RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

DEPARTMENT OF BIOTECHNOLOGY

VII & VIII SEMESTER B.E

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute:

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 13 UG programs and 15 PG programs. All these programs are approved by AICTE. All the UG programs & 09 PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with 'A' grade by NAAC in 2014. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs till the year 2029. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility to all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), an initiative of Ministry of Human Resource Development (MHRD), Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. It has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. **As per the National Institutional Ranking Framework, MHRD, Government of India, M S Ramaiah Institute of Technology has achieved 59th rank among 1071 top Engineering institutions of India for the year 2020 and 1st rank amongst Engineering colleges (VTU) in Karnataka**.

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 15 faculty members, of them 11 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 be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs.

MISSION OF THE INSTITUTE

RIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization.
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations.
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs.

QUALITY POLICY

We at 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 stakeholders concerned

DEPARTMENT VISION

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.

DEPARTMENT MISSION

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 impart strong foundation in mathematics, basic and engineering sciences contributing to Biotechnology.

PEO 2: To produce graduates who can pursue higher education and research in biotechnology and allied fields.

PEO 3: To produce graduates with an ability to design, develop and implement research projects and apply to solve problems related to areas of biotechnology.

PEO 4: To provide opportunities to students to work in multidisciplinary teams with professional ethics, good communication, leadership skills and commitment to society.

Programme Outcomes (PO): As per NBA guidelines

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

1. To have thorough grounding in Mathematics, Chemistry and Biology.
2. To be proficient in the principles and practices of advanced biological sciences.
3. To apply engineering principles to biological systems to solve Biotechnology problems.

Curriculum Course Credits Distribution
Batch 2017-2021

Semester	Humanities & Social Sciences (HSS)	Basic Sciences / Lab (BS)	Engineering Sciences/ Lab (ES)	Professional Courses - Core (Hard Core, Soft Core, Lab)	Professional Courses - Electives	Other Electives	Project Work	Internship/ other activities	Total semester load
First	2	9	14						25
Second	4	9	10						23
Third		4		21					25
Fourth		4		21					25
Fifth	2			19	4				25
Sixth				15	4		6		25
Seventh				14	8	4			26
Eighth	2				4		16	4	26
Total	10	26	24	90	20	4	22	4	200

SCHEME OF TEACHING
VII SEMESTER

SI. No	Course Code	Course	Teaching Dept.	Component	Credits				
					L	T	P	S	Total
1.	BT71	Bioprocess Modelling and Equipment Design	BT	HC	3	1	0	0	4
2.	BT72	Plant Design, Economics and Entrepreneurship	BT	HC	3	0	0	1	4
3.	BT73	Bioethics and Biosafety	BT	HC	3	0	0	1	4
4.	Open Elective	Institutional Elective	Other Departments	OE	4	0	0	0	4
5.	Elective-C	Departmental Elective	BT	Elective	4	0	0	0	4
6.	Elective-D	Departmental Elective	BT	Elective	4	0	0	0	4
7.	BTL74	Bioprocess Simulation lab	BT	Lab	0	0	1	0	1
8.	BTL75	Downstream Process Technology & Bioseparation Techniques Lab	BT	Lab	0	0	1	0	1
				Total	**21**	**1**	**2**	**2**	**26**

VIII SEMESTER

SI. No	Course Code	Course	Teaching Dept.	Component	Credits				
					L	T	P	S	Total
1.	Elective-E	Departmental Elective	BT	Elective	4	0	0	0	4
2.	BTIN	Internship	BT	Internship	0	0	4	0	4
3.	BTP	Project Work	BT	Project	0	0	14	0	14
				Total	**4**	**0**	**18**	**0**	**22**

SI. No	Course Code	Course	Teaching Dept.	Component	Credits				
					L	T	P	S	Total
1.	EAC	Extra Curricular/Co-Curricular Activities	-	HSS	**0**	**0**	**2**	**0**	**2**
				Total	**0**	**0**	**2**	**0**	**2**

Electives

SI. No	Course Code	Course	Teaching Dept.	Credits				
				L	T	P	S	Total
Elective -C								
1	BTE07	Animal Biotechnology	BT	4	0	0	0	4
2	BTE08	Medical Biotechnology	BT	4	0	0	0	4
3	BTE09	Bioinstrumentation	BT	4	0	0	0	4
Elective -D								
1	BTE10	Pharmaceutical Biotechnology	BT	4	0	0	0	4
2	BTE11	Drug Design and Development	BT	4	0	0	0	4
3	BTE12	Nanotechnology	BT	4	0	0	0	4
Elective -E								
1	BTE13	Forensic Science	BT	4	0	0	0	4
2	BTE14	Research Methodology	BT	4	0	0	0	4
3	BTE15	Tissue Engineering	BT	4	0	0	0	4

Open Elective offered by the department

SI. No	Course Code	Course	Teaching Dept.	Credits				
				L	T	P	S	Total
1	BTOE01	Principles of Food Processing and Preservation	BT	4	0	0	0	4

L – Lecture **T – Tutorial** **P- Practical**
S-Self Study **HC-Hard Core** **OE-Open Elective**

BIOPROCESS MODELLING AND EQUIPMENT DESIGN

Course Code	**:** BT71	**Credits:**	3:1:0:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Heat and Mass transfer and Bioreaction Engineering		
Course Coordinator(s)	**:** Mr. Samrat & Dr. Chandraprabha M N		

UNIT-I

Bioprocess Modelling

Definitions, Conservation Principle, Model Representation, Types of Modelling Equations, Types of Mathematical Models, Use of Simulated Process Model, Modelling and Assessment in Process Development, Process and fermentation models for development of processes for bioproducts and biopharmaceuticals, Sustainability assessment of bioprocess.

UNIT-II

Bioprocess Simulation:

Solving linear and nonlinear algebraic equations, ordinary differential equations, partial differential equations. Design and analysis of experiments, Machine learning approaches in process simulation and optimization.

Unit-III

Introduction to Process Design:

Nature of design, design factors, degrees of freedom, design variables, optimization, nature of process equipment, general design procedure, basic considerations in design, standards, codes, and their significance, equipment classification and their selection, design pressure, design temperature, design stress, design loads, review of fabrication techniques, economics and environmental considerations in design procedure. Piping design. Materials of construction. Sketching techniques, Equipment symbols, Process Flow sheet development for production of citric acid, penicillin, monoclonal antibodies, enzymes etc. Safety considerations in design.

UNIT-IV

Design of Bioreactors and Heat Exchangers:

Bioreactors: Overview, basic design equation for bioreactors. Functional and mechanical design of bioreactors. Heat exchangers: Introduction to heat exchanger, Functional design and mechanical design of double pipe heat exchangers, Shell and tube heat exchangers, cooling coils, jacked vessels.

UNIT-V

Design of Mass transfer Equipment:

Functional and mechanical design of tray and bubble column distillation units, evaporators, absorbers, crystallizers, dryers, extraction systems.

Textbooks:

1. Amiya K Jana, Chemical Process Modelling and Computer Simulation, 3rd edition, Prentice Hall India, 2017.
2. Michael B. Cutlip, Mordechai Shacham. Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB, Prentice Hall, 2008.
3. S Thakore, B Bhatt. Introduction to Process Engineering and Design, 2nd edition McGraw Hill Education, 2015.

Reference Books:

1. William M. (Bill) Huitt, Bioprocessing Piping and Equipment Design: A Companion Guide for the ASME BPE Standard, John Wiley & Sons, Inc., 2016.
2. Ashok Kumar Verma, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, 2017.
3. Binay Kanti Dutta, Mathematical Methods in Chemical and Biological Engineering, CRC Press, 2017.
4. Simant R. Upreti, Process Modeling and Simulation for Chemical Engineers: Theory and Practice, John Wiley & Sons, Inc., 2017.
5. Coulson JM, Richardson JF, Sinnott RK and Gavin Towler (2009). Chemical Engineering Design, Vol. 6, fifth edition, Butterworth-Heinemann press.
6. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

Course Outcomes (COs): On completion of this course, student will have improved ability to:

1. Develop model equations for given bioprocess systems from the problem statement. (PO-1, 2, 3, 5 PSO-3)
2. Demonstrate the ability to solve bioprocess models and use of process simulation. (PO- 2, 3, 5 PSO-3)
3. Understand the basic aspects of bioprocess equipment design. (PO- 2, 3, 4; PSO-2, 3)
4. Design bioreactors and heat transfer equipment for bioprocess operations. (PO- 2, 3, 4, 5; PSO-3)
5. Design mass transfer equipment employed in bioprocess industries. (PO- 2, 3, 4, 5; PSO-3)

PLANT DESIGN, ECONOMICS AND ENTREPRENEURSHIP

Course Code	**:** BT72	**Credits:**	3:0:0:1
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Mrs. Bhavya S G & Dr. Chandraprabha M N		

UNIT- I

Process Design Development & General Design Considerations: Process design and development, flow diagrams, marketability of the product, availability of technology, raw materials, equipment design-specification and manufacturing/procurement, human resources, land and utilities, site characteristics, waste disposal, government regulations and other legal restrictions, community factors and other factors affecting investment and production costs.. Depreciation & interest and investment cost: Time value of Money, Types of Interests, Nominal and effective interest rates, Continuous interest, annuities, Perpetuities, Depreciation, Types of depreciation, Methods for estimating depreciation**.** Numericals.

UNIT- II

Cost Estimation: Capital Investments: Fixed capital investments including land, building, equipment and utilities, installation costs, working capital investment. Cost indius. Manufacturing costs: Direct production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.,), fixed charges, Plant Overhead cost: Administration, safety and other auxiliary services, payroll overhead, warehouse and storage facilities. Numericals.

UNIT- III

Profitability, Alternative Investments and Replacements: Profitability, basis for evaluating project profitability, Methods for profitability evaluation, Alternative investments, Replacement analysis: Replacement models, Break-Even analysis: Meaning and importance of Break-even point, Break-even chart and analysis. Numericals.

UNIT- IV

Entrepreneurship: Meaning and importance, concepts of entrepreneurship, characteristics of successful entrepreneurs, classification of entrepreneurs, myths of entrepreneurship, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in the economic development , entrepreneurship development in India, barriers for entrepreneurship, profiles of

successful entrepreneurs. Identification of business opportunities, market, technical, financial and social feasibility studies.

Preparation Report: meaning of the project, project identification, project selection, project report, need and significance of report, formulation and guidance by Planning Commission for project Report, network analysis, errors of project report, project appraisal.

UNIT- V

Small scale Industries: Definition, characteristics, need, rationale objectives, scope for SSIs. Role of SSI in economic development, advantages of SSI, Steps to start SSI, Govt. policies and support for SSI (during 5 year plans), Impact of liberalization, globalization of SSI, Effect of WTO/GATT, IPR and small Business enterprises, supporting agencies of Govt. for SSI – nature of support, objectives, types of help, Brief definitions and description of ancillary and tiny industry. IPR and small business tnerprises.

Institutions supporting SSIs and SBEs – central and state level institutions

Women entrepreneurs: definition, environment, challenges, for women entrepreneurs, strategies for development of women entrepreneurs self help groups, Institutions and women's organization supporting women entrepreneurs, profiles of successful women entrepreneurs.

Text Books:

1. Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn., McGraw Hill.
2. Rudd and Watson (1987) Strategy of Process Engineering, Wiley.
3. Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises, Pearson education.

Reference Books:

1. Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House.
2. Khanka SS (2004) Entrepreneurship Development, S Chand & Co.
3. Thomas W. Zimmer, Norman M. Scarborough.(2007), Essentials of Entrepreneurship and small Business Management.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Acquire knowledge in the design of a chemical plant. (PO–1, 2, 3; PSO-1)

2. Conduct preliminary feasibility study of the plant design assigned. (PO–2, 3, 4; PSO-2)
3. Estimate the cost analysis involved in the design of a chemical plant. (PO–4, 5; PSO-2)
4. Analyze the project profitability and alternative investments for the selection of good investment projects. (PO–4, 5; PSO-2)
5. Develop entrepreneurs with substantial knowledge in engineering concepts. (PO– 6, 11; PSO-3)

BIOETHICS AND BIOSAFETY

Course Code	**:** BT73	**Credits:**	3:0:0:1
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Bindu S		

UNIT-I

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

UNIT-II

Ethical Issues: Ethical issues in 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; Xenotransplantion and its ethical and social issues. Human Genome project.

UNIT-III

Biosafety regulations in transgenic research: National and international guidelines on rDNA protocols. MOEF guidelines evolution, Good laboratory practice, Good manufacturing practice and FDA regulations Pharmacopia standards Regulations for recombinant DNA research and manufacturing process Public perception. National Institute of health (NIH) guideline, guidelines for research in transgenic organisms. Experiments with microorganisms. Canadian Council on Animal Care (CCAC) Guidelines on Transgenic Animals.

UNIT-IV

Case studies in transgenic research: Case studies of GEAC approved projects. Drafting of application to IBSC and procedure. BT cotton, golden Rice, genetic manipulation and ethical considerations. Genetic studies in ethnic races. Recombinnt DNA Advisory Committee Advisory Committee (RDAC).

UNIT-V

Bioethics and biosafety in biotechnology: Ethical issues related to biotech products, Challenges to Indian Biotech Industries and research institutes, Biological weapons

CARTAGENA protocol highlights. Examples of Monarch butterfly, HIV vaccine, Starlink maize.

Text Books:

1. V Sree Krishna (2007) Bioethics and Biosafety in Biotechnology, New Age International (P) Limited.
2. Sateesh M.K (2008) Bioethics & Biosafety, IK Publishers.
3. Traynor PL (2000) Biosafety Management, Virginia polytechnic Institute Publication.

Reference Books:

1. Erbisch F H and Maredia K M (2004), Intellectual Property Rights in Agricultural Biotechnology, Orient Longman Ltd.
2. Rao MB (2003), WTO and International Trade, Vikas Publishing House Pvt. Ltd.
3. Cartagena Protocol on Biosafety, January 2000.
4. Sassaon A. (1988) Biotechnologies and development. UNESCO Publications.
5. Sasson A. (1993) Biotechnologies in developing countries present and future, UNESCO Publishers.
6. Dano MR (1994) Biological Warfare in the 21st century, by, Brassies London.
7. Safety Considerations for Biotechnology (1992 and latest publications), OECD Paris.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. List & interpret the social, legal & ethical issues connected with BT. (PO-7, 8; PSO-2)
2. Identify biosafety as relevant to Biotechnology & apply this knowledge in maintenance of biosafety in research lab, field & industry. (PO-3, 4, 5, 7, 8; PSO-2)
3. Interpret & describe biosafety regulations & their relevant applications in BT. (PO-3, 4, 5, 7; PSO-2)
4. Analyze the risk assessment studies of various GEAC approved transgenics. (PO-3, 4, 5, 7; PSO-2)
5. Identify & discuss the potential dangers in Biotechnology due to compromise on biosafety & apply precautionary measures to avoid /overcome it. (PO-3, 4, 5, 7, 8; PSO-2)

ANIMAL BIOTECHNOLOGY

Course Code	**:** BTE07	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Prabha M		

UNIT-I

Introduction to animal biotechnology: Introduction, History and Scope; Cell culture Laboratory design & Equipments: Layout; Maintenance of sterility; CO2 incubator; Inverted stage microscope. Cell culture vessels; Cryopreservation; Media and reagents, CO2 and bicarbonates buffering, Different Types culture Media-Natural and Artificial Media. Principles of animal cell and tissue culture.

UNIT-II

Animal cell culture: Initiation of Cell culture-Preparation and Sterilization of substrate, Primary animal cell culture:Isolation of Explants, Disaggregation of explants, contamination. Monolayer culture. Secondary culture; Trypsinization; Passage or subcultivation. Different tissue culture techniques; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: Morphology, division, growth pattern; Development of cell lines Characterization and maintenance of cell lines.

UNIT-III

Animal cell culture applications: Cell cloning and selection; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs, Application of cell culture technology in production of human and animal viral vaccines, Hybridoma Culture- monoclonal antibody Production and its applications. Cell culture products- interferons, hybrid antibodies.

UNIT-IV

Development and use of transgenic animals: Transfection and its methods and applications. Transgenic animals; Transgenic-mice methodology: Mammalian virus vector- Retroviral vector method, SV40 vector DNA microinjection method, Engineered-embryonic stem cell method, Transgenic animals produced- Mice, Rabbits, Goat, Sheep and fish. Transgene integration. Targeted gene transfer- Gene disruption and Gene replacement. Knocking in and knocking out of genes; Applications: transgenic animals as bioreactors for production of proteins of pharmaceutical value.

UNIT-V

Biotechnology for animal improvement: Conventional methods of animal improvement: cross breeding, artificial insemination, in vitro fertilization, embryo transfer technology; Ethical issues related to IVF. Cryopreservation- procedure and applications. Gene mapping, marker assisted selection and genetic improvement of desired characters of domestic animals. Detection of Transgene and transgene function. Rapid diagnosis of diseases in live-stock via: RIA, ELISA and PCR.

Textbooks:

1. Freshney RI (2016) Culture of Animal Cells, 7th Edition, Wiley-Blackwell Publisher.
2. Spier RE and Griffiths JB (2012) Animal Cell Biotechnology, Academic Press.
3. Gorakh Mal, Manishi Mukesh, Sanjeev K. Gautam, Birbal Singh (2019) Advances in Animal Biotechnology, Springer Publications.

Reference Books:

1. B. Singh (2013) Text book of Animal biotechnology. Published by TERI press.
2. Anchal Singh, Ashish S. Verma Anchal Singh, Ashish S. Verma (2013) Animal Biotechnology: Models in Discovery and Translation, Second Edition, Academic press in imprint of Elsevier.
3. Channarayappa (2006) Molecular Biotechnology: Principles and Practices. University Press (India) Pvt. Ltd., Worldwide CRC Press.
4. Channarayappa (2010) Cell Biology: Universities Press (India) Pvt Ltd.
5. John RW, Masters, (2000) Animal Cell Culture: Practical Approach, 3rdEdn, Oxford.

Course Outcomes (COs): on completion of this course students will be able to:

1. Apply the basics and principles of animal biotechnology. (PO – 2,3,4,5; PSO - 1)
2. Theoretical Knowledge of basics animal cell culture techniques (PO – 3; PSO - 2)
3. Application of stem cells, cloning, large animal models for disease and development of therapies and treatments. (PO – 2,3,5, 9, 10; PSO - 2,3)
4. Apply the gene transfer techniques for the development of transgenic animal production. (PO – 2,5,10; PSO – 3)
5. Apply the basic Knowledge of Breeding Technology, diagnosis techniques using ELISA, PCR and RIA. (PO – 2,5,9,10; PSO – 3)

MEDICAL BIOTECHNOLOGY

Course Code	**:** BTE08	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Biochemistry		
Course Coordinator(s)	**:** Dr. Lokesh K N & Dr. Prabha M		

UNIT-I

Introduction to infectious diseases & Stem Cells in Health Care: Introduction to Medial Biotechnology, scope and applications, List of disease causing microbes and detection. Microbial Diseases of Humans: Viruses (AIDS, Hepatitis- B, Rabies, HSV-1) Bacteria (Typhoid, STD, TB, Plague). Mammalian embryonic stem cells – Definition, formation and properties of embryonic stem cells. Formation of differentiated cells from stem cells. Differentiated progeny, epidermal stem cells in basal layer, differentiating epidermal cells, synthesis of differentiating epidermal stem cells- a subset of basal cells, basal cell proliferation, secretory cells in the epidermis.

UNIT-II

Hemopoietic Stem Cell Disorder: Classification and manifestations of Hemopoeitic stem cell disorders, a plastic 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

Vaccine Technology: Definition, history, classification of vaccines, preparation and standardization of vaccines, cancer vaccine, birth control vaccines, AIDS vaccine, Pneumococcal vaccine, measles vaccines, Future development and scope of vaccines.

UNIT-IV

Molecular Diagnostics: PCR bases diagnosis, Southern blot-based diagnosis DNA sequencing of representative clones to detect mutation(s), PCR-SSCP to detect SNP analysis for known SNPs, PAGE: Immunodiagnostics, DNA fingerprinting. Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase.

UNIT-V

Gene Therapy: General introduction, potential target diseases for gene therapy, gene transfer methods, and their applications, clinical studies, pharmaceutical production and

regulation. Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer.

Text Books

1. Glick, B. R., Patten, C. L., & Delovitch, T. L. (Eds.). (2020). Medical biotechnology. John Wiley & Sons.
2. Pratibha Nallari and V. V. Rao (2010) Medical Biotechnology. First edition, Oxford University Press.
3. Judit Pongracz, Mary Keen (2009) Medical Biotechnology, A Churchill Livingstone publication.

Reference Books

1. Albert Sasson, (2006) Medical Biotechnology, Brookings Institution Press.
2. S N Jogdand (2008) Medical Biotechnology 2nd Edition Himalaya publishers.
3. Keith Wilson & John Walker, (2000) Practical Biochemistry- 5th Edition, Cambridge University Press, UK.
4. Judit Pongracz Mary Keen (2009) Medical Biotechnology 1st Edition, Churchill Livingstone Publications.
5. Daan Crommelin, Robert D Sindelar (2013) Pharmaceutical Biotechnology an Introduction for pharmacists and pharmaceutical scientists, Springer Publisher.

Course Outcomes (COs): On completion of this course student will have improved ability:

1. To detect the disease-causing microbes for diagnosis, production of vaccines in prevention and treatment of diseases. (PO–2,5, 11; PSO-1,2)
2. To understand the benefits and scope of Embryonic stem cells, Hemopoietic stem cells for therapeutics and transplantation. (PO–2, 3, 5, 12; PSO-2,3)
3. To understand the strategy used for development and standardization of biologics. (PO–2, 5, 6; PSO-2)
4. To apply the techniques such as PCR, Southern blot, PAGE, DNA finger printing for analysis and diagnosis. (PO–3, 5, 6; PSO-1,3)
5. To analyze the gene transfer methods and pharmaceutical production for application of gene therapy and treatment. (PO–4, 5,12; PSO-1,2)

BIOINSTRUMENTATION

Course Code	**:** BTE09	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Bioprocess Control & Automation		
Course Coordinator(s)	**:** Mr. M. Gokulakrishnan & Mr. Krishna Murthy TP		

UNIT-I

Introduction: Electrical quantities and units; functional elements of an instrumentation system; static and dynamic characteristics; principles of analog and digital meters; CRO, energy meters, time andfrequency meters; multimeters. Transducers: Classification, resistive strain gages, RTD, LVDT, Piezoelectric transducers, electromagnetic transducers, optical transducers, transducers forbiomedical applications. Conceptual numericals.

UNIT-II

Bio Electric Potentials and Measurements: Origin of bioelectric potentials: resting and action potential, propagation of action potential, Electrophysiology of heart, origin of ECG, ECG waveforms and characteristics, electrodes and lead configurations, Vector cardiograph, magneto cardiograph, EEG waveforms and characteristics, 10-20 electrode placement system, EEG machine, evoked potential study, Recoding of EMG, measurement of conduction velocity.

UNIT-III

Non-Electrical Parameter Measurements: Measurement of blood pressure: direct and indirect methods, Blood flow measurement: electromagnetic blood flow meter, ultrasound blood flow meter, laser doppler blood flow meter Cardiac output measuring techniques: dye dilution method; thermal dilution method, Heart rate measurement Ultrasonic blood flow meter, NMR blood flow meter, laser doppler blood blow meter Respiratory volumes and capacities, spirometry, Pneumotachometers: different types , Measurement of lung volume.

UNIT-IV

Medical Imaging Techniques:

X-ray machine, Computer Tomography, different generations, Ultrasonography: A, B and M Mode scans, Magnetic Resonance Imaging System, Positron Emission Tomography (PET), Single-Photon Emission Computed Tomography(SPECT), Thermography.

UNIT-V

Telemetry, Therapeutic and Assist Devices: Biotelemetry: basics components, and its different types. Patient monitoring system, Assist and therapeutic devices: cardiac pacemakers, Defibrillators, Heart Lung machine, different types of oxygenators, Hemodialysis and Peritoneal dialysis, Respiratory therapy equipments: ventilators, anesthesia machine, Artificial heart valves and types.

Textbooks:

1. R. S. Khandpur, Handbook of Bio-Medical instrumentation, Tata McGraw Hill Publishing Co Ltd., 3rd Edition, 2014.
2. John G. Webster, Specifications of Medical Instrumentation Application and Design, Wiley India Pvt Ltd India, 4th Edition, 2015.

Reference Books:

1. Joseph J Carr and John M Brown, Introduction to Biomedical equipment Technology, Pearson Education New Delhi, 4th Edition, 2004.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Bio-Medical Instrumentation and Measurements, Pearson Education, PHI Learning Private limited India, 2nd Edition, 2007.

Course Outcomes (COs): On completion of this course student will have improved ability:

1. Analyze the types of transducers for biomedical applications. (PO 1,3; PSO-1)
2. Predict the response of various bioelectric instruments for human system. (PO 3,4; PSO-3)
3. Predict the response of various blood measuring instruments. (PO 3,4,5; PSO-3)
4. Analyze various imaging techniques useful in medical applications. (PO 3,4; PSO-3)
5. Apply the theories of biological systems in the design and development of therapeutic devices. (PO 3,4; PSO-3)

PHARMACEUTICAL BIOTECHNOLOGY

Course Code	**:** BTE10	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Lokesh K N and Dr. Dhamodhar		

UNIT-I

Introduction to Pharmaceutical Biotechnology: scope, Development of drugs and pharmaceutical industry-organic therapeutic agent's uses and economics, regulatory bodies, introduction to drugs and cosmetics act, overview and important schedule C and C1, schedule M, Schedule Y.

UNIT-II

Pharmacokinetics and Pharmacodynamics: Introduction to pharmacokinetics and pharmacodynamics, Drug metabolism- half-life of drugs, physico chemical principles, Biotransformation/pharmacokinetic studies, elimination and distribution of protein therapeutics, pharmacodynamics principles.

UNIT-III

Recent Advances in Pharmaceutical Biotechnology: Introduction to nutraceuticals, edible vaccines, Introduction to Health Bioinformatics, pharmacogenomics. Commercially available important diagnostic kits, diagnostic kits for detection of blood sugar, HIV, Malaria etc, recent advances in diagnostic kits.

UNIT-IV

Manufacturing Principles: Manufacturing facilities, Clean room concept introduction to recombinant DNA technology and production of important therapeutic biopharmaceutical like haemopoietic growth factors (interleukins, erythropoietin's), therapeutic hormones (insulin, human growth factor) and blood products.

UNIT-V

Formulations of Biopharmaceutical, Analysis and Control: Manufacturing facilities, excipients used in parental formulations, shelf life of protein based pharmaceuticals, delivery of protein (rate controlled, target specific, site specific, soluble carrier system etc) Analytical methods for the tests for various drugs and pharmaceuticals, different packaging techniques, quality control.

Textbooks:

1. Heinrich Klefenz (1995) Industrial Pharmaceutical Biotechnology, Wiley-VCH.
2. Gary Walsh (2013) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc.

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, John Wiley & Sons, Inc.
2. Susanna Wu-Pong, Yongyut Rojanasakul, and Joseph Robinson (2006) Biopharmaceutical Drug Design and Development, Humana Press.
3. Herbert A Kirst, Wu-Kuang Yeh, Milton J (2001) Enzyme technologies for pharmaceutical and biotechnological applications, Marcel Dekker, Inc.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Correlate the importance of Pharmacy with other basic science for development of novel therapeutics and diagnostics. (PO-2, 5, 12; PSO-1,3)
2. Assess pharmacokinetic and Pharmacodynamic profile of new drug candidates. (PO-, 2, 3, 5; PSO-3)
3. Comprehend the principles of immunodiagnostics or other molecular biological tools for disease management. (PO-2, 3, 5; PSO-2)
4. Apply GMP / GLP guidelines in development or processing of Biopharmaceuticals. (PO-2, 3, 4; PSO-2)
5. Competent to serve in Pharmaceutical Industry/clinical research organization (CRO). (PO-4, 5, 7, 9, 10, 11; PSO-1,3)

DRUG DESIGN AND DEVELOPMENT

Course Code	**:** BTE11	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Genomics, Proteomics & Bioinformatics		
Course Coordinator(s)	**:** Mr. Krishna Murthy T P and Dr. Sravanti V		

UNIT-I

Drug discovery: Introduction to Drug design and development pathway. Pharmacokinetics: Drug absorption, Drug distribution, Drug metabolism, Drug excretion, Drug administration, Drug dosing, Formulation-Drug delivery, Pharmacodynamics, Classification of drugs, Drug nomenclature. Types of Drug targets, Miscellaneous drug targets: Lipids, carbohydrates, biosynthetic building blocks.

UNIT-II

Enzymes as drug targets- Enzyme kinetics, Inhibitors acting at the active site of an enzyme-Inhibitors acting at allosteric binding sites, Uncompetitive and non-competitive inhibitors- Transition-state analogues, Suicide substrates, Medicinal uses of enzyme inhibitors.

Receptors as drug targets: Role of the receptor, Neurotransmitters and hormones, Receptor types and subtypes, Receptor activation. Receptors and signal transduction, Design of agonists and antagonists, Partial agonists, Inverse agonists, Desensitization and sensitization, Tolerance and dependence, Affinity, efficacy, potency.

UNIT-III

Nucleic acids as drug targets: Intercalating drugs acting on DNA, Topoisomerase poisons: non-intercalating, Alkylating and metallating agents, Chain cutters. Chain terminators, Control of gene transcription, Agents that act on RNA, Agents those bind to ribosomes. Antisense therapy.

Target identification: Choosing a disease, Choosing a drug target, Target specificity and selectivity, Multi-target drugs, Identifying a bioassay, Finding a lead compound, Properties of lead compounds, Isolation and purification, Structure determination, Herbal medicine.

UNIT-IV

Drug Design: Structure activity relationships, Identification of a pharmacophore, Drug optimization, Optimizing access to the target: Optimizing hydrophilic/hydrophobic properties-Making drugs more resistant to chemical and enzymatic degradation,

Making drugs less resistant to drug metabolism, Prodrugs, Drug alliances, Endogenous compounds as drugs, Peptides and peptidomimetics in drug design.

Drug Development: Preclinical and clinical trials: Toxicity testing, Drug metabolism studies, Pharmacology, formulation, and stability tests, Clinical trials, Patenting and regulatory affairs: Patents, Regulatory affairs, Chemical and process development.

UNIT-V

***in-silico* Drug Design** Computer aided lead design-Determining Target Structure: Literature, Experimental methods, Protein structure Prediction methods, Molecular Modelling- Complementarity between a Target and Drug: Intermolecular Forces, molecular shape, drug pharmacophore, Ligand Based drug design, Structure Based drug design, Fragment Based Drug Design, Computer aided drug design, Molecular Docking procedures: software for molecular docking**,** steps in molecular docking. Quantitative structure–activity relationship (QSAR).

Text Books:

1. Erland Stevens. Medicinal Chemistry: The Modern Drug Discovery Process. Prentice Hall; 2nd edition, 2012.
2. Graham L. Patrick. An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, USA. 2013.

Reference Books:

1. Gareth Thomas. Medicinal Chemistry: An Introduction, Wiley-Blackwell, 2nd Edition, 2007.
2. Rick Ng, Drugs: From Discovery to Approval, Wiley-Blackwell; 3rd Edition, 2015.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Correlate the relationship between various steps of Drug design & development process. (PO-2, 3; PSO2)
2. Classify and compare various molecular drug targets. (PO-2, 3, 4; PSO2)
3. Identify the target and develop lead molecules. (PO-2, 4, 6; PSO-3)
4. Optimization of lead and development of drug candidate. (PO-2, 3, 5; PSO-3)
5. Evaluate the role of Bioinformatics in *in-silico* drug design. (PO-2, 4, 5, 6; PSO-3)

NANOBIOTECHNOLOGY

Course Code	**:** BTE12	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Mr. Samrat K		

UNIT-I

Introduction: A Brief History of the Super Small; Definition of Nano*bio*technology. Discussions on nanofabrication, Bottom-Up versus Top-Down, Nanolithography, Structure-property relationships in materials, biomolecule-surface interactions, Fabrication of Hydrogels/PDMS/other polymers and base materials for nano and micro fabricated devices, Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires.

UNIT-II

Synthesis and their Characterization: Synthesis of nanomaterials by physical, chemical and biological methods. Nanobiomaterials: Function and application of DNA based nanostructures. Carbon nanotube and its bio-applications. Characterization of nanomaterials - UV visible spectroscopy and dynamic light scattering (DLS), SEM, TEM, Atomic force microscopy(AFM) and XRD.

UNIT-III

Nano-diagnostics and Nano-biotechnological applications: Diagnostics and Sensors, Rapid *Ex-Vivo* Diagnostics, Nanosensors as agnostics, Nanotherapeutics. Nanotechnology in point-of-care diagnostics, Nanomaterials for cancer diagnosis, Nanoparticles for imaging, Nano-biotechnological applications in health and disease - infectious and chronic, Environment and food - detection and mitigation, molecular recognition elements in nanosensing of different analytes various transducing elements as part of nanobiosensors.

UNIT-IV

Drug Discovery and Drug Delivery: Drug Discovery Using Nanocrystals, Drug Discovery Using Resonance Light Scattering (RLS) technology, Benefits of Nano-Imaging Agents, Drug Delivery using Nanobiosensors, Drug Delivery Applications, Bioavailability, Sustained and targeted release, Nanorobots, Benefits of Nano-Drug Delivery, Drug Delivery, Health Risks, and Challenges, Targeting, Drug Delivery Revenues, use of micro-needles and Nanoparticles for highly controlled drug delivery.

UNIT-V

Nanomaterials for biotechnological applications: Cellular uptake mechanisms of nanomaterials, *in-vitro* methods to study antimicrobial and anticancer properties of nanomaterials, Nano artificial cells,DNA nanotechnology, Nanotechnology in tissue engineering, Nanopharmacology &nanotoxicology.

Textbooks:

1. Stephen Lee and Lynn M Savage (1998) Biological molecules in Nanotechnology, International Business Communications, Inc.
2. Rosenthal, Sandra J and Wright, David W (2005) Nanobiotechnology Protocols, Humana Press.
3. Richard Booker and Earl Boysen (2005) Nanotechnology, Wiely Dreamtech Edition.

Reference Books:

1. Chapman & Hall (2002) Nanobiotechnology – Basic Science & Emerging Technologies,CRC.
2. Gregory Timp (1998) Nanotechnology, (Ed) Spring.
3. Mark Ratner and Daniel Ratner (2002), Nanotechnology: A gentle introduction to the next big thing, Prentice Hall of India.
4. D.V.S Murthy (2008), Transducers and instrumentation, Prentice Hall of India.
5. L. A. Geddes & L.E. Baker (1989), Principles of Applied Biomedical Instrumentation, 3rd Edition, Wiley.
6. Jing Chung & Larry J. Kricka (2001), Biochip Technology, Harwood academic publishers.

Course Outcome (COs): On completion of this course students will have improved ability to:

1. Apply the fundamental concepts of nanotechnology in biotechnology. (PO-1, 7; PSO-2)
2. Identify appropriate methods to synthesize and characterize nano materials. (PO-2, 3, 5; PSO-2, 3)
3. Apply nanotechnology in diagnostics and therapeutics. (PO-4, 5, 7; PSO-2)
4. Improve drug discovery and delivery methods by applying nanorobotics, nanobiosensors and nanomaterials. (PO-2, 3, 5; PSO-3)
5. Apply the principles of nanotechnology in the field of biotechnology. (PO-2, 3, 5; PSO-3)

BIOPROCESS SIMULATION LAB

Course Code	**:** BTL74	**Credits:**	0:0:1:0
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Biokinetics & Bioreaction Engineering		
Course Coordinator(s)	**:** Mr. Krishna Murthy T P and Mr. Samrat K		

LIST OF EXPERIMENTS

1. Introduction to MATLAB software and its basic commands
2. Solving an algebraic equation using MATLAB
3. Solving ordinary and partial differential equation
4. Screening and optimisation of process parameters using design of experiments
5. Data management and analysis of bioprocess data using Microsoft Excel
6. Piping and Instrument Diagram for Bioreactor facility
7. 2D Drafting of Bioreactor/ Fermenter
8. 2D Drafting of heat transfer and mass transfer equipment
9. Development of process flowsheet for bioproducts production
10. Modelling and simulation of batch bioprocess
11. Modelling and Simulation of Brewery process/ Monoclonal Antibody production
12. Batch Process Modelling of Monoclonal Antibody (MAb) production
13. Modelling and simulation of broth mixing in a bioreactor using COMSOL Mixer module
14. Simulation of biochemical reactions in batch bioreactors using COMSOL CRE module

Reference Books:

1. Michael B. Cutlip, Mordechai Shacham. Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB, Prentice Hall, 2008.
2. Ashok Kumar Verma, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, 2017.
3. Binay Kanti Dutta, Mathematical Methods in Chemical and Biological Engineering, CRC Press, 2017.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Understand the fundamentals and to solve linear and nonlinear equations using MATLAB and Microsoft Excel®. (PO-2, 3, 4, 5; PSO-2,3)

2. Draft the drawings of bioprocessing equipment using CAD software. (PO-3, 4, 5; PSO-3)
3. Develope fermentation and process model for production of industrial products. (PO-2, 3, 4, 5; PSO-2, 3)
4. Able to simulate and analyze the results obtained from process (PO-4, 5; PSO-3)
5. Utilize wide range of software dedicated to bioprocessing development and optimization. (PO-4, 5; PSO-3)

DOWNSTREAM PROCESS TECHNOLOGY & BIOSEPARATION TECHNIQUES LAB

Course Code	**:** BTL75	**Credits:**	0:0:1:0
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Unit Operations & Bioanalytical Techniques		
Course Coordinator(s)	**:** Dr. K N Lokesh & Mr. Samrat K		

LIST OF EXPERIMENTS

1. Cell disruption techniques
2. Solid-liquid separation methods: Sedimentation
3. Solid-liquid separation methods: Centrifugation, Filtration
4. Product enrichment operations: Precipitation – $(NH_4)_2 SO_4$ fractionation of a protein
5. Product enrichment operations: Two – phase aqueous extraction
6. Protein enrichment by altering the dielectric constant
7. Methods for Cell biomass estimation (Packed cell volume (PCV), Dry weight & wet weight of biomass)
8. Separation of Amino acids / Carbohydrates by TLC
9. SDS polyacrylamide gel electrophoresis
10. DNA separation by Agarose Gel Electrophoresis
11. Estimation of % ethanol from fermented broth
12. Estimation of Citric acid from fermented broth
13. Separation of proteins by molecular sieving
14. Analysis of biomolecules by HPLC / GC

Note: Any 12 experiments must be performed

Reference Books:

1. Upadhyay, Upadhyay, and Nath (2003) Biophysical Chemistry Principles and techniques, Himalaya Publishing House.
2. Sivasankar B (2005) Bioseparations: Principles and Techniques, Eastern Economy Edn.
3. Okotore RO (2002) Basic Separation Techniques in Biochemistry, New age publishing Co.

Course Outcomes (COs):

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

1. To understand the importance of RIPP (Recovery, isolation, purification and polishing) scheme in the downstream operations. (PO-2, 5, 6, 9; PSO-1,2)
2. Choose appropriate unit operations for isolation and purification of biomolecules. (PO-1,2, 5, 6, 9; PSO-1,3)
3. Identify appropriate qualitative and quantitative analysis methods depending upon the chemical nature of analyte. (PO-1, 2, 4, 5, 9; PSO-1,2)
4. Enhance product output by selection of appropriate method of enrichment operation. (PO-1,2, 3, 4, 5, 6, 10, 11; PSO-3)
5. Enhance product quality by appropriate method of purification operation. (PO-1,2, 3, 4, 5; PSO-1,2)

FORENSIC SCIENCE

Course Code	**:** BTE13	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Biochemistry		
Course Coordinator(s)	**:** Mr. Samrat K		

UNIT-I

Introduction: 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.

UNIT-II

Forensic Criminalistics in forensic science, 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, Trace evidence and contact evidence- targeting potential traces, recovery of trace material assessment of significance- Hair, fiber and Paint. Marks and impressions, Drug of abuse. Ploygraphy. Eye witness Tesatimony.

UNIT-III

Forensic Biology: Cause of Death- Forensic Pathology: Rigor mortis, Lovor mortis, Algor mortis. Forensic Anthropology-Remain Examinations Developing Biological Profile,Autopsy- External Examination, Cause of Death. Forensic Toxicology- Alcohol & it relationship to human anatomy & metabolism, Testing for drugs and poisons using pH. TLC, immunoassay, & chemical tests, Forensic Entomology, Forensic Psychiatry, Forensic Odontology- Identification Species, Race and Sex determination, Forensics Engineering, forensic serology, Wild Life forensic, DNA Analysis, Finger prints: history, fundamental principle of Fingerprints, Classification and patterns, AFIS, Method of Detecting fingerprint.

UNIT-IV

Forensic Digital Imaging: Introduction, Digital cameras and forensic imaging, image acquisition technique. Methods and applications, Authenticity, image processing. Technical investigation on image storage media. Digital image processing- sharpening, contrast, blur smoothing digital videos and scanners, presenting pictures in courtroom, internet crime. Forgery and steganography, Voice analysis. Detecting compression and

forgeries and Maintaining Records, Hand Writing analysis. Computerized facial reconstruction.

UNIT-V

Forensic Ethics: Introduction and importance of Professional ethics in Forensic Science, organizational forensic Science ethics, Code of ethics in Forensic Science Practice. Standard for Good Forensic practice. Ethical problems in ethical forensic sciences. Ethical Dilemmas.

Textbooks:

1. Jay Siegal, Geoffrey Knuper, PekkuSaukko (2000): Enyclopedia of Forensic Sciences, Three-volume SET1-3, Elsvier book publication.
2. Max M. Houck (2007): Forensic Science: Modern methods of solving problems, Praeger West Port London.
3. AynEmbar-Seddon, Allan D. Pals (2009): Forensic Science, Salem Press, Inc. Paradena, California.

Reference Books:

1. Jami J. St Clair (2002): Crime Laboratory Management-Academic Press.
2. Richard Saperstein(2001): Criminalistics: An Introduction to Forensic Science – Prentice Hall.
3. David Ellen(2003):The Scientific Examination of Documents Methods and Techniques-, Taylor and Francis.

Course Outcomes (COs): On completion of this course students will have improved ability to:

1. Apply the basic principles, duties and functions of Forensics. (PO–1, 6, 9, 12; PSO-1)
2. Apply the principles of collection and analyze the different types of evidences in criminalistics. (PO–1, 3, 4, 5; PSO-2)
3. Apply the various analytical techniques to understand forensic biology . (PO–1, 3, 4, 5; PSO-2)
4. Analyze and apply methodology in fingerprinting, DNA analysis, and different areas of forensic science. (PO–2, 4, 5, 10; PSO-2)
5. Evaluate the professional codes of ethics outlined by various professional forensic science organizations. (PO–6, 8, 10, 12; PSO-2)

RESEARCH METHODOLOGY

Course Code	: BTE14	**Credits:**	4:0:0:0
Contact Hours	: 56L		
Prerequisite(s)	: Biostatistics and Biomodelling		
Course Coordinator(s)	: Dr. Ravi Kumar Y.S and Dr. Priyadarshini Dey		

UNIT-I

Introduction to research methodology: Definition and Meaning of Research (Approach to Research), characteristics of research objectives of Research – Types of research. Various Steps in Research process inter and multi-disciplinary research. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.

UNIT-II

Research Formulation and design: Formulating a Research Problem, List the steps involved in formulating a research problem, Reviewing the literature Sources of research problems. (Web Search: using search engines: science direct, pubmed, Google Scholar and other advanced search tools.) Factor Considered in formulating a research problem Research (Identification of Gaps), Constructing hypotheses and qualities of good hypothesis (logic and importance). Research design: Types of Research Designs, Basic Principles- Need of research design-Features of good design sampling design, random sample and complex random sample design.

UNIT-III

Research methods Data collection: collection of primary and secondary data, methods of data collection in quantitative and qualitative research: observation, the interview, the questionnaire and the case study method. Survey methods and sampling techniques: Experimental research methods. Data processing and analysis (Tool used: SPSS/MATLAB).

UNIT-IV

Writing a research report, Structure and Components of Research Report – Types of Report, developing outline of research report. Characteristics of Good Research Report, referencing and bibliography systems. (Tool used: Zotero). Writing research paper (Review writing and Research articles) and thesis. (Tool used: Latex). Proof reading, developing your publication skills, Developing discipline-specific english skills.

UNIT-V

Computer and its role in research and research and ethics: Spreadsheet tool: Introduction to spread-sheet applications, features and functions, using formulae and functions, data storing, features for statistical data analysis, generating charts/graphs, tables and other features. Presentation tool: Introduction to presentation tool, features and functions, creating presentations, customizing presentation. (Tool used: Microsoft Power point). Research ethics. Self-plagiarism and plagiarism. (Tool used: SEO plagiarism tool).

Textbooks

1. C.R. Kothari, 2014. Research Methodology: Methods and Techniques. New Age International.
2. C.G. Thomas, 2015. Research Methodology and Scientific Writing. Ane Books Pvt. Ltd.

Reference books

1. David V. Thiel, 2014.Research Methods for Engineers. Cambridge University Press.
2. Heather Silyn-Roberts, 2012.Writing for Science and Engineering: Papers, Presentations and Reports. Elsevier Insights.
3. W.M.K. Trochim, 2005. Research Methods: The concise knowledge base. Atomic Dog Publishing.

Course Outcomes (COs):

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

1. Compare and analyze various experimental research methodologies. (PO-3; PSO-3)
2. Analyze and appreciate various techniques of research based on research problem. (PO-4, 5; PSO-1)
3. Plan, design and execute experiments in an organized fashion. (PO-3, 5; PSO-3)
4. Report the research results in a standard format. (PO-10, 11, 12; PSO-3)
5. Analyze research results using modern computing facilities. (PO-10, 11, 12; PSO-3)

TISSUE ENGINEERING

Course Code	**:** BTE15	**Credits:**	4:0:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Cell Biology		
Course Coordinator(s)	**:** Dr. Prabha M		

UNIT-I

Introduction to tissue engineering, Cell and Tissue Biology: Basic definition of tissue engineering; current scope of development; use in therapeutics**.** Introduction to cell – biology and biochemistry. Tissue development and organization. Stem cells (embryonic), Stem cells (adult). Introduction to cell adhesion, Adhesion Receptors in Tissue Structures, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion, Effect of Biomaterial on Physiological Behavior. Introduction to cell migration, Characteristics of Mammalian Cell Migration, Measurement of cell characteristics morphology, number viability, cell-fate processes, cell motility, cell function. Regulation of Cell Movement, Cell Migration Assays, Mathematical Models for Cell Migration and Tissue Growth. Control of cell migration in tissue engineering.

UNIT-II

Extracellular Matrix: Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signaling Complexes, ECM and Skeletal Tissues, Sources of ECM for Tissue Engineering Applications, Properties of ECM , Mining the ECM for Functional Motifs, Summary of Functions of ECM Molecules, Polymeric Materials and their Surface Modification, Formation of Gradient Structures, Delivery of Growth Factors. Applications of growth factors: VEGF/angiogenesis, Basicproperties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self renewal.

UNIT-III

Biomaterials & Drug Delivery Systems: Introduction to synthetic polymers, Biodegradable materials vs permanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications. Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering, Introduction to growth factors, Polymer scaffold delivery systems, Polymer hydrogel delivery systems, Polymer microsphere technology.

UNIT-IV

Tissue Engineering Bioreactors - Design and Fabrication: Introduction, Most common Bioreactors in Tissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, Design Considerations, Challenges in Bioreactor\ Technologies. Tissue Biomechanics, Scaffold design and fabrication, Natural Polymers for Scaffold Fabrication, Synthetic Polymers for Scaffold Fabrication, Scaffold Design Properties.

UNIT-V

Clinical & Regulatory Aspects of Engineered Tissues: Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal, Tissue Engineering, Cardiovascular Tissue Engineering, Musculoskeletal Tissue Engineering, (tendon/ligament/muscle), Adipose Tissue Engineering. Tissue engineered therapies. Introduction, FDA Regulation, Regulation of Pharmaceutical / Medical Human Tissue Products in Europe, Regulation of Pharmaceutical / Medical Human Tissue Products in Japan, Other considerations Relevant to Engineered Tissues.

Text Books:

1. John P. Fisher, AG Mikos & Joseph D. Bronzino (2007) Tissue Engineering CRC Press.
2. Anthony Atala & P Lanza (2006) Methods of Tissue Engineering, Academic Press Elsevier.
3. Drioli (2005), Biocatalytic Membrane Reactor, Taylor & Francis.

Reference Books:

1. Channarayappa (2010) Cell Biology: Universities Press (India) Pvt Ltd.
2. Patrick CW, Mikos AG, McIntire LV (1998) Frontiers in Tissue Engineering, Pergamon Press.
3. Bernhard O Palsson, Sangeeta N Bhatia (2003) Tissue Engineering, Pearson Prentice Hall.

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Identify and differentiate between stem cells and characteristics study of cells for various stages of tissue development. (PO-1, 3, 4, 5, 9; PSO-2)
2. Analyze the mechanism and organization of ECM and their applications in tissue engineering. (PO-1, 3, 4, 5, 9; PSO-2)

3. Utilize the Biomaterials for invitro studies and Apply knowledge of drug delivery mechanism & protein drug interactions. (PO-1, 2, 3, 4, 5, 9; PSO-3)
4. Design and Fabrication of Bioreactors for application in functional tissues in tissue engineering. (PO-1, 3, 4, 5, 9; PSO-2)
5. Integrate the knowledge of clinical and regulatory aspects on different engineered tissues in pharmaceutical and tissue products. (PO-1, 2, 3, 4, 5, 6, 9; PSO-3)

INTERNSHIP			
Course Code	**:** BTIN	**Credits:**	0:0:4:0
Contact Hours	**:** 56 P		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Coordinators		

Course Outcomes (COs): On completion of this course student will have improved ability to:

1. Acquire knowledge, critical thinking skills and experience in advanced techniques in Biotechnology. (PO 2, 3,4,5; PSO 2 &3)
2. Learn and acquire skill sets like time-bound work habits, ethics, safety measures and team work. (PO 6,8,9; PSO 2 &3)
3. Communicate and present the acquired knowledge in a style consistent with scientific standards. (PO 10 & 11; PSO 2 &3)
4. Appreciate the interdisciplinary nature of contemporary biotechnology research. (PO 7 & 12; PSO 2 &3)
5. Integrate theory and practice to explore job opportunities in the filed of biotechnology and allied fields. (PO 7 & 12; PSO 2 &3)

PROJECT WORK			
Course Code	**:** BTP	**Credits:**	0:0:16:0
Contact Hours	**:** 224 P		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Coordinators		

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

1. Demonstrate a sound technical knowledge of their selected project topic. (PO-1,5; PSO-1)
2. Analyze complex data and draw scientific inferences or conclusion. (PO-1,2, 3, 4, 5; PSO-2, 3)
3. Apply research methodology for strategic formulation of research design. (PO-2, 3, 4, 5; PSO-3)
4. Apply ethical, biosafety or socio-environmental concepts in their research work and at professional career. (PO-6, 7, 8; PSO-3)
5. Develop managerial and teamwork/independent work skills, which can pave way for entrepreneurship. (PO-10, 11, 12; PSO-3)

PRINCIPLES OF FOOD PROCESSING & PRESERVATION

Course Code	**:** BTOE02	**Credits:**	4:0:0:0
Contact Hours	**:** 56 L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Bindu S		

UNIT-I

Basic consideration: Aim and objectives of preservation and processing of foods, characteristics of food components, primary sources of microorganisms found in foods, deterioration of food quality, causes of quality deterioration and spoilage of perishable foods, spoilage in canned foods.

UNIT-II

Low temperature Preservation of foods: Chilling temperatures: Considerations relating to storage of foods at chilling temperatures, low temperature applications in food preservation, controlled and modified atmosphere storage of foods.

Freezing temperature: Preparation of foods for freezing, freezing process, slow and fast freezing of foods and its consequences, storage stability of frozen foods, effect of freezing on microorganisms.

UNIT-III

High temperature preservation of foods: Basic concepts in thermal destruction of microorganisms-D, Z, F, values, Heat resistance and thermophilisms in micro-organisms. Cooking, blanching, pasteurization and sterilization of foods. Assessing adequacy of thermal processing of foods, general process of canning of foods.

UNIT- IV

Preservation by Dehydration: Principles, technological aspects and applications of drying and dehydration of foods. Principles, technological aspects and applications of evaporative concentration processes, freeze concentration and membrane processes for food concentrations.

UNIT-V

Other techniques in preservation: Principles, technological aspects and applications of sugar and salt, anti-microbial agents, non-ionizing and ionizing radiations in preservations of foods, Fermented foods.

Text Books:

1. Norman N. Potter and Joseph H. Hotchkiss (2013) Food Science, CBS publishers and Distributors.
2. James M Jay (2012) Modern food microbiology, 5th Edn, CBS publishers and Distributors.
3. B. Sivasankar (2009) Food processing and preservation, Eastern economy edition, Prentice-Hall of India Pvt. Ltd.

Reference Books:

1. Osman Erkmen and T. Faruk Bozoglu (2016) Food Microbiology Principles in to Practice, John Wiley & Sons, Ltd, UK.
2. Shakuntala N. Manay and M. Shadaksharamurthy (2008) Foods: Facts and Principles, 3rd edition, New Age International.
3. Rick Parker (2003) Introduction to Food Science, Delmar/Thomson Learning.
4. Subbulakshmi G and Shobha A. Udupi (2006) Food Processing and Preservation, 1st edition**,** New Age International.
5. John M DeMan (2013) Principles of Food Chemistry, 3rd Edition, Springer – Verlag

Course outcomes (COs): On completion of this course student will have improved ability to:

1. List & identify the factors responsible for food spoilage including a description of the different types of spoilages. (PO-1, 2; PSO- 2)
2. Compare and contrast the different low temperature food preservation methods & discuss their principles. (PO-2, 3, 4, 5; PSO-2)
3. Compare and contrast the different high temperature food preservation methods & discuss their principles. (PO-2, 3, 4, 5; PSO-2)
4. Able to identify & discuss the applications of dehydration, membrane based separation & irradiation as methods of food preservation. (PO-2, 4, 5; PSO-2)
5. Apply principles of drying & dehydration for food processing & preservation. (PO – 2,3,4,5 ; PSO – 2)