

CURRICULUM

for the Academic year 2018 – 2019

DEPARTMENT OF BIOTECHNOLOGY

I-IV Semester M.Tech Biotechnology

RAMAIAH INSTITUTE OF TECHNOLOGY

(Autonomous Institute, Affiliated to VTU)

BANGALORE – 54

About the Institute:

Ramaiah Institute of Technology (RIT) (formerly known as M. S. Ramaiah Institute of Technology) is a self-financing institution established in Bangalore in the year 1962 by the industrialist and philanthropist, Late Dr. M S Ramaiah. All engineering departments offering bachelor degree programs have been accredited by NBA. RIT is one of the few institutes with faculty student ratio of 1:15 and achieves excellent academic results. The institute is a participant of the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. All the departments are full with competent faculty, with 100% of them being postgraduates or doctorates. Some of the distinguished features of RIT are: State of the art laboratories, individual computing facility to all faculty members. All research departments are active with sponsored projects and more than 130 scholars are pursuing PhD. The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus. RIT has a strong Placement and Training department with a committed team, a fully equipped Sports department, large air-conditioned library with over 80,000 books with subscription to more than 300 International and National Journals. The Digital Library subscribes to several online e-journals like IEEE, JET etc. RIT is a member of DELNET, and AICTE INDEST Consortium. RIT has a modern auditorium, several hi-tech conference halls, all air-conditioned with video conferencing facilities. It has excellent hostel facilities for boys and girls. RIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. RIT obtained Academic Autonomy for all its UG and PG programs in the year 2007. As per the National Institutional Ranking Framework, MHRD, Government of India, Ramaiah Institute of Technology has achieved 45th rank in 2017 among the top 100 engineering colleges across India and occupied No. 1 position in Karnataka, among the colleges affiliated to VTU, Belagavi.

About the Department:

The department of Biotechnology established in 2002 offers a four year B.E. Biotechnology Program with an intake of 60 students and a two years PG Program, M.Tech in Biotechnology with an intake of 18 students. The department is a recognized Research Centre by VTU, Belgaum, offering M.Sc (Engg.) by research and PhD programs. The Department also offers a Post Graduate Diploma in Biopharmaceutical Technology under the Biotechnology Skill Enhancement Programme (BiSEP), supported by the Department of IT & BT, Government of Karnataka with a sanctioned budget of Rs. 162.5 Lakhs.

The department has 14 faculty members, of them ten are Ph.D holders and the others are M.Tech pursuing Ph.D. The faculty members have competence in Core areas of Biotechnology viz. Food and Agricultural Biotechnology, Health and Medical Biotechnology & Environmental Biotechnology and Bioprocess Engineering. The department research is focused towards these core areas and funded by national and state funding agencies like DST, KBITS, AICTE, VGST, VTU and RGUHS.

The department faculties and students have publications in Scopus Indexed peer reviewed Journals of Elsevier, Taylor and Francis and Springer. Faculties have published book chapters and presented their research work in National and International conferences. A sizeable number of students have pursued their higher education at various premier institutes in India and abroad after having qualified GATE, GRE & TOEFL exams. The students undergo internships at various premier institutes in India and abroad. Several students receive the Indian Science Academies Summer Internship every year. The department has collaborations with some of the leading biotech industries like: Biocon, Hindustan Unilever Limited (HUL), Bristol Myers Squibb India Ltd, Novozymes South Asia Pvt Ltd, Himalaya Drug Company, Beckman Coulter, Sami Labs, Sartorius AG, Genotypic Technology, Aristogene Biosciences, GangaGen, Connexios Life Sciences, Acquity Labs & Celest Pharma.

VISION OF THE INSTITUTE

To evolve into an autonomous institution of international standing for imparting quality technical education

MISSION OF THE INSTITUTE

MSRIT shall deliver global quality technical education by nurturing a conducive learning environment for a better tomorrow through continuous improvement and customization

QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

“To be a leading Biotechnology Engineering department that imparts quality technical education with strong research component, to develop solutions in the field of food, health and environment”

MISSION OF THE DEPARTMENT

“To provide quality technical education in a conducive learning environment to produce professionals, researchers with a zeal for lifelong learning and a commitment to society”

Programme Educational Objectives (PEOs) of the program

PEO 1: To produce postgraduates who can articulate technical developments in the field of biotechnology and apply relevant tools to solve problems in real life situations

PEO 2: To enable postgraduates to have an ability to design and conduct research to meet desired needs within realistic economic, environmental, socio-political, ethical, health, safety & sustainability realms

PEO 3: To prepare post graduates to be successful professionals in industry, academia, research, entrepreneurial pursuit and consulting firms

PEO 4: To prepare students to enrich their knowledge & skills throughout their career

Programme Outcomes (POs)

PO1: An ability to independently carry out research/investigation & development work to solve practical problem

PO 2: An ability to write & present a substantial technical report/document

PO 3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO 4: Demonstrate the ability to design, conduct experiments and analyze data in the field of Biotechnology

PO 5: Able to employ Biotechnology tools in biological research

SCHEME OF TEACHING FOR THE BATCH 2018-2020

I SEMESTER

SI. No.	Course Code	Course	Credit				
			L	T	P	S	Total
1	MBT11	Cell Biology & Metabolic Engineering	3	1	0	0	4
2	MBT 12	Recombinant DNA Technology	3	1	0	0	4
3	MBT 13	Advanced Upstream and Downstream Technology	3	1	0	0	4
4	MBTE	Elective 1	4	0	0	0	4
5	MBTE	Elective 2	4	0	0	0	4
6	MBTL14	Practical-I	0	0	2	0	2
7	MBTL15	Practical-II	0	0	2	0	2
8	MBT16	Technical Seminar 1	0	0	1	0	1
Total			17	2	5	1	25

II SEMESTER

SI. No.	Course Code	Course	Credit				
			L	T	P	S	Total
1	MBT 21	Bioprocess Engineering	3	1	0	0	4
2	MBT 22	Bioanalytical and Biophysical Techniques	3	0	0	1	4
3	MBT 23	Biopharmaceutical Technology	3	1	0	0	4
4	MBT E	Elective 3	4	0	0	0	4
5	MBT E	Elective 4	4	0	0	0	4
6	MBT L24	Practical-III	0	0	2	0	2
7	MBT L25	Practical-IV	0	0	2	0	2
8	MBT 26	Technical Seminar 2	0	0	1	0	1
Total			17	2	5	1	25

L – Lecture

T – Tutorial

P- Practical

S-Self Study

III SEMESTER

SI. No.	Course Code	Course	Credit				
			L	T	P	S	Total
1	MBT 31	Bioethics & Intellectual Property Rights	3	0	0	1	4
2	MBTE	Elective 5	4	0	0	0	4
3	MBT 32	Technical Seminar 3	0	0	1	0	1
4	MBT 33	Internship/Industrial Training	0	0	10	0	10
5	MBT 34	Project Work -I	0	0	6	0	6
Total			7	1	17	0	25

IV SEMESTER

SI. No.	Course Code	Course	Credit				
			L	T	P	S	Total
1	MBTP	Project Work-II	0	0	25	0	25
Total			0	0	25	0	25

L – Lecture

T – Tutorial

P- Practical

S-Self Study

Project Work-II: Phase I

Review of Project Work-I

Project Work-II: Phase II

Presentation on detailed design, implementation and validation

Project Work-II: Phase III

Seminar with project demonstration, project report submission and viva voce. Outcome as a paper publication in journal/conference approved by the department with plagiarism check limit < 25%.

ELECTIVES


Sl No	Course Code	Course	Credit				
			L	T	P	S	Total
1	MBTE01	Industrial and Environmental Biotechnology	4	0	0	0	4
2	MBTE02	Medical Biotechnology	4	0	0	0	4
3	MBTE03	Bioreaction Engineering	4	0	0	0	4
4	MBTE04	Toxicology and Forensic science	4	0	0	0	4
5	MBTE05	Plant Biotechnology	4	0	0	0	4
6	MBTE06	Experimental Designs	4	0	0	0	4
7	MBTE07	Applied Bioinformatics	4	0	0	0	4
8	MBTE08	Advanced Research Methodology	4	0	0	0	4
9	MBTE09	Applied Animal Biotechnology	4	0	0	0	4
10	MBTE10	Biotechnology of Alternative Fuels	4	0	0	0	4
11	MBTE11	Protein Engineering & Industrial Applications	4	0	0	0	4
12	MBTE12	Bioreactor Technology	4	0	0	0	4
13	MBTE13	Nanobiotechnology	4	0	0	0	4

L – Lecture

T – Tutorial

P- Practical

S-Self Study

	CELL BIOLOGY AND METABOLIC ENGINEERING			
	Sub Code	: MBT 11	CIE	: 50 Marks
	Credit	: 3:1:0:0	SEE	: 50 Marks

Course coordinators: Dr. Bindu S and Dr. Ravi Kumar YS

UNIT-I

Cell biology: Cell structure: prokaryotic and eukaryotic cells, Structure and functions of nucleus, mitochondria, ribosome, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, chloroplasts, vacuoles, plasma membrane. Fluid mosaic theory of plasma membrane. Active and passive transport systems of plasma membrane. Cell division and cell cycle regulation (mitosis and meiosis). Cellular and sensory communications.

UNIT-II

Genetics and inheritance: Introduction to Mendelian genetics, Gene interactions and exceptions to Mendelian laws. Different types of gene interactions. Structure and organization of genetic material in eukaryotes, structure of chromosomes, special chromosomes. Linkage and recombination. Introduction to microbial genetics, different types of microorganisms used in molecular biology,

UNIT-III

Plants: Photosynthesis: light and dark reaction, ATP synthesis in chloroplasts, CO₂ fixation, respiration and photorespiration, electron transport chain and ATP synthesis in mitochondria. Phytohormones and their role in plant development plant response to abiotic and biotic stress.

Animals: introduction to human digestive, circulation, respiration, excretion and reproductive systems. Nervous systems: peripheral and CNS. Introduction to immune system: innate and adaptive immunity, antibody structure and functions,

UNIT-IV

Introduction to metabolic engineering: review of cellular metabolism, models for cellular reactions, material balance and data consistency- Block box model, elemental balance, heat balance and analysis. Regulation of enzyme activities and concentration. Regulation of transcription and translation. Regulation of metabolic networks.

UNIT-V

Manipulation of metabolic pathways: enhancement of product yield and productivity-ethanol, amino acids and solvents. Product spectrum and novel products: antibiotics, polyketides, vitamins and biological pigments. Metabolic flux analysis: methods for determination of metabolic fluxes by isotope labeling-fractional label enrichment. Application of metabolic flux analysis; amino acid production by Glutamic acid bacteria and mammalian cell cultures, flux analysis of metabolic networks- bottom-up and top-down approach.

Textbooks:

1. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis (2013) Essential Cell Biology, 4th Edition, W. W. Norton & Company.
2. Jeff Hardin (2015) Becker's World of the Cell, 9th Edition, Pearson Publishers.
3. Gregory N. Stephanopoulos, Aristos A. Aristidou and Jens Nielsen (1998) Metabolic Engineering: principles and methodologies. Academic Press, USA.

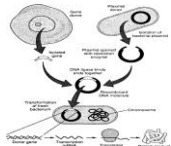
4. Nestor V. Torres and Eberhard O. Voit (2002) Pathways and optimization in metabolic Cambridge University Press.

Reference Books

1. Shuler M and Kargi F (2010) Bioprocess engineering basic concepts, 2nd Edn. Prentice Hall.
2. Cortassa S, Aon M A, Lglesias AA and Lyod L (2002) An Introduction and Metabolic and cellular Engineering. World Scientific Publications Pvt. Ltd. Singapore.
3. Sujit K Chaudhuri (2010) Concise Medical Physiology, New Central Book Agency, Pvt. Ltd.

Course Outcome: On completion of this course student will have improved ability

1. To describe basic cellular concepts and principles. (PO1, PO3, PO4 and PO5)
2. To apply genetic principles and analyze inheritance patterns. (PO1, PO3, PO4 and PO5)
3. To analyze plant & animal physiology. (PO3)
4. To describe the metabolic process of cell and their regulation. (PO3)
5. To apply metabolic engineering concepts in biological system for industrial application. (PO1, PO 4 & PO5).

	RECOMBINANT DNA TECHNOLOGY			
	Sub Code	: MBT 12	CIE	: 50 Marks
Credits	: 3:1:0:0	SEE	: 50 Marks	

Course coordinators: Dr. Prabha M

UNIT-I

Introduction to Recombinant DNA technology: Introduction to recombinant DNA technology. The importance of recombinant DNA technology. Vectors: Structure and function of cloning and expression vectors. Regulatory sequences of prokaryotic and eukaryotic genes. Different host systems for cloning and expression. Transformation techniques: physical, chemical and biological.

UNIT-II

Important enzymes used in the recombinant DNA technology: Enzymes are the molecular tools. Enzymes cleave nucleic acids: nucleases, restriction endonucleases, RNases. Enzymes synthesize nucleic acids: DNA and RNA polymerases, ligases. Enzymes in modification of DNA: DNA methylases, phosphatases, kinases, topoisomerases. Construction and screening of genomic and cDNA libraries.

UNIT-III

Advanced techniques used in recombinant DNA technology: Isolation of DNA and RNA. Estimation of purity and quantity of nucleic acids, Polymerase chain reaction (PCR), Autoradiography, DNA sequencing. Detection of DNA, RNA and proteins by Southern blotting, Northern blotting, western blotting and *in situ* hybridization techniques. Site-specific mutagenesis, Gene mapping and Microarrays.

UNIT-IV

Applications of recombinant DNA technology in Medicine and Health: Production of specialty chemicals and proteins: secondary metabolites, phytochemicals. Genetically modified microbes (Recombinant bacteria) for the production of commercial scale production of proteins and pharmaceuticals, antibiotics, enzymes, insulin, growth hormones, monoclonal antibodies. Applications rDNA in diagnosis of pathogens and abnormal genes. Transgenic animals. Transgenic animals for production of proteins and pharmaceuticals. Genetically modified insect cells for the production of commercially important bioproducts.

UNIT-V

Applications of recombinant DNA technology in agriculture, industry and environment: Transgenic plants, Transgenic crops for increased yield, resistance to biotic and abiotic stresses, clearing oil spills. Application of transgenic plants. Industrial production of specialty chemicals and proteins: organic molecules and commercially important proteins. Biosafety regulations and evaluation of genetically modified microorganisms (GMOs), plants and animals.

Text Books

1. Sambrook et. al. (2000) Molecular cloning: a laboratory manual. Volumes I - III. Cold Spring Harbor laboratory Press, New York, USA.
2. Channarayappa (2006) Molecular Biotechnology: Principles and Practices. Universities Press (India) Pvt. Ltd. Worldwide publishing: CRC Press, Taylor and Francis.


3. David S Latchman (1994) From Genetics to Gene Therapy – The Molecular Pathology of Human Disease by, BIOS scientific publishers.

Reference Books

1. Old R W and Primrose S B (1993) Principles of gene manipulation, an introduction to genetic engineering. Blackwell Scientific Publications.
2. Benjamin Lewis (2008) Genes VIII. Oxford University & Cell Press
3. Channarayappa (2010) Molecular Biology: Universities Press (India) Pvt Ltd.

Course Outcome: On completion of this course student will have improved ability:-

1. To know the importance of molecular biology to understand the mechanism of recombinant DNA technology. (PO3)
2. To have the knowledge of an enzymes and their modification for construction and screening of rDNA. (PO2)
3. To isolate and detect nucleic acids and analyze advanced techniques of rDNA. (PO1)
4. To apply the techniques in modification of genes and their function to construct the genetically modified organisms and transgenic animals for research, Health and Medicine. (PO3)
5. To know the significance of recombinant DNA technology with Biosafety regulations and its wide applications in various fields-agriculture, industry and an environment. (PO5)

	ADVANCED UPSTREAM AND DOWNSTREAM PROCESSING			
	Sub Code	: MBT 13	CIE	: 50 Marks
	Credit	: 3:1:0:0	SEE	: 50 Marks

Course coordinators: Dr. Chandrababha MN and Dr. Lokesh KN

UNIT-I

Media development and Design of Biological reactors: Introduction, Types of cell culture media, components of animal origin, inoculum development strategies, Ideal reactors, Reactor dynamics, Sterilization of reactors, Immobilized biocatalysts, Multiphase Reactors, Animal and plant cell reactor technology.

UNIT-II

Mammalian and plant cell culture technology: Introduction. Cell line transfection and selection, Increase in efficiency in selecting a producer cell line, Stability of gene expression, Optimization of the fermentation process, Bioreactors. Bioreactor consideration for plant cells.

UNIT-III

Cell disruption and protein enrichment operations: Centrifugation; Sedimentation; Flocculation; Microfiltration; Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis. Membrane based purification: Ultrafiltration; Reverse osmosis; Dialysis; Diafiltration; Pervaporation; precipitation (Ammonium sulfate solvent). Extraction (solvent aqueous two phase, supercritical).

UNIT-IV

Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds). Electrophoretic technique, Electrophoresis.

UNIT-V

Product polishing techniques; Crystallization; Drying. Case studies; product formulation and additives, freeze drying process.

Text Books:

1. Harris ELV and Angal S (1988) Protein Purification Methods, Ed. IRL Press at Oxford University Press.
2. Belter PA, Cussler EL and Wei-Shou Hu (2001) Bioseparations-Downstream Processing for Biotechnology, Wiley-Interscience Publication.

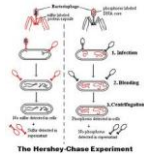
Reference Books:

1. Michael Butler (2007) Cell Culture and Upstream Processing, T & F informa.
2. James E. Bailey and David F. Ollis (1997) Bioprocess Engineering fundamentals. Mc Graw Hill Book Publication.
3. Bailey JE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd Edn, Mc-Graw Hill, Inc.
4. Scopes RK Berlin (1982) Protein Purification: Principles and Practice, Springer.

Course Outcome: On completion of this course student will have improved ability:-

1. To acquire real-time working knowledge on media formulation, sterilization and optimization process which are considered as pre-requisites of upstream processing. (PO3, PO4)
2. To implicate the knowledge of animal cell culture technology in upstream processing. (PO3, PO4)

3. Demonstrate strong basics in principles of separation & purification of fermented products and utilize membrane based operations for product purification. ((PO3, PO4)
4. Design and develop various chromatographic techniques with respect to product recovery. (PO3, PO4)
5. Design and develop various techniques with respect to product polishing. (PO3, PO4)

 <p>The Hershey-Chase Experiment</p>	PRACTICAL - I			
	Sub Code	: MBTL14	CIE	: 50 Marks
Credit	: 0:0:2:0	SEE	: 50 Marks	

Course coordinators: Dr. Sravanti V and Dr. Ahalya N

LIST OF EXPERIMENTS

1. Isolation of Lipolytic bacteria.
2. Production of Amylase by fermentation technique.
3. Demonstration of lysogeny in *E. coli*.
4. Measurement of BOD/COD of waste water.
5. Determination of sugar/glucose transport in *S. cerevisiae*.
6. Production and estimation of citric acid from microbes.
7. Production and estimation of lactic acid from microbes.
8. Determination of growth curve and growth inhibition.
9. Cultivation of Anaerobes.
10. Production and estimation of Single Cell Protein.
11. Glucose uptake by Yeast and Other bacteria.
12. Ultraviolet irradiation survival curve.
13. Control of micro organism by physical and chemical factors; effects of pH, osmotic factors.
14. Isolation of Yeast.

Note: At least any 12 experiments must be performed

Text Books:

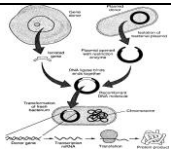
1. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994) Methods of General and Molecular Bacteriology, Ed. American Society for Microbiology, Washington D.C.
2. P. M. Rhodes and P. F. Stanbury (1997) Applied Microbial Physiology : A Practical Approach, IRL Press

Reference books:

1. Cappuccino J.G, Sherman N (1999) Microbiology: A Laboratory Manual, 4th Edn., Addison-Wesley International Student.
2. Prescott, Harley and Klein (2008) *Laboratory Exercises in Microbiology*, 7th Ed Harley, McGraw-Hill, USA
3. Pollack RA, Walter F, Mondschein W, Modesto R (2004) *Laboratory Exercises in Microbiology*, 2nd Edn. John Wiley Publication.

Course Outcome: On completion of this course student will have improved ability:

1. To design, execute, analyze experiments independently and improve scientific writing skills (PO1, PO2, PO3, PO4, PO5)
2. To estimate and quantify organic acids, proteins, sugars. (PO1, PO4, PO5)
3. To apply basic biochemical techniques in Environmental Biotechnology. (PO3, PO5)
4. To isolate, grow microbes and express secondary metabolites for various applications. (PO1, PO3, PO5)
5. To correlate the effect of environmental factors on microbial growth. (PO3, PO5)

	PRACTICAL - II			
	Sub Code	: MBTL15	CIE	: 50 Marks
Credits	: 0:2:0:0	SEE	: 50 Marks	

Course coordinators: Dr. Prabha M

LIST OF EXPERIMENTS

1. Introduction to recombinant DNA technology and good laboratory practices.
2. Cell disruption
3. Protein precipitation by NH_4SO_4 by solvent methods and its recovery
4. Protein purification by chromatography.
5. Cloning: transfer a gene into plasmid vector and transformation into bacteria.
6. Screening of recombinant bacteria.
7. Establishment of plant/animal cell culture.
8. Transformation of plant/animal cells through vector carrying gene of interest.
9. Screening and characterization of transformed cells.
10. Estimation and Isolation of total DNA from tissues/cells
11. Characterization of DNA by Southern blot
12. Detection of recombinant proteins by Western blotting
13. Amplification of target DNA by PCR
14. Isolation and quantification of RNA

Note: *At least any 12 experiments must be performed*

Text books:

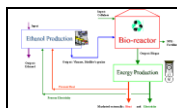
1. Russell, David W, Sambrook, Joseph (2001). Molecular cloning: a laboratory manual. Volumes I - III. Cold Spring Harbor laboratory Press, USA.
2. Channarayappa (2006) Molecular Biotechnology: Principles and Practices. Universities Press (India) Pvt. Ltd. Worldwide publishing: CRC Press, Taylor and Francis.
3. Harris ELV and Angal S (1988) Protein purification methods, Ed. IRL Press at Oxford University press.

Reference Books:

1. Brondyk W. H. (2009) —Chapter 11 selecting an appropriate method for expressing a recombinant protein||. Methods in enzymology 463: 131-147.
2. Old RW and Primrose SB (1993) Principles of gene manipulation, an introduction to genetic engineering. Blackwell Scientific Publications.

Course Outcome: On completion of this course student will have improved ability:-

1. To perform cell disruption and the protein purification process and their applications. (PO1)
2. To understand the importance of cloning and gene transformation in bacteria and their applications in genetic engineering. (PO4)
3. To establish the animal cell culture and their benefits in DNA transfection and gene cloning. (PO1)
4. To gain the knowledge in the production of recombinant proteins in research. (PO2)
5. To know the characteristics of nucleic acids and applications of recombinant DNA proteins in the medicine, industry, agriculture and an environment. (PO5)



BIOPROCESS ENGINEERING

Sub Code	: MBT 21	CIE	: 50 Marks
Credit	: 3:1:0:0	SEE	: 50 Marks

Course coordinators: Mrs. Bhavya SG and Dr. Chandraprabha MN

UNIT-I

Bioprocessing Fundamentals:

Biotechnology and Bio-process engineering-Historical development of bioprocess technology-Difference in approaches by biologist and engineer-Introduction to Bioproducts- Bioprocess principles and operations-Outline of a bioprocess and the various unit operations involved in bioprocesses. Steps in bioprocess development-General material balance equation for steady state (for manufacture of penicillin and ethanol) - Generalized bioprocess flow sheets: example of penicillin/Bacitracin/ethanol. Bio-process regulatory constraints.

UNIT-II

Microbial growth and product formulation:

Quantification of cell concentration, Phases of cell growth in batch culture, growth associated and non-growth associated product formation kinetics, environmental factors affecting growth kinetics. Heat generation by microbial growth. Structured and unstructured models for microbial growth- Substrate limited growth-models with growth inhibitors- growth model for filamentous organisms. Microbial interaction in mixed cultures: Major classes of microbial interactions, microbial participation in the natural cycles of matter, Industrial utilization of mixed cultures in biological waste water treatment.

UNIT-III

Enzyme kinetics:

Specificities of enzyme catalysis-Mechanistic models for simple enzyme kinetics: Michaelis-Menten Equation and Briggs-Haldane Equation. Experimental determination of rate parameters for Michaelis-Menten type kinetics, models for inhibited enzyme kinetics. Effect of pH and Temperature, Immobilized enzyme systems: Methods of Immobilization, Diffusional limitations in immobilized enzyme systems. Industrial utilization of enzymes.

UNIT-IV

Fermentation Principles:

Fermentation Process-General requirements of fermentation Process; An overview of aerobic and anaerobic fermentation process and their application in industry. Media Design: Medium requirements for fermentation process-examples of simple and complex media; Design and usage of commercial media for industrial fermentations, Sterilization: Batch and continuous heat sterilization-sterilization of Liquid media, Filter sterilization of liquids. Thermal death kinetics. Bioreactors and their modes of operations.

UNIT-V

Development of sustainable Bioprocesses:

Modeling and Assessment in Process Development- Types of Bioprocess and Biocatalysts, Raw Materials for industrial bioprocess- Biologics and Biosimilars- Process and fermentation models for development of

processes for bioproducts and biopharmaceuticals –Sustainability assessment of Bioprocess. Process economics of bioproducts.

Text Books:

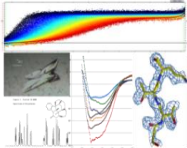
1. Pauline M Doran (2013) Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA.
2. Michael L Shuler & Fikret Kargi. (2008) Bioprocess Engineering: Basic Concepts., 2nd Edition, Prentice Hall of India, New Delhi.
3. Elmar Heinzle, Arno P. Biwer, Charles L. Cooney. (2006) Development of Sustainable Bioprocesses Modeling and Assessment, John Wiley & Sons Ltd.

Reference Books:

1. James E Bailey & David F Ollis. (1986) Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Book Co.-Singapore.
2. Tapobrata Panda. (2011) Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi.
3. Douglas S. Clark, Harvey W. Blanch. (1995) Biochemical Engineering, 2nd Edition, CRC Press.

Course Outcome: On completion of this course student will have improved ability to:-

1. Describe the steps in a catalytic mechanism and how one goes about deriving a rate law, mechanism, and rate-limiting step that are consistent with biological experimental data. (PO4)
2. Ability to understand the product formulation of microbial growth models. (PO5)
3. Ability to understand the chemical and physical transport processes and their mechanism in bioreactors. (PO5)
4. To apply the design procedures of process equipment used in biochemical process plants to design novel bioreactors. (PO1)
5. To apply and analyze metabolic engineering concepts for the development of sustainable bioprocess. (PO1, PO5)

	BIOANALYTICAL & BIOPHYSICAL TECHNIQUES			
	Sub Code	: MBT 22	CIE	: 50 Marks
	Credit	: 3:0:0:1	SEE	: 50 Marks

Course coordinators: Dr. Sravanti V and Dr. Ahalya N

UNIT-I

Sequencing and separation techniques: DNA sequencing- Principle & technique of Pyrosequencing, Introduction to Next generation sequencing. Protein sequencing: Edman degradation, Separation techniques: Capillary electrophoresis, 2D- Gel Electrophoresis, Chromatographic technique- High Performance Liquid Chromatography, Reverse Phase-HPLC. Centrifugation- Preparative centrifugation, Analytical Ultra centrifugation, Flow cytometry- Fluorescence activated cell sorting (FACs) and its applications.

UNIT-II

Spectroscopic techniques I: Nature of Electromagnetic radiation, Electromagnetic spectrum; Atomic energy levels, Molecular electronic energy levels- Translational, Vibrational, Rotational Electronic states; Principle and applications of Infrared Spectroscopy, Raman spectroscopy, UV-visible spectroscopy in biomolecular analysis. Fluorescence, Quenching, Quantum yield, Chromophore, Fluorophore, Principle, technique and applications of Fluorescence Resonance Energy Transfer (FRET) in biological systems.

UNIT- III

Spectroscopic techniques II: Polarization of light, Plane polarized vs Circularly polarized light, Optical rotation; Circular Dichroism, Principle and applications of CD for structural analysis. Principle and applications of Dynamic Light Scattering (DLS), Mass spectrometry- Ionization methods-EI, ESI, DI, MALDI; Mass analysis- Magnetic sector, Double-focus, Quadrupole, TOF analyzer, detection and quantitation of spectrum. Applications in Proteomics- Peptide Mass finger printing, Protein sequencing, and Post translational modification analysis.

UNIT-IV

Macromolecular structure determination: X-ray crystallography: protein crystal growth X-ray crystallography: protein crystal growth methods, X-ray diffraction; Bragg's law, single crystal techniques of data collection, Phase problem, Phase determination methods; Structure Refinement, structure validation- Ramachandran Plot. NMR spectroscopy, Nuclear spin states, Electronic spin behavior. Chemical shift & Shielding, Nuclear Magnetic Spectrometer, NMR- 1-D, 2-D, Nuclear Overhauser effect (NOE), COSY, NOESY. Structure, Function/applications of Green Fluorescent Protein (GFP) and Proteasome complex.

UNIT-V

Functional studies of biomolecules: Principle of Surface Plasmon Resonance (SPR) and its applications, Calorimetric application in binding studies-Isothermal Titration Calorimetry (ITC), Differential scanning calorimetry (DSC), Microarrays- DNA, Protein Microarray and their applications, Phage display, Yeast-two-hybrid (Y2H), Three-hybrid assay for identifying interaction partners for biomolecules.

Textbooks:

1. M. Daniel (2012), Basic Biophysics for Biologists, AgroBios
2. Keith Wilson & John Walker (2010), 7th Edition, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.

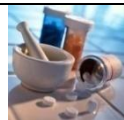
3. Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2006), Principles of Instrumental Analysis, Cengage Learning.
4. Donald L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan (2008), Spectroscopy, Cengage Learning.

Reference Books:

1. Roland Glaser (2004), Biophysics: An Introduction, Springer.
2. Cantor CR and Schimmel PR (1980) Biophysical Chemistry: Part I, The conformation of biological macromolecules.
3. Kensal Edward Van Holde, W. Curtis Johnson, Pui Shing Ho (2006), Principles of Physical Biochemistry. Pearson Printice Hall.

Course Outcome: On completion of this course student will have improved ability:

1. To analyze and chose appropriate analytical techniques to purify/separate biomolecules. (PO1, PO3, PO4)
2. To apply spectroscopic techniques to characterize biomolecules. (PO3, PO4)
3. To correlate structure-function relationships of macromolecules. (PO3)
4. To apply laws of physics, chemistry and computer science to instrumental techniques of analysis.(PO1, PO4, PO5)
5. To operate analytical instruments at research labs and industries. (PO1, PO5)



BIOPHARMACEUTICAL TECHNOLOGY

Sub Code	: MBT 23	CIE	: 50 Marks
Credit	: 3:1:0:0	SEE	: 50 Marks

Course coordinators: Dr. Lokesh KN and Dr. Dhamodhar

UNIT-I

Drug development process of protein based therapeutics: Transforming New Molecular Entities into Drugs, Differences between Development of Biotechnology Products of Macromolecules and Chemical Products, Current Trends in Drug Development, Drug designing: Rational, combinatorial and High Throughput screening.

UNIT-II

Immuno-pharmacology: Overview to immunopharmacology, Antibody-mediated response, Vaccines, Cell mediated immune response, Cancer immunotherapy, Immunosuppressant and immunostimulators.

UNIT-III

Biotherapeutics: Hematopoietic Growth Factors and Coagulation Factors, Interferon's and Cytokines for Anti-infective and Cancer Therapy, Hormones, Enzymes, Antibodies and Derivatives.

UNIT-IV

Nanotechnology for the delivery of proteins and nucleic acids based therapeutics: Introduction to Nanotechnology in drug deliver, Nano-sized Advanced Delivery Systems as Parenteral formulation Strategies for Hydrophobic Anti-cancer Drugs, Engineering of Amphiphilic Block Copolymers for Drug and Gene Delivery, Nanoemulsions for Intravenous Drug Delivery. Nanotechnology for Cancer Chemotherapy, Nanotechnology for Cancer Vaccine Delivery.

UNIT-V

Formulation of proteins and peptides: Making Small Protein Particles, Lyophilization, Multiphase Drug Delivery Systems, Protein Compaction, Self-Emulsifying Drug Delivery Systems, skin and parental drug delivery system.

Text books:

1. Christine M. Bladon (2002) Pharmaceutical Chemistry, *John Wiley & Sons, Ltd.*
2. Manfred E. Wolff (2000) Burger's Medicinal Chemistry and Drug Discovery (5th edition) A Wiley & Sons, Inc.
3. Grietje Molema and Dirk KF. Meije (2002) Drug Targeting Organ-Specific Strategies r. Wiley-VCH.
4. Melgardt M. de Villiers (2007) Nanotechnology in Drug Delivery, Springer.

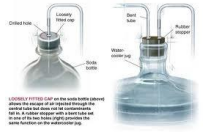
Reference Books:

1. Rodney JY, Milo Gibaldi (2003) Biotechnology and Biopharmaceuticals transforming proteins and genes into drugs, A John Wiley & Sons, Inc., Publication.
2. Gavin Brooks (1998) Biotechnology in Healthcare, An introduction to biopharmaceuticals, Pharmaceutical Press (London).
3. Shayne cox gad (2007) Handbook of pharmaceutical Biotechnology A John Wiley & Sons, Inc., Publication

4. Grietje Molema and Dirk KF (2002) Drug Targeting Organ-Specific Strategies by Meijer. Wiley-VCH.
5. Gary Walsh (2003) Biopharmaceuticals Biochemistry and Biotechnology, Wiley.

Course Outcome: On completion of this course student will have improved ability to

1. To Impart principle aspects of pharmaceutical biotechnology in research and development existing and novel biotherapeutic proteins. (PO1, PO5)
2. Understanding the pre-requisite basic information required to work in biopharmaceutical or clinical research organization (PO1, PO 4, PO 3)
3. Applying the knowledge of immunology in development of immuno-therapeutics and diagnostics. (PO1, PO3)
4. To apply the recent trends of nanotechnology in production, research- development of nano-medicines. (PO1, PO 3, PO 5)
5. Understanding of basic mode of protein based drug formulation and development by understanding the physico-chemical and pharmacological properties of drug (PO1, PO 2)

	PRACTICALS - III		
	Sub Code : MBTL24 Credits : 0:0:2:0	CIE : 50 Marks SEE : 50 Marks	

Course coordinators: Dr. Prabha M and Dr. Ravikumar Y S

LAB SESSIONS

LIST OF EXPERIMENTS:

1. Estimation of total oil content of seed
2. Determination of density and Viscosity of oil/biodiesel
3. Estimation of free fatty acids (Acid value) in oil / biodiesel
4. Determination of iodine value of the oil
5. Determination of Saponification value of oil
6. Production of Biodiesel by Conventional Transesterification
7. Cultivation of Oil-Producing algae
8. Production of biodiesel from algae
9. Production of bio-ethanol from various surceases
10. Micro propagation of oil yielding plants
11. Production and Estimation of citric acid
12. Estimation of Lycopene from tomato fruits
13. Estimation of Anthocyanin from leaf /callus tissue
14. Induction of Secondary metabolite –Anthocyanin/ catheranthin

Note: *At least any 12 experiments must be performed*

Text books

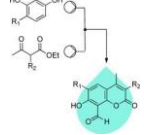
1. Rafael Luque Carol Lin Karen Wilson James Clark. (2016) Handbook of Biofuels Production 2nd Edition Woodhead Publishing.
2. D. Grierson & S.N. Covey Blackie. (1998) Plant Molecular biology Springer International Publishing, London.

References

1. Van Gerpen J, Shanks B, Pruszko R, Clements D, Knothe G (2004) Biodiesel production technology. National Renewable Energy Laboratory, NRRL/SR-510-36244
2. R.A. Dixon & Gonzales. (1995) Plant Cell Culture: A Practical Approach, IRL Press.
3. Doran, P. M. (2013) Bioprocess Engineering Principles, Academic Press.

Course Outcome: On completion of this course student will have improved ability:-

1. To learn the important properties of oils used in biodiesel production (PO1, PO 2, PO 4)
2. To understand the parameters of biodiesel production and its properties with applications (PO1, PO 2, PO 3, PO 4).
3. To apply the concepts of biotechnology to increase the yield of oils in plants and algae(PO1, PO 2, PO 4)
4. To analyze various feedstock for ethanol production(PO1, PO 2, PO 3, PO 4)
5. To quantify the phytochemicals from plant sources (PO1, PO 2, PO 3, PO 5)

	PRACTICALS - IV		
	Sub Code : MBTL25 Credits : 0:0:2:0	CIE : 50 Marks SEE : 50 Marks	

Course coordinators: Dr. Lokesh K N

LIST OF EXPERIMENTS:

- 1) Determination of minimum inhibitory concentration of given antibiotic.
- 2) LAL test for parenteral injection.
- 3) Bacteriological Test for Water for injection (WFI).
- 4) Standardization of herbal formulation.
- 5) Validation of Autoclave.
- 6) Lyophilization of protein based product.
- 7) Analysis of multicomponent formulation by spectroscopic method.
- 8) Tri- dot test for HIV
- 9) Determination of Partition coefficient of given formulation.
- 10) Determination of antioxidant activity of given formulation.
- 11) Extraction and isolation of Nutraceuticals from given sample.
- 12) ELISA techniques (Demo).
- 13) Preparation of controlled release formulation.
- 14) Preparation of liposome for drug delivery.

Note: At least any 12 experiments must be performed

Textbooks:

1. Industrial Pharmaceutical Biotechnology by Heinrich Klefenz, Wiley-VCH edition.,1995
2. Gary Walsh (1998) Biopharmaceuticals: Biochemistry and Biotechnology.

Reference Books:

1. Gregory Bock, Dalia Cohen, Jamie Goode, Novartis and J. Craig Venter (2001) From Genome to Therapy: Integrating New Technologies with Drug Development - No. 229.
2. Susanna Wu-Pong, Yongyut Rojanasakul, and Joseph Robinson (2006) Biopharmaceutical Drug Design and Development.
3. Herbert A Kirst, Wu-Kuang Yeh, Milton J (2001) Enzyme technologies for pharmaceutical and biotechnological applications

Course Outcome: On completion of this course student will have improved ability:-

1. Students will be capable to perform important quality control tests to validate quality of product. (PO1, PO 2, PO 3, PO 5)
2. Able to standardize the therapeutic compounds. (PO1, PO 3, PO 5)
3. Imply the knowledge of formulation of biopharmaceuticals to extent release of shelf life. (PO1, PO 3, PO 5)
4. Competent to work in Pharmaceutical /Clinical research organization. (PO1, PO 4, PO 5)
5. Improving the research aptitude of students by imparting the knowledge of nanotechnology and advanced drug delivery system (PO1, PO 2, PO 3, PO 4, PO 5)



BIOETHICS & INTELLECTUAL PROPERTY RIGHTS

Sub Code	: MBT 31	CIE	: 50 Marks
Credits	: 3:0:0:1	SEE	: 50 Marks

Course coordinator: Dr. Bindu S

UNIT-1

Introduction to Bioethics and Biosafety: definition and needs of Bioethics, Social and Ethical issues in biotechnology. Application of bioethics: the expanding scope of ethics from biomedical practice to biotechnology. Introduction to Biosafety: definition and needs of biosafety, levels of biosafety, applications of biosafety at work place, Biosafety during development of biotech products. Examples and case studies.

UNIT-2

Ethical Issues: Ethical issues regarding genetically modified organisms (foods and crops); bioethics in biodiversity and resource management. Animal cloning and human cloning and their ethical aspects. Testing of drugs on human volunteers, organ transplantation and ethical issues; Xenotransplantation and its ethical and social issues. Human Genome project.

UNIT-3

Biosafety regulations in transgenic research: National and international guidelines on rDNA technology. MOEF guidelines, Good laboratory practice, Good manufacturing practice and FDA regulations, Regulations for recombinant DNA research and manufacturing process, Public perception. National Institute of health (NIH) guidelines, guidelines for research in transgenic organisms.

UNIT-4

Introduction to IPR: IP definition and needs, GATT & WTO, Different forms of IPR – Copyrights, Trademarks, Industrial designs, Geographical Indications, Traditional Knowledge, Plant varieties, Trade Secrets. WIPO, TRIPS, Role of IPR in Research and Development.

Trademarks and copyrights: nature of trademarks and branding, tips on names for trademarks, acquiring trademarks protection, brand valuation, packaging and selling, increase the value of a technology through the use of trademark. Introduction and characteristics of copyrights and neighboring rights, performers and broadcasting organizations rights, transfer of copyrights.

UNIT-5

Patents: Introduction of Patents, patent as an intellectual property, Brief history of patents-Indian and global scenario, types of patents, patent life cycle, criteria for patenting, novelty, inventiveness, utility, patentable subject matter, inventions that are not patentable, term of patent, maintenance of a patent, granted patents Vs. patent publications.

Ideas: Generation and review of ideas, documenting ideas, literature scanning for possibility of IP rights, decision to go for IP protection or not, and consideration of choice of IP protection, disclosure, inventors interview, Process and Product Patents.

Textbooks:

1. Sateesh M.K (2008) Bioethics & Biosafety, IK Publishers.
2. Traynor PL (2000) Biosafety Management, Virginia Polytechnic Institute Publication.
3. Acharya N K (2007), Text book on Intellectual Property Rights, 4th Edn, Asia Law house.

Reference Books:

1. Sasson A (1993) Biotechnologies in developing countries present and future, UNESCO Publishers.
2. Rao MB (2003) WTO and International Trade, Vikas Publishing House Pvt. Ltd.
3. Erbisch FH and Maredia KM (2003) Intellectual Property Rights in Agricultural Biotechnology, Orient Longman Ltd.
4. Deborah E Bouchoux (2005) Intellectual Property Rights, Delmar Cengage learning
5. Thomas T Gordon and Arthur S Cookfair (1995), Patent Fundamentals for Scientists and Engineers, CRC Press.

Course Outcome: On completion of this course student will be

1. Capable of understanding biosafety practices (PO5).
2. Aware of the ethical issues relevant to Biotechnology (PO3).
3. Conversant with biosafety regulations (PO4).
4. Have thorough understanding of intellectual property rights (PO4).
5. Conversant with procedures used to protect intellectual property rights (PO5).



INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY

Sub Code : MBTE 01

CIE : 50 Marks

Credit : 4:0:0:0

SEE : 50 Marks

Course coordinators: Mrs. Bhavya SG and Dr. Chandraprabha MN

UNIT-I

Introduction to industrial biotechnology: An introduction to fermentation processes - the range of fermentation processes. Microorganisms used in industrial microbiological processes - the isolation, preservation, Screening for Productive Strains and Strain Improvement in Biotechnological Organisms – Manipulation of the genome of industrial organisms. Use of recombinant system for the improvement of industrial microorganisms, Media and materials required for industrial microbiological processes - sources, formulation, antifoams and optimization.

UNIT-II

Metabolic Pathways for the Biosynthesis of Industrial Products: The Nature of Metabolic Pathways, Industrial Microbiological Products as Primary and Secondary Metabolites, Trophophase-idiophase Relationships in the Production of Secondary Products, Role of Secondary Metabolites in the Physiology of Organisms, Pathways for the Synthesis of Primary and Secondary Metabolites of Industrial Importance. Carbon Pathways for the Formation of Some Industrial Products Derived from Primary Metabolism.

UNIT-III

Production of enzymes, organic acids and solvents: Carbon Pathways for the Formation of Some Products of Microbial Secondary Metabolism of Industrial Importance. Mechanisms Enabling Microorganisms to Avoid Overproduction of Primary Metabolic Products Through Enzyme Regulation, Derangement or Bypassing of Regulatory Mechanisms for the Over-production of Primary Metabolites, Regulation of Overproduction in Secondary Metabolites. Industrial products produced by microorganisms - Enzymes (amylase, proteases), organic acids (lactic acid, citric acid, vinegar), Ethyl alcohol.

UNIT-IV

Production of antibiotics and health care products: Mechanisms Enabling Microorganisms to Avoid Overproduction of Primary Metabolic Products Through Enzyme Regulation, Derangement or Bypassing of Regulatory Mechanisms for the Over-production of Primary Metabolites, Regulation of Overproduction in Secondary Metabolites - Production of important antibiotics - penicillin, Cephalosporins, streptomycin, erythromycin, bacitracin, Other beta-lactam antibiotics and tetracyclines. Production of Vitamins B12 & Baker's yeast production and hormones. Microbial transformation of Steroids and sterols. amino acids (L-lysine, L-glutamic acid) as food supplement.

UNIT-V

Environmental Biotechnology: Treatment of Wastes in Industry- Wastes from Major Industries, Systems for the Treatment of Wastes- Aerobic breakdown of raw waste waters, Treatment of the Sludge- Anaerobic Breakdown of Sludge. Hazardous waste management - Bioremediation, Biological detoxification- examples of biotechnological applications for hazardous waste management. Mining and Metal biotechnology, microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects.

Textbooks:

1. Nduka Okafor, Modern industrial microbiology and biotechnology (2007), Science publishers.

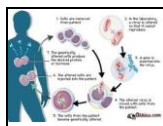
2. Prescott and Dunn, Industrial Microbiology (2002), AVI Publishing Company Inc.
3. Alan Scragg, Environmental Biotechnology (2005), oxford university press.

Reference Books:

1. Stanbury PE, Whitaker A, and Hall SJ (1999) Principles of Fermentation Technology by, Butterworth Heineman, Aditya Books (P) Ltd.
2. Wulf Crueger and Anneliese Crueger, (2002) A text book of Industrial Microbiology, Panima Publishing Corporation.

Course outcomes: Upon completion of this course, the students will be able to:

1. Describe the methods involved in isolation and screening of potential microorganisms for production of industrial bioproducts. (PO4, PO5)
2. Describe the steps involved in the production of bioproducts and methods to improve the biosynthesis of industrial products. (PO4, PO5)
3. Analyze the different metabolic pathways and its metabolism for the production of desired processes. (PO5)
4. Choose and manage appropriate mechanism of microbiological processes to produce microbiological products. (PO1, PO5)
5. Apply the principles of waste management to treat waste form the bioprocess industries. (PO1, PO5)



MEDICAL BIOTECHNOLOGY

Sub Code	: MBTE 02	CIE	: 50 Marks
Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. Prabha M and Dr. Lokesh KN

UNIT-I

Introduction scope and applications in Medical Biotechnology: Disease: bacterial, viral, fungal and parasitic. Investigation of epidemics. Methods of culturing and assaying: bacterial, viral and parasitic. Viral vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins. Future development and scope of vaccines.

UNIT-II

Hemopoietic Stem Cells: Haematopoietic stem cells differentiation, transdifferentiation and growth factors. Classification and manifestations of Hemopoietic stem cell disorders, aplastic Hemopoietic stem cell disorders, clinical applications of colony stems, complications of germ therapy, replacement therapy and bone marrow transplantation, immunological principles, preservation and clinical use of blood and blood components.

UNIT-III

Regenerative and nano medicine: Encapsulation technology and therapeutics- Diabetes, Hypothyroidism, Haemophilia Bioartificial organs, Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Nanomedicine – Nanoparticles, Nanodevices- medical microrobotics, nanorobotics, Microbiovers, Nanomedicine.

UNIT-IV

Molecular Diagnostics: Molecular techniques for analysis of these disorders; Biochemical disorders; Immune, Genetic and Neurological disorders; Assays for the Diagnosis of inherited diseases; Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis

UNIT-V

Gene and molecular therapeutics: General introduction, potential target diseases for gene therapy, gene transfer methods, and their applications, clinical studies, pharmaceutical production and regulation. Liposome and nanoparticles mediated gene delivery. Antisense technology, Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone.

Text Books:

1. Daan Crommelin, Robert D Sindelar and Bernd Meibohm (2007). Pharmaceutical Biotechnology and Fundamental Applications, 2nd edition. Informa Health care USA, Inc.
2. William Irving, Time Boswell and Dlawar Ala'Aldeen (2006) BIOS Instant notes in Medical Microbiology. BIOS Scientific Publication.
3. Sambamurthy K and Ashutosh Kar (2006) Text book of Pharmaceutical Biotechnology, Paperback 1st edn. New Age International.

Reference Books:

1. Judit Pongracz and Mary Keen (2009) Medical Biotechnology, Churchill Livingstone publication.
2. Albert Sasson (2006) Medical Biotechnology, Brookings Institution Press.
3. Bernhard O Palsson and Sangeeta N Bhatia (2003) Tissue Engineering, Pearson Prentice Hall.
4. Pamela Greenwell, Michelle McCulley. (2007) Molecular Therapeutics: 21st century medicine, 1st Edition.
5. Lela Buchingham and Maribeth L Flawsm. (2007) Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA.

Course Outcomes

1. To have the knowledge on disease causing microbes, diagnosis, prevention of diseases and treatment.(PO3)
2. To understand the benefit and scope of Hemopoietic stem cells used for the applications in transplantation for the treatment of cancer and other various diseases.(PO1)
3. To apply embryonic and adult stem cells for therapeutics, regenerative and nanomedicine. (PO1)
4. To analyze the molecular techniques for Biochemical, Immune, Genetic and Neurological disorders. (PO4)
5. To understand the clinical applications of molecular therapeutics and gene therapy for the treatment of genetic and other diseases with pharmaceutical production and regulation. (PO5)



BIOREACTION ENGINEERING

Sub Code	: MBTE 03	CIE	: 50 Marks
Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Mr. Gokulakrishnan and Mr. Samrat K

UNIT-I

Kinetics of Microbial Growth and Product Formation: Phases of cell growth in batch culture, simple unsaturated kinetic models for microbial growth, growth associated and non-growth associated product formation kinetics, Mono and Leudeking-piret models, Introduction to structured models for growth and product formation.

UNIT-II

Media Design and Sterilization for Fermentation Process: Medium requirements for fermentation process-examples of simple and complex media; Design and usage of commercial media for industrial fermentations, Thermal death kinetics of microorganisms, Batch and continuous heat-sterilization of Liquid media, Filter sterilization of liquids

UNIT-III

Transport Phenomena in Bioreactors: Mass transfer in heterogeneous biochemical reaction systems, Oxygen transfer in submerged fermentation process, Oxygen uptake rate and determination of oxygen transfer coefficients (k_{La}), role of aeration and agitation in oxygen transfer, Heat transfer process in biological systems

UNIT-IV

Mechanical Design of Bioreactors and Ancillary Equipments: Basic design and construction of fermenters and its ancillaries; Material of construction, Vessel geometry, Bearing assemblies, Motor drives, Aseptic seals, Flow measuring devices, Valves, Agitator and Spurges Design, Sensor.

UNIT-V

Process Design and Operation Bioreactors: Operational models of reactors, Batch continuous, Fed Batch, repetitive batch, recycle and continuous cultivation, novel bioreactors, stirred tank, Air lift and loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; Scale-up of bioreactors, SSF bioreactors.

Text Books:


1. Bailey and Ollis (2010): Biochemical Engineering Fundamentals, McGraw Hill (2nd Ed)
2. Schuler M L and Kargi F (2002) Bioprocess Engineering- Basic concepts, 2nd Edition , Prentice Hall
3. Levenspiel O (2006) Chemical reaction Engineering, 3rd ed., John Wiley.

Reference Books:

1. Ghose TK (Ed)(1994) Process computation in Biotechnology Tata Mc-Craw Hill.
2. Athinson B and Maviuna F (1993) Biochemical Engg. And Biotechnology Handbook, Mc-Graw hill (2nd Edition)
3. Pauline M. Doran (2009): Bioprocess Engineering Principles, Reed Elsevier India.
4. HC Vogel, Noyes. (1996) Fermentation & Biochemical Engineering Hand book, Elsevier.

Course Outcome: On completion of this course student will have improved ability:-

1. Describe the algorithm that allows the student to solve chemical reaction engineering problems through logic rather than memorization. (PO1, 4)
2. Size isothermal and non-isothermal reactors for homogeneous and heterogeneous reactions. (PO3, 5)
3. Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors to determine selectivity and yield. (PO1, 3,4)
4. Analyze the various parameters for bioreactor design. (PO1, 4)
5. Analyze different reactors for bioprocess operations. (PO3, 4)

	TOXICOLOGY AND FORENSIC SCIENCE			
	Sub Code	: MBTE 04	CIE	: 50 Marks
Credit	: 4:0:0:0	SEE	: 50 Marks	

Course coordinators: Dr. Ravikumar YS and Dr. Sharath R

Unit-I

Introduction to toxicology: History and scope of toxicology, Source of toxicants. Classification of toxic agents. Occupational toxicology: Workplace, hazardous exposure, and occupational diseases. Mechanism of toxicity: Toxicant delivery, reaction with the target molecule, cellular dysfunction, inappropriate repair and adaptation. Non target organ toxicity: Chemical carcinogenesis mechanisms of carcinogens. Genetic toxicology mechanisms of genetic alterations. *Teratology:* teratogens, teratogenesis. Cytotoxicity mechanisms of cell death mitochondrial dysfunction,

Unit-II

Target organ toxicity and metabolism of toxicants: Toxic effects on liver, kidney, nervous, endocrine, respiratory, immune and reproductive systems. Metabolism of toxicants: Phase I Reactions: Microsomal oxidation Nonmicrosomal oxidations Reduction Reactions, Hydrolysis, Epoxide Hydration. cooxidation. Phase II Reactions: Conjugation reactions, Methyltransferases and Acylation. Reactive Metabolites: nature, stability and fate of reactive metabolites, Elimination of Toxicants: renal, hepatic and respiratory elimination

Unit-III

Toxicology Testing: Food toxicology: introduction, safety standards for foods and food ingredients and contaminants. *In Vivo* Toxicology: Testing of acute, subchronic and chronic toxicity. *In Vitro testing:* Cell Culture Methods, Ames forward mutation assay, Assessing genotoxicity: mitotic index, chromosomal aberrations, micronucleus assay, cytotoxicity and apoptosis assay. Neurotoxicity testing.

Unit-IV

Introduction to Forensic science: Introduction, Definition and Scope, History and Development of Forensic science, basic Principles of Forensic Science. Organization of crime Laboratory services, services provided by full service crime laboratories, Physical Science unit, Biological Unit, Firearms Unit, Documentation Examination Unit- Function and Duties Performed by each unit and lab. The Crime Scene investigation- Making and recording observations (including sketches with measurements and digital photographs), Chain of Custody, Locard Exchange principle, Evidences and Collection techniques, Firearms, Marks and impressions, Drug of abuse. Ploygraphy. Computer Forensics.

Unit-V

Forensic Biology: Forensic Pathology: Rigor mortis, Lovor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Forensics Engineering, forensic serology, DNA Analysis, Dactyloscopy, Finger prints: history, fundamental principle of Fingerprints, Classification and patterns, AFIS, Mrthod of Detecting fingerprint. Trace evidence and contact evidence- targeting potential traces, recovery of trace material assessment of significance- Hair, fiber and Paint.

Textbooks:

1. Barile FA (2008) principles of toxicology testing CRC Press is an imprint of the Taylor & Francis Group New York

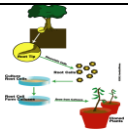
2. Hodgson E (2004) A Textbook of Modern Toxicology Third edition John Wiley & Sons, Inc., publication
3. Curtis D. Klaassen (2001) Casarett and Doull's Toxicology The Basic Science Of Poisons Sixth Edition Mcgraw-Hill publishers New Delhi

Reference books

1. Osweiler G D (1996) Toxicology, Wiley-Blackwell Publisher,
2. Marquardt H (1999) Toxicology, Academic Press
3. Derelanko M J (2002) Handbook of toxicology, CRC Press,

Course Outcome: On completion of this course student will have improved ability:-

1. To describe the general toxicology principles, chemical basis of toxicity carcinogenesis and genotoxicity (PO3 & PO4)
2. To recognize that toxic outcomes result from interaction between the toxic substance and the metabolic machinery of the organ and identify the damage process, action and metabolism of toxic chemicals. (PO3 & PO4)
3. To describe how toxic chemicals are tested and regulated. (PO1, PO4 & PO5)
4. To describe the historical development of the forensic sciences and Demonstrate the crime scenes, physical evidence and organization of forensic laboratory. (PO3 & PO4)
5. To develop skills in the basic scientific method and the use of problem-solving within the field of forensic science. (PO1, PO2, PO4 & PO5)

	PLANT BIOTECHNOLOGY			
	Sub Code Credit	: MBTE 05 : 4:0:0:0	CIE SEE	: 50 Marks : 50 Marks

Course coordinators: Dr. Sharath R

UNIT-I

Introduction: Introduction and historical developments and applications of Plant tissue and cell culture. Laboratory Design and Developments. Instrumentation. Sterilization techniques, Plant Tissue Culture Media, Cellular totipotency, Factors affecting Tissue Culture success: (Media explant, light, Temperature, Polarity, Subculture, Genotype, Season), Hormones.

UNIT-II

Plant Tissue and cell culture: Micropropagation, organ culture, Establishing callus and cell culture, Dynamics of callus growth, callus subculture and maintenance, organogenesis. Embryogenesis, variant selection, Somaclonal variation, cell suspension culture, Somatic embryogenesis in plant. Protoplast isolation and culture. Acclimatization of micro propagated plant. Primary and secondary metabolic products (Phytochemicals) of plant cells, Biosynthesis of secondary metabolites of biotechnological importance.

UNIT-III

Genetic Engineering in Plants: Structure and organization of plant genome, regulation of plant genome expression, transcriptional, translational regulation of plant genome. Transposons, Transfer of DNA to plant cells- Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector Theory and techniques for the development of new genetic traits, conferring resistance to herbicide, pesticide, plant pathogens.

UNIT-IV

Methods in Plant Biotechnology: Amplification of DNAs by Polymerase Chain Reaction (PCR). Gene transfer technology Vectors, Gene transfer using Particles Bombardment, Microinjection method, Marker assisted selection (RAPD, RFLP, AFLP, SNP's etc.). Methods for crop improvement.

UNIT-V

Application of Plant Biotechnology: Herbicide resistance, disease resistance, novel proteins, vaccines, antibodies and antigens. Immobilized cell systems and Biotransformation. Plant Genome Project: Rice genome project. Hairy root culture and its importance.

Text Books

1. Singh BD (2014) Biotechnology- Expanding Horizons. Kalyani Publishers, Rajindernagar, Ludhiana.
2. Reinert J and Bajaj YPS (2013) Applied and Fundamental aspects of Plant Cell, Tissue and organ Culture. Springer Verlag, Berlin.
3. Narayanaswamy S (2008) Plant Cell and Tissue Culture. Tata McGraw Hill, New Delhi.
4. Sathyanarayana B. N. and Varghese, D.B. (2007) Plant Tissue Culture: Practices and New Experimental Protocols. I. K. International Pvt Ltd.

References:

1. Bengochea T and Doods JH (2012) Plant Protoplasts: A Biotechnological Tool for Plant Improvement. Chapman and Hall. London.
2. Gamborg OL and GC Phillips (2013) Plant Cell, Tissue and organ culture. Narosa Publishing House, New Delhi.
3. Razdan MK (2003) An Introduction to Plant Tissue Culture, Oxfords & IBH Pub. Co, Pvt., Ltd., New Delhi
4. Bhojwani SS and Razdan MK (2003) Plant Tissue Culture: Theory and Practice, a revised edition. Elsevier Publication.
5. Dodds JH and Roberts LW (1995) Experiments in plant Tissue Culture. Cambridge University Press, Cambridge.

Course Outcome: On completion of this course student will have improved ability:

1. Able to understand the concept of plant tissue culture its importance (PO-3,5)
2. Able to formulate the media, Optimization and design of experiments for development of new bioprocess protocols (PO-2,3,4)
3. Able to discuss the significance of plant tissue culture to the nursery and agricultural crop industries (PO-2,3,4,5)
4. Identify and apply basic plant growth theories to plant tissue culture techniques (PO-3,4,5)
5. Able to understand plant biotechnology used for plant improvement and discuss the ethical implications of that use (PO-3,4,5)

	EXPERIMENTAL DESIGN			
	Sub Code	: MBTE 06	CIE	: 50 Marks
	Credits	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. S H C V Subba Bhatta

UNIT-I

Random variables — discrete and continuous, Mathematical expectation and its laws, Moments, coefficient of skewness and kurtosis

Probability distributions — Bernoulli/Binomial, Poisson, Geometric, Normal Joint probability distributions for discrete and continuous random variables, conditional expectation, stochastic independence

UNIT-II

Correlation, Regression analysis, Partial and multiple correlation and regression, Regression diagnostics - residuals, multicollinearity, testing adequacy of fit and validation in regression analysis; Sampling distribution of correlation and regression coefficients; Testing of hypothesis: z – test, t-test, Chi-square test and F-test

UNIT-III

Concept of analysis of variance (ANOVA) for one-way and multi-classified experiments; Multiple Mean Comparison, Pair wise Contrasts, Type of Models (Fixed or Random), Incomplete Blocks/Missing data Fisher's principles, Basics of designing an experiment

Completely Randomized Design (CRD), Principles and Usage, Randomization, Data Analysis/Model (one-way ANOVA), Advantages/Disadvantages, Ideal Conditions

Randomized Complete Block Design (RCBD), Data Analysis, Advantages and disadvantages, Comparison with CRD

UNIT-IV

Latin Square Design, Construction and arrangement, Analysis, Relative efficiency of LSD over CRD and RCBD

Graeco Latin Square Design: Construction and arrangement, data analysis

Factorial Experiments: 2^2 and 2^3 Designs, the general 2^k Design, Methods to find the factorial effects, Yate's algorithm of computing factorial effects

UNIT-V

Blocking and confounding, Blocking a 2^k factorial design, Confounding in 2^k factorial design, Partial and Complete Confounding

Two level fractional factorial designs, One half fraction of the 2^k design, One quarter fraction of the 2^k design, Plackett- Burman design

Analysis of Covariance (ANCOVA), Assumptions and Model for ANCOVA, Statistical analysis

Test books:

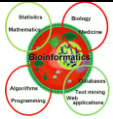
1. Douglas C. Montgomery (2009) Design and Analysis of Experiments, 7th Edition, Wiley publication.
2. Misra BL (2005) Design & Analysis of Experiments for Agricultural Workers, 1st Ed, Kalyan Pub.

Reference Books:

1. Steel & Torrie (1980) Principles and Procedures of Statistics A Biometrical Approach, McGraw-Hill Publication.
2. Kuehl (2000) Design of Experiments: Statistical Principles of Research Design and Analysis. Duxbury press.

Course Outcome: On completion of this course student will have improved ability to:-

1. Identify the random variables and use standard discrete and continuous probability distributions. (PO-4)
2. Perform test of hypothesis for a given data using parametric and nonparametric tests. (PO-4)
3. Apply one way and two way ANOVA for CRD and RCBD. (PO-4,5)
4. Apply three way and four way ANOVA for Latin Squares and Graeco Latin Squares and construct a factorial experiment. (PO-4,5)
5. Apply Blocking and construct fractional factorial design. (PO-4,5)

	APPLIED BIOINFORMATICS			
	Sub Code	: MBTE 07	CIE	: 50 Marks
	Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. Sharath R and Mr. Krishna Murthy T P

UNIT-I

Elementary algorithmics: Introduction, Prediction algorithms; Asymptotic Notations, Efficiency of Algorithms, BLAST algorithm, Ktup identification, PSSM, Progressive alignment procedure, Dynamic Programming: UPGMA method, Nighbour Joining method, Randomized algorithm.

UNIT-II

Database Warehousing in bioinformatics: Data, transforming data into knowledge, data warehousing and architecture, data quality. Data mining for bioinformatics: Biomedical data analysis, DNA data analysis, protein data analysis, machine learning in bioinformatics: Artificial neural networks, neural network architectures and applications, genetic algorithms, fuzzy systems.

UNIT-III

Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics, SNP arrays, EST database. Rearrangement of genes.

UNIT-IV

Molecular modeling and simulations: Macro-molecular force fields, salvation, long-range forces, Geometry optimization algorithms: Steepest descent, conjugate gradient Various simulation techniques: Molecular Dynamics, Monte Carlo, docking strategies etc.. Molecular mechanics, conformational searches. **Drug design:** Drug discovery process, Role of Bioinformatics in drug design, Target identification and validation, lead optimization and validation, Structure-based drug design and ligand based drug design, Modeling of target-small molecule interactions.

UNIT-V

DNA microarray: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches). DNA microarray database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases.

Text Books:

1. Yi-Ping Phoebe Chen (2005) Bioinformatics Technologies, Springer International Edition
2. Shui Quing Ye (2007) Bioinformatics A Practical Approach, Chapman and Hall/CRC,
3. Mathematical and Computational Biology Series.

Reference Books:

1. Andreas D. Baxevanis (2002) Bioinformatics – A practical guide to the analysis of genes and proteins, 2nd John Wiley & Sons.
2. David W Mount (2005) Bioinformatics Sequence & Genome Analysis, 2nd CBS Publishers & Distributors

3. Jin Xiong (2005) Essential of Bioinformatics, 2nd edition, John Wiley & Sons.
4. Benson G and Page R (2003) Algorithms in bioinformatics; Springer.
5. Basu O and SK Thukral SK (2007) Bioinformatics: Databases, tools and algorithms; Oxford Press.
6. Clote P and Backofen R (2000) Computational molecular biology: an introduction. Wiley & Sons.

Course Outcome: On completion of this course student will have improved ability:-

1. Student can get the knowledge of using bioinformatics online tools, free softwares and servers to uncover the diversity of life revealed in genomes and explore the genomic origins of life. (PO-1,3,4)
2. Get the knowledge of using high-throughput methods to characterize cellular roles for proteins, utilization of structural information to discern how proteins work and incorporate structural methods to develop better drugs. (PO-1,3,5)
3. Apply *in silico* and *in vivo* methods to comprehend whole proteome interactions and evaluate methods for quantifying and comparing proteomes. (PO-1,2,3,4)
4. Get hands on experience of using online tools to analyze genome sequences.(PO-5,4)
5. Ability to write computer programs in various programming techniques to analyze bioinformatics data. (PO-1,3,4,5)



ADVANCED RESEARCH METHODOLOGY

Sub Code	: MBTE 08	CIE	: 50 Marks
Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. Sravanti V and Mr. Krishna Murthy T P

UNIT-I

Introduction to Research Methodology: definition and objectives. Types of research: descriptive research, experimental method of research, inter and multi disciplinary research. Design of research: basic principles of experimental designs, features of good research design, types of designs. Literature search & formulation of research project.

UNIT-II

Different techniques of research: observation, the interview, the questionnaire & the case study method. Survey methods and sampling techniques: sampling design, random sample and complex random sample design. Data collection: collection of primary and secondary data.

UNIT-III

Basic statistical methods, concepts and techniques: Processing and analysis of data-types of analysis, measure of dispersion; Correlation: Simple, partial and multiple correlations. Regression: linear and non liner regression.

UNIT-IV

Research report/paper writing: types of reports, steps in report writing, meaning and techniques of interpretations. Dissertation/ Thesis writing: Introduction, review of literature, materials and methods, experimental results, discussion/ interpretation of results in the light of earlier research findings, summary and bibliography.

UNIT-V

Computers – its application in research: Computer Skills: Spread sheet and DBMS. Graphics-histograms, line diagrams, bar diagrams and Pie charts. Statistical analysis using computer packages: Design Expert/Statistica /Minitab software's, SPSS

Text Books:

1. Debbie Holmes, Peter Moody, and Diana Dines (2006) Research Methods for the Biosciences, 2nd Edition, Oxford University Press.
2. Oxford University Press Inc., New York.
3. Kothari, C.R. (2002) Research Methodology, 7th Print, 2nd Edition, New Age International, Bangalore.

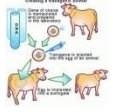
Reference Books:

1. Suresh C. Sinha and Anil K. Dhiman (2002) Research Methodology, 2 volumes, Ess. Ess. Publishers, New Delhi,
2. Kumar (2008) Research Methodology, 7th Edn, Lakshmi Narayan Agarwal, Agra, India
3. Panneerselvam, R. (2004) Research Methodology, 1st Edition, Prentice-Hall of India Pvt. Ltd., New Delhi.

Course Outcome: On completion of this course student will have improved ability:-

1. To apply various methods of literature survey and formulate research project. (PO1, PO2, PO3)
2. To analyze various sampling and data collection methodologies in research. (PO1, PO3, PO5)
3. To design and execute experiments according to research goal. (PO1, PO3, PO4)

4. To apply statistical methods of analysis for evaluation of data. (PO3, PO4, PO5)
5. To report the research work in a comprehensive thesis. (PO1, PO2)

	APPLIED ANIMAL BIOTECHNOLOGY			
	Sub Code	: MBTE 09	CIE	: 50 Marks
	Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. Ravikumar YS and Dr. Sharath R

Unit-I

Animal Tissue culture and Hybridoma Technology: Cell culture media and preparations. Cell culture techniques: Monolayer and suspension culture, cell lines, organ culture- techniques, three dimensional culture. Somatic cell fusion and its applications (cybrids, membrane fluid mobility and hybridoma technology). Cryopreservation and storage of animal cells. Primary and immortalized cells, Cell transformation and malignancy.

Unit-II

Advanced cell culture techniques and application of cultured cells

Microscopic techniques: light, electron microscopic, fluorescent and phase contrast microscopic studies. cell culture and viability, Cell Synchronization and cell cycle Analysis (mitotic and flow cytometry). Gene transformation: Transfection, electroporation and liposome). Immuno-techniques IFA (membrane, cytoplasmic and nuclear proteins) Detection of contamination in cell culture.

Unit-III

Artificial animal Breeding and Transgenic Technology: Artificial insemination, Transplantation, *in vitro* fertilization and embryo transfer, Advantages of cell manipulation, Nuclear transplantation and cell cloning, selective animal breeding and their potential. Production and uses of transgenic animals. Animals as a bioreactor for production various chemicals. Application of functional genomics and discovery of new genes, animal welfare and human health

Unit-IV

Stem cells and its application: Source and isolation of stem cells, Embryonic and adult stem cells, culture and maintenance of stem cells. Generation and manipulation of mouse and human embryonic stem cells. Germ Cell Development: Epigenesis and Reprogramming of adult-stem cells. Molecular mechanisms of self-renewal and differentiation, pluri/multi potency and lineage differentiation. Bone transplant and reconstitution of hematopoietic system. Stem cells and therapeutics. Novel sources of multipotent stem cells. Science policies and Ethics in Stem Cell Research

Unit-V

Applications of Animal Biotechnology: Animal improvement: diary, fishery and poultry). Medicine: diagnosis of diseases, detection of genetic disorders. Treatment: vaccines, gene and cell therapy, tissue transplantations. Production of pharmaceutical chemicals, interferons, interleukins, stem cell factors and hormones. Industrial applications: metabolites production, bio control agents, industrially important enzymes. Drug testing and evaluation.

Text books:

1. Freshney RI (2005) Culture of Animal Cells, 5th Edn, Wiley-Liss.
2. Spier RE and Griffiths JB (1988) Animal Cell Biotechnology, Academic Press.
3. Clynes (1998) Animal Cell Culture Techniques, 1st Edn, Springer.

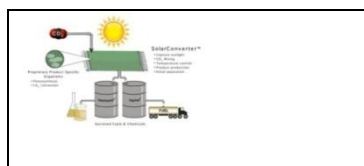
Reference Books:

1. Channarayappa (2006) *Molecular Biotechnology: Principles and Practices*. University Press (India) Pvt. Ltd., Worldwide CRC Press.
2. Channarayappa (2010) *Cell Biology: Universities Press (India) Pvt Ltd*.
2. John RW, Masters, (2000) *Animal Cell Culture: Practical Approach*, 3rdEdn, Oxford.
3. Murray Moo-Young (1989) *Animal Biotechnology*, Pergamon Press, Oxford.
4. Doyle A, Hay R, and Kirsop BE (1990) *Living Resources for Biotechnology, Animal cells*, Cambridge University Press

Course Outcome:

On completion of this course student will have improved ability:-

1. To understand the basic nutritional requirements of animal cell and different types of cell culture techniques (PO-3,4)
2. Appraise the novel and advanced cell culture techniques used in cell culture. (PO-2,3,4)
3. To impart knowledge on artificial breeding and production of transgenic animals (PO-3,4)
4. To explain isolation and culturing of stem cells and their application in biomedical field. (PO-2,3,4)
5. To describe applications of cell culture, transgenic and stem cell culture techniques in the field of modern life science. (PO-4 ,5)



BIOTECHNOLOGY OF ALTERNATIVE FUELS

Sub Code	: MBTE 10	CIE	: 50 Marks
Credit	: 3:0:0:1	SEE	: 50 Marks

Course coordinators: Dr. Ahalya N and Mr. Samrat K

UNIT-I

Introduction to energy, sources of energy, renewable energy. Non-renewable energy resources. Alternative biofuels, bio-diesel. List of vegetable oils, biodiesel from vegetable oils and animal fats. Production of biodiesel. Biofuel plants and their design.

UNIT-II

General aspects of trans-esterification. Factors influencing the transesterification Biodiesel fuel properties. Characteristics of efficient biodiesel. Glycerol - biodiesel by-product. Biodiesel and the environment. Biodiesel standards. Biofuel policy. Biofuel and biodiesel in India and Biodiesel around the world.

UNIT-III

Design and development of biofuel production unit. Assessing effect of variation of injection pressure on performance and exhaust emission of C.I. engine using biodiesel, combustion enrichment and emission reduction of biodiesel using exhaust gas recirculation and fuel conditioning,

UNIT-IV

Effect of air preheating influence on performance and emission characteristics of di diesel engine using *Jatropha curcas*, coconut oil, pongamia (karanj) oil, karanji seed (*Pongamia glabra*) oil-diesel, esterified mahua oil, tree borne seed oils-engine, diesel-vegetable oil blends and pungam methyl ester. Ricardo variable compression engine.

UNIT-V

Emission testing of diesel engine on B20 biodiesel blend as per EMA durability test/nitin, Environmental effects of biodiesel-exhaust emission, establishing auto-gasification of coir pith using thermo gravimetric analysis. Calculate the biofuel cost benefit ratios for various biofuels.

Textbooks:

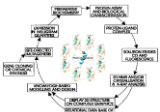
1. Meena Devi GS and Nagendra Prasad (2007) Fuels & Biofuels, Vijayalakshmi Agrobios India
2. Poonia MP and Mehla SK (2008) Biofuels Engine Performance & Exhaust Emissions, Pointer Pub, India

Reference Books:

1. Ahindra Nag (2007) Biofuels Refining and Performance, McGraw-Hill Professional, India
2. Ayhan Demirbas (2008) Biofuels: Securing the Planets Future Energy Needs (Green Energy and Technology), Springer, Netherland

Outcome of the course: The students will be able to

1. Identify the biofuel source to use as an alternative energy to fossil fuel (PO1).
2. Standardize the process to convert raw material into biodiesel (PO4).
3. Standardize the designs and improve the biodiesel production efficiency at industrial scale (PO4).
4. Evaluate different biodiesel sources for various parameters to meet the national and international standards and work out economic feasibility of different energy sources (PO5).
5. Testing the biodiesel for different engines as per EMA standards. (PO5)

	PROTEIN ENGINEERING AND INDUSTRIAL APPLICATIONS			
	Sub Code	: MBTE 11	CIE	: 50 Marks
	Credit	: 4:0:0:0	SEE	: 50 Marks

Course coordinators: Dr. Prabha M

Unit-I

Outline and Characterization for Protein engineering - Definition, applications; Features or characteristics of protein that can be engineered (definition and methods of study)-affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities etc. Forces stabilizing proteins - Van der Waals, electrostatic; hydrogen bonding weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation;

Unit-II

Experimental methods of Protein engineering and Protein design: Outline of bioengineering of macromolecules a multidisciplinary approach; Methods to alter primary structure of protein: Examples of engineered proteins, protein design, principles and examples. Steps involved in protein engineering and protein modeling to the desired needs. Site directed mutagenesis; by the rational design method. Module shuffling; Guided protein recombination etc., Optimization and high throughput screening methodologies like Giga Matrix, High throughput microplate screens etc., Protein Engineering for Biosensors.

Unit-III

Control of Protein Function: Mechanisms of Regulation, Protein Interaction Domains, regulation by Location, Effector Ligands: Competitive Binding and Cooperativity, Conformational Change and Allostery, Protein Switches Based on Nucleotide Hydrolysis, GTPase Switches: Small signaling G Proteins, Signal Relay by Heterotrimeric GTPases, Protein Synthesis, Motor Protein Switches, Regulation by Degradation, Control of Protein Function by Phosphorylation, Regulation of Signaling Protein Kinases: Activation Mechanism, Cdk Activation, Protein trafficking.

Unit-IV

Making of proteins and Health care: Native and fusion proteins, Yeast expression systems, The baculovirus expression system, Mammalian cell lines. Creation of Hybrid proteins: StEP and ITGHy method. Improving enzymes: Oxidation-resistant variants of α 1-antitrypsin (AAT). Enhanced Recovery and Folding of Recombinant Proteins Using Fusion Protein Strategies. Protein Engineering for Affinity Purification: The Strep-tag Protein Engineering in Vaccine Development. Expression and Use of Tagged Cell Surface Receptors for Drug Discovery: Estrogen Receptor as a Target for New Drug Discovery.

Unit-V

Protein Biocatalysis and Enzyme engineering: Random and rational approach of protein engineering; Directed evolution and its applications in the field of biocatalysis; Various approaches of creating variant enzyme molecules; Future of biocatalysis; Ideal Biocatalyst. Stabilization of Industrial Enzymes by Protein Engineering Engineering β -Glycoside Hydrolases. Biocatalysis for the synthesis of some chiral pharmaceutical intermediates such as synthesis of ACE inhibitors; Synthesis of anti-cholesterol drugs by biocatalytic routes; Calcium channel blocking drugs; Potassium channel openers; Anti-psychotic compounds; Anti-infective drugs; Anti-inflammatory drugs; Antiviral agents.

Text Books

1. Edited by T.E. Creighton (1997) Protein structure: A practical approach, 2nd Edition, Oxford University Press.
2. Cleland and Craik (1998) Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.


Reference Books

1. Mueller and Arndt. (2006) Protein Engineering protocols, 1st Edition, Humana Press.
2. Ed. Robertson DE, Noel JP (2004) Protein Engineering Methods in Enzymology, 388 Elsevier Academic Press.
3. J Kyte, Structure in protein chemistry, 2nd Edition, Garland publishers, 2006.
4. Lilia Alberghina (200) Protein engineering in industrial Biotechnology, CRC Press
5. Graham Ramsay (1998) Commercial Biosensors, John Wiley Publishers.

Course Outcomes:

On completion of this course student will have improved ability to:

1. Analyze the fundamental characteristics of protein that can be engineered. (PO-3)
2. Identify the different approaches to construct and design the proteins. (PO-2)
3. Learn to understand the regulation mechanisms of proteins to alter and modify their function. (PO-4)
4. Appraise the protein manipulation strategies for creativity in Healthcare. (PO-4)
5. Apply the scope and benefits of protein engineering in therapeutics and as biocatalysts for industries. (PO-5)

	BIOREACTOR TECHNOLOGY	
	Sub Code: MBTE13 Credits : 4:0:0:0	CIE: 50 Marks SIE : 50 Marks

Course Coordinator: Dr. Chandrababha MN and Mr. Krishna Murthy TP

Unit-I

Introduction:

Overview of biological reactions and bioproducts. Purpose and importance of bioreactors in bioprocess industries, Requirements for a bioreactor, Development of bioreactors, classification of bioreactors. Elements in bioreactor design. Major components of bioreactor and their purpose, Basics of energy transfer and mass balance. Biochemical engineering aspects of bioreactors. Bioreactor configurations-Classification of bioreactors based on application: Microbial Process, Mammalian cell culture, plant cell culture, immobilized catalyst, environmental applications.

Unit-II

Bioreactors for Submerged Liquid Fermentation (SLF)

Batch Bioreactors, Continuous Flow Bioreactors, Semi-Continuous Bioreactors, Recycle Bioreactors, Combination of Bioreactors-Bioreactors for enzyme reactions and Immobilized Cells-Rheological properties of fermentation broths-Mixing in bioreactors- Gas liquid hydrodynamics- Heat transfer process in SLF, Mass transfer in SLF-Molecular diffusion, Oxygen uptake and solubility. Role of aeration and agitation SLF bioreactors. Case studies of SLF in bioproducts production.

Unit-III

Bioreactors for Solid State Fermentation (SSF):

General Considerations about Solid-state Fermentation Processes- Factors Affecting Solid-state Fermentation- Aerobic and anaerobic Solid State Fermentation- Kinetics in Solid-state Fermentation- Water Relations in Solid-state Fermentation- Heat and Mass Transfer in Solid-State Fermentation Bioreactors- Aspects of Design of Bioreactors in SSF- Scale-up Challenge for SSF Bioreactors- Groups of SSF Bioreactors: Un-aerated and Unmixed, Forcefully-Aerated Bioreactors Without Mixing, Rotating-Drum and Stirred-Drum Bioreactors, Continuously-Mixed, Forcefully-Aerated Bioreactors, Intermittently-Mixed Forcefully-Aerated Bioreactors, Continuous Solid-State Fermentation Bioreactors. Instrumentation and Controls in SSF-Case studies.

Unit-IV

Bioreactors for Cell Culture Technology:

An Overview of Cell Culture Technology and its application importance in biopharmaceutical industries. Cell Culture Bioreactors, Aeration, Mixing and Hydrodynamics in Cell culture Bioreactors. Instrumentation and Process Control. Perfusion bioreactors, hollow fiber bioreactors. Disposable/ Single-Use Bioreactors for mammalian cells. Bioreactors for Immobilized biocatalysts. Fed-Batch Cultivation of Mammalian Cells. Bioreactor systems for tissue engineering. Design of Bioreactors for Plant Cell and Organ Cultures. Bioreactors for bioartificial Organs. Plant Bioreactor for Bioactives. Production of Biomass and Bioactive Compounds Using Bioreactor Technology.

UNIT-V

Membrane Bioreactors (MBR):

Principle of MBR, Brief History of MBR Technology-Comparison of CAS and MBR Processes-Operational Condition and Performance of MBR- Direction in Research and Development (R&D) of MBR-Biological Wastewater Treatment-Microbial Stoichiometry and kinetics in MBR-Membranes, Modules, and Cassettes-Membrane Fouling-MBR Operation: Operation Parameters, Aeration for Biotreatment and Membrane Aeration- Design of MBR. Bioreactors for waste gas treatment. Case studies.

Text Books:


1. Tapobrata Panda. (2011) Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2. Mitchell, David A., Krieger, Nadia, Berovic, Marin.(2006) Solid-State Fermentation Bioreactors: Fundamentals of Design and Operation, Springer-Verlag Berlin Heidelberg.
3. Michael C. Flickinger. (2013) Upstream Industrial Biotechnology. John Wiley & Sons, Inc.
4. Hee-Deung Park, In-Soung Chang, Kwang-Jin Lee.(2015) Principles of Membrane Bioreactors for Wastewater Treatment. CRC Press.

Reference Books:

1. Kee-Yoeup Paek, Hosakatte Niranjana Murthy Jian-Jiang Zhong. 2014) Production of Biomass and Bioactive Compounds Using Bioreactor Technology., Springer Science+Business Media Dordrecht.
2. William L. Hochfeld.(2006) Producing Biomolecular Substances with Fermenters, Bioreactors, and Biomolecular Synthesizers. CRC Press.
3. Sar faraz K. Niazi. (2012) Disposable Bioprocessing Systems, CRC Press.
4. Regine Eibl, Dieter Eibl, Ralf Pörtner, Gerardo Catapano, Peter Czermak. (2009) Cell and Tissue Reaction Engineering., Springer-Verlag Berlin Heidelberg.

Course outcome:

1. To understand the principles of design, operation and major components of industrial bioreactors (PO-1,3,4).
2. To explain the various aspects of submerged Liquid Fermentation bioreactors (PO-2,3,5)
3. To analyze the design aspects of Solid State fermentation bioreactors (PO-4,5).
4. To Have knowledge of bioreactors designed for cell culture technologies in biopharmaceutical industries (PO-2,5).
5. Elucidate the underlying principles of Membrane bioreactors and apply them for related industrial applications (PO-3,4,5)

	NANO-BIOTECHNOLOGY			
	Sub Code : MBTE14 Credits : 4:0:0:0	CIE : 50 Marks SEE : 50 Marks		

Course coordinator: Dr. Ravikumar YS and Dr. Bindu S

UNIT-I

Introduction to Nanotechnology and Nanobiotechnology. History and scope of nano technology; role of size in nanomaterials: Properties of nano materials- Physical & Chemical properties. Classification of nano particles- nano-clusters, nanotubes, nanowires and nanodots. Electronic structure: quantum dots, quantum wires and quantum wells, confinement of electrons energy quantization, Semiconductor nanocrystals, carbon nanotubes, quantum wells.

UNIT –II

Synthesis of Nanomaterials: Chemical Method: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, myle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; , Photochemical synthesis, Synthesis in supercritical fluids. Physical Methods: Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition - Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning). Biological Methods: Microbial production of inorganic nanoparticles – Magnetosomes .DNA based nanostructures

UNIT-III

Characterization of Nanomaterials: Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), , Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Spectroscopic characterizations: application of UV-VIS-IR Raman spectroscopy for analysis of nanomaterials, Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion, Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). Resonance Methods: Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR), Mossbauer Spectroscopy.

UNIT-IV

Biological Nano-materials: Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers. DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing. Nano diamonds. Biocompatible polymers: liposomes, dendrimers, chitosan

UNIT –V

Biological Application of Nanotechnology: Nanoparticles in Therapeutic applications– Drug delivery, imaging and cancer treatment, bone substitutes and dentistry, Implants and Prosthesis, Reconstructive Intervention and Surgery, Nanorobotics in Surgery, Photodynamic Therapy, Neuro-electronic Interfaces, Protein Engineering. Nanotechnology in Agriculture and Food Technology, Biosensors: Principles- DNA based biosensors – Protein based biosensors, Nanosensors in Diagnosis. DNA Templated Electronics,

Sequence –specific molecular lithography, Single Biomolecule. Manipulation for Bioelectronics, DNA as a semiconductor. Environmental issues, toxicity of nanomaterials., ethical issues, the future of nanotechnology in medicine.

Text books:

1. Edelstein A.S, Cammaratra R.C (1996) Nanomaterials: Synthesis, Properties and Applications, Second Edition, CRC PressTaylor and Francis group New York USA
2. Christof M. Niemeyer, Chad A. Mirkin (2004)Nanobiotechnology: Concepts, Applications and Perspectives John Wiley & Sons
3. Yubing Xie (2012) The Nanobiotechnology Handbook CRC Press Taylor and Francis group New York USA

Reference Books:

1. Richard Booker and Earl Boysen (2005) Nanotechnology, Wiley Dreamtech.
2. Chapman & Hall (2002) Nanobiotechnology–Basic Science & Emerging Technologies, CRC Press.
3. Eric K Drexler, Pelerson C, Pergamit G (1993) Unbounding the future. William Marrow and Company
4. Mark Ratner and Daniel Ratner (2005) Nanotechnology. Prentice Hall
5. Murthy DVS (1995) Transducers and instrtumentation. Prentice Hall of India
6. Jing Chung & Larry J. Kricka (2001) Biochip Technology. Harwood academic publishers.

Course Outcome: On completion of this course student will have the improved ability to:-

3. Develop an understanding of the fundamental concepts in nanotechnology and different classes of nano-materials. (PO1 and PO3)
4. Impart basic knowledge on various synthesis techniques involved in Nanotechnology and characterization. (PO3 and PO4)
3. Describe applications of various techniques used in characterization of nano-materials (PO3 and PO4).
4. Think of novel, future applications of nanotechnology in biotechnology and for molecular medicine. (PO4 and PO5)
5. Have knowledge in Applications of Nano-Drug Delivery, Diagnostics and Nanotherapeutics.(PO4 and PO5)