PIM101 BASIC MATHEMATICS

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Course objective: The objective is to develop basic computing skills and application of quantitative and statistical operations required for biological studies and rationalization of experimental designs.

Course contents:

Algebra: Linear and quadratic equations; Complex numbers, Argand plane and polar representation of a complex number, square root of a complex number; Permutations and Combinations; Binomial theorem for positive/negative index and its simple applications; Arithmetic and Geometric progression.

Trigonometry: Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations .and C-D formulas for trigonometric functions; Identities related to sin (2x), cos(2x) and tan (2x).

Determinants and Matrices: Matrices, Operations on Matrices, Determinants and its properties, singular and non-singular matrices, Adjoint and inverse of a matrix and its properties,; Solution of system of linear equations using Cramer's rule and inverse of a matrix.

Differentiation: Review of sets, relations and functions, Limit, Continuity and Differentiability, Differentiation of standard functions (polynomials, trigonometric, inverse trigonometric exponentials and logarithmic); Product rule, Quotient rule, applications of derivatives in Graphing,

Integration: Integral as anti derivative. Integration by substitution, by partial
Fractions and by parts. Definite integral and its properties. Areas of bounded regions

Coordinate geometry: Rectangular Coordinate system, Straight lines, Circles. (in standard form)

Course Outcome*:* Students will acquire mathematical concepts in continuous learning and connecting ideas like numerical analysis, calculus, coordinate geometry to other subjects and support learning through applications of mathematics.

Recommended Books

1. *Mathematics, A Text book (Parts I & II), 2011, NCERT, New Delhi.*
2. *Thomas, G.B. and Finney, R.L. Calculus and Analytical Geometry, Pearson Education. (2007) 10^{th} ed.*
3. *Shanti Narayan, Differential and Integral Calculus, S. Chand (2005).*
4. *Krishnamurthy V.K., Mainra V.P. and Arora J.L. An introduction to Linear Algebra. Associated East West Press (2007).*

PBT101 INTRODUCTION TO LIFE SCIENCES

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Course Objective: The objective of this course is to enable the students to gain knowledge of diversity of life and to understand various aspects of living systems. The course will provide understanding of basic organization of plant and animal systems at cellular, tissue and organ levels and their specialized functions.

Course contents:

Introduction: Definition of biology and its various branches, Origin of life, Molecular basis and characteristics of life, Levels of Biological Organization.

Diversity of Living World: Lower and higher forms of life, Plant Kingdom and its classification, Major phyla of Animal Kingdom and their distinguishing features, General features of plant and animal life.

Cell Reproduction: Process of Mitosis and Meiosis and their significance, Karyotyping

Genetics: Mendelian Genetics, Patterns of inheritance – Incomplete dominance, Multiple alleles, Co-dominance, Lethal genes, Polygenic inheritance, Sex linked inheritance

Cell specialization and Structural organization: Organization of plant and animal tissues, Vegetative and reproductive parts of a flowering plant, modifications of its vegetative parts, Reproduction in Plants.

Plant Physiology: Absorption and transportation of water, Photosynthesis in higher plants, Plant growth hormones.

Animal and Human Physiology: Digestion and absorption of food, Breathing and exchange of gases, Structure of human heart and circulation of blood, Excretion and Osmoregulation, Nervous system and sense organs of human body, Endocrine system.

Course Outcome: At the end of the course, the students will be able to understand different levels of organization in a living system and their specialized functions. They will acquire precise knowledge of various aspects of a living cell, its structure, reproduction, genetics and gene interactions and different physiological processes of living systems.

Recommended Books

1. *Bhatia K.N. and Tyagi M.P., Elementary Biology, Trueman Book Company (2007).*
2. *Dhami P.S., Srivastava H.N. and Chopra G., A Textbook of Biology, Pradeep Publications (2007).*
3. *Campbell, N.A. and Reece, J.B., Biology, Pearson-Education (2005).*
4. Paulose,P.A., Certificate Biology, Oxford University Press

PBT102 MICROBIOLOGY

L	T	P	Cr
3	1	3	5.0

Prerequisite(s): None

Course Objective: The objective of this course is to make students understand the existence of microbial world and diversity along with their origin and scope in present day life.

Course contents:

Introduction to Microbiology: Scope of microbiology and emerging avenues, Development of microbiology.

Microbial Diversity: Microbial taxonomy and detailed classification of the microbial world as per Bergey's manual of classification (Bacteria, Archaea, Eukarya), Bacterial cell structure and morphological features (cell wall, outer membrane, flagella, endospores and gas vacuoles), microbes beyond cellular organization (Viruses, viroids, virusoids and prions).

Microbial Nutrition and Growth: Cultural characteristics of microorganisms, Techniques for enumeration of microorganisms in soil and water, Pure culture and enrichment culture techniques for the isolation of heterotrophs and autotrophs, Reproduction and growth, Growth measurement and growth yields, factors affecting growth, synchronous growth continuous culture.

Microbial Physiology: Metabolic diversity among microorganisms, Aerobic and anaerobic respiration, Fermentation, Bacterial photosynthesis.

Preservation and Control of Microorganisms: Culture collection and maintenance and preservation, Cryopreservation and lyophilization, Physical and chemical agents for the control of microbial growth, Antimicrobial agents, Antibiotics and their mode of action, Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP and GMP.

Microbial diseases: Major diseases in plants and animals, food and water borne diseases; emerging and resurgent infectious diseases.

Microbial Genetics: Transfer of genetic material in bacteria - Transformation, conjugation and transduction, Plasmid biology, Transposons, Sources of variation, Mutation and induced mutagenesis, Strain improvement, Ames test.

Laboratory Work :Cell morphology and cell identification, Cell counting, Measurement of cell dimension, Microscopic observations of stained cell preparations, Media preparation and enumeration of microorganisms in air soil and water, Identification of various sources of contamination in aseptic microbiological work, Isolation of pure cultures (aerobic and autotrophic bacteria) and culture techniques, Bacterial growth curve, Growth measurement, Plasmid isolation and transformation, Induced mutagenesis and replica plating technique.

Course outcome: The students will be able to identify microbes and know their importance in food, agriculture, industry and environment and diseases.

Recommended Books

1. *Cappuccino, J.G. and Sherman, N., Microbiology- a Laboratory Manual, Pearson Education (2006).*
2. *Pelczar Jr. M.J., Chan E.C.S. and Krieg R., Microbiology, McGraw Hill (1998).*
3. *Stainer R.Y., Ingraham J.L., Wheelis M.L. and Pamler P.R., General Microbiology, MacMillan (2003).*
4. *Tortora G.J., Funke B.R., and Case C.L., Microbiology, An Introduction, Pearson Education (2009) 10th ed.*
5. *Madigan, M., Martinko, J., Dunlap, P. and Clark, D., Biology of Microorganisms, Pearson Education (2008).*

PBT103 BIOCHEMISTRY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Course Objective: Objective of studying biochemistry is to know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving things.

Course contents:

Chemical Foundations of living systems: Molecular basis of life, Biological chemistry – Biomolecules, Metabolism – Basic concepts and Design, Bioenergetics- Entropy, Biochemical equilibria,
Dissociation and association constants, pH and buffers.

Interactions in biological systems: Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges, Hydrophobic and hydrophilic molecules and forces, Water and weak interactions, Debye-Huckel Theory.

Biomolecular organization: Configuration and Conformation of carbohydrates, proteins and nucleic acids, Conformational analysis, Structural simulations of biomolecules (Monte Carlo methods, Molecular dynamics methods).

Biocatalysis: The basis of metabolism, Nomenclature ofenzymes, Enzyme kinetics, Mechanism of enzymatic catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, Km and Vmax value, Regulation of enzyme activity (single-substrate and multi-substrate reactions).

Signal Transduction and Regulation: Hormones and their classification, Hormone analogs, Agonists and antagonists, Endocrine, Receptors and hormones, Receptor classification and signaling pathways (metabotropic/ionotropic/steriod/peripheral and cellular receptors), Signal transduction and metabolism, Signaling in plants and their function.

Metabolism of Carbohydrates: Glycolysis, Gluconeogenesis, Pentose phosphate pathway, TCA cycle, Minor pathways of glucose metabolism, Electron transport system, Oxidative phosphorylation and bioenergetics, C3 and C4 photosynthesis.

Lipid Metabolism: Fatty acids, Phospholipids, Cholesterol and related steroids, Complex lipids, Oxidation of fatty acids, Biosynthesis of fatty acids and cholesterol.

Protein and Nucleic acid Metabolism: Amino acids, Conformation and configuration of proteins and peptides, Catabolism of amino acids and amino-acid derived products, Nucleotides, Nucleic acid and protein metabolism.

Integration of Metabolism: Inter-relationships between carbohydrate, protein, lipid and nucleic acid metabolism.

Laboratory Work:
Preparation of buffer solutions, Determination of pK values, Estimation of reducing sugars, total carbohydrates, amino acids and proteins, Quantitative analysis of lipids, Enzyme assays from microbes and eukaryotes, Basic strategies for enzyme purification, Enzyme kinetics, Estimation of total and available nitrogen, phosphorous and sulphur, Estimation of chlorophyll and other photosynthetic pigments.

Course Outcome: The students will gain considerable knowledge on structure and function of different molecular constituents present in the living systems. By studying various metabolic pathways, they will learn how the molecules are getting converted to various products within the cell through intermediates mediated by biocatalysts. Gaining such knowledge on biochemistry is a fundamental prerequisite to excel in the area of modern biotechnology.

Recommended Books:

1. *Metzler, D.E., Biochemistry - The Chemical Reactions of Living Cells, Vol. I &II,Elsevier (2002)2nd ed.*
2. *Berg, J.M., Tymoczko, J.L., Stryer, L., Biochemistry, WH Freeman and Company (2006)6th ed.*
3. *Nelson, D.L., Cox, M.M., Lehninger's Principles of Biochemistry, McMillan Publishers (2008) 4thed.*
4. *Daune, M, Molecular Biophysics, Oxford University Press (1999)*
5. *Glaser, R, Biophysics, Springer (2004).*

PBT104 CELL AND MOLECULAR BIOLOGY

	L	T	P	Cr
Prerequisite(s): None	**3**	**0**	**3**	**4.5**

Course Objectives: To understand the structure and function of cell and cell membranes and macromolecular components of cells and their functions, general principles of gene organization and expression in prokaryotic and eukaryotic organisms, basic pathways and mechanisms in biological energy transduction and cell cycle control and relate properties of cancerous cells to mutational changes in gene function.

Course contents:

Structural Organization and Function of Intracellular Organelles: Cell structure, Cell wall, Mitochondria, Chloroplast, Nucleus and other organelles, Cytoskeleton and its role in motility.

Membrane Structure and Function: Structure and function of membranes, Dynamics of membrane components, Electrical properties of membranes, Transport of nutrients, ions and macromolecules across membranes, Mechanism of sorting and regulation of intracellular transport.

Cell Division and Cell Cycle: Cell Division, Cell cycle, Regulation of cell cycle.

Cell Signaling and Cellular Communication: Cell surface receptors, Signaling molecules, Paracrine and autocrine signaling, Signal transduction pathways and their regulation, Second messengers, Two-component signaling systems, Cell adhesion, Extracellular matrix, Integrins**.**

Molecular Biology: Introduction, Chromosomal structure and organization, Nucleic acids, DNA replication in prokaryotes and eukaryotes, DNA damage and repair, Recombination, Transcription - Mechanisms of transcription of prokaryotes and eukaryotes, RNA processing, Ribosomes, Structure of mRNA, Genetic code, Protein synthesis, Regulation and fidelity of protein synthesis, Post-translational modifications, Regulation of gene expression in phages, viruses, prokaryotes and eukaryotes, Transfer of genetic material in microorganisms - Molecular mechanisms, Regulatory sequences and transacting factors, Gene silencing, Oncogenes, Genetic and Metabolic disorders, Programmed cell death, Aging and senescence.

Laboratory Work*:* Subcellular fractionation and marker enzymes, Histochemical techniques, Isolation of genomic DNA and total RNA, Quantitation of nucleic acids, Agarose gel electrophoresis, Expression of inducible genes, β-galactosidase assay, mutagenesis, Isolation of auxotrophic mutants and their characterization.

Course Outcome: The students will gain an in-depth understanding of cellular, molecular and genetic foundations of living systems, which would help in correlating between genotypic and phenotypic attributes of an organism. Such knowledge base is required not only to pursue advanced studies but also useful in the applied aspects of modern biotechnology.

Recommended Books

1. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).*
2. *Becker, W.M., Kleinsmith, L.J. and Haldin, J., The world of the Cell, Seventh Edition, Pearson Education (2008).*
3. *Glover, D.M. and Hames, B.D., DNA Cloning I & II, IRL Press Oxford University Press (1995) 2nd ed.*
4. *Lewin, B., Genes VIII, International Edition, Pearson Education International (2004).*
5. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed.*

PBT105 BIOTECHNIQUES AND INSTRUMENTATION

	L	T	P	Cr
	3	**0**	**3**	**4.5**

Prerequisite(s): None

Course objective: The course is aimed to acquaint the students with various techniques used in biotechnology and basic principles involved. The course also aims to make students learn about modern instruments for various analytical works.

Course Contents:

Chromatography: Principle, Distribution coefficient, selectivity factor, Theoretical plates, peak broadening and resolution, van Deemter equation, normal and reverse phase liquid chromatography, ion exchange, molecular exclusion, affinity chromatography, HPTLC, HPLC, GC

Electrophoretic Techniques: General principle, effect of heat, electroendosmosis, Support media (agarose and polyacrylamide gels), agarose gel electrophoresis of DNA and RNA, southern and northern transfer, PFGE (brief introduction to OFAGE, TAFE, FIGE & CHEF), Native PAGE, SDS-PAGE, Urea PAGE, gradient gels, isolectric focusing and 2D-PAGE, western transfer, capillary electrophoresis, SSCP, CGGE, TGGE and DGGE

Centrifugation Techniques: Principle of sedimentation, centrifugation, types of rotors, general applicatons of centrifugation, ultracentrifugation, analytical centrifugation, preparative centrifugation, precautions and safety aspects

Spectrophotometric Techniques: Electromagnetic waves and their interaction with matter, theory and applications of CD, UV-VIS, IR, Raman, Fluorescence, Atomic absorption spectroscopy, FRET, applications in biotechnology**,** Mass spectrophotometry (ionization methods, mass analyzers and detectors) and biotechnological applications, ESR, NMR spectroscopy (brief introduction to NOESY, COSY and ROESY), MRI and X-ray crystallography

Radioisotope Techniques: Radioactivity and radioisotopes, rate of decay, units of radioactivity, specific activity, Detection and measurement of radioactivity Cerenkov counting and autoradiography, Applications in biological sciences - Analytical, diagnostics and metabolic studies, Safety aspects of radioactive handling, alternatives to radio-labeling.

Microscopy: Magnification and resolution of microscopes, components of light microscope, Theory and principles of microscopy, light, dark field, fluorescence microscopy, TEM, SEM, AFM, confocal microscopy, microtomy, ultramicrotomy, freeze fracturing, flow cytometry, FACS.

Laboratory Work: Thin layer chromatography (preparative, analytical, reverse phase), Column chromatography, Gas chromatography, HPLC, UV-Vis spectroscopy, Atomic absorption spectroscopy, Microscopy, PAGE, SDS-PAGE, Agarose Gel electrophoresis.

Course outcome: The students will be able to apply these techniques in research and other applications. The students would also be able to handle several modern instruments for analytical works.

Recommended Books

1. *Wilson K and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (2005) 6th ed.*
2. *Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. Bioseparations: Science and Engineering, Oxford University Press (2006).*
3. *McHale, J.L., Molecular Spectroscopy, Prentice Hall (1998).*
4. *Marimuthu, R., Microscopy and Microtechniques. MJP Publishers (2008).*

PHU- PROFESSIONAL COMMUNICATION

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Course Objective: To provide the students with the essential skills required for effective communication and to provide a comprehensive view of business communication and its role in the corporate environment.
Course Contents:

Essentials of Communication: Meaning, Definition, process, feedback, emergence of communication as a key concept in the corporate and global world, impact of technological advancements on communication.
Channels of Communication: Formal and Informal: Vertical, horizontal, diagonal, and grapevine.
Methods and Modes of Communication: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication, Non-verbal Communication: Characteristics of non-verbal communication, kinesics, proxemics and chronemics.
Barriers to Communication: Physical, semantic, language, socio-cultural, psychological barriers, Ways to overcome these barriers.
Listening: Importance of listening skills, cultivating good listening skills.
Written Communication: Business letters, memos, minutes of meeting, notices, e-mails, agendas and circulars.
Technical Report Writing: Types of Reports, contents of reports. Formatting, writing styles and documentation.
Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing.
Interviews and Group Activities: Personal interviews, group discussion and panel discussion
Creative writing: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.
Paper writing: Styles of paper writing: Short Communication, Review papers and Research papers, referencing styles: MLA, Chicago Style and APA.

Course Outcome: Students will be able to understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction, write effective and concise letters and memos, prepare informal and formal reports, proofread and edit copies of business correspondence, develop interpersonal skills that contribute to effective personal, social and professional relationships.

Recommended Books:

1. *LehmanC.M.,DuFrene D.D.,& Walker R(Ed. 2).B-BCOM-An Innovative Approach to Learning and Teaching Business Communication .Cengage Learning New Delhi*
2. *McMurrey A.M& Buckley J.(ed 1), Handbook for Technical Writing. Cengage Learning, New Delhi*
3. *Lesikar R.V & Flately M.E.,Basic Business Communication-Skills for Empowering the Internet Generation.(ed. 9)Tata McGraw-Hill Publishing Company Limited. New Delhi.*

PBT201 BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

This course will encompass the methodology and theory of statistics as applied to problems in the field of life and health sciences. The course will provide students with basic understanding and application of computational biology.

Course objective:

Introduction: Biology and statistics, Variables and data, Sampling and sampling errors in biologicaldata, Sampling techniques, Probability and distribution.

Regression and correlation analysis: Simple, linear and multiple regression, Simple and multiple correlation.

Hypothesis Testing: Test of hypotheses, one and two sample analysis, Paired sample analysis, Non-parametric statistics and limitations. Confidence limits and tests of confidence, Single, Two and Multi-factorial analysis, Non-parametric Analysis of Variance, Multiple comparison tests – Tukey, Newman-Keul, Scheffe tests, Goodness of fit test.

Design of Experiments and Data Presentation: Response Surface Methods, Cantor Plots, Survivalship curves, Graph plotting and significance of Curves, Data representation

Programming languages: Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked, List concepts

Procedural languages - C language introduction: Variables, Data Types – Arrays (one and two dimensional arrays) - Functions: Types, Parameters, Recursion, Function prototype, and Standard C library -Structures. Pointers: Introduction, Pointer with variables, Arrays and Strings, Pointers and structures, Pointers and linked list – Unions - File handling: File I/O, File opening modes – C Preprocessor - Graphical Interfaces: Dialog Boxes, Dynamic Memory Allocation.

Algorithm: History, Principles, types, development and its complexity, Complexity of algorithms –NP complete problem- polynomial-Reducibility-sorting problem and Fibonacci Problem; Algorithm types: Linear, Exhaustive search ,Branch and Bound, divide and conquer, Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning, Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm etc

Dynamic programming methods of sequence analysis: Principles and its uses. Hidden Markov models in sequence analysis. Introduction of Markov Chain and Hidden Markov models. Forward-backward algorithm, Viterbi and Baum-Welch algorithms, Heuristics second generation alignment tool (Blast, FASTA, ClustalW), Monte Carlo method, Molecular dynamics

Molecular computational biology: DNA binding motif finding by sequence alignment, Gibbs sampling approaches, Regulatory module (a combination of DNA binding motifs) detection, Bayesian networkapproach to study the gene expression network based on expression quantitative trait loci (eQTL) data, Statistical methods for pre-mRNA alternative splicing

Elements of Graphics and Visualization: Basics of two and three dimensional computer graphics systems, modeling and rendering, and selected graphics software APIs. Other topics may include interactive graphics, animation, graphical user interfaces, and the graphical presentation of information.

Distributed and Grid Computing: Distributed and grid computing principles and technologies.Covers common modes of grid computing for scientific applications, development of grid-enabled applications, and future trends in grid computing

Laboratory Work: MS Excel and Graphpad Prism software, Data entry and graphical representation, Equation formulation and analysis for sample testing, correlation and regression, ANOVA, Multiple comparisons, Survivalship tests, C programming, Multiple sequence alignment, DNA binding motif finding by sequence alignment

Course Outcome: Students will be able to organize, summarize and display quantitative data and design to address public health and clinical problems, calculate summary estimates, measures of variability and confidence intervals and manipulate probabilities and the Normal and Binomial distributions.

Recommended Books:

1. *Waterman M.S., Introduction to Computational Biology: Maps, Sequences and Genomes.Waterman. Chapman and Hall/ CRC Press (1995) ISBN -10: 0412993910*

2. *Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.(1996). ISBN 10 0070240353*
3. *DeGroot M.H,. and SchervishM.J., Probability and Statistics, Addison-Wesley, 3rd ed., (2002)*

PBT202 PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Course Objectives: To acquire knowledge of steps of new drug discovery, development and approval process and drug manufacturing and its quality control in pharmaceutical industry.

Course Contents:

Discovery and Development of Drugs: Introduction to drug discovery, finding a lead compound, rational drug design, computer aided drug design, combinatorial chemistry, new drug development and approval process, clinical trial design.

Drug Pharmacokinetics: Routes of drug administration, membrane transport, absorption, distribution, metabolism and excretion of drugs.

Drug Pharmacodynamics: Pharmacological classification of drugs, mechanism of drug action on human beings, receptor pharmacology, factors modifying drug action, pharmacogenomics, adverse effects of drugs and drug toxicology.

Natural Products: Natural products from animal, plant and microbial origin having pharmaceutical importance. Principles of pharmacognosy, Composition, physical and chemical properties, occurrence and uses of carbohydrates and glycosides, proteins, peptides and amino acids, sterols, saponins, alkaloids, phenols, volatile oils.

Pharmaceutical Manufacturing: Drug formulation and their classification- oral solid dosage forms, coating of pharmaceutical dosage forms, parenteral preparations, novel drug delivery systems-carrier systems and liposomes for drug targeting, good laboratory and good manufacturing practices-issues, packing techniques.

Pharmaceutical Testing, Analysis and Control: Analysis of pharmaceuticals using physical, chemical and biological methods, quality assurance and control, stability of pharmaceutical products, Quality control and testing as per Indian/US Pharmacopoeia.

Biotechnology and Drugs – Recombinant drugs, biotechnology derived therapeutics- approved and in developmental stage.

Laboratory work

Quality assurance of antibiotic/non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic and biological methods as per Indian/US Pharmacopoeia, sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins), assays for screening antimicrobial/antifungal agents from plants and other natural sources.

Course Outcome:

To be able to apply the knowledge of pharmaceutical drug discovery process, pharmacokinetics, pharmacodynamics, pharmaceutical manufacturing in the development of biotechnology derived pharmaceuticals.

Recommended Books

1. *Beringer, P., DerMarderosian, A., Felton, L., et al., Remington-The Science and Practice of Pharmacy, Lippincott Williams and Wilkins (2005).*
2. *Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2004).*
3. *Klefenz, H., Industrial Pharmaceutical Biotechnology, Wiley –VCH Verlag GmbH., (2002).*
4. *Walsh, G., Biopharmaceuticals-Biochemistry and Biotechnology, John-Wiley (2003) 2nd ed.*

PBT203 FOOD PROCESSING

L	T	P	Cr
3	0	2	3.0

Prerequisites: None

Course objective: The objective of this course is to provide knowledge on various processing technologies of food and food products, preservation and long term storage.

Course contents:

Non-Conversion Operations: Food raw materials, Physical, Functional and other properties, Cleaning of raw materials - Methods and contamination, Sorting, Grading of food materials on the basis of size, Buoyancy, Photometry, Size.

Food Conversion Operations: Size reduction and screening of solids - Equipment, Modes of operation, Disintegration of materials, Mixing and emulsification, Filtration and membrane separation, Centrifugation, Solid-liquid extraction and expression, Heat processing - Modes of heat transfer, Methods of applying heat to food.

Preservation Operations: Microbiological considerations, Methods of heat sterilization in containers, Pasteurization by heat processing, Evaporation - Evaporation principles and equipment, Dehydration, Water in food, Drying, Freezing, Food storage - Storage conditions and packaging, Food products processing primer - Dairy products, Meat products, Juice, Vegetables.

Labelling and Packaging in Foods: Structures of packages, Degradability, Reusability and regulations, Types of packages and future packages, Labeling guidelines of foods.

Non-thermal Processing Operations in Foods: Advantages/disadvantages of thermal technologies, Nutritional and consumer considerations, advanced non-thermal operations, Operational criteria and applications.

Conversion Operations for Food Wastes: Characteristics of food/agro industry wastes, Current treatment options – Overview, Feasibility of reuse and conversion processes for value added products.

Laboratory Work *:* Microbial and other quality tests of fluid milk/meat/fish, Preparation of casein and fermented milk; Dehydration of fruits and vegetables, Preparation of tomato products, Determination of thermal process time, Pickling of meat, Use of hurdle concept for preservation of foods, Qualitative analysis of processed food samples, Microbiology of raw produce and processed foods, Microbiology of processing areas, Compositional analysis of food plant wastes and their reusability, Visit to mechanized food-processing Industries.

Course outcome: The student will know about various processing technologies of food and food products, preservation and long term storage as applicable in food process industries.

Recommended books

1. *Fellows, P.J., Food Processing Technology: Principles and Practice, Woodhead Publishers Ltd. (2005) 2nd ed.*
2. *Mariott, N.G., Principles of Food sanitation. Kindle Publication (2005) 5th ed.*
3. *Jay, J.M., Modern Food Microbiology, Kindle Publication (2006) 7th ed.*

PBT204 GENETIC AND METABOLIC ENGINEERING

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Course objective: The objective of this course is to make students learn about basic techniques of recombinant DNA technology such as molecular cloning, gene manipulation and producing GMOs. This will also make students learn about fundamentals and applications of metabolic engineering.

Course contents:

DNA modifying enzymes: DNA modifying enzymes (Restriction enzymes, methylases, nucleases, RNA polymerases, DNA polymerases, PNK, alkaline phosphatases, DNA ligases), linkers and adapters

Molecular Cloning: essential and desired properties of cloning vectors, based on plasmids, phages, phagmids and phasmids, YACs, BAC, PAC, Restriction mapping of DNA fragments, Expression vectors, examples of prokaryotic and eukaryotic expression vectors, added features for aiding purification of recombinant protein, prokaryotic (T7 expression system in *E.coli*) and eukaryotic expression systems (*Pischia pastoris,* Baculovirus and mammalian cells).

Genomic and cDNA libraries: Molecular techniques for cloning for library construction, screening libraries, subrative hybridization for tissue specific cDNA libraries, PCR and Real time PCR and their applications.

Applications of genetic engineering: Studying regulation of gene expression by reporter gene assays studies, DNA sequencing, Site-directed mutagenesis, hybridization based detection (Southern blot, northern blot analysis), DNA protein intraction studies (EMSA, DNase I footprinting, South western blot assay), protein-protein interaction studies (phage display, yeast two hybrid analyses), Antisense RNA technology, RNA interference, DNA Microarray technology

Applications of Gene Technology: Therapeutic proteins, Recombinant vaccines, Monoclonal antibodies, Gene therapy and tools of molecular diagnostics

Metabolic Engineering: Principle of engineering metabolic pathways, Directed production of small molecules in microorganisms, Production of novel compounds and diverse chemical structures, Case studies on re-routing of metabolic pathways in microbes, plants and animals.

Laboratory Work: Competent cells preparation, Bacterial transformation, Isolation of plasmid/bacteriophage DNA, Restriction analysis of DNA, Cloning in plasmid vectors, PCR amplification, applications of PCR, Gene expression in bacterial system, Reporter gene assay.

Course outcome: After successful completion of the course the students will know about various enzyme used in genetic manipulations, various types of cloning and expression vectors and methods of cloning and screening. They would also know about construction of libraries, screening and site directed mutagenesis and importantly engineering of various metabolic pathways.

Recommended Books

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed.*
2. *Lewin, B., Genes VIII, International Edition, Pearson Education (2003).*
3. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2007).*
4. *Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (2007).*
5. *Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).*

Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1989).

PBT205 IMMUNOLOGY AND IMMUNOTHERAPY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Course Objective: The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS.

Course contents:

Basic concept and cells of the Immune System: Hematopoietic Stem Cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in Innate and Adaptive Immunity, Antigen and Antibody, Antigen Presentation and processing, MHC

Cell activation and Cell mediated Immune Response: T and B cell maturation, activation and differentiation, T and B cell tolerance, Cytokines and its role in immune response, Cell mediated Cytotoxic Response: Cytotoxic T cell, NK cell and Antibody dependent cell mediated cytotoxicity, inflammatory response

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 immunoinformatics tool

Autoimmunity, Hypersensitivity and Immunodeficiency: Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, AIDS

Immune response to Infectious disease, Cancer and Transplantation: Immune Response to viral, bacterial and other infections, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Vaccine: Live and Killed Vaccines, Sub unit vaccines, Recombinant Vaccines, DNA vaccines, Peptide vaccines, Plant-based vaccines, Reverse vaccinology, Vaccines against infectious diseases,

Immunotherapy: Immunosuppressive therapy, Immunostimulation, Cytokines therapy, Immunotherapy for infectious diseases, allergies, autoimmune diseases and cancer

Laboratory work: Blood film preparation and identification of cells, Immuno-diffusion, Hemagglutination, Agglutinaton inhibition, Rocket immunoelectrophoresis, Western blotting, ELISA, Epitope prediction using Immunoinformatics tool, Isolation of Peripheral blood mononuclear cells

Course Outcome: At the end of this course, students should be able to explain role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development. Students will be able apply the knowledge of immune associated mechanisms in medical biotechnology research.

Recommended Books

1. *Janeway C. A. Travers P.,Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012) 8th ed.*
2. *Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013), 7 th ed.*
3. *Roitt I., Brostoff J., Male D., Immunology, Mosby Elsevier (2004) 10th ed.*
4. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*

PBT206 MICROBIAL TECHNOLOGY

L	T	P	Cr
3	0	2	4

Prerequisite(s): None

Course Objective The course will impart a comprehensive knowledge and understanding of technological processes involved in biotechnological industries exemplifying a wide range of manufacturing and production of commercially important Bio products.

Microbial Systems: Introduction to microbial activities in nature (soil, water, industry, food and environment), Importance and industrial applications.

Beneficial Soil Microbes: The soil-plant-microorganism system, Rhizosphere and phyllosphere microorganisms, Rhizosphere engineering, Microbial interactions; Symbiotic and non-symbiotic nitrogen fixation; Microbes involved in improving soil fertility (biofertilizers) and pest control (biopesticides).

Biogeochemical Cycling: Microbial transformations, Nitrogen (ammonification, nitrification, denitrification), Phosphorus, Sulphur and Iron cycling, Organic matter Degradation, Microbes as activator's in rapid decomposition, Humus formation and its benefits.

Biotransformation: Industrially important primary and secondary metabolites and their production (alcohol, organic acids, amino acids, antibiotics), Microbiology of production of wine, beer, vinegar and distilled beverages, Non-ribosomal peptides and polyketides, Utilization of microbial biomass as food/feed, Fuel, Chemicals.

Microbial food products: Microbes in fermented dairy products, Mushroom cultivation, biopreservatives: Nisin, cheese, biopolymers: xanthan gum, PHB, SCP

Innovative Microbial Approaches in Remediation: Bioleaching concepts and application, Soils, sediments and aquatic systems contaminated with metals, pesticides and PAHs.

Microbes and Alternative Sources of Energy: Biofuels, Biogas production and its advantages, Production of bioethanol.

Laboratory Work: Isolation and enumeration of free living and symbiotic nitrogen fixers, Phosphate solubilizers and plant growth promoting bacteria, Organic matter decomposition, Estimation of soil pH, EC, organic carbon, N, P, K, Whc and soil texture, Preservation of cultures, Microbiological assays of vitamins and hormones, Ethanol production from sugars and molasses, Fermentative production of enzymes, amino-acids and organic acids.

Course Outcome
At the end of the course, the students will acquire a complete understanding of production of bioproducts and relevant methods important for future industrial application.

Recommended Books

1. *Microbial Biotechnology, Alexander N.Glazer, Hiroshai Nikaido.*
2. *Stanbury P.F., Whitaker A. and Hall S.J (1997), Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi.*
3. *Casida L.E (1991), Industrial Microbiology, Wiley Eastern, New Delhi.*
4. *Crueger W and Crueger A (2000), Biotechnology: A Textbook of Industrial Microbiology, 2nd Edi. Panima Publishing Corporation, New Delhi.*
5. *Patel A.H. (2004), Industrial Microbiology, Macmillan India Ltd.,New Delhi.*
6. *Peppler H.J and Perlman D (2006), Microbial Technology,Vol I and II, Academic Press,New York.*

PBT301 ANIMAL AND STEM CELL TECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Course Objective: The objective of this course is to introduce students to develop basic aseptic skills for vertebrate cell culture and the maintenance of cell lines and *in vitro* application of cell and molecular techniques.

Course contents:

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation.

Layout and Equipments: Layout, Essential equipment's, Aseptic technique, Objectives, Elements, Sterile handling, Safety, Risk assessment, General safety, Fire, Radiation, Biohazards.
Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages and their applications.

Primary Culture and Culture of Specific Cell Types: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature,Cell line designations, Routine maintenance, Immortalization of cell lines,Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture.

Measurement of viability and cytotoxicity: MTT assays, Trypan Blue, PI, FDA assays, Survival Assays, Applications of cytotoxicity assays.

Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time.

Contamination and Cryopreservation: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Need of cryopreservation, Cell banks, Transporting cells.

Transgenic Animals and Animal Cloning: Methodology, Embryonic stem cell method, Microinjection method, Retroviral method, Applications of transgenic animals, Fertilization and Cloning, Conventional methods for animal improvement, Embryo biotechniques, Transfection techniques, Micro manipulation and cloning, Somatic cell cloning, Embryo sexing Artificial insemination, Concept of nuclear transfer in cloning, Creation of Dolly, Polly, Hand guided cloning

Nucleic acid based therapeutic agents & Gene Therapy: siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids, Gene therapy: *Ex-vivo* gene therapy, *In-vivo* gene therapy, Use of Retro and adenovirus as vectors for gene therapy, Gene therapy used for treatment of Cystic Fibrosis, SCID.

Stem Cell Biology: Introduction to stem cells, Basic concepts and properties, Totipotency, Pluripotency, Multipotency, Adult stem cells, Fetal Stem Cells, Niches of stem cells, Blastocyst and inner cell mass cells; Organogenesis; Embryonic stem cells, Isolation of ES cells, Maintenance of ES in undifferentiated state, Hematopoietic stem cells, Clinical use of HSC, stem cell transplantation, Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSC's, Molecular basis of pluripotency, general methods of characterization of stem cells, Stem Cells and Cloning: Therapeutic and reproductive cloning, Nuclear Transfer method, Application of NT ES cells, Safety of NT ES cells.Applications of stem cells in medicine and different disease models, Biosafety and Stem cell research, Regulatory considerations and FDA requirements for stem cell therapy.

Laboratory work: Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Viability assay, Cryopreservation technique, Sub-culturing and maintenance of Cell line, In vitro anticancer assay (MTT Assay), Genomic DNA Isolation from Blood and Tissue.

Course Outcome:

The students will be able to establish cultures of animal cell lines, and understand their roles in treatment of human diseases using gene therapy and nucleic acid-based therapies.

Recommended Books

1. *R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, 4th Edition" 2000.*
2. *Ranga, M.M., Animal Biotechnology, Agrobios (2007) 2nd ed.*
3. *Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rd ed.*
4. *Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).*

PBT302 BIOPROCESS TECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Course Objective: To acquire knowledge on reaction engineering systems with emphasis on bioreactor design and operation and analysis of kinetics in biochemical engineering reactions along with separation and purification of desired products.

Course contents:

Introduction and Basic Concepts: Units and dimensions, Relation between Bioprocess engineering and Biotechnology, Bioprocess Development, advantages over chemical process, types of reactors, Material and Energy balance.

Sterilization Concepts: Sterilization principles and practices, Media sterilization, thermal-death batch and continuous sterilization systems, Sterilization of air fibrous filters, Design of continuous sterilization.

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.

Bioreactor Studies: Study of Batch, CSTR (Continuous stirred tank fermenter) and Plug flow reactor (PFR), Calculations for steady state substrate, Product concentration, External and internal feedback system, Airlift bioreactors.

Aeration and Agitation: Aeration and agitation systems for bioreactors and their design, Functions of mixing, Mixing Equipment, Vessel Geometry, Flow patterns in stirred tanks, Mass transfer in microbial system, Gas liquid mass transfer, Microbial heat generation.

Downstream processing: Product isolation and recovery, Disruption of microbial cells, Filtrations, Reverse osmosis, Spray drying methods, Quality control and bioprocess economics-Scale-up considerations of bioprocesses, Freeze drying.

Laboratory Work: To study different types of bioreactors, Fermenter sterilization, Medium preparation, sterilization and checking sterility by thermal death kinetics, Surface culture fermentation to study the production of lactic acid using sucrose and lactose as the raw material, Production of citric acid, Growth kinetics for some industrially useful organism, Immobilization of cell, Estimate the mass transfer coefficient in a fermenter, Study solid state fermentation.

Course Outcome:

The students will able to demonstrate bioreactor operations, scale-up, modeling, simulation, separation and purification of products as applicable in bioprocess industries.

Recommended Books

1. Shuler M.L. and Kargi F., Bioprocess Engineering: Basic Concepts, Prentice-Hall (2001) 2nd ed.
2. Stanbury, P.F., Principles of Fermentation Technology, Book News, Inc. (1992) 2nd ed.
3. Vogel H. C.and Haber C. C., Fermentation and Biochemical Engineering Handbook, Noyes Publications (2001) 2nd ed.
4. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill (1986).
5. Wang D.C. and Humphrey, L, Fermentation and Enzyme Technology, John Wiley (1989).
6. Doran P M, Bioprocess Engineering Principles, Academic Press (1995)

PHU301 ENTREPRENEURSHIP AND IPR

L	T	P	Cr
3	1	0	3.5

Prerequisites: None

Course Objectives

Students will be able to demonstrate and develop awareness of personal as well as external resources with a view to successfully launching and subsequently managing their enterprises. They will be able to develop skills in operations, finance, marketing and human resource management and be aware of rights resulting from intellectual property rights, infringement of intellectual property rights (with particular emphasis on patent infringement and plagiarism) and free use of intellectual property rights

Entrepreneurship: Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur.

Project Management: Formulation, Identification and selection based on size, Technological assessment, Project cost and market potential and marketing concepts.

Project Appraisals: Technical reports and feasibility reports with commercial viability, Break-even analysis, Depreciation, Sources of funding.

Financing: Sources of finance, Initial capital, Capital structure, Venture capital and Institutional finance.

Economics: Demand-supply-pricing, Business ethics, Industrial laws, Women entrepreneurs – Role, problems and development.

Industrial Sickness: Symptoms, control and rehabilitation of sick units.

Introduction to Intellectual Property: Intellectual property and IPR, patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs, Patent law, Legislations covering IPR's in India, product planning and development, filing patent, provisional and complete specification, patentable and non-patentable items, Valuation & business concerns.

Course Outcome

This course will help the students in understanding of their personal characteristics and interests to that of the "successful" entrepreneur, identification and assess sources of support for small businesses and entrepreneurs and to evaluate methods of entering an entrepreneurship venture – including but not limited to starting a new venture, buying an existing business, or becoming a franchisee.

Recommended Books

1. *Desai, V., Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).*
2. *Singh, I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).*
3. *Sateesh, M.K., Bioethics and Biosafety, IK International (2008).*

PBT303 BIOINFORMATICS

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Course Objective: The objective of this course is to provide students with basic understanding and application of bioinformatics. The course will provide the basic concepts behind the sequence and structural alignment, database searching, protein structure prediction and computer based drug designing.

Course contents:

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats, DNA and protein sequence databases, Structure databases

Pairwise sequence alignment and database searching: Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Dot matrix method, Scoring matrices Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA , BLAST

Multiple sequence alignment and phylogenetics: Scoring multiple sequence alignments, Progressive alignment method, Iterative alignment method, Block-based alignment, Molecular evolution and phylogenetics, Phylogenetic trees, Molecular clock theory, Maximum Parsimony, Distance based methods: UPGMA, Maximum likelihood method, Bayesian statistical analysis

Structural Bionformatics: Ramachandran plot, protein secondary structure prediction, Chou-Fasman and GOR method, Neural networks, Protein three dimensional structure prediction: Homology modeling and protein Threading, Molecular visualization, Computer aided drug design, Docking and QSAR

Machine Learning and Bio-programming: Development of Algorithms, Hidden Markov Models, Artificial Neural Networks, Perl introduction

Laboratory Work*:* DNA and protein sequence and PDB file formats, Local and global sequence alignment of protein and DNA sequences, Needleman Wunsch and Smith-Waterman algorithm, BLAST, Multiple sequence alignment and Sequence logo, Phylogenetic tree construction, Secondary structure prediction, Visualization and editing of three dimensional structure, Homology modeling, Active site prediction, Docking, Perl

Course Outcome: At the end of this course, students should be able to explain key concepts of different bioinformatics tool and then extend knowledge in analyzing the sequence and structure data obtained from bioinformatics tool. Students should be able apply the knowledge of bioinformatics in the biotechnology research and industry.

Recommended books

1. Xiong J , Essential Bioinformatics, Cambridge University Press (2006)
2. Mount D W , Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001)
3. Ghosh Z, and Mallick B , Bioinformatics – Principles and Applications, Oxford University Press (2008)
4.. Dwyer, R.A., Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press (2004).
5. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).

PBT304 PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Course Objective: The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Introduction, Aim and Scope of Plant Biotechnology: Major challenges and prospects of traditional and modern plant biotechnology, Important milestones of plant biotechnology

Plant tissue culture—its history, development and applications, Plant tissue culture media, Types of cultures, Callus cultures, Cell and suspension cultures, Single cell clones, Protoplast culture and somatic hybridization.

Micropropagation: Techniques and various steps involved in micropropagation, Production of disease free plants, Commercial aspects and limitations of micropropagation.

Production of haploid plants: Androgenesis and Gynogenesis, Significance and uses of haploids.

Embryo culture and embryo rescue and its applications in plant improvement.

Strategies for producing novel plants: Manipulation of Phenotypic Traits: Strategies of molecular cloning of plant genes, Gene transfer methods—Vector mediated, Virus mediated and Vector less DNA transfer, rDNA approaches for introducing herbicide tolerance, pest resistance, plant disease resistance, Abiotic & biotic stress tolerance, Improvement of crop yield and quality, Molecular markers and marker assisted selection, Applications of plant transformations/ transgenics, Commercial transgenic crops. Molecular farming of Alkaloids, Useful enzymes, Therapeutic proteins, custom- made Antibodies, Edible vaccines.

Secondary metabolite extraction: Primary vs secondary metabolites, Role of plant tissue culture in secondary metabolite production, Hairy root culture, Immobilized cell system, Elicitation and Biotransformation.

Somaclonal variations: Isolation of somaclonal variants, Applications and limitations of somaclonal variations, Gametoclonal variations.

Germplasm conservation and Cryopreservation

Transgenics-Issues and Concerns: Biosafety, Societal and ethical concerns on genetically modified foods and crops.

Laboratory Work *:* Plant tissue culture media, Explant preparation, Callus induction and differentiation, microscopic study of callus, Meristem culture for virus free plants , Rooting of plantlets and accilimatization, Protoplast isolation, Preparation of artificial seeds, Isolation and
purification of plant DNA and RNA, Quantification of DNA, restriction analyses, *Agrobacterium*-mediated transformation of plants, Electroporation techniques.

Course Outcome: At the end of this course, the students will be well acquainted with the techniques of plant protoplast, cell, tissue and organ culture under *in vitro* conditions. They will acquire knowledge regarding micropropagation technique and DNA recombinant technology to produce plants with novel characters for crop improvement.

Recommended Books

1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Oxford University Press (2008) 2nd ed.
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing (2006) 7th ed.
3. Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Concepts in Biotechnology, Universities Press (1999).
4. Satyanarayana, U., Yeast Biotechnology: Diversity and Applications, Springer (2009).
5. Razdan, M.K., Introduction to Plant Tissue Culture, Science Publishers (2003) 2nd ed.

Elective1

PBT305 GENOMICS, METAGENOMICS AND PROTEOMICS

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Course objective: The objective of this course is to teach genomes, metagenomes and proteomes their characteristics and sequencing to the students and their applications in comparative genomics and transcriptomics.

Course contents:

The Organization and Structure of Genomes: Prokaryotic genomes, Prokaryotic gene structure, Open reading frames, Conceptual translation, Termination sequences, GC content in prokaryotic genomes, Prokaryotic gene density, Eukaryotic genomes, Eukaryotic gene structure and open reading frames, GC content in Eukaryotes.

Genome Mapping and Sequencing: Sequence tags, RFLP, SNP, Pedlock probes, Radiation hybrid mapping, HAPPY mapping, Sequencing genomes-High throughput sequencing, clone-by-clone approach, Whole genome shot gun approach, quality of genome sequence, human genome sequencing project.

Comparative Genomics: Comparative genomics of bacteria, Comparative genomics of organelles, Comparative genomics of eukaryotes, Large scale mutagenesis and interference.

Analysis of transcriptomes: Introduction, DNA microarray technology, Functional genomics, ESTs and SAGE, Allele mining and SNPs, Applications of genomics.

Metagenomics: Introduction to sequence based and function based metagenomics, filtering and quality assessment of high throughput sequence data, Clustering of high throughput sequence data, Taxonomic and genetic annotation of high throughput sequence data, Diversity analyses, Analyses of community composition and change, Metabolic reconstruction analyses, metatranscriptome and metaproteome analyses

Proteomics: Introduction to proteomics, Proteomics Technologies - Protein Arrays, Protein Chips and their application, 2D Gel Electrophoresis and its application, Mass Spectrometry and Protein identification, Shotgun proteomics, Role of Bioinformatics in Proteomics, Proteomics Databases, Protein-Protein Interactions - Concepts and Databases, Proteomics Analysis Tools at ExPaSy , Applications of Proteomics in Life Sciences.

Laboratory Work : Comparison of genomes, comparison of introns in higher eukaryotes, CpG islands, SNPs, RAPD, ESTs & STS, Proteomics tools, Structural and functional predictions, Phylogenetic construction

Course outcome: After passing this course the students will know about various aspects of genomes of different types of organisms. They would know strategies and challenges of genome sequencing, comparative genomics, transcriptomics using microarray technology. The students will also know about metagenomics, and different methodologies used in proteomics as well as structural proteomics.

Recommended Books

1. *Primrose, S.B. and Twyman, R.M., Principles of gene manipulation and genomics. Blackwell Publishing (2006) 7th ed.*
2. *Akay, M. Genomics and Proteomics Engineering in Medicine and Biology, John Wiley (2007).*
3. *Pennington, S.R. and Dunn, M. J., Proteomics: from protein sequence to function. Viva Books (2001).*
4. *Mount, D.W., Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press (2001).*
5. *Metagenomics – Sequencing from the environment, NCBI (2006)*

PBT306 MOLECULAR FARMING

L	T	P	Cr
3	0	2	4.0

Prerequisites: None

Course Objective: The students will learn about molecular farming an emerging branch of plant biotechnology and wide range of products for molecular farming such as carbohydrates, fats, proteins, secondary products and commercially important molecules using plant systems as 'bioreactors'.

Course contents:

Introduction: Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

Strategic details of various molecular farming: Major targets for carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms; Various molecular approaches & strategies relevant to molecular farming; Production of carbohydrates: increased starch amount, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids having pharmaceutical and nutraceutical values, Critical evaluation on various case studies of molecular farming & their future prospects; Economic and regulatory considerations for molecular farming.

Production of biodegradable plastics in plants: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) & polyhydroxyalkanoate co-polymers; Strategies for production of biodegradable plastics in plants.

Genetically engineered plants as protein factories: Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes.

Laboratory work:
Isolation & characterization of genomic & cDNA clones relevant to molecular farming, making genetic constructs, Transient expression studies in plants, Genetic transformation of plants, Gene expression studies, studying molecular techniques/protocols related to various case studies: production of carbohydrates, lipids, proteins, antibodies, edible vaccines.

Course Outcome: Students will gain sufficient exposure and knowledge in this new branch of modern plant biotechnology with regard to large-scale production and processing and will help them in undertaking advanced studies and research.

Recommended Books:

1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Seventh Edition, Blackwell Publishing (2006).
3. Satyanarayana, U., Biotechnology, Books and Allied (P) Ltd. (2005).
4. Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).
5. Primrose, S.B., Molecular Biotechnology, Second Edition, Panima Publishing Corporation (2001)

PBT307 MOLECULAR MEDICINE AND DIAGNOSTICS

L	T	P	Cr
3	0	2	4.0

Course objectives: To provide an advanced understanding of the molecular basis of the pathogenesis, diagnosis and treatment of human diseases. To describe and discuss topics related to infectious diseases, chronic diseases, genetic diseases, endocrine disorders, malignancy and diseases arising from abnormal immune responses.

Course contents:

Concepts and perspective of molecular medicine: Basic biochemistry, molecular biology and genetics relevant to Molecular Medicine. Human genome: implication and applications. Single Nucleotide Polymorphism. Gene therapy as a potential tool to cure human diseases. Recombinant molecules in medicine. Transgenic and knock out animal models. Stem cell research and its application in human health. Intellectual property right issues and ELSI (Evaluation of the Ethical, Legal and Social Implications program)

Molecular basis of metabolic disorders: Introduction to metabolic disorders and metabolic profiling. Reproductive disorders. Cardiovascular diseases. Disorders in hormonal action. Insulin dependent and independent diabetes. Ligand induced signaling and gene expression in eukaryotic cells. Importance of intracellular trafficking & its related pathogenesis. Molecular endocrinology in health and disease. Cancer and cell cycle.

Nuclear Receptors in Health and Disease: Nuclear Receptor superfamily: an introductory overview; structural and functional domains of nuclear receptors; ligand-mediated regulation of nuclear receptor function; nuclear

receptor localization; receptor-ligand interactions and gene transcription regulation; histone (acetylase, deacetylase, methylase, demethylase), ATP dependent chromatin remodellers; receptor regulation by post-translational modifications, nuclear receptors as drug targets; xenobiotic receptors and drug metabolism; screening and analysis of therapeutic ligands by high-throughput microscopy, co-transfection and transcriptional assays; steroid hormones and their receptors; molecular basis of endocrinopathies: endocrine-related cancers ligand-independent transcriptional activation of steroid hormone receptors; endocrine disruptors and selective steroid receptor modulators; current concepts and future challenges.

Free radicals and metal ions in biology and medicine: Chemistry and biology of Reactive Oxygen Intermediates (ROI), Transition metals in oxidative processes, Mechanisms of lipid, protein and DNA oxidation, Antioxidants-small molecules and enzymes, Involvement of oxidative processes in ageing, cancer and atherosclerosis, Metal ions in gene regulation, Iron in human diseases-anaemia, thalassemia, primary and secondary hemochromatosis. Menkes' and Wilson's disease: Genetic disorders of copper transport. Metals and free radicals in Alzeihmer's disease and other neurodegenerative diseases

Cell Junctions: Biology and Diseases: Introduction to epithelial and endothelial junctional complexes; molecular composition, structure and function of tight junctions, adherens junctions, gap junctions and desmosomes; role in cell-cell adhesion; junctional diffusion barriers; regulation of paracellular permeability; signaling from the apical junctional complex and role in epithelial polarization, cell differentiation, proliferation and gene expression; junctional components targeted by disease causing micro-organisms; diseases associated with intercellular junctions including multiple sclerosis, type 1 diabetes, inflammatory bowel disease, and cancers of the breast, prostate and colon.

Laboratory work:
Isolation and Culturing of Peripheral Blood Lymphocytes, Cell line culturing, Viability assay, In vitro anticancer assay (MTT Assay), Genomic DNA & RNA isolation from Blood and Tissues.RFLP-PCR for identification of SNP's, RT-PCR for analyzing gene expression, PCR-SSCP technique for mutation identification, Evaluation of Antibody titre by direct ELISA,Methods for prototype development of Immunodiagnostics (ICT card), Preparation of chromosomes from blood samples

Course Outcome: Students in the basic science area will receive insights into the translational and clinical aspects of science and conversely students in clinical medicine will have the opportunity to gain new insights into molecular mechanisms, disease models and preclinical work.

Recommended Books:

1. *Methods in Molecular Medicine: Molecular Diagnosis of Genetic disease. Edited by ROB ELLES. Humana Press Inc., Towa, NJ, 1996. 356 pp.*
2. *Introduction to Molecular Medicine: Ross, Dennis W.3rd ed. 2002, XV, 153 p.*
3. *Molecular Medicine, 4th Edition Genomics to Personalized Healthcare: Trent, RJ. 4th ed 2012 Academic Press*

Principles of Molecular Medicine: Runge, Marschall S.; Patterson, Cam (Eds.) 2nd ed. 2006 Humana