Total Contact Hrs. = 24 **Total Marks = 700** **Total Credits = 22**

SEMESTER 1st		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MBOT1-101	Bio Molecules & Metabolism	4	0	0	40	60	100	4
MBOT1- 102	Bio Statistics & Computer Applications	4	0	0	40	60	100	4
MBOT1-103	Bio Chemical & Biophysical Techniques	4	0	0	40	60	100	4
MBOT1-104	Immunology	4	0	0	40	60	100	4
MBOT1-105	Microbial Technology	4	0	0	40	60	100	4
MBOT1-106	Immunology Lab.	0	0	2	60	40	100	1
MBOT1-107	Biostatistics & Computer Applications Lab.	0	0	2	60	40	100	1
Total		**20**	**0**	**4**	**320**	**380**	**700**	**22**

Total Contact Hrs. = 22 **Total Marks = 800** **Total Credits= 20**

SEMESTER 2nd		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MBOT1-208	Bioprocess Engineering & Technology	3	0	0	40	60	100	3
MBOT1-209	Enzyme Technology	3	0	0	40	60	100	3
MBOT1-210	Molecular Biology	4	0	0	40	60	100	4
MBOT1-211	Environmental Biotechnology	3	0	0	40	60	100	3
MBOT1-212	Industrial Biotechnology	3	0	0	40	60	100	3
MBOT1-213	Intellectual Property Rights & Biosafety	2	0	0	40	60	100	2
MBOT1-214	Bioprocess Engineering & Technology Lab.	0	0	2	60	40	100	1
MBOT1-215	Enzyme Technology Lab.	0	0	2	60	40	100	1
Total		**18**	**0**	**4**	**360**	**440**	**800**	**20**

Total Contact Hrs. = 32 **Total Marks = 800** **Total Credits = 24**

Semester 3rd		Contact Hrs.			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MBOT1-316	Proteomics and Genomics	4	0	0	40	60	100	4
MBOT1-317	Bioinformatics	4	0	0	40	60	100	4
MBOT1-318	Animal Biotechnology	4	0	0	40	60	100	4
MBOT1-319	Plant Biotechnology	4	0	0	40	60	100	4
MBOT1-320	Proteomics and Genomics Lab.	0	0	4	60	40	100	2
MBOT1-321	Bioinformatics Lab.	0	0	4	60	40	100	2
MBOT1-322	Animal Biotechnology Lab.	0	0	4	60	40	100	2
MBOT1-323	Plant Biotechnology Lab.	0	0	4	60	40	100	2
Total		**16**	**0**	**16**	**400**	**400**	**800**	**24**

Total Contact Hrs. = 24 **Total Marks = 800** **Total Credits = 24**

Semester 4th		Contact Hrs.- 24			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MBOT1-424	Industrial Training/ Project Work	24 Hrs./ Week			400	400	800	24

BIOMOLECULES AND METABOLISM

Subject Code: MBOT1-101 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

To introduce students regarding structure and functions of biomolecules and their metabolism

UNIT-I (9 Hrs.)

Introduction to Biomolecules & Water: Shape and Dimensions of Biomolecules, Supramolecular Assemblies and Cell Organelles. Structure of Atoms, Molecules and Chemical Bonds, Physical Properties and Structure of Water, Hydrogen Bonding, Solvent Properties of Water, Ionization of Water, Fitness of Aqueous Environment for Living Organisms

UNIT-II (11 Hrs.)

Carbohydrates & Lipids: Definition Importance and Functions, Families of Monosaccharides and Structure of Carbohydrates, Stereoisomerism and Mutarotation, Derivatives of Monosaccharides, Disaccharides, Trisaccharides and Polysaccharides (Starch, Glycogen, Cellulose, Dextrins). Classification of Lipids, Fatty Acids and Essential Fatty Acids, General Structure and Functions of Major Lipid Subclasses, Acylglycerols, Phosphoglycerides, Sphingolipids, Terpenes, Steroids, Eicosanoids.

UNIT-III (12 Hrs.)

Carbohydrates & Lipids Metabolism: Glycolysis (Key Structure and Reactions Formation of Pyruvate and Generation of ATP, Conversion of Pyruvate into Acetyl Co-A and Ethanol/ Lactate), Pentose Phosphate and its Regulation (Generation of NADPH and its Interconnection with Glycolysis, Gluconeogenesis and its Regulation (Synthesis of Carbohydrates by Non-Carbohydrate Precursors, Synthesis of Glucose from Pyruvate). Oxidation of Saturated and Unsaturated and Odd Chain Fatty Acids, Ketone Bodies), Biosynthesis of Fatty Acids (Formation of Melonyl Co-A, Fatty Acid Synthase Complex, Citric Acid and Regulation of Fatty Acid Biosynthesis)

UNIT-IV (13 Hrs.)

Protein, Nucleic Acids & Their Metabolism: Structure and Functions, Amino Acids as Building Blocks of Proteins, Essential Amino Acids, Non-Protein Amino Acids, Structure of Peptide Bond, Organizational Levels of Protein Structure, Relationship Between Primary and Higher Order Structures, Supramolecular Assemblies of Proteins, Solubility, Denaturation, Functional Diversity and Species Specificity of Proteins, Protein Classification, Chemical Synthesis of Polypeptides. Biosynthesis of Amino Acids (Conversion of Nitrogen to Ammonia, Conversion of Ammonia into Amino Acids by Way of Glutamic and Glutamine, Conversion of Citric Acid Intermediates to Amino Acids, and Feedback Regulation of Amino Acid Biosynthesis), Purine and Pyrimidine Bases, Nucleotides and Nucleic Acids, Composition of DNA and RNA, Structural Features of Nucleic Acids.

Recommended Books

1. D.L. Nelson and M.M., 'Lehninger Principles of Biochemistry', 6th Edn., Macmillan Worth Publishers, New Delhi, **2013**.
2. J.M. Berg, J.L. Tymoczko, G.J. Gatto and L. Stryer, 'Biochemistry', 8th Edn., W.H. Freeman & Co., New York, **2015.**
3. D. Voet, J.G. Voet and C.W. Pratt, 'Fundamentals of Biochemistry', 5th Edn., John Wiley & Sons, New York, **2011.**

BIOSTATISTICS AND COPUTER APPLICATIONS

Subject Code: MBOT1-102 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

Students will understand the various aspects of biostat and its importance in the life sciences.

UNIT-I (12 Hrs.)

Introduction to statistics: Biological Data Types, Accuracy and Significant Figures, Frequency Distribution and its Graphical Representations, Sampling, Measures of Central Tendency, AM, GM, HM, QM, Median, Quartiles and Quantiles, Mode. Measures of Dispersion and Variability, Range, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Coefficient of Variation, Shannon-Wienner Diversity Index.

UNIT-II (9 Hrs.)

Probability and Distributions: Permutations, Combinations, Probability, Addition and Multiplication of Probabilities, Binomial Distribution, Poisson Distribution, Normal Distribution, Symmetry and Kurtosis of Normal Distribution Curve, Proportions of Normal Distribution.

UNIT-III (13 Hrs.)

Hypothesis Testing: Introduction to Statistical Hypothesis Testing, Significance Level and Critical Value, Type I and Type II Errors, Power of Statistical Test, One and Two Tailed Tests, Confidence Interval, Parametric and Non-Parametric Tests. One Sample, Two Sample and Paired Sample T-Tests, Mann Whitney Test and Wilcoxon Paired Sample Test, Variance Ratio Test, ANOVA, Tukey Test, Chi-Square Test, Simple Linear Regression, Coefficient of Correlation, Coefficient of Determination and Rank Correlation.

UNIT-IV (11 Hrs.)

Computer Application: Applications of Computers in Biostatistics, Introduction to Spreadsheets, MS-Excel, Major Functions in MS-Excel, Writing Formulae, Solving Statistical Problems and Plotting Graphs Using MS Excel, Graph pad Prism and Its Applications in Statistical Analysis, SPSS.

Recommended Books

1. J.H. Zar, 'Biostatistical Analysis', 5th Edn., Pearson Education.
2. K.V. Rao, 'Biostatistics-A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology', 2nd Edn., Jay Pee Brothers.

BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

Subject Code: MBOT1-103 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

Students will learn the various techniques uses in the fields of biology and also learn their applications.

UNIT-I (11 Hrs.)

Chromatography: Basic Principles of Chromatography, Stationary and Mobile Phases, Distribution Coefficient, Parameters Influencing Chromatography, Retention Time, Capacity Factor, Selectivity Factor, Theoretical Plates, Plate Height and Resolution, Beak Broadening, Van Deemter Plot. Different Types of Equilibria, Adsorption, Partition, Ion-Exchange, Exclusion and Binding Equilibrium. TLC, HPTLC, Column Chromatography, Column Packing, Application of Sample, Analyte Development, Elution, Detection and Fraction Collector for Preparative Chromatography in LPLC, HPLC, FPLC, GC.

UNIT-II (12 Hrs.)

Electrophoresis: General Theory of Electrophoresis, Effect of Voltage, Current and Temperature on Electrophoretic Analysis, Generally Used Media, Agarose and Polyacrylamide, Gel Casting and Electrophoretic Apparatus for Various Types of Electrophoresis. Agarose Gel Electrophoresis for Analysis of Nucleic Acid Samples, PFGE and its Modifications for Separation of Very Large DNA Molecules, Polyacrylamide Gel Electrophoresis for Analysis of Nucleic Acids and Proteins, Native PAGE, SDS-PAGE for Separation of Proteins, Gradient Gels, Isoelectric Focusing and 2D Gel Electrophoresis, Urea PAGE, Capillary Electrophoresis, Visualization of Sample in Various Types of Electrophoreses.

UNIT-III (13 Hrs.)

Spectroscopy: Electromagnetic Waves and Their Interactions with Matter, UV and Visible Spectroscopy, Beer-Lambert Law, Relationship Between Transmittance and Absorption, Molar Extinction Coefficient, Quantitative Analysis, Wavelength Scan and Time Scan, Bathochromic and Hypsochromic Shifts, Application of UV and Visible Spectroscopy, Basic Understanding of Spectrophotometer, Spectrofluorometry, Circular Dichroism Spectroscopy and its Applications, Atomic Absorption Spectroscopy, Principle and Applications of IR Spectroscopy, ESR and NMR Basic Theory, Instrument and Application. X-Ray Diffraction Crystallography, Bragg's Law, Applications, XRD.

UNIT-IV (9 Hrs.)

Centrifugation & Radioactive isotopes: Principles of Sedimentation, Earth's Gravitational Force, Buoyant Force and Viscous Force Centrifugal Field and RCF, Sedimentation Coefficient. Types of Rotor, Safety Aspects Associated with Centrifugation. Differential Centrifugation, Pre-Formed (Sucrose) and Self-Establishing (CsCl) Density Gradient Centrifugation, Applications of Centrifugation in Biological Sciences, Ultracentrifugation, Analytical and Preparative Centrifugation, Stability of Radioactive Isotopes, Types of Radioactive Decay, Half-Life, Isotopes used Popularly in Biological Research, Energy and Penetration of Rations, Specific Activity, Detection by Geiger-MüLler Counter, Solid and Liquid Scintillation Counting, Cerenkov Counting, Autoradiography. Safety Aspects Required While Using Radioactive Isotopes.

Recommended Books

1. K. Wilson and J. Walker, 'Principles and Techniques of Biochemistry and Molecular Biology', 6th Edn., Cambridge University Press.
2. A. Pingoud, A. Urbanke, C. Hoggett, J. and A. Jeltsch, 'Biochemical Methods', Wiley-VCH.
3. R. Glaser, 'Biophysics', Springer, **2004.**

IMMUNOLOGY

Subject Code: MBOT1- 104 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS as well as the application of immunological techniques.

UNIT-I (9 Hrs.)

Cells and Organs of the Immune System: Cells and Molecules Involved in Innate and Adaptive Immunity, Toll-Like Receptors, Lymphoid Cells, Heterogeneity of Lymphoid Cells, T-Cells, B-Cells, Null Cells, Monocytes, Polymorphs, Primary and Secondary Lymphoid Organs-Thymus, Bursa of Fabricius, Spleen, Lymph Nodes, Lymphatic System,

Mucosa Associated Lymphoid Tissue (MALT), Lymphocyte Traffic, Activation of B and T Cells and Their Differentiation.

UNIT-II (13 Hrs.)

Humoral & Cell mediated Immunity: Antigen-Antibody Interactions, Primary and Secondary Immune Modulation. Affinity and Avidity, High and Low Affinity Antibodies, Immunoglobulins, Classes and Structure, Complement Fixing Antibodies and Complement Cascade. T-Cell Subsets and Surface Markers, T-Dependent and T-Independent Antigens, Recognition of Antigens by T-Cells and Role of MHC in Antigen Processing and Presentation, Structure of T- Cell Antigen Receptors, TCR, BCR, Cell Mediated Effecter Functions.

UNIT-III (12 Hrs.)

Immune Response to Disorders & Disease: Autoimmune Disorders, Their Underlying Molecular Mechanism, Etiology, Diagnostic, Prognostic and Prophylactic Aspects, Immune Deficiency Disorders: Congenital and Acquired, Immune Response during Bacterial (Tuberculosis), Parasitic (Malaria), and Viral (HIV) Infections, Tumour Immunity and Tumour Antigens.

UNIT-IV (11 Hrs.)

Immunological Techniques: Cross Reactivity, Precipitation and Agglutination Reaction, Coomb's Test, Immuno-Electrophoresis, RIA, ELISA, ELISPOT Assay, Western Blotting, Immunofluorescence and Flow Cytometry, Immunomagnetic and Immunodensity Method of Cell Isolation, Lymphocytes Cell Proliferation Assay, Immunological Database and Immuno Informatics Tool.

Recommended Books

1. J.A. Owen, J. Punt and S.A. Stranford, 'Kuby Immunology', 7th Edn., W.H. Freeman and Company, NY, **2013**.
2. D. Male, J. Brostoff , I. Roitt and D. Roth, 'Immunology', W.B. Saunders Co. USA, **2012.**
3. A.K. Abbas, H.H. Lichtman and S. Pillai, 'Cellular and Molecular Immunology' 8th Edn., Elsevier, **2015.**

MICROBIAL TECHNOLOGY

Subject Code: MBOT1-105 **L T P C** **Duration: 45 Hrs.**

4 0 0 4

Course Objectives

Students will understand the various aspects of biostat and its importance in the medical sciences.

UNIT-I (11 Hrs.)

Introduction to Microbiology and Microbial Diversity: Discovery of the Microbial World, Controversy over Spontaneous Generation. Bergey's Manual Classification (Bacteria, Archaea, Eukarya), Bacterial Cell Structure and Viruses, Viroids and Prions.

UNIT-II (13 Hrs.)

Microbial Growth, Nutrition and Physiology: Definition of Growth, Mathematical Expression of Growth, Growth Curve, Synchronous Culture, Continuous Culture, Factors Affecting the Growth. Metabolic Diversity (Aerobic, Anaerobic Respiration, Fermentation, Bacterial Photosynthesis).

UNIT-III (12 Hrs.)

Biogeochemical Cycling and Biotransformation: Nitrogen (Ammonification, Nitrification, Denitrification), Phosphorus, Sulphur and Iron Cycling. Industrially Important Primary and Secondary Metabolites (Alcohol, Amino Acids, Antibiotics and Steroids).

UNIT-IV (9 Hrs.)

Innovative Microbial Approaches in Remediation: Bio- Inoculants, Bioleaching Concepts and Application, Bioremediation and Application, Biofuels, Biogas, and Production of Bioethanol.

Recommended Books

1. Prescott, Harley & Klien, 'Microbiology', 7th Edn., McGraw Hill Higher Education.
2. R.Y. Stainer, J.L. Ingraham, M.L. Wheelis and P.R. Palmer, 'General Microbiology', MacMilan Press Ltd.
3. M.J. Jr. Pelczar, E.C.S. Chan and R. Krieg, 'Microbiology', McGraw Hill.
4. M.T. Madigan, J.M. Martinko, D.A., D.P. Clark, 'Brock Biology of Microorganisms', Benjamin Cummings.
5. A.N. Glazer, H. Nikaido, 'Microbial Biotechnology Fundamentals of Applied Microbiology', Cambridge University Press.
6. H.J. Peppler and D. Perlman, 'Microbial Technology Vol 1 & 2', Academic Press, New York.
7. R.P. Gupta, A. Kalia, S.K. Kapoor, 'Bioinoculatns: A Step Towards Sustainable Agriculture', New India Publishers.

IMMUNOLOGY LAB.

Subject Code: MSBOT1-106 **L T P C**
0 0 2 1

1. Measurement of TLC and DLC
2. Blood group test
3. Agglutination test
4. ELISA: Dot/Antigen/antibody capture/sandwich
5. Single and Double Immuno- diffusion
6. Immuno Electrophoresis
7. Western Blotting
8. Separation of Immune cells; Identification and viability test by dye exclusion method.

Recommended Books

1. H. Hudson and F.C. Hay, 'Practical Immunolog', 1st Edn., Blackwell Scientific Publications, Oxford, **1976.**
2. G.P. Talwar, 'A Handbook of Practical Immunology', Vikas Publication House Pvt Ltd., New Delhi, **1983.**
3. D.M. Wair, 'Handbook of Experimental Immunology', 3rd Edn., Blackwell Scientific Publications, Oxford, **1978.**

BIOSTATISTICS AND COMPUTER APPLICATION LAB.

Subject Code: MBOT1-107 **L T P C**
0 0 2 1

1. Calculation of AM, GM, HM, QM of given raw data. Also plot frequency polygon and bar graph of the raw as well as classified data
2. Determine median, mode, range, quartile deviation, mean deviation, standard deviation and coefficient of variation for the give set of data
3. Determining Shannon-Wienner diversity index
4. Determine binomial and Poisson probability distributions
5. To plot normal density function
6. Hypothesis test problems based on normal distribution, two sample test and paired t-test

7. ANOVA based problems and extension into Tukey test problem
8. Non parametric test based problems
9. Problem based on test of goodness by chi square test
10. Correlation, regression and rank correlation based problems
11. Find the sum of reciprocal of first 50 natural numbers by using Microsoft Excel spreadsheet
12. Graphpad prism application in solving statistical problems

Recommended Books

1. J.H. Zar 'Biostatistical Analysis', 5th Edn., Pearson Education.
2. K.V. Rao, 'Biostatistics-A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology' 2nd Edn., Jay Pee Brothers.

BIOPROCESS ENGINEERING & TECHNOLOGY

Subject Code: MBOT1-208 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

Course Objectives

Students will understand the processing and use of biological materials in the design and operation of fermentation systems.

UNIT-I (9 Hrs.)

Bioreactor Designing & Sterilization

Study of Batch, CSTR (Continuous stirred tank fermenter), Plug flow reactor (PFR), Airlift bioreactors, deep jet fermenter, and cyclone column; designing of batch, continuous fermentation process, filter sterilization (media, air and exhaust air).

UNIT-II (10 Hrs.)

Aeration & Agitation

Oxygen requirement for industrial bioreactors, oxygen demand and supply and balance between them, volumetric oxygen transfer, determination of Kla values, sulphite oxidation techniques, gassing out techniques: static method and dynamic method, oxygen balance method. Fluid rheology: Bingham plastic, pseudo plastic, Dilatants, Casson body. Factors affecting KLa values in bioreactors, the effect of medium rheology on KLa values, scale up and scale down of aeration and agitation.

UNIT-III (11 Hrs.)

Cell Growth and Enzyme Kinetics

Cell number and Cell mass calculations, Media design for growth, Continuous and batch fermentation, Microbial growth kinetics, Kinetic models for cell growth, Substrate and product inhibited growth models, Factors affecting microbial growth, Cell and enzyme immobilization, Enzyme kinetics, Submerged and solid state fermentation.

UNIT-IV (8 Hrs.)

Downstream Processing

Product isolation and recovery, Disruption of microbial cells (Physical, chemical and enzymatic), Filtrations, Centrifugation, and Membrane process, Drying.

Recommended Books

1. M.L. Shuler and F. Kargi, 'Bioprocess Engineering: Basic Concepts', 2nd Edn., Prentice-Hall, **2001.**
2. P.F. Stanbury, 'Principles of Fermentation Technology', 2nd Edn., Book News, Inc., **1992.**
3. B. Atkinson, 'Biochemical Engineering and Biotechnology Hand Book', Mac Millan Press **2009.**

ENZYME TECHNOLOGY

Subject Code: MBOT1-209 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

Course Objectives

Enzyme technology helps students to understand the applications of enzymes as the tools of industry.

UNIT-I (9 Hrs.)

Structure, Function of Coenzymes and Enzyme Action

Pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin; mechanism of lysozyme, chymotrypsin, DNA polymerase, zymogens, ribozymes, catalytic antibodies.

UNIT-II (8 Hrs.)

Enzyme Inhibitions

Kinetics of competitive, non-competitive & uncompetitive inhibitions; nucleophilic & electrophilic attack; role of metal ions in enzyme catalysis.

UNIT-III (11 Hrs.)

Immobilized Enzymes

Principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulase, artificial enzymes; immobilized enzyme in industrial processes.

UNIT-IV (8 Hrs.)

Industrial Applications of Enzymes

Industrial utilization of enzymes in food, detergents, energy, waste treatment, pharmaceuticals and medicine.

Recommended Books

1. H.R. Mahier & E. Cordes, 'Biological Chemistry', **1986.**
2. Benjemin Lewin, 'Gene VII', Oxford University Press, **1994**.
3. A.L. Lehinger, D.L. Nelson and M.M. Cox, 'Principles of Biochemistry', Worth Publishers, **1993**.

MOLECULAER BIOLOGY

Subject Code: MBOT1-210 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

Students will understand the new discoveries and applications, as well as a firm grasp of the fundamental concepts on medical, agricultural, and social aspects that shape modern-day molecular biology.

UNIT-I (13 Hrs.)

Genetic Material and DNA Replication

Structure and properties of nucleic acids, DNA as genetic material, nucleosomes, chromosomal structure and organization, Semiconservative mode of DNA replication, linear and circular replicons, origin of replication in bacteria and yeast, DNA replication in bacteria, eukaryotes and phages, prokaryotic and eukaryotic DNA polymerases and their properties, semi-discontinuous mode of DNA synthesis, Okazaki fragments, other proteins in DNA replication such as helicase, sliding clamps, clamp loader, primase.

UNIT-II (12 Hrs.)

Repair and Recombination

DNA damage, structural distortions and mutations, pyrimidine dimers, DNA repair, photoreactivation, mismatch repair system, excision repair (BER and NER), recombination repair, error prone repair, SOS system. Genetic recombination, synapsis and homologous

recombination, site-specific recombination, mechanism involving breakage and reunion of DNA strands, Holliday structure.

UNIT-III (10 Hrs.)

Transcription

Transcription initiation, structure and properties of bacterial RNA polymerase, sigma factor, promoter structure and its recognition by RNA polymerase, transcription elongation and termination, rho dependent and rho-independent termination, operons, regulation of lac and trp operons, *cis*-elements and *trans*-factors. Structure and function of eukaryotic RNA polymerases and their respective promoters, transcription factors, TBP, regulatory elements, enhancers and insulators.

UNIT-IV (10 Hrs.)

Protein Expression

Post translational modifications, 5' capping, 3' polyadenylation and splicing of mRNA. mRNA, tRNA and rRNA, and their role in protein synthesis, structure of tRNAs, aminoacyl-tRNA, ribosome. Initiation, elongation and termination of protein synthesis, bacterial initiation factors, initiator tRNA, Shine-Dalgarno sequence. Initiation of translation in eukaryotes, eukaryotic initiation factors, elongation factors. Genetic code, degeneracy of codons, wobble hypothesis, initiation codon and termination codons.

Recommended Books

1. B. Lewin, 'Genes IX', Prentice Hall.
2. G.M. Malacinski, G.M. Freifelder's Essentials of Molecular Biology', 4th Edn., Narosa Publishing House.

ENVIRONMENTAL BIOTECHNOLOGY

Subject Code: MBOT1-211 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

Course Objectives

The course will help to understand the use of biotechnology to design cleaner manufacturing process and to solve the pollution problems.

UNIT-I (11 Hrs.)

Environmental Pollution Monitoring and Control

Air – Types, Sources & Effects, Transport and diffusing of pollutants, air quality standards, monitoring and control of SOx, NOx, COx, SPM, RPM, Pm10; Soil - Physicochemical and bacteriological analysis of soil, problems associated with soil alkali soils, acidic soils, and solid waste; Noise - Measurement of noise, noise control and abatement, impact on human health.

UNIT-II (8 Hrs.)

Microbiology of Waste Water Treatment

Aerobic processes, activated sludge, oxidation ponds, trickling filters, and rotating biological contactors; Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors.

UNIT-III (8 Hrs.)

Bioremediation

Types of bioremediation, use of fungi, algae and bacteria in biosorption, cautions for using bioremediations, biodegradation of oilspills, TNT wastes, dye stuff wastes, pesticides and xenobiotics.

UNIT-IV (9 Hrs.)

Polymers and Plastic Degradation

Introduction, polymer synthesis, polymer degradation, photochemical degradation, biodegradation of naturally occurring polymeric substances, disposable synthetic polymers, polymer recycling, carry bags – a menace, role of microorganisms in degradation of polymers and plastic.

Recommended Books

1. M. Alexander, 'Biodegradation and Bioremediation', Academic Press, San Diego, **1999.**
2. S.A. Abbasi and E. Ramasami, 'Biotechnological Methods of Pollution Control'. Universities Press, Hyderabad,**1999.**
3. D.E. Rittmann, P.L. McCarty,' Environmental Biotechnology: Principles and Applications', McGraw Hill, New York, **2001.**
4. D. Allsopp, Kenneth J. Seal, Christine C. Gaylarde, 'Introduction to Biodeterioration', Cambridge University Press, **2004.**

INDUSTRIAL BIOTECHNOLOGY

Subject Code: MBOT1-212 **L T P C** **Duration: 36 Hrs.**

3 0 0 3

Course Objectives

1. Course fundamental focus is on the use of microbes in the various biotechnology based industries.

UNIT-I (8 Hrs.)

Historical Development in Industrial Biotechnology

Isolation and screening of industrial important microbes (Primary and Secondary Screening), maintenance of industrial cultures.

UNIT-II (9 Hrs.)

Fermenter & Fermentation

Definition of fermentation, fermenter/bioreactor, design of CSTR fermenter, fermentation media, inoculum development.

UNIT-III (11 Hrs.)

Production of Primary & Secondary metabolites

Alcohols (Beer, Wine), acetone- butanol, SCP, amino acids (lysine and glutamic acid), citric acids, enzyme productions; Antibiotics (Penicillin, Tetracycline), alkaloids.

UNIT-IV (8 Hrs.)

Treatment of Wastes in Industry

Methods for the determination of organic Matter content in waste waters (DO, BOD, COD, TOC, TSS, VSS), Systems for the Treatment of industrial wastes aerobically and anaerobically.

Recommended Books

1. L.E. Casida, 'Industrial Microbiology', New Age International Publishers, **1996.**
2. Prescott and Dunn, 'Industrial Microbiology', **1991.**
3. W. Crueger and A. Crueger, 'Biotechnology', 2nd Edn., Panima Publishers, **1992.**
4. Peppler and Perlman, 'Microbial Technology', Vol. I and II, Academic Press, **1979.**
5. Stansbury and Whittaker, 'Principles of Fermentation Technology', Pergamon Press, **2006.**

INTELLECTUAL PROPERTY RIGHTS & BIOSAFETY

Subject Code: MBOT1-213 **L T P C** **Duration: 24 Hrs.**
2 0 0 2

Course Objectives
This course has been designed to cover various aspects of IPR and Biosafety.

UNIT-I (4 Hrs.)

Fundamentals of IPR
Introduction of patent claims, ownership of tangible and intellectual property. Patents, copyrights, trademarks, trade secrets, geographical indications, industrial designs, protection of IC layout designs, WIPO, TRIPS agreement.

UNIT-II (6 Hrs.)

Biotechnology Patents
Disclosure requirements, collaborative research, competitive research, foreign patents, patenting of microorganisms and cells, patenting animals and plants, PPA, PVPA, PVPC, utility patents.

UNIT-III (8 Hrs.)

Patent Litigation
Substantive aspects of patent litigation, procedural aspects of patent litigation, recent development in patent system and patentability of biotechnology inventions, IPR issues of the Indian content, current patent laws, International Depository Authority (IDA), International agreements relevant to biological inventions: PCT, UPOV, Budapest Treaty, EPC, Pan- S Union Convention.

UNIT-IV (6 Hrs.)

Good Safety Practices & Biosafety Management
GLP standards, lab contaminants, GMPs, The Cartagena protocol on biosafety. Regulatory bodies- EPA, USDA, FDA, APHIS.

Recommended Books

1. 'New Developments in Biotechnology: Patenting Life-special Report (1990) Office of Technology Assessment (OTA), US Congress (Washington D.C. Dekker).
2. D.N. Choudhary, 'Evolution of Patent Laws: Developing Countries Perspective', Capital Law House, **2006.**
3. M.K. Sateesh, 'Bioethcis and Biosafety', I.K. International Pvt. Ltd.

BIOPROCESS ENGINEERING & TECHNOLOGY LAB.

Subject Code: MBOT1-214 **L T P C**
0 0 2 1

1. Bioreactors assembling and dismantling.
2. Sterilization of fermenter and fermentation media.
3. Dissolve oxygen probe standardization.
4. Determinations of thermal death point (TDP) and thermal death time (TDT) of microorganisms for designing of sterilization.
5. Study the effect agitation on aeration and determination of KLa volumetric oxygen transfer rate in the bioreactor by dynamic gassing out technique.
6. Isolation screening and characterization of cellulase producing micro organisms
7. Isolation screening ad characterization of alkaline protease producing microorganisms.

Recommended Books

1. B. Atkinson, 'Biochemical Engineering and Biotechnology Hand Book', Mac Millan Press, **2009**.

2. J.G. Cappuccino and N. Sherma, 'Microbiology: A Laboratory Manual', Pearson Benjamin Cummings, **2007.**

ENZYME TECHNOLOGY LAB.

Subject Code: MBOT1-215 **L T P C**
0 0 2 1

1. Extraction and purification of enzymes.
2. Effect of pH on enzyme activity and stability.
3. Effect of temperature on enzyme activity and stability.
4. Effect of metal ions on enzyme activity.
5. Effect of substrate concentration on enzyme activity and demonstration of the Km and Vmax of the reaction.
6. Immobilization of enzymes.

Recommended Books

1. D.T. Plummer, 'An introduction to Practical Biochemistry', Tata McGraw Hill Publishers Co. Ltd., New Delhi, **2004.**
2. Hans Bisswanger, 'Practical Enzymology', Wiley-VCH, Weinheim, **2004.**
3. S.K. Sawhney, Randhir Singh, 'Introductory Practical Biochemistry', Alpha Science International, **2005.**

PROTEOMICS AND GENOMICS

Subject Code: MBOT1-316 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

1. To teach about genomes, proteomes and their applications.

UNIT- I (12 Hrs.)

Introduction to genomics: Genome size and structural variation in different phyla, genome complexity and DNA sequence characteristics such as moderately repetitive (transposons), highly repetitive (satellite DNA) and unique (coding DNA) sequences, mapping genomes using various kind of markers such as RFLP, RAPD, STS, EST, SNP, AFLP, *in situ* hybridization, HAPPY mapping. Genome sequencing and the methods involved such as clone by clone method and whole genome shotgun sequencing, Human genome project and its implications.

UNIT- II (9 Hrs.)

Comparative Genomics: Concept of orthologs and paralogs and their role in gene evolution, protein evolution by exon shuffling, horizontal gene transfer and application of comparative genomics in these studies. Comparative genomics of bacteria, organelles and eukaryotes, application of comparative genomics.

UNIT- III (10 Hrs.)

Transcriptomics: Traditional methods for gene expression profiling, definition of transcriptome and its study based on EST sampling and SAGE methods, DNA microarrays and their role in transcriptomic analysis, spotted nylon arrays, DNA mircroarrays and oligonucleotide based arrays, their construction and use, application of transcriptomic analyses.

UNIT- IV (14 Hrs.)

Proteomics: Defining proteome, proteomic analysis for studying global gene expression profiling at protein level, comparison of proteomic analysis with transcriptomic analysis, methods of proteomic analysis such as 2D gel electrophoresis coupled with mass

spectrometry, multi-dimensional liquid chromatography coupled with mass spectrometry, protein arrays, structural proteomics, methods for protein structure determination and application of structural proteomics.

Recommended Books

1. S.B. Primrose and R.M. Twyman, 'Principles of Gene Manipulation and Genomics', 7th Edn., Blackwell Publishing, **2006.**
2. A.M. Lesk, 'Introduction to Genomics', Oxford University Press, **2008**.
3. A.M. Lesk, 'Introduction to Bioinformatics' Oxford University Press, **2011.**
4. Z. Ghosh and B. Mallick, 'Bioinformatics Principles and Applications' Oxford University Press, **2008.**

BIOINFORMATICS

Subject Code: MBOT1-317 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

1. This course lays emphasis on the role of computational tools in the field of biotechnology. The students will be exposed to various databases pertaining to DNA, RNA and protein sequences.

UNIT- I (12 Hrs.)

Introduction to Bioinformatics: Biological data and its analysis using computer application, branches and scope of bioinformatics, biological sequence file formats and molecular file formats, biological databases, their classification and retrieval systems. Biological sequence databases, gene expression databases, biological annotation and data curation. Examples of biological data bases such as EMBL, DDBJ, GEO, PIR, PDB, Swiss-Prot, CDD and MMDB. Introduction to NCBI tools.

UNIT- II (10 Hrs.)

Sequence Alignment: Concept of sequence alignment, scoring matrices such as PAM and BLOSUM and their importance in sequence alignment, pairwise sequence alignment, alignment algorithms for local and global alignment, application of dynamic programming and heuristic methods in sequence alignment, concept and different forms of BLAST, multiple sequence alignment, gene prediction methods.

UNIT- III (9 Hrs.)

Molecular Phylogeny: Representation of phylogeny using phylogenetic tree, types and features of phylogenetic trees, molecular clock and methods of phylogenetic tree construction such as UPGMA, NJ and Fitch-Margoliash methods, softwares for phylogenetic analyses.

UNIT- IV (14 Hrs.)

Protein Structure Prediction and Molecular Viewers: Protein structure prediction, prediction of protein secondary structures using Chou-Fasman method and GOR method, Homology modeling of proteins, fold recognition method and *ab initio* method for prediction of 3D structure of proteins. Molecular viewers and their application, examples of molecular viewers such as RasMol and Cn3D.

Recommended Books

1. Z. Ghosh and B. Mallick 'Bioinformatics – Principles and Applications', Oxford University Press, **2008.**
2. J. Xiong, 'Essential Bioinformatics', Cambridge University Press, **2006.**
3. D.W. Mount, 'Bioinformatics - Sequence and Genome Analysis', Cold Spring Harbour Laboratory Press, **2001**.
4. A.M. Lesk, 'Introduction to Bioinformatics', Oxford University Press, **2011.**

ANIMAL BIOTECHNOLOGY

Subject Code: MBOT1-318 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

1. The objective of this course is to introduce students to develop skills for vertebrate cell culture, maintenance of cell lines and their applications.

UNIT- I (12 Hrs.)

Introduction to Animal Cell Culture Technology: Structure an organization of animal cell; equipments and materials for animal cell culture technology; primary and established cell line cultures; balanced salt solutions and simple growth medium; role of carbon dioxide, serum and other supplements; serum and protein free media and their application.

UNIT- II (10 Hrs.)

Cell Culturing: Techniques of mammalian cell culture in vitro; desegregation of tissue and primary culture; maintenance of cell culture; cell separation; scaling- up of animal cell culture; cloning, micromanipulation, transformation and applications of cell animal cell culture.

UNIT- III (14 Hrs.)

Stem Cell Technology: Stem Cells: Basic, embryonic and adult stem cells; trans differentiation, applications, ethical issues; cell culture based vaccines; organ culture; three dimensional culture.

UNIT- IV (9 Hrs.)

Applications of Animal Biotechnology: Transgenic animal and their applications; role in pest control, aquaculture and sericulture; role in biodiversity conservation.

Recommended Books

1. R.R. Spier and J.B. Griffiths, 'Animal Cell Biotechnology', Academic Press, London **1990.**
2. E.J. Gareth, 'Human Cell Culture Protocols', Humana Press, **1996.**
3. E. Julio, 'Cell Biology-A Laboratory Hand Book', Vol. I-IV, 2nd Edn., Academic Press, New York, **1998.**
4. M. Butler, 'Animal Cell Technology', 2nd Edn, BIOS Scientific Publishers, U.K., **2004.**
5. R.T. Freshney, 'Culture of Animal Cells', 5th Edn., John Wiley and Sons, New York, **2006.**

PLANT BIOTECHNOLOGY

Subject Code: MBOT1-319 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

Course Objectives

1. The course will enable the students to acquire knowledge about various techniques to produce genetically modified plants with novel characters.

UNIT- I (14 Hrs.)

Introduction to Plant Cell and Tissue Culture: Tissue culture technique to produce novel plants and hybrids, tissue culture media (composition and preparation) Initiation and maintenance of callus and suspension cultures; Single cell clones; Somatic embryogenesis; Transfer and establishment of whole plants in soil. Shoot tip culture; Rapid clonal propagation. Embryo culture and embryo rescue; Protoplast isolation, culture and fusion, selection of hybrid cell and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids, Cryopreservation, slow growth and DNA banking for germplasm conservation.

UNIT- II (10 Hrs.)

Plant Transformation Technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, viral vectors, genetic markers and reporter genes; Methods of nuclear transformation, multiple gene transfer, vectorless or direct DNA transfer (particle bombardment, elctroporation, microinjection), transformation of monocots, transgene stability and gene silencing.

UNIT- III (12 Hrs.)

Application of Plant Transformation for Productivity and Performance: Herbicide resistance, (phosphoinothricin, glyphosphate, sulfonyl urea, atrazine), insect resitance (Bt genes,non-Bt like protease inhibitors, alpha amylase inhibitor), virus resistance (coat protein mediated, nucleocapsid gene), disease resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins,PR proteins) & Nematode resistance. Abiotic stress, post-harvest losses, use of ACC synthase (polygalactrouranase, ACC oxidase), male sterile lines, bar and barnase system. Biosafety and ethical issues associated with transgenic plants.

UNIT- IV (9 Hrs.)

Molecular Farming: Production of therapeutics: proteins, edible vaccines; purification strategies. Plant secondary, metabolites.

Recommended Books

1. S.S. Bhojwani and M.K. Razdan, 'Plant Tissue Culture. Theory and Practice', Elsevier. **1996.**
2. Fu Tong-Jen, Fu, Gurmeet Singh & Wayne R. Curtis, 'Plant Cell & Tissue Culture for the Production of Food Ingredients'. Kluwer Acad, N.Y.
3. K.G. Ramawat and J.M. Merillon, 'Biotechnology: Secondary Metabolites', Science Publishers, U.S., **1999.**
4. S.S. Purohit, 'Biotechnology Fundamentals & Application'. 3rd Edn., Agrobios (India), New Delhi, **2000.**

PROTEOMICS AND GENOMICS LAB.

Subject Code: MBOT1- 320 **L T P C**
0 0 4 2

1. Genome size comparison of organisms belonging to different phyla.
2. Comparison of size and number of introns in eukaryotic genes from different phyla.
3. Search of CpG islands, ORFs, SNPs and ESTs in a given genomic sequence.
4. Search for orthologs and paralogs,.
5. Data retrieval and analysis from gene expression databases.
6. Prediction of molecular mass.
7. Isoelectric point of given polypeptide sequence.
8. Determining molecular size of peptides produced by proteolytic cleavage in an *in silico* experiment.

Recommended Books

1. S.B. Primrose and R. M. Twyman, 'Principles of Gene Manipulation and Genomics', 7th Edn. Blackwell Publishing, **2006.**
2. A.M. Lesk, 'Introduction to Genomics', Oxford University Press, **2008.**

BIOINFORMATICS LAB.

Subject Code: MBOT1-321 **L T P C**
0 0 4 2

1. Downloading a given DNA, genomic DNA, protein sequence in different file formats.

2. Finding ORF in a given sequence, pairwise sequence alignment of DNA and protein sequences, multiple sequence alignment of given DNA and protein sequences.
3. Construct phylogenetic tree for given orthologous sequences, BLAST given protein and DNA sequences.
4. Determine protein structure based on polypeptide sequence using homology modeling.
5. Visualize 3D structure of protein using molecular viewer.

Recommended Books

1. Z Ghosh and B Mallick, 'Bioinformatics – Principles and Applications', Oxford University Press, **2008.**
2. J. Xiong, 'Essential Bioinformatics', Cambridge University Press, **2006.**

ANIMAL BIOTECHNOLOGY LAB.

Subject Code: MBOT1-322 **L T P C**
0 0 4 2

1. Laboratory Design & Instrumentation in ATC.
2. Preparation of animal cell culture media.
3. Growth and maintenance of cell line(s).
4. Trypsinization method for recovery of cells from monolayer.
5. Doubling time of a given cell line and cell cycle analysis.
6. Cytotoxic assay method for a given cell line and testing by trypan blue dye exclusion method.

Recommended Books

1. R. Ian Freshney, 'Culture of Animal Cells: A Manual of Basic Technique', 4th Edn., **2000.**
2. M.M. Ranga, 'Animal Biotechnology', Agrobios, **2007.**
3. J.R.W. Masters, 'Animal Cell Culture', Oxford University Press, **2000.**
4. L. Marshak, 'Stem Cell Biology', Cold Spring Harbor Publication, **2001.**

PLANT BIOTECHNOLOGY LAB.

Subject Code: MBOT1-323 **L T P C**
0 0 4 2

1. Laboratory design setup for PTC unit.
2. Preparation, sterilization of media (Liquid & solid).
3. Surface sterilization, sealing of cultures, sources of contamination and their check measures.
4. Callus induction, propagation and differentiation.
5. Protoplast isolation and culture.
6. Agrobacterium mediated transformation of plant cell

Recommended Books

1. A. Slater and N. W. Scott, 'Plant Biotechnology', Oxford University Press **2008**
2. S.B. Primrose and R. M. Twyman, 'Principles of Gene Manipulation and Genomics', 7th Edn. Blackwell Publishing **2006**
3. D. Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman, 'Concepts in Biotechnology', Universities Press, **1999.**
4. U. Satyanarayana, 'Yeast Biotechnology: Diversity and Applications', Springer, **2009.**