COURSE STRUCTURE
M.SC. (MICROBIOLOGY)

EFFECTIVE FROM ACADEMIC SESSION – 2021-22

Approved in Academic Council Meeting held on 28 July, 2021

M. SC. (MICROBIOLOGY) PROGRAM

I st SEMESTER (MBI)

S.No.	New Code	Subject	L-T-P	Credits
1	21MS1MB111	General Microbiology and Bacteriology	3-0-0	3
2	20MS1MA111	Basics of Mathematics and Statistics	2-0-0	2
3	20MS1BT111	Biochemistry	3-0-0	3
4	21MS1MB112	Molecular Biology	3-0-0	3
5	20B1WBI831	Virology	2-0-0	2
6	21MS1MB113	Fungal Biology	2-0-0	2
7	21MS7MB171	General Microbiology and Bacteriology Lab	0-0-4	2
8	21MS7BT171	Biochemistry Lab	0-0-2	1
9	21MS7MB172	Molecular Biology Lab	0-0-4	2
10	21MS7MB173	GLP and Bioinstrumentation Lab	0-0-2	1
		Total	**27**	**21**

II nd SEMESTER (MBII)

S.No.	New Code	Subject	L-T-P	Credits
1	18MS1BT211	Immunology and Immunotechnology	3-0-0	3
2	21MS1MB211	Enzymes and Bioprocess Technology	3-0-0	3
3	21MS1MB212	Microbial Genetics and Physiology	3-0-0	3
4	18MS1BT313	Recombinant DNA Technology	3-0-0	3
5	20MS1BT213	Bioinformatics	2-0-0	2
6	18MS7BT211	Immunology and Immunotechnology Lab	0-0-2	1
7	21MS7MB271	Enzymes and Bioprocess Technology Lab	0-0-2	1
8	18MS7BI214	Basic Bioinformatics Lab	0-0-2	1
9	18MS7BT373	Recombinant DNA Technology lab	0-0-4	2
10	18MS9BI211	Masters Research Review seminar	0-0-2	1
		Total	**26**	**20**

III rd SEMESTER (MBIII)

S.No.	Code	Subject	L-T-P	Credits
1	21MS1MB311	Environmental Microbiology	3-0-0	3
2	21MS1MB312	Diagnostic Microbiology and vaccines	3-0-0	3
3		Elective-I	3-0-0	3
4	21MS9MB311	Master's Dissertation &Thesis Part-I	0-0-16	8
		Total	**25**	**17**

IV th SEMESTER (MBIV)

S. No.	New Code	Subject	L-T-P	Credits
1	21MS1MB411	Food & Dairy Microbiology MBIV	3-0-0	3
2	21MS1MB412	Plant and Agricultural Microbiology MBIV	3-0-0	3
3		Elective-II	3-0-0	3
4	21MS9MB411	Master's Research Thesis Part-II	0-0-16	8
		Total	**25**	**17**

Total Credits: 75

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ELECTIVE - 1				
S. No.	**New Code**	**Subject**	**L-T-P**	**Credits**
1	21MS2MB311	IPR, Biosafety and Bioethics	3-0-0	3
2	21MS2MB312	Biosensors:Principles & Applications	3-0-0	3
3	21MS2MB313	Computational Systems Biology	3-0-0	3
4	21MS2MB314	Protein Engineering	3-0-0	3

ELECTIVE - 2				
S. No.	**New Code**	**Subject**	**L-T-P**	**Credits**
1	21MS2MB411	Microbial Toxicology MBIV	3-0-0	3
2	21MS2MB412	Experimental models in microbial Research MBIV	3-0-0	3
3	21MS2MB413	Nano-Biotechnology MBIV	3-0-0	3
4	21MS2MB414	QC Analysis and Management MBIV	3-0-0	3

I[st] SEMESTER (MBI)

GENERAL MICROBIOLOGY AND BACTERIOLOGY **COURSE CODE: 21MS1MB111** **L-T-P: 3-0-0** Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of microbiology useful in biotechnology industry**.** Scientific evaluation of various characteristics of icroorganisms, especially bacteria their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able to: ▪ Acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of bacteria. ▪ Analyze and interpret the experiments/pathways relevant to bacterial analysis ▪ Designate vital role of the bacteria in the environment and their genetics and association with human beings. ▪ Retrieve and use cotemporary information and industrial potential related to microbial world.

Syllabus:

Unit	Topics Covered
Unit 1: Introduction, history and scope of Microbiology 4 lectures	Introduction, history and scope of Microbiology. General characteristics and composition of Prokaryotes and Eukaryotes. Classification of Microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, classification and salient features of bacteria according to Berger's Manual of Determinative Bacteriology. Nomenclature and modern methods of Bacterial taxonomy.
Unit 2: Morphology and Anatomy of bacteria 6 lectures	Morphology and ultra-structure of bacteria: size, shape, and arrangement of bacteria, ultra-structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form. Components external to cell wall: Structure and function of flagella, fimbriae and pilli, capsule- types, composition and function, slime layers, S-layers. Prokaryotic cell membrane and cytoplasmic matrix – cell membrane structure and function of bacteria and archaebacteria, mesosomes, ribosomes, cytoplasmic inclusion bodies (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycean granules) and nucleoid. Bacterial response to external stimulus and bacterial endospores: Chemotaxis and phototaxis structure, formation and germination of bacterial

	endospore.
Unit 3: Analytic techniques and control measures in bacteriology 7 lectures	Staining methods: fixation, types of dyes, simple staining, differential staining - Gram and Acid-fast staining, staining of specific structures capsule, flagella and spore staining Control of microorganisms: Microbial death curve, concept of bio-burden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Control of bacteria by physical agents: heat - moist and dry, filtration and radiation. Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes
Unit 4: Bacterial growth and kinetics 7 lectures	Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media. Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture. Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture. Measurement of growth and influence of environmental factors affecting growth.
Unit 5: Bacterial reproduction and genetics 7 lectures	General concept of Prokaryotic and Eukaryotic genome. Genome of *E. coli.* Genetic recombination and transformation. Transduction: generalized and specialized transduction, phage conversion. Plasmid: types and their significance. Conjugation and chromosomal mobilization. *E. coli* as model prokaryotes.
Unit 6: Bacterial epidemiology and diseases 5 lectures	Human diseases caused by bacteria; The epidemiology, pathogenesis, antigenic characteristics and diagnosis of diseases
Unit 7: Microbial Ecology and Industrial applications 6 lectures	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophiles, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy

Recommended Textbooks and References:

1. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
2. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
3. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
4. Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
5. Nester: Microbiology Study Guide McGraw Hill.
6. Black: Microbiology: Principles and Applications Prentice Hall

Basics of Mathematics and Statistics **COURSE CODE: 20MS1MA111** **L-T-P: 2-0-0** Credits 2	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students for application in biological sciences	**Students Learning Outcomes** On completion of this course, students should be able to: ▪ Gain broad understanding in mathematics and statistics; ▪ Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I Algebra 8 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II Calculus 6 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.).
Unit III Mathematical models in biology 6 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modelling chemical reaction networks and metabolic networks.
Unit IV Statistics 8 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Biochemistry **COURSE CODE: 20MS1BT111** **L-T-P: 3-0-0** Credits 3	**Course objective** Following are the objectives of Biochemistry course. ▪ To understand the basic biochemical processes and their principles those govern complex biological systems. ▪ To understand the structure, functions of essential biomolecules and their interactions with each other. ▪ To understand the various metabolic and energy generation processes which are essential for sustainability of life.	**Students Learning outcomes** After learning and completion of Biochemistry course, student will be able to: ▪ Define the structural features of basic biomolecules ▪ Describe the functionality of biomolecules in relation to their usage for steady state of an organism. ▪ Get complete understanding of metabolic processes and their integration with each other.

Unit/ Module	Description
Unit I: Origin of Life (Biochemical basis) 4 lectures	Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water and its essential role for life, pH and its regulation in relation to microorganisms
Unit II: Biomolecules in Microbial world 8 lectures	**Carbohydrates:** Classification, basic chemical structures and their role in microbial life. **Lipids:** Classification, structure and function of major lipid subclasses in microbe's especial consideration bacterial membranes. **Proteins:** Amino acids: Classification, Properties, Protein Structure: primary, secondary, tertiary and quaternary structure, basics of enzymes and their catalysis. **Nucleotides:** Nucleotides, Nucleosides structures, Different confirmations of DNA
Unit III: Microbial nutrition and basic biochemical process for growth 4 lectures	Microbial metabolic diversity and classification based on nutritional types. Transport Mechanisms across membrane: Diffusion, facilitated Diffusion, Active and passive transport.
Unit IV: Central Metabolic Pathways and Carbohydrate metabolism 10 lectures	Bacterial aerobic respiration, Embden-Meyerhof pathway, Entner-Doudoroff pathway, Pentose phosphate pathway, Tricarboxylic acid cycle, components of electron transport chain, chemiosmotic theory, oxidative and substrate level phosphorylation, , Utilization of sugars other than glucose and complex polysaccharides. Bacterial anaerobic respiration and fermentation
Unit IV: Metabolism of lipids and hydrocarbons: 6 lectures	Biosynthesis and degradation of fatty acids and phospholipids, lipopolysaccharide biosynthesis
Unit V: Protein and amino-acid metabolism 6 lectures	Metabolism of amino acids: Amino acid biosynthesis and utilization, lysine and glutamine overproduction, polyamine biosynthesis and regulation.
Unit VI: Metabolism of nucleotides 4 lectures	Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Recommended Textbooks and References:

1. J M Berg, L Stryer, J Tymoczko, G Gatto, “Biochemistry”, 9th Ed., (2019) W H Freeman
2. D L Nelson and MM Cox, “Lehninger Principles of Biochemistry”, 7th Ed. (2017) WH Freeman
3. J Willey, L Sherwood, C J Woolverton “Prescott's Microbiology”, 10th Ed., (2016) Mc GRaW-Hill

	Course objective	Students Learning outcomes
Molecular Biology **COURSE CODE: 21MS1MB112** **L-T-P: 3-0-0** Credits 3	The objective of this course is to equip students with detailed knowledge of molecular biology, applications of molecular biology, and enhance their abilities to understand modern research and developments in the life science sector.	On successful completion of this course, student will be able to: ▪ Understand physical and chemical properties nucleic acids ▪ Develop deep understanding about DNA replication, damage and repair ▪ Understand the processes of transcription and translation at molecular level ▪ Will recognize the different mechanism of gene regulation in microbial systems ▪ Will get apprised with different molecular biology techniques and their applications in modem research and life science sector

Unit I **Chemical and Physical Properties of Nucleic acids** 3 lectures	Introduction to molecular Biology; Chemical and physical properties of Nucleic acids
Unit II **DNA replication Damage and repair** 8 lectures	DNA replication, Nature of replication, Enzymes and proteins involved, Replication Fork and priming, leading and lagging strand, Process of Replication: initiation elongation, termination, specific features of replication in Prokaryotes, fidelity of replication, inhibitors of replications and their applications, DNA damage repair and recombination: DNA damage, DNA Mismatch Repair, Double Strand Break Repair, Homologue and site-specific recombination,
Unit III **RNA synthesis and processing** 8 lectures	Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNAi and miRNAs, post-transcriptional gene regulation.
Unit IV **Protein synthesis and processing** 8 lectures	Translation: Mechanisms of translation in prokaryotes, initiation complex, ribosomes and tRNA, factors, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational elongation and termination, inhibitors of translation

Unit V **Gene Regulation expression** 8 Lectures	Control of gene expression at transcription and translation level regulating the expression of phages, viruses, prokaryotic and
Unit VI **Molecular Biology Techniques** 7 Lectures	Labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, Hybridization techniques: northern, southern, fluorescence in situ hybridization, Polymerase chain reaction and its variations

Recommended Textbooks and References:

Suggested Text Book(s):

1. Lehninger "Principles of Biochemistry".
2. Principles of Genetics – D. Peter Snustad, Michael J. Simmons

Suggested Reference Book(s):

1. Lewin's GENES XI
2. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). Molecular Cell Biology.
3. W. H. Freeman and Company
4. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6th edition, Benjamin Cummings, San Francisco, USA, 2007.
5. Molecular Biology by R.F. Weaver, 4th edition, McGraw Hill. New York. USA, 2007.
6. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5th edition, Garland Science, New York and London, 2007. 5.

VIROLOGY COURSE CODE: 20B1WB831 L-T-P: 2-0-0 Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of virology useful in biotechnology industry**.** Scientific evaluation of various characteristics of viruses, their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able ▪ To acquire the knowledge about fundamental concepts related virology and its history ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic virological techniques including growth and control of viruses ▪ Analyze and interpret the experiments/pathways relevant to virus analysis

Unit 1 **Introduction and classification of viruses** 4 Lectures	Brief outline on discovery and origin of viruses. General properties of viruses, Classification and general properties of major families of viruses
Unit 2 **Structure and morphology of viruses** 4 Lectures	Morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents-viroids and prions.
Unit 3 **Cultivation and analytical techniques in virology** 7 Lectures	Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems; serological methods – haemagglutination and HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmuno assays; assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy) – Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses.
Unit 4 **Viral replication; uncoating, assembly and release** 6 Lectures	Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. Brief account of M13, Mu, T4, Ø x174 and lambda phage. Uncoating, assembly and release

Unit 5 **Plant viruses: Infection and diseases of plants** 7 Lectures	Classification and nomenclature; effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato and sugarcane; viruses of cyanobacteria, algae, fungi, life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection – virus- free planting material; vector control
Unit 6 **Animal viruses: infections and diagnosis** 7 Lectures	Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA virurses Picorna, Ortho myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses.
Unit 7 **Viral vaccines and antiviral agents** 7 Lectures	Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA vaccines with examples) interferons and antiviral drugs.

Recommended Textbooks and References:

1. Reference Books 1. Virology; Renato Dulbecco and Harold S. Ginsberg

2. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.

	Course objective	Students Learning Outcomes
Fungal Biology COURSE CODE: 21MS1MB113 L-T-P: 3-0-0 Credits 2	The objectives of this course are to introduce field of field biology with special emphasis on fungal diversity, morphology, physiology and reproduction; their application to industry and a human-host or plant-fungal interactions.	Students should be able to: Identify major categories of fungi and analyze their classification, diversity, and ubiquity Identify major categories of fungi, demonstrate and evaluate interactions between hosts (plant/human) and environment.

Unit I **Introduction and classifications** 3 lectures	Introduction to the course; characteristics of fungi Fungal life cycles, ecological role of fungi, and human-fungus interactions, Model organisms and genetics
Unit II **Division or Phylum Zygomycota** 04 lectures	**General overview** **Class Zygomycetes (Order Mucorales)** Fermented Foods etc
Unit III **Division or Phylum Basidiomycota (General overview) Class Basidiomycetes** 07lectures	Cultivation of mushrooms & other fungi Spore release and dispersal Poisonous and hallucinogenic mushrooms; Mycotoxins in the grain and other food products. **Class Urediniomycetes & Ustomycetes (Rusts and Smuts)**
Unit IV **Division or Phylum Ascomycota** 08 lectures	**General overview** Ergot & ergotism; Mycotoxins in Food Alcoholic fermentations, cheeses, and fungal metabolites Physiology of Fungal Growth Bioremediation Yeast-Model organism and expression system
Unit V **IMPERFECT FUNGI** **FUNGUS-LIKE ORGANISMS** 7 lectures	**Form Division or Form Phylum Deuteromycota: (General overview)** Symbiotic and Parasitic relations Allergies and Fungal Diseases of Animals & Humans Slime molds Zoosporic Fungi: Chytrids, Oomycetes, and others

Recommended Textbooks and References:

1. Introduction to Fungi. 3rd Edition (2007) Webster & Webster. Cambridge University Press.
2. Bessette, A. E., Bessette, A. F., & Lewis, D. P. (2019). Mushrooms of the Gulf Coast States: A Field Guide to Texas, Louisiana, Mississippi, Alabama, and Florida. University of Texas Press.
3. https://fungalbiolbiotech.biomedcentral.com/articles
4. https://www.frontiersin.org/research-topics/9823/innovative-approaches-in-diagnosis-of-emergingre-emerging-infectious-diseases
5. https://www.frontiersin.org/research-topics/11600/fungal-genetics-in-plant-biomass-conversion
6. https://www.frontiersin.org/research-topics/13305/plant-pathogenic-fungi-molecular-systematics-genomics-and-evolution

General Microbiology and Bacteriology Lab **COURSE CODE: 21MS7MB171** **L-T-P: 0-0-4** Credits: 2	**Course Objectives** The objective of this laboratory course is to provide practical skills on basic microbiological techniques.	**Students Learning outcomes** Students should be able to: ▪ Isolate, characterize and identify ▪ Common bacterial organisms ▪ Determine bacterial load of different samples ▪ Perform antimicrobial sensitivity tests ▪ Preserve bacterial cultures.

Syllabus:

1. To study construction and working of compound microscope and study of microbiology lab instruments
2. Sterilization, disinfection and safety in microbiological laboratory.
3. Preparation of media for cultivation of bacteria.
4. Isolation of bacteria in pure culture by streak plate method.
5. Pour plate technique and study of colony and growth characteristics of some common bacteria
6. Preparation of bacterial smear and Gram's staining.
7. Acid-fast staining for study and differentiation of acid-fast bacteria.
8. Enumeration of bacteria: serial dilution and standard plate count.
9. Antimicrobial sensitivity test and demonstration of drug resistance
10. Determination of Minimum Inhibitory Concentration (MIC)
11. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
12. Determination of phenol co-efficient of antimicrobial agents.
13. Isolation and identification of bacteria from soil/water samples.
14. Study of bacterial growth kinetics.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Benson, Harold J. (2007) *Microbiological Applications : Laboratory Manual in General Microbiology*, McGraw-Hill Higher Education
4. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

BIOCHEMISTRY LAB COURSE CODE: 21MS7BT171 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The Objective of the course is ▪ To provide training and skills for the handling and analysis of biomolecules. ▪ To acquaint the students with laboratory techniques related to detection and estimation of primary biomolecules which are essential in an organism for life sustainability.	**Students Learning outcomes** After completion of Biochemistry lab, student will be able ▪ To understand the basic biochemistry laboratory practices and independently handle different instruments utilized ina biochemistry lab. ▪ To identify and quantify accurately different biochemical identities in a given sample. ▪ To observe, analyze and record the results of biochemical experiments and independently draw reasonable conclusions from results.

Syllabus:

1. Basic guidelines for safety measures to avoid hazards in biochemistry lab and preparing various stock solutions and working solutions.
2. To prepare buffer solution of varying pH by using Henderson-Hasselbalch equation and pH meter.
3. To identify and classify different sugars on the basis of qualitative methods.
4. To determine concentration of carbohydrates by Anthrone method: a quantitative approach.
5. To isolate the proteins from bacterial culture using differential centrifugation and their detection using qualitative methods.
6. To estimate concentration of proteins with Bradford's method.
7. To estimate concentration of proteins by Lowry's method.
8. To separate different bacterial proteins using SDS PAGE technique.
9. To study the enzyme activity (amylase enzyme) using DNS method.
10. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
11. To determine presence of lipid in a given sample through qualitative method.
12. To Estimate the Saponification value of oils.
13. To quantify the concentration of DNA using spectrophotometer.
14. To detect the presence of microorganism in milk using specific biochemical tests.

Recommended Textbooks and References:

1) Irwin H. Segel "Biochemical Calculations", 2ed (2010) Wiley
2) Andreas Hofmann & Samuel Clokie Wilson and Walker's "Principles and Techniques of Biochemistry and Molecular Biology" (2018) Cambridge university press

Molecular Biology Lab **COURSE CODE: 21MS7MB172** **L-T-P: 0-0-4** Credits 1	**Course objective** The objective of this course is to familiarize the students with some basic and advanced techniques of molecular biology.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Understand the fundamentals of procedure of isolation, quantification and visualization of various biomolecules from different cellular or tissue. ▪ Interpret and conclude experimental results involving molecular biology

Syllabus

1. Introduction to molecular biology lab and facilities, Calculations of molarity and normality of the solutions
2. Preparation of Buffer Stocks (TBE, TAE, TE) and Buffers for gel electrophoresis
3. To perform agarose gel electrophoresis of DNA samples
4. Estimation of DNA quantity and quality by gel electrophoresis
5. To isolate genomic DNA from *E. coli* (DH5-α) using heat boiling method
6. To isolate *E. coli* (DH5-α) genomic DNA using phenol chloroform
7. Isolation of genomic DNA from human blood sample
8. Preparation of reagents and isolation plant genomic DNA using CTAB method
9. Quantification of DNA concentration and purity by spectrometric/nanodrop method
10. Introduction to Polymerase Chain Reaction and to amplify gene using genomic DNA of *E. coli.*
11. To separate serum and plasma proteins from human blood
12. To visualize human serum and plasma proteins using SDS-PAGE technique
13. To isolate RNA from bacterial cell and its quantification

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Good Laboratory Practice and Bioinstrumentation Lab **COURSE CODE: 21MS7MB173** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The Objective of the course is to provide training of good laboratory practices and various instrumentations used in Biotech/Pharmaceutical industry. This course covers practical aspects of modern instrumentation used for analysis in biological research	**Students Learning outcomes** Students should be able to: ▪ To understand basic guidelines, importance of good laboratory practice, documentation and conduct of non-clinical studies ▪ To Understand basic principles and applications of bio-instruments ▪ To develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process

Syllabus:

1. To introduce good lab practices, Lab safety and Bio hazard
2. Introduction to the OECD Principles of good laboratory practice. Overview and Purpose of GLP
3. Good Documentation practice and maintenance of lab note book
4. Quality control & Quality Assurance in laboratory
5. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
6. Instrumentation and working principles of infra red (IR) spectroscopy using salt plates.
7. Chromatography (Ion exchange, Molecular Sieve, Affinity, Thin layer, GC)
8. Instrumentation and working principles of HPLC
9. Instrumentation and working principles Electron Microscopy
10. Principle and application Gel electrophoresis
11. Principle and application of lypholization
12. Instrumentation and working principles of mass spectroscopy
13. Determination of molar mass of simple compounds using mass spectroscopy.
14. MALDI-TOF instrumentation and analysis of serum proteins
15. To study the effect of chemical denaturants on protein stability using CD spectroscopy.
16. Principle and applications of Centrifugation and ultracentrifugation

Recommended Textbooks and References:

1. Milton. A. Anderson (2002) GLP Essentials: a Concise Guide to Good Laboratory Practices
2. Sandy Weinberg (2007) Good Laboratory Practice Regulations
3. Nally, J. D. 6th edition. CRC Press (2006) *GMP for Pharmaceuticals*
4. Andreas Hofmann & Samuel Clokie Cambridge university press (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology

IInd SEMESTER (MBII)

	Course objective	Students Learning outcomes
Immunology and Immunotechnology **COURSE CODE: 18MS1BT211** **L-T-P: 3-0-0** Credits 3	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.	On successful completion of this course, student will be able to: • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I **Immunology fundamental Concepts:** 6 lectures	Historical perspectives, Cells and organs of the immune system, Types of immunity (innate and acquired immunity), Components of innate and acquired immunity, Antigens: mitogens Immunogenicity, antigenicity, epitopes, haptens.
Unit II **Immune responses generated by B and T lymphocytes** 8 lectures	Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants, B-cell receptor, B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system,
Unit III **Antigen-antibody interactions** 5 lectures	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and FACS.
Unit IV **Vaccinology** 7 lectures	A short history of vaccination, Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin

Unit V **Clinical immunology** 8 Lectures	Autoimmunity: Types of autoimmune diseases (organ specific and systemic), Mechanisms of autoimmunity, Hypersensitivity reactions: Type I, II, II and IV, hypersensitivity reactions, treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy
Unit VI **Immune response to infectious diseases and tumor immunity** 4 Lectures	Viral, bacterial, protozoan diseases, parasitic infections, Immunodeficiency diseases: Primary and secondary immunodeficiency diseases, Acquired immunodeficiency syndrome (AIDS)
Unit VII **Immunogenetics** 4 Lectures	Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing. General organization and inheritance of MHC, structure of MHC class I and II molecules, peptide binding by MHC molecules, MHC and susceptibility to disease.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
6. Parham, P. (2005). The Immune System. New York: Garland Science.

	Course objective	Students Learning outcomes
Enzymes & Bioprocess Technology **COURSE CODE: 21MS1MB211** **L-T-P: 3-0-0** Credits 3	The objectives of this course are to develop an understanding in students about the fundamental and important concepts of enzymes and bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.	On successful completion of this course, student will be able to: • Describe the fundamentals and importance of enzymes and its kinetics • Appreciate relevance of microorganisms from industrial context • Analyze bacterial growth kinetics in batch/continuous/Fed-batch reactor and thermal death kinetics • Give an account of bioreactor design and their applications • Calculate yield and production rates, the need for oxygen and oxygen transfer in a biological production process, and also interpret data; • Apply principles of various unit operations in designing and optimization of downstream processes • Give an account of importance of enzymes and microbials in food processing and production of various bioproducts.

Unit I **Enzymology** 5 lectures	Introduction to Enzymes; Classification; General properties; Kinetics; Reversible and irreversible inhibition; Coenzyme and cofactors; Isoenzymes
Unit II **Basic Principles of Bioprocess Technology** 4 lectures	Introduction to fermentation; Isolation, screening, preservation and maintenance of industrially important microbes; Strain improvement
Unit III Bioreactor Design and Analysis 10 lectures	Microbial growth and Death Kinetics; Factors affecting microbial growth; Batch and Continuous Fermentation; Modifying Batch and continuous Fermentation: Fed-batch, Chemostat with recycle, multistage chemostat systems; Cell and enzyme immobilization Criteria for ideal fermenter; Configuration; Bioreactor designs-mechanically agitated; Pneumatic and hydrodynamic fermenters. Whole Cell Immobilized Fermenters; Stability of microbial reactors
Unit IV **Upstream processing**	Fermentation media; Media formulation; Sterilization; Aeration, agitation and heat transfer in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process

6 lectures	
Unit V Downstream processing and Product Recovery 7 Lectures	Separation of insolubles: Filtration, Centrifugation, Sedimentation; Cell disruption; Separation of solubles: Liquid-liquid extraction; Precipitation; chromatographic techniques; Reverse osmosis and ultra and micro filtration; Final purification: Drying; Crystallization; Storage and packaging; Effluent Treatment and its disposal
Unit VI Applications of Enzyme technology in food processing 4 Lectures	Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions food processing
Unit VII Applications of microbial technology in bioproduct production 6 Lectures	Industrial Production of Bioproducts: Ethanol, Acids (Citric, acetic, Lactic and gluconic), Antibiotics (Penicillin, streptomycin, tetracycline), Semi-synthetic antibiotics, Ethanol, Single Cell Protein

Recommended Textbooks and References:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
2. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
3. Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
4. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
5. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
6. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
7. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.
8. Klaas Van't Riet, Johannes Tramper, "Basic Bioreactor Design", 2nd ed., Marcel Dekker, Inc., New York, 1991.
9. JE Bailey and DF Ollis, "Biochemical Engineering Fundamentals", 2nd ed., McGraw-Hill Book Company, New York, 1986.
10. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
11. Abhilasha S. Mathuriya, "Industrial Biochnology" 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Microbial Genetics and Physiology **COURSE CODE: 21MS1MB212** **L-T-P: 3-0-0** Credits 3	**Course objective** The objectives of this course are to take students through basics of genetics and physiology covering prokaryotic/phage genetics to yeast and higher eukaryotic domains. Students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, genetics of evolution, microbial metabolism, energy generation, microbial communication and energetics.	**Students Learning Outcomes** On successful completion of this course, student will be able to: ▪ Describe fundamental molecular principles of genetics. ▪ Describe the basics of genetic mapping. ▪ Understand the principles of Population genetics. ▪ Acquaint with energy generation and fermentation pathways. ▪ Acquaint with energetics of Chemolithotrophs, and microbial cross-talk

Unit I Genetics of bacteria, bacteriophages, and Yeast 10 lectures	Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; Yeast mating type switch; dominant and recessive genes/mutations, complementation groups, transposon mutagenesis, Mapping QTLs
Unit II **Drosophila genetics as a model of higher eukaryotes** 5 lectures	Analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics
Unit III **Population genetics and genetics of evolution** 7 lectures	Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, Fishers theorem, Hardy Weinberg equilibrium, in-breeding depression & mating systems; population bottlenecks
Unit IV Microbial Physiology 10 lectures	Metabolic genetic regulation, Energy, oxidation-reduction vs. fermentation, Microbial growth: Growth cycle, continuous culture, factors affecting growth. Regulatory systems during aerobic- anaerobic shifts. Osmotic control of gene expression, SOS response and Heat shock response, Phosphate starvation
Unit V Energetics of autotrophs and chemolithotrophs 10 Lectures	pH Homeostasis, specific transport systems, Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation; Characteristics and Metabolism of autotrophs; Biosynthesis of Fatty acids; Degradation of Lipids, Endospore formation (differentiation). Bacterial Quorum sensing

Recommended Textbooks and References:

1. Hartl, D. L., & Jones, E. W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.

2. Pierce, B. A. Genetics: a Conceptual Approach. New York: W.H. Freeman.

3. Tamarin, R. H., & Leavitt, R. W. Principles of Genetics. Dubuque, IA: Wm. C. Brown.

4. Smith, J. M. Evolutionary Genetics. Oxford: Oxford University Press.

5. Klug, W.S., Cummings, R., Spencer, C. A., & Michael A. P., Concepts of Genetics. Pearson Publications

6. Albert G. M., & John W. F., Microbial Physiology, Wiley-Liss, A John Wiley& Sons, Inc. Publications.

7. Trudy T. A, Endang P. et al, Microbial Physiology and Genetics. Intelliz Press,

8. Davis K. Microbial Physiology and Genetics. Apple Academic Press.

Recombinant-DNA Technology **COURSE CODE: 18MS1BT313** **L-T-P: 3-0-0** **Credit 3**	**Course objective** The objectives of this course are to teach students with various approaches to conducting recombinant DNA technology and their applications in biological research as well as industries.	**Students Learning outcomes** Given the impact of recombinant DNA technology in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit I **Introduction and tools for rDNA technology** 3 lectures	Recombinant DNA technology: gene cloning, Genetic engineering, - concept and basic steps - rDNA Glossary, history of rDNA-recombinant Insulin
Unit II **DNA modifying enzymes and cloning techniques** 06 lectures	Restriction Endonucleases, DNA Ligation Enzymes and, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, and Reverse transcriptase other tools used for DNA Modification
Unit III **Cloning Vectors and Expression Vectors** 12 lectures	Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules Principles for maximizing gene expression, expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors
Unit IV **Construction libraries and sequencing technologies** 10 lectures	Genomic library, cDNA library, Growing & Storing Libraries, construction of microarrays, cDNA Cloning (5'&3' RACE) Basic DNA Sequencing, Whole genome sequencing, Next generation sequencing technologies
Unit V **Gene Expression in Microbial and Eukaryotic Systems** 06 lectures	Microbial, Yeast Saccharomyces *Cerevisiae* as heterologous protein expression platforms, Protein expression in insect Cells and Mammalian Cells; protein-protein interactions using yeast two-hybrid system;
Unit VI **Genetic Manipulation Of microorganisms** 05 lectures	Gene transfer techniques, Application of Genetically Engineered Strains of microbes; Biosafety Issues related to recombinant DNA Technology Genetic Manipulation of microorganisms

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Bioinformatics **MBII** **COURSE CODE: 20MS1BT213** **L-T-P: 2-0-0** Credits 2	**Course objective** The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Develop an understanding of basic theory of these computational tools; ▪ Gain working knowledge of these computational tools and methods; ▪ Prediction of structure from sequence and subsequently testing the accuracy of predicted structures ▪ Appreciate their relevance for investigating specific contemporary biological questions; ▪ Critically analyse and interpret results of their study.

Unit I **Introduction** 4 lectures	Bioinformatics basics: Protein and nucleic acid databases; Structural databases; search tools: biological background for sequence analysis; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; sequence, sequence similarity, homology, alignment.
Unit II **Pairwise Sequence Alignment** 6 lectures	Different scoring models, Substitution matrices (PAM and BLOSUM), Pairwise Alignment: Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, FASTA and BLAST algorithms.
Unit III **Multiple Sequence alignment** 6 lectures	Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) based methods of MSA, Profile and BLOCK level analysis, Motif and Pattern searching and primer designing.
Unit IV **Phylogenetic Analysis** 4 lectures	Molecular evolution basics, phylogenetic tree and terminology, different methods of Phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods, Phylogenetic and evolutionary analysis.
Unit V Structural Alignment Tools and Protein Tertiary Structure Prediction 5 Lectures	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure aided sequence techniques of structure prediction; structural profiles.
Unit VI **RNA Structure Analysis**	terminology of RNA secondary structure, inferring structure by comparative sequence analysis, RNA secondary structure prediction, Basic algorithms and methods of RNA folding.

3 Lectures	

Recommended Textbooks and Reference books:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.

Reference Books:

1. J. Setubal and J. Meidanis (1997) *Introduction to Computational Molecular Biology***,** PWS Publishing Co.

2. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Immunology and Immunotechnology Lab **COURSE CODE: 18MS7BT211** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objectives of this lab course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.	**Students Learning outcomes** **Students should be able** • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection. (viral or bacterial) by looking at cytokine profile.

Syllabus:

1. To perform blood typing by agglutination.
2. To antigen detection by Dot ELISA method.
3. To quantify the concentration of unknown antigen by radial Immunodiffusion (RID).
4. To perform ouchterlony antigen for antibody titration.
5. To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis.
6. To characterized the given antibody by Immunoelectrophoresis.
7. To quantify the amount of precipitation by Quantitative precipitation assay.
8. To determine the concentration of antigen by sandwich ELISA method.
9. To separate mononuclear cells from peripheral blood
10. To isolate the lymphocyte from whole blood by density gradient centrifugation method
11. To estimate the antibody titer using haemagglutination assay.
12. To determine Total Leukocytes Count (TLC) of the given blood sample.
13. To determine the relative number of white cells in the blood by performing differential cell counts
14. To perform Erythrocyte Rosette-forming Cell Test, ERFC

Recommended Textbooks and References:

1. Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.

2. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing. 3.

3. Virtual Lab. (http://vlab.amrita.edu/?sub=3&brch=70),
https://vlab.amrita.edu/?sub=3&brch=69)

Enzymes & Bioprocess Technology Lab **COURSE CODE: 20MS7MB271** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objective of the course is to provide hands on training to students in bioprocess technology with the usage of microbials and enzymes. This course covers practical aspects of upstream processing and downstream unit operations with respect to current requirements of the manufacturing industries.	**Students Learning outcomes** **Students should be able** ▪ To investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess technology problems; ▪ To learn how to operate bench scale bioreactor; ▪ To learn how to determine various Monod's Kinetics parameter; ▪ To learn how to determine various Michaelis Menten Kinetics parameter; ▪ To learn how to recover the various bioproduct after their production; ▪ To learn how to characterize the products after their recovery

Syllabus:

1. Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.
2. Batch fermentation using shake-flask for ethanol production by *Saccharomyces cerevisae*.
3. To study growth kinetics parameters of *E. coli*.
   a) Specific growth rate (μ) h^{-1}
   b) Doubling time (t_d) h
   c) Maximum specific growth rate (μ_m) h^{-1}
   d) Saturation constant (K_s) gm/l
4. Setting up of a fermentation process for the production of extracellular industrial enzyme from the selected microbe of industrial importance
5. Determination of Growth yield coefficient ($Y_{x/s}$) and Productivity of biomass after setting of a fermentation

6. Downstream processing of the industrial enzyme produced by the fermentation process.
    a) Clarification
    b) Yield estimation
    c) Concentration using salt-induced precipitation
    d) Dialysis
    e) Purity check through SDS-PAGE and specific activity determination
7. Disruption of yeast cells using sonication to recover intracellular Invertase enzyme
8. Determination of protein and enzyme content in the cell lysate after the cell disruption
9. Determination of Michaelis Menten's kinetics parameters of purified amylase enzyme
10. Preparation of Immobilized yeast cells in calcium alginate beads
11. Characterization of immobilized yeast cells in terms of activity and stability
12. Preparation of Immobilized enzyme in calcium alginate beads
13. Characterization of immobilized enzyme in terms of activity and stability

Recommended Textbooks and References:

1) Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.
2) M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3) Keith Wilson, John Walker, "Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
4) Raja Ghosh, "Principles of Bioseparation Engineering", World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
5) Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
6) Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
7) Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
8) Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
9) Nicholas C. Price and Lewis Stevens, "Fundamental of Enzymology", Oxford University Press, Oxford. ISBN: 9780198502296.
10) Sawney S.K., Singh R. "Introductory Practical Biochemistry", Narosa Publisher, 2000. ISBN 9788173193026.

Bioinformatics MBII Lab **COURSE CODE: 18MS7BI214** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objectives of this course are to provide practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** **Students should be able** ▪ Understand the use of common bioinformatics resources (NCBI) ▪ Understand various databases and tools in NCBI (PubMed, Nucleotide, gene, proteins, BLAST) ▪ Understand various databases and tools in Expasy (Swissprot, PROSITE) ▪ Hands-on of pairwise sequence alignment tools-global and local ▪ Hands-on of multiple sequence alignment tools ▪ Developing three-dimensional model of a protein structure ▪ Hands-on of phylogenetic analysis tools and visualization

Syllabus:

1. Retrieval of literature and biological sequences from PubMed and NCBI.
2. BLAST program for comparing primary biological sequence information.
3. Protein resources: Use of ExPASy for sequence retrieval and analysis.
4. Use of EMBOSS tools for sequence analysis: Pairwise Sequence Alignment.
5. Use of Clustal and other tools (MAFFT, MUSCLE) for Multiple Sequence Alignment (MSA).
6. Use of PDB structural database and structure visualization using Pymol, Rasmol, and Discovery Studio.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Phylogenetic analysis of protein and nucleotide sequences.
9. Secondary structure prediction using protein sequence.
10. Use of different protein structure prediction databases (SCOP & CATH).
11. Homology modelling of proteins in MODELLER.
12. Use of various primer designing and restriction site prediction tools.
13. Prediction of RNA secondary structure.
14. Use of tools for mutation and analysis of the energy minimization of protein structures.

Recommended Textbooks and References:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
8. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Recombinant DNA Technology Lab COURSE CODE: 18MS7BT373 L-T-P: 0-0-4 Credits: 2	**Course Objectives** The objectives of this course are to provide students with experimental knowledge and hands-on skills of methods and techniques for recombinant DNA technology and molecular cloning.	**Students Learning outcomes** Students should be able to gain hands-on experience in recombinant DNA technology techniques of gene cloning, protein expression. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Syllabus:

1. Preparation of stock buffers (TBE, TAE, TE) and Agarose gel electrophoresis
2. Plasmid DNA isolation and DNA quantitation
3. Extraction of DNA from gel
4. In vitro amplification of DNA fragment by Polymerase Chain Reaction
5. Designing of Primers and PCR cycle for given DNA sequence and analysis by Gradient PCR
6. Restriction Enzyme digestion of plasmid DNA (Blunt & Cohesive)
7. Vector and Insert Ligation (Using T_4 DNA ligase)
8. Preparation of competent cells by $CaCl_2$ treatment
9. Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency
10. Electroporation of plasmid DNA into mycobacterial cells
11. Confirmation of the insert by Colony PCR and Restriction mapping
12. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E. coli*
13. SDS-PAGE analysis of proteins
14. Plating of Bacteriophage

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.