chatterjee Medical Publishers.
8. Bailey & Scott's Diagnostic Microbiology, Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld, Ernest A. Trevino, Published by C.V. Mosby
9. Jawetz, Melnick, & Adelberg's Medical Microbiology, Geo F. Brooks, Stephen A. Morse, Janet S. Butel.
10. Fundamentals of Molecular Diagnostics. David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
11. Henry's Clinical Diagnosis and Management by Laboratory Methods Mcpherson

PRACTICALS IN MOLECULAR DIAGNOSTICS (4 Hrs. per Week)

1. Isolation of genomic DNA from peripheral blood.
2. Agarose gel electrophoresis
3. Determinations of DNA quality & concentration by spectrophotometry
4. Polymerase chain reaction (PCR)
5. RFLP/RAPD
6. Automated DNA Sequencing/NextGen Sequencing
7. SDS-PAGE and Western blotting
8. RNA isolation
9. cDNA synthesis
10. Molecular diagnosis of Human Immunodeficiency virus (HIV) by western blotting



BIOINFORMATICS (BM 19203)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19203	Core	Bioinformatics	4	0	4	60	4+2=6

Objective:

The objective of the course is to impart knowledge about advanced tools and techniques in Bioinformatics.

Outcomes:

At the end of the course the student will have knowledge about existing softwares used to extract information from large databases and to use this information in understanding computer modeling, structure-function relationships, information theory, gene expression, and database queries.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Biology in the Computer Age: An Introduction to Bioinformatics	How is computing changing biology? Isn't bioinformatics just about building databases? What does informatics mean to biologists? How do I understand sequence alignment data? What challenges does biology offer computer scientists? What skills should a bioinformatician have? Why should biologists use computers? How can I configure a PC to do bioinformatics research? What information and software are available? Can I learn a programming language without classes? How can I use web information How do I understand sequence alignment data? How do I write a program to align two biological sequences? How do I predict protein structure from sequence? What questions can bioinformatics answer?	10
Unit II	Computational Approaches to Biological Questions	Introduction, Computational methods in Bioinformatics. What Biologists Model? Accessing 3D Molecules through a 1D Representation, Abstractions for Modeling Protein Structure. Mathematical Modeling of Biochemical Systems. Why Biologists Model?	10
Unit III	Biological Research on the Web	Introduction using search engines, Boolean searching, search engine algorithms, finding scientific articles, using PubMed effectively, the public biological databases, data annotation and data formats, 3D molecular structure data, DNA, RNA, and protein sequence data, genomic data, biochemical pathway data	10
Unit IV	Sequence Analysis, Pairwise Alignment, and Database Searching	Introduction, Genefinders and feature detection in DNA, predicting gene locations, feature detection, pairwise sequence comparison, scoring matrices, gap penalties, global alignment, local alignment, tools for local alignment, sequence queries against biological databases, local alignment-based searching using BLAST, the BLAST algorithm	10



Sr. No.	Topic	Detail of syllabus	Hrs.
Unit V	Multiple Sequence Alignments, Trees and Profiles	Introduction, taxonomy and evolution, concept of molecular evolution, terms: orthologs, paralog and xenologs. Multiple sequence alignment: MSA by Clustal-W, application of MSA phylogenetic inferences, phylogenetic trees based on neighbor joining, software for phylogenetic analysis, profiles and motifs: general concepts FASTA	10
Unit VI	Tools for Genomics and Proteomics	Introduction, from sequencing genes to sequencing genomes, analysis of raw sequence data: basecalling sequencing an entire genome, the shotgun approach, the clone contig approach, NCBI genome resources, TIGR genome resources, Ensembl, other sequencing centers, annotating and analyzing whole genome sequences, genome annotation, functional genomics: new data analysis challenges, sequence-based approaches for analyzing gene expression, proteomics, tools for proteomics analysis.	10

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books Recommended:

Developing Bioinformatics computer skills – Gibas C and Jambeck P

Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.

Introduction to Bioinformatics: Lesk, A.M. Oxford University press.

Developing Bioinformatics Computer Skill: Cynthia Gibbs and Per Jambeck. O'Reilly & Associates.

PRACTICAL IN BIOINFORMATICS (4 hrs. per week)

LIST OF EXPERIMENTS

1. Introduction to SPDBV (deep view).
2. Basic exercise in protein structure visualization.
3. Basic exercise in protein structure visualization coloring.
4. To study the PubMed using internet.
5. To study the NCBI website using internet
6. BLAST
7. FASTA



RESEARCH METHODOLOGY, INTELLECTUAL PROPERTY RIGHTS, BIOETHICS & BIOSAFETY (BM 19204)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19204	Core	Research Methodology, Intellectual Property Rights, Bioethics & Biosafety	4	0	2	60	4+2=6

Objective:

To provide fundamental theoretical knowledge to the students about patent, copyrights & IPR protection acts.

To provide knowledge in Bioethics and aware them the legal, safety and public policy issues raised due to the progress in biotechnology.

Outcome:

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted National IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research environment release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction	Definition- objectives- types- significance of research- steps in research process- criteria for good research. Defining and formulating a research problem- literature survey- development of working hypothesis.	10
Unit II	Intellectual Property Rights	Introduction to IPR, IPR in India, IPR in abroad, types of IPR- Patent, Copyright, Trademark, Design & Trade Secret. Biotechnology & IPR- commercial potential of biotechnology inventions; patenting biotechnological inventions- objective, concept of novelty, concept of inventive step, microorganism, moral issues in patenting biotechnological inventions.	10
Unit III	IPR: Protection	Plant Varieties Protections- objective, justification, international position, Plant Variety Protection in India. Protection of geographical indication- objective, justification, international position, multilateral treaties, national level, Indian positions, protection of traditional knowledge- objective, concept of traditional knowledge, bioprospecting & biopiracy, protectability.	10
Unit IV	Bioethics	Bioethics- history & introduction; social, legal & ethical issues in biotechnology, ethical concerns of biotechnology research, Bioethics Committees, Animal ethics- Norms in India-Licensing of	10



Sr. No.	Topic	Detail of syllabus	Hrs.
		animal house- ethical clearance norms for conducting studies on human subjects, IAEC	
Unit V	Bio-safety	Introduction & development of Bio-safety; practices & principles; general lab equipments; definitions & Bio-safety levels I, II, III, IV; Biological Safety Cabinets, centrifuge; shipment of biological specimens; biological waste management; decontaminations, bio-safety manuals; medical surveillance, emergency response.	20

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books Recommended:

1. T. M. Murray & M. J. Mehlman, Encyclopedia of ethical, legal and policy issues in biotechnology, John Wiley & sons 2000.
2. Ethical Issues in Biotechnology by Richard Sherlock & John D. Morrey, Rowman & Littlefield Publishers
3. Singh K. Intellectual Property Rights on Biotechnology, BCIL, and Newdelhi-1993.
4. Shaleesha A. Stanley, Bioethics, Wisdom educational service-2010.
5. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
6. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from <http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf>.
7. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. <http://www.ipindia.nic.in/>
8. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
9. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
10. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
11. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An Overview of General Features of Risk Assessments of Genetically Modified Crops. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8.



SEMESTER IV

FOOD & INDUSTRIAL BIOTECHNOLOGY (BM 19211)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19211	Core	Food & Industrial Biotechnology	4	0	2	60	4+2=6

Objective:

The course will provide a broad grounding in techniques & processes involved in formulation of food products and also to familiarize students with fermentation of antibiotic, alcohol and alcoholic beverages, organic acids and amino acids.

Outcome:

On completion of this course students will be able to:

- Understand the principles involved in food preservation via fermentation processes.
- Understand the principles & current practices of processing techniques & the effect of processing parameter on product quality.
- Understand production of antibiotics, alcohol, organic acids and amino acids.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Bioreactor Technology	Bioreactor / Fermenter: types & operation of bioreactors, introduction to batch, fed-batch and continuous culture systems, s, limitations of bioreactors, stages of fermentation processes, media design for fermentation processes, solid substrate fermentation, advantages & disadvantages of solid substrate & liquid fermentations.	12
Unit II	Downstream Processing	Importance of downstream processing and methods of downstream processing, centrifugation, filtration, precipitation, dialysis, chromatographic techniques- gel filtration, ion exchange chromatography and affinity chromatography, electrophoresis, capillary electrophoresis, quality assurance techniques and its importance in marketing.	14
Unit III	Immobilized Systems	Methods of enzyme immobilization: adsorption, entrapment, direct covalent linking, cross-linking, kinetics of immobilized enzymes, effect of solute partition & diffusion on the kinetics of immobilized enzymes, enzyme electro-catalysis (biosensors)	10
Unit IV	Food Biotechnology	Introduction, elementary idea of canning and packing, sterilization and pasteurization of food products, probiotic, prebiotic and functional foods: concepts and applications in food; functional foods (oat products, milk and dairy products, sea food products); bio-preservatives; production of alcoholic beverages and post fermentation processing of beer, wine, whiskey.	14
Unit V	Biotechnology Industry and Medicine	Production of important primary metabolites (citric acid, lactic acid), production of enzymes (proteases, amylases, lipases), antibiotics, therapeutic applications, developing recombinant proteins with therapeutic & diagnostics applications, vaccine development- insulin, Singe Cell Protein.	10



METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED:

1. Introduction to food processing- Jelen P.
2. Preservation of fruits and vegetables – Girdhari lal, G. S. Siddappa, G. L. Tondon
3. A handbook on PHM of fruits and vegetables – P. Jacob John
4. Technology of Cereal – Kent N. L.
5. Food packaging – Robert son G.L.
6. Principles of fermentation technology – 2nd edition peter F. Standbury, Allan Whitaker
7. Microbial technology – Vol-1 & 2 – H. J. Peppler and D. Perlman
8. A.H. Patel “ Industrial Microbiology” Macmillan.
9. Presscott, S.C. and Cecil G. Dunn, “Industrial Microbiology”, Agrobios (India), 2005.
10. Cruger, Wulf and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Panima Publishing, 2000.
11. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
12. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.
13. Industrial microbiology: An introduction. Mike J. Waites, Neil Morgan, John Rackey, Gary Higton, John S. Rockey.
14. Bioreactor recovery in bioprocess technology. Biotol Series
15. Principles of fermentation technology. P. F. Stanbury et al.
16. Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6., Shree i. publishers, New Delhi, 2007.
17. Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology. CRC Publishers, Washington, 2003

PRACTICAL IN PHARMACEUTICAL BIOTECHNOLOGY (4 hrs. per week)

LIST OF EXPERIMENTS

1. Estimation of casein protein in milk.
2. Isolation of proteolytic enzymes from soil sample
3. Production of baker's yeast and inoculums preparation
4. Production of lactic acid, citric acid & ethanol
5. Preparation of standard plot of protein
6. Preparation of standard plot of sugar
7. Growth of microorganism and yield calculation



NANOBIOTECHNOLOGY (BM 19212)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19212	Major	Nanobiotechnology	4	0	4	60	4+2=6

Objective:

To sensitize the students from a varied background about the biotechnological basics & culminates into modern day application of nanoscience in biotechnology.

Outcomes:

After the end of this course, the student will able to

- Develop a fundamental understanding of basic concept of nanobiotechnology and its uses in the field of life sciences & medical.
- Evaluate applications of various concepts & techniques of nanobiotechnology to facilitate better biotechnological advancement & innovations which can drive medicines.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Nanobiotechnology: an overview	Nanobiotechnology & Nanomaterials: background, preparation & characterization, wet chemical processes, mechanical processes, methods to synthesis nanoparticles: bacteria, yeast & fungi in nanoparticles synthesis	10
Unit II	Biomaterials Science	Third generation biomaterials (2000 onwards), types of biomaterials: cellulose, polyesters, overview about biopolymers chemistry of biodegradable solid polymers, mode of erosion, molecular structure effects on hydrolytic breakdown, factors influencing hydrolysis rate, degradable materials for biological recognition, biomaterials in tissue engineering, micro/nanotechnology and biomaterials, nanofabrication and nanotechnology.	10
Unit III	Fabrication and Characterization of Nanostructures	Introduction, nanoparticle synthesis techniques: methodology and classification, solid-state synthesis of nanoparticles, vapour-phase synthesis of nanoparticles, solution processing of nanoparticles, sol-gel processing, solution precipitation, water-oil microemulsion (reverse micelle) method, characterization of nanostructure, thin film deposition, nanospheres, atomic force microscope, high-resolution imaging of biological and nano-structured material, Fourier Transform Infrared Spectroscopy, importance of Infrared Spectroscopy, Differential Scanning Calorimetry.	10
Unit IV	Nanotechnology in Biomedical Applications	introduction, application of micro-and nano-electromechanical devices to drug delivery converging technology. combination therapy, targeting specific cellular function-sensitive linkages. conjugation to carrier molecules, synthetic peptides, polymers, composite targeting, advances in the manufacturing, types and applications of biosensors. quantum dot technology in cancer treatment, quantum dots in early diagnosis of cancer, advantages of inorganic quantum dots over. nanotechnology: a focus on	10



		advanced drug delivery system nanoparticles as drug carriers, evading phagocytosis, nanotechnology and opportunities for agriculture and food systems.	
Unit V	Nanomedicine and Novel Drug Delivery Systems	Introduction, drug delivery systems, nanomaterials for drug delivery, nanoparticles target cancer cells in vivo, dendrimers as nanoparticulate drug carriers, dendrimers as drug carriers, encapsulation of drugs in dendrimers, conjugation of drug in dendrimers, cell-penetrating peptides in combination with nanoparticles for novel drug delivery, bio-responsive hydrogels, bio-responsive hydrogels for drug delivery, application of materials in medicine: cardiovascular medical devices, peripheral stents and stent grafts, orthopaedic applications.	10
Unit VI	Health and Environmental Impacts of Nanotechnology	Introduction, engineered nanomaterials of relevance to human health, engineered nanomaterials in the body, routes of entry: gastrointestinal tract, skin, lungs, toxic mechanisms, environmental implications of nanoparticles, toxicological health effects caused by nanoparticles, pulmonary inflammation induced by ultrafine particles, nanotechnology and ethical responsibility	10

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED:

Reference Book:

1. Nanobiotechnology, Subbiah Balaji
2. Nanotechnology: A Fundamental Approach, Dr. U. Kumar
3. Nanobiotechnology: Concepts, applications and perspectives, Chtistolf M. Niemeyer, Chand A. Mirkin, Wiley Publishers
4. Nanotechnology: A Gentle Introduction to next big idea, mark Ratner and Daniel Ratner
5. Nanotechnology: Willian Illsey Atkinson, JAICO publishing house.
6. Bio Molecular Computation for Bio nanotechnology, Liu and Shimohara, Artech house- London.

PRACTICALS IN NANOBIO TECHNOLOGY (4 Hrs. per Week)

1. Synthesis of Nanoparticles from fungus / bacteria / plant (Demonstration)
2. Characterization of Nanoparticles through UV spectrophotometer



CLINICAL RESEARCH (BM 19213A)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19213A	Elective	Clinical Research	4	0	4	60	4+2=6

Objective:

The objective of the course is to impart the knowledge of clinical research in understanding the concept of clinical trials and in drug discovery and development.

Outcome:

At the end of the course the student will be capable to design, execute & inspects data of clinical research & trials.

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Introduction to Clinical Research	Introduction to clinical research, terminologies and definition in clinical research, origin and history of clinical research, difference between clinical research and clinical practice, types of clinical research, phases of clinical research, clinical trials in India –the national perspective, post marketing surveillance, pharmaceutical industry – global and Indian perspective	6
Unit II	Pharmacology & Drug Development	Introduction to pharmacology, concept of essential drugs, routes of drug administration, introduction to drug discovery and development-hurdles in drug development, sources of drugs approaches to drug discovery, pharmacovigilance, factors affecting drug response	8
Unit III	Preclinical Studies	Guidelines for care and use of laboratory animals, introduction to preclinical pharmacology, pre – clinical toxicity, lab animals in pharmacology, preclinical drug testing, calculation of first human dose, investigational new drug application, clinical trials new drug application and approval	8
Unit IV	Guidelines and Regulations in Clinical Research	International Conference on Harmonization (ICH)-Brief history of ICH, Structure of ICH, ICH Harmonization Process, Good Clinical Practice: ICH guidelines, Indian GCP guidelines (CDSCO guidelines), ICMR Guidelines - ethical guidelines for biomedical research on human subjects, schedule y, institutional review board / independent ethics committee stakeholders in clinical research (investigators, sponsors, CRO, SMO), clinical trial protocol and protocol amendment(s), investigator's brochure, essential documents for the conduct of a clinical trial, introduction of clinical trial regulation, European medicine agency, Food and Drug Administration (US FDA), Drug and Cosmetic act, GMP	10
Unit V	Clinical Development	Research question, Case report form, Informed Consent, preparing data collection forms, Protocol writing, new drug discovery process- purpose, main steps involved in new drug discovery process, timelines of each step, advantages and purposes of each step, ethics in clinical research, unethical trials, Phase-I, II, III, IV trials- introduction and designing, principles of sampling, inclusion	10



		and exclusion criteria, -methods of allocation and randomization, termination of trial, safety monitoring in clinical trials	
UNIT VI	Clinical Regulatory Requirements	Audit/ Inspection, Fraud and Misconduct in Clinical Trials Conflict of interest in Clinical research, Vaccine trails in children Bioavailability and Bioequivalence, how to fill an ADR reporting form and methods for causality assessment, risk to benefit ratio bias and confounding factor, uses of placebo	10
Unit VII	Marketing	Promotional inputs & development of Medico-Marketing, Prescribing Information (PI) Or Package Insert (PI), Publication issues	4
Unit VIII	Data Management	Clinical data management (CDM): introduction, CRF Design, electronic data capture, data validation, discrepancy management, clinical data coding, SAE reconciliation, archiving clinical data.	4

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

BOOKS RECOMMENDED

1. Basic and Clinical Pharmacology, Prentice Hall, International, Katzung, B.G.
2. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
3. Drug interaction, Basic Bussiness Publ, Bombay, J.K. Mehra
4. Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2001.
5. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996
6. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi

PRACTICAL IN CLINICAL RESEARCH (4 hrs. per week)

LIST OF EXPERIMENTS

1. Introduction to animal house
2. Handling of lab animals
3. Various routes of drug administration (lab animals)
4. Assessment of adverse drug reaction
5. Documentation for clinical research



REGENERATIVE MEDICINE (BM 19213A)

Course Code	Category	Course Name	L	T	P	Total Hours	Credits (T+P)
BM 19213A	Elective	Regenerative Medicine	4	0	4	60	4+2=6

Objective:

The course deals with the understanding of *in vitro* regeneration of organs, therapeutics and application of stem cells in medicine.

Outcome:

After completing the course, the student should be able to

- describe different types of stem cells and their specific characteristics
- describe methods of applications to replace damaged or destroyed cells including tissue engineering
- account for regenerative medicine applications to human diseases
- account for and evaluate methods and techniques within the research field, their practical execution and application

Sr. No.	Topic	Detail of syllabus	Hrs.
Unit I	Tissues	Introduction: basic definition, structural and organization of tissues: epithelial, connective, vascularity and angiogenesis. current scope of development and use in therapeutic and <i>in-vitro</i> testing.	14
Unit II	Cell Culture	Cell culture: different cell types, progenitor cells and cell differentiations, different kinds of matrix, cell-cell interaction. aspect of cells in culture, bioreactors.	15
Unit III	<i>In vitro</i> Organogenesis	Scaffolds & tissue engineering – basic properties. <i>in vitro</i> organogenesis - engineering tissues for replacing bone, skin and liver	15
Unit IV	Stem Cells and Wound Healing	Stems cells: introduction, types (adult & embryonic), properties, sources; haematopoiesis, ES cells, Blood from ES cells. Basic wound healing. Cell migration, transport limits on 3D cultures. Application of FACs, flow cytometer, SNPs analysis	16

METHODOLOGY

The course would be taught through lectures, demonstrations and practical sessions.

Books Recommended:

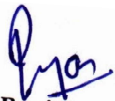
1. Principles of tissue engineering, Robert. P. Lanza, Robert Langer & William L. Chick, Academic press-2008
2. Tissue Engineering, B. Palsson, J.A. Hubbell, R. Plonsey & J.D. Bronzino, CRC- Taylor & Francis-2004
3. Tissue Engineering, Bernhard Palsson, Sangeeta Bhatia, Pearson Prentice Hall, 2003
4. Culture of Cells for Tissue Engineering, Academic press, 1997 3. Gordana Vunjak-Novakovic, R. Ian Freshney



DISSERTATION (BM 19214)

Course Code	Course Name	Credit
BM 19214	Dissertation	04




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