RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2021 – 2022

DEPARTMENT OF BIOTECHNOLOGY

V & VI 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 17 UG programs and 15 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^{+}' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. 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 for 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, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems & 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 Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" 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), by MoE, 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. The institute 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 (NIRF), MoE, Government of India, M S Ramaiah Institute of Technology has achieved 65th rank among 1143 top Engineering institutions of India for the year 2021 and is 1st amongst the Engineering colleges affiliated to VTU, 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 14 faculty members, of them 13 are PhD holders. 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, Springer etc. 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

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 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.

SEMESTER WISE CREDIT BREAKDOWN

BATCH: 2019-2023

Category	Semester								Total
	I	II	III	IV	V	VI	VII	VIII	
Basic Sciences (BSC)	9	8	4	4					25
Engineering Sciences (ESC)	11	10							21
Humanities, Social Sciences and Management (HSMC)		2			3		3		8
Professional Courses-Core (PCC)			21	21	15	11	10		78
Professional Courses-Elective (PEC)					3	6	6		15
Other Open Elective Courses (OEC)					3	3			6
Seminar (SE), Project Work (PROJ), Internship (IN)						4	1	17	22
Total	**20**	**20**	**25**	**25**	**24**	**24**	**20**	**17**	**175**

SCHEME OF TEACHING

V Semester						
Sl. No.	**Course Code**	**Course**	**Credits**			
			L	**T**	**P**	**Total**
1.	BT51	Immunology	4	0	0	4
2.	BT52	Genomics, Proteomics and Bioinformatics	3	1	0	4
3.	BT53	Bioreaction Engineering	3	1	0	4
4.	BT54	Bioethics and Biosafety & IPR	3	0	0	3
5.	BTE55X	Professional Elective-I	3	0	0	3
6.	BTOE01	Open Elective-I	3	0	0	3
7.	BTL56	Genetic Engineering Lab	0	0	1	1
8.	BTL57	Immunotechnology Lab	0	0	1	1
9.	BTL58	Biokinetics and Bioreaction Engineering Lab	0	0	1	1
Total			**19**	**2**	**3**	**24**

Professional Elective-I						
1.	BTE551	Industrial and Environmental Biotechnology	3	0	0	3
2.	BTE552	Plant and Agricultural Biotechnology	3	0	0	3
3.	BTE553	Biomaterials	3	0	0	3
Open Elective-I						
1.	BTOE01	Biology for Engineers	3	0	0	3

VI Semester						
Sl. No.	**Course Code**	**Course**	**Credits**			
			L	**T**	**P**	**Total**
1.	BT61	Enzymology and Enzyme Technology	3	1	0	4
2.	BT62	Upstream and Downstream Process Technology	3	1	0	4
3.	BTE63X	Professional Elective-II	3	0	0	3
4.	BTE64X	Professional Elective-III	3	0	0	3
5.	BTOE02	Open Elective-2	3	0	0	3
6.	BT65	Mini Project/ NPTEL Course	4	0	0	4
7.	BTL66	Upstream Process Technology Lab	0	0	1	1
8.	BTL67	Downstream Process Technology Lab	0	0	1	1
9.	BTL68	Bioinformatics Lab	0	0	1	1
Total			**19**	**2**	**3**	**24**

Professional Elective-II						
1.	BTE631	Bioprocess Engineering	3	0	0	3
2.	BTE632	Food Biotechnology	3	0	0	3
3.	BTE633	Tissue Engineering	3	0	0	3
Professional Elective-III						
1.	BTE641	Forensic Science	3	0	0	3
2.	BTE642	Research Methodology	3	0	0	3
3.	BTE643	Nanobiotechnology	3	0	0	3
Open Elective-II						
1.	BTOE02	Principles of Food Processing and Preservation	3	0	0	3

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years Degree Program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8th Semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; eight semester Grade Card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the Eight Semester grade card.

IMMUNOLOGY

Course Code	**:** BT51	**Credits:**	4:0:0
Contact Hours	**:** 56L		
Prerequisite(s)	**:** Biochemistry		
Course Coordinator(s)	**:** Dr. Dhamodhar P & Dr. Bindu S		

UNIT-I

The immune system: Introduction, Cells and Organs of the immune system: Hematopoiesis, Cells of the myeloid and lymphoid lineage, Lymphoid cells, Primary and secondary Lymphoid organs, Antigens, Adjuvants, Haptens. Classification of immune system - innate and adaptive immunity. Complement and their biological functions, Cytokines and their role in immune response.

UNIT-II

Humoral and Cell mediated immunity: B-lymphocytes and their activation; Basic structure of Immuno globulins; immunoglobulin classes and biological activity, Antibody diversity, Antigenic Determinants on Immunoglobulins: Isotype, Allotype & Idiotype. Thymus derived lymphocytes (T cells) and types, MHC Complex, Structure and functions of MHC molecules. Antigen processing and presentation: Endogenous & Exogenous pathway. Mechanism of T cell activation, Antigen presenting cells (APCs), mechanism of phagocytosis.

UNIT-III

Immunological disorders: Hypersensitivity and its types: Types I -IV. Allergy: General mechanism, diagnostic tests and treatment. Autoimmune disorders and types, pathogenic mechanisms. Primary and Secondary immunodeficiency disorders (AIDS). Transplantation Immunology: Types of grafts, Grafts acceptance and rejection, Immunological basis of graft rejection, Clinical manifestations, HLA typing and matching.

UNIT-IV

Molecular immunology: Production of monoclonal antibodies: Hybridoma technology and their applications, B cell cloning, Antibody Engineering: Chimeric and Hybrid Monoclonal Antibodies, Application of PCR technology and stem cells to produce antibodies, Immunotherapy with genetically engineered antibodies. Active and Passive Immunisation, Immunisation protocol, Vaccines and their types. Live attenuated, inactivated, subunit vaccines, recombinant, DNA vaccines.

UNIT-V

Immunodiagnosis: Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Blood typing, A, B, ABO and Rh. Principles and applications of ELISA, radio immuno assay (RIA), western blot analysis, immuno-electrophoresis, Immunofluorescence, Flow cytometry.

Text Books:

1. Thomas J. Kindt, Richard A. Goldsby and Barbara A. Osborne (2006) Kuby Immunology 6th Edition, W.H. Freeman.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt (2011) Roitt's Essential Immunology, Wiley-Blackwell.

Reference Books:

1. IanTizard (2006) Immunology – An Introduction, Cengage Learning (RS).
2. Eli Benjamini, Geoffrey Sunshine and Sidney Leskowitz (2000) Immunology: A Short course, 3rd Revised edition, Wiley-Blackwell.
3. Chakravarthy AK (2006) Immunology & Immunotechnology. Oxford University Press.

Course outcome (COs):

On completion of the course, student will have improved ability to:

1. Classify and describe the functions of the major components of the immune system in human. (PO-1; PSO-1)
2. Differentiate the humoral and cell mediated response against infectious antigens. (PO-1; PSO-1)
3. Analyse the basis for Immunological disorders and understand the pathogenesis. (PO-1; PO-2; PSO-1)
4. Analyse the recent advancement in molecular immunology. (PO-3; PO-5; PSO-2, PSO-3)
5. Identify the appropriate Immunological technique for diagnosis of infectious diseases. (PO-5; PSO-2, PSO-3)

GENOMICS, PROTEOMICS & BIOINFORMATICS

Course Code	**:** BT52	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Biochemistry, Cell and Molecular Biology		
Course Coordinator(s)	**:** Dr. Bhavya S G & Dr. Priyadarshini Dey		

UNIT-I

Genome Sequencing & Genome Projects: DNA sequencing methods: Sanger dideoxy method, Maxam Gilbert method, Pyrosequencing, Automated Fluorescence method, Nanopore. Introduction to Next Generation Sequencing technology (NGS). Genome size and C-value paradox, Human Genome Project- Shotgun and Clone contig methods, Organelle genome: Mitochondria. Translational Genomics: applications in medicine and agriculture

UNIT-II

Functional Genomics & Proteomics: cDNA library and EST library. SAGE, Microarrays in functional genomics. Introduction to Structural genomics, Comparative genomics, Metagenomics and Transcriptomics. Proteomics analysis pathway, 2D Gel electrophoresis, Mass spectrometry, MALDI-TOF, Peptide mass fingerprinting, Yeast-two hybrid interaction screens, protein chips/microarray. Case study of pharmaceutical and clinical applications of Proteomics.

UNIT-III

Protein engineering and Applications: Introduction and need for protein engineering, Rational and De Novo protein design, Steps involved in protein engineering by Directed evolution, Phage display. Applications of protein engineering in Protein therapeutic development, agriculture and food industry.

UNIT-IV

Bioinformatics: Introduction, History, Scope, Application, Limitations- Data mining and analytical tools for OMICS studies-Sequence alignment and database similarity searching. Multiple sequence alignment-molecular phylogeny-computational gene prediction. Introduction to NGS data analysis.

UNIT-V

Structural Bioinformatics: Protein Structure Visualization, Comparison, and Classification-Secondary and tertiary structure Prediction. Bioinformatics in Drug discovery and design: Molecular targets, structure-based drug design, principles of

molecular docking-Molecular dynamics and simulations (basic concepts including force fields, protein-protein, protein-nucleic acid, protein-ligand interaction).

Textbooks:

1. T A Brown (2017), Genomes, 4th edition, Garland Science.
2. Daniel C Liebler (2002), Introduction to proteomics: Tools for the new biology, Humana Press.
3. Jonathan Pevsner (2015), Bioinformatics and Functional Genomics, 3rd edition, John Wiley & Sons, Inc.

References:

1. Aurther M Lesk (2012), Introduction to Genomics, Oxford University Press.
2. Nawin Mishra (2010), Introduction to Proteomics: Principles and Applications, John Wiley & Sons Publications.
3. Richard M. Twyman (2013) Principles of Proteomics, Garland Science.
4. Arthur Lesk (2016), Introduction to Protein Science: Architecture, Function, and Genomics, 3rd Edition, Oxford University Press.
5. Arthur Lesk (2013), Introduction to Bioinformatics, Fourth Edition, Oxford University Press.

Course Outcomes (COs):

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

1. Apply DNA/genome sequencing techniques to genome projects. (PO-1, 5, 11; PSO-2)
2. To correlate the relationship between Genome, Transcriptome and Proteome. (PO- 2, 3, 4, 5, 6, 9; PSO-2)
3. Design steps for engineering proteins. (PO-2, 3, 4, 5, 10; PSO-3)
4. Compare various bioinformatics tools used for sequence alignment and phylogenetic studies. (PO-2, 4, 5, 9; PSO-3)
5. To predict protein structure and apply bioinformatics for drug discovery (PO-2, 4, 5, 9; PSO-3)

BIOREACTION ENGINEERING

Course Code	**:** BT53	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Bioprocess Principles & Calculations		
Course Coordinator(s)	**:** Mr. M. Gokulakrishnan & Dr. Chandraprabha MN		

UNIT-I

Kinetics of Homogeneous Bioreactions: Basic Concepts of Bioreaction and bioprocess engineering, Concentration dependent term of a rate equation. Rate Constant. Representation of elementary reaction and non-elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.

UNIT-II

Interpretation of Batch Bioreactor Data: Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalysed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data.

UNIT-III

Ideal Bioreactor and bioprocess models: Ideal Batch Reactor, Batch cycle time, Space-Time and Space-Velocity, Mixed flow reactor, plug flow Reactor, General features of reactors, Holding time and space time for flow reactors Design for Single Reactions: Size comparison of single reactors. Growth kinetics quantification- Unstructured models for microbial growth- Substrate limited growth-models with growth inhibitors, product formation kinetics. Monod kinetics.

UNIT-IV

Heterogeneous Biocatalysis and Non Ideal reactors:

Immobilised enzyme systems: Methods of Immobilisation, Requirements and choice of immobilisation methods, Diffusional limitations in immobilised enzyme systems. Various types of reactors for immobilised cell and enzyme systems Non ideal flow, Residence time distribution, step and impulse response, conversion in non-ideal flow reactors.

UNIT-V

Analysis of Bioreactors: Challenges and issues in bioprocess industries- mixing, interphase mass and heat transfer, Bioreactor instrumentation and control, bioreactor considerations for animal cell cultures and plant cell cultures. Novel Bioreactors: Packed bed bioreactors, Air lift bioreactors, loop bioreactors, Hollow fiber Bioreactors. Solid state fermentation Bioreactors.

Textbooks:

1. Scott Fogler, H (2009) Elements of Chemical Reaction Engineering, 4th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2001) Bioprocess Engineering. 2nd edn., Prentice Hall PTR.

Reference Books:

1. Bailey JE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. McGraw- Hill.
2. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
3. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
4. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

Course Outcomes (COs):

Course Outcome: On completion of this course student will be able to:-

1. Predict the order and rate of the different reactions. (PO-1, 2; PSO-1)
2. Analyse the batch bioreactor data for different reactions. (PO-2, 3, 9; PSO-3)
3. Design the suitable bioreactor for different biochemical reactions. (PO- 2, 3, 4, 9; PSO-3)
4. Predict the residence time distribution to determine the conversion in non-ideal flow reactors (PO-3,4; PSO-2).
5. Analyse bioreactors for various cell cultures. (PO-4, 5, 9; PSO-2)

BIOETHICS, BIOSAFETY & IPR

Course Code	**:** BT54	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Bindu S and Dr. Abhijith S R		

UNIT-I

Introduction to Bioethics and Biosafety: Needs and definition of Bioethics, Application and scope of bioethics. Ethical issues in biotechnology inventions (Genetically modified organisms, Animal and Human cloning, Testing of drugs on human volunteers, Organ and Xenotransplantation, Human Genome project), 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

Biosafety regulations in transgenic research: National and international guidelines on rDNA protocols. MOEF guidelines, Recombinant DNA Advisory Committee Advisory Committee (RDAC), Genetic Engineering Approval Committee (GEAC), Role of Institutional Biosafety Committee (IBSC), Good laboratory practice, Good manufacturing practice and FDA regulations. National Institute of health (NIH) guideline on rDNA research, Canadian Council on Animal Care (CCAC) guidelines on transgenic animals.

UNIT-III

Case studies and Ethical issues in transgenic research: Case studies of GEAC approved projects, BT cotton, BT Brinjal, golden Rice, genetic manipulation and ethical considerations. Genetic studies in ethnic races. Biological weapons, CARTAGENA protocol highlights. Examples of Monarch butterfly, HIV vaccine, Starlink maise.

UNIT-IV

Introduction to IPR: History of IPR. Need of IP. International organisation for IP control: GATT, WTO, WIPO & TRIPS. Introduction to different forms of IPR: Copyrights, Trademarks, Industrial designs, Patents, Geographical Indications, Traditional Knowledge, Plant varieties, Trade Secrets.

Trade Marks: Nature, Essentials, Protection, Trademarks, Service marks and Laws. Procedure for trade mark registration, Case studies on trademarks: Related to Biotechnology and allied industries.

Copy Rights: Characteristics and Requirements; Subject matter of copyright, Procedure for copyright registration, Infringement of Copyright. Case Studies on Copyrights: Related to Biotechnology and allied industries.

UNIT-V

Patents: Patent as an intellectual property, Principles underlying Patent law. Patentable and non-patentable subject matter, Infringement of patents, Process and Product Patents. Patent Drafting, Patent application Indian and global scenario, Types of patent and patent application, Patent Revocation, Case studies Related to Biotechnology and allied industries.

Textbooks:

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. Acharya N K (2007) Text book on Intellectual Property Rights, 4th Edn. Asia Law house.

Reference Books:

1. OECD Paris, Safety Considerations for Biotechnology (1992 and latest publications).
2. Wadehhra BL (2002) Intellectual Property Law Handbook, Universal Law Publishing Co. Ltd.
3. Manish Arora (2007) Guide to Patents Law, Universal Law Publishing, 4th Ed.
4. Singh K (2000) Intellectual Property Rights on Biotechnology. BCIL, New Delhi.
5. Traynor PL (2000) Biosafety Management, Virginia polytechnic Institute Publication.
6. Bouchoux (2005) Intellectual Property Rights, Delmar Cengage learning.

Course Outcomes (COs):

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

1. List & interpret the social, legal & ethical issues connected with BT. (PO-7, 8; PSO2)
2. Identify biosafety regulations as relevant to Biotechnology & apply this knowledge in maintenance of biosafety in research lab, field & industry. (PO-3, 4, 5, 7, 8; PSO2)

3. Analyze the risk assessment studies of various GEAC approved transgenics (PO-3, 4, 5, 7, 8; PSO2).
4. Identify the different types of IP and scope of protection, and discuss the role of the international intellectual property rights system. (PO-6, 10, 12, PSO-1, 2)
5. Understand the importance of patents and its application in modern scientific and industrial research (PO-6, 10, 12, PSO-1, 2)

INDUSTRIAL & ENVIRONMENTAL BIOTECHNOLOGY

Course Code	**:** BTE551	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Microbiology		
Course Coordinator(s)	**:** Dr. Krishna Murthy T P and Dr. Priyadarshini Dey		

UNIT-I

Introduction to Industrial Biotechnology

History and development of industrial biotechnology, Characteristics and comparison of bioprocessing with chemical processing, Biosystems for industrial products production, Isolation and improvement of industrially important biosystems, Media for industrial bioprocess, Sterilisation, Culture preservation and inoculum development, Cell growth kinetics, Biosynthetic pathways and regulation of metabolic products, Bioreactors for industrial Bioprocess. Systems, synthetic and computational biology applications in industrial biotechnology.

UNIT-II

Bioprocess Technologies-I

Commodity chemicals (lactic, citric, succinic, fumaric, gluconic, itaconic, acetic and propionic, acrylic and butyric acids, propanediol, butanediol etc.), enzymes (cellulase, amylase, lipase, protease, pectinases, xylanases, laccase, restriction enzymes, therapeutic enzymes etc.), amino acids (l-lysine and l-glutamic acid), microbial cells (spirulina, yeast and algae).

UNIT-III

Bioprocess Technologies-II

Vitamins, antibiotics, vaccines, interferons, monoclonal antibodies, drugs, biologics and biosimilars. Fermented foods and beverages, Functional foods (Nutraceuticals, pro and prebiotics), cosmetics, flavours and fragrances, dyes and pigments, biosurfactants, biopesticides and biofertilisers. Extremophiles and mixed cultures in industrial bioprocess.

UNIT-IV

Environmental Biotechnology

Sources of pollution, wastewater treatment-characteristics and treatment strategies (primary, secondary and tertiary treatment), solid waste management, bioremediation, biotransformation and biodegradation, biomining & biohydrometallurgy, Heavy metal and oil spill bioremediation, biosensors in pollution monitoring and control, national and international environmental policies.

UNIT-V

Bioenergy and Bioplastics

Types of fuels and biofuels, generations of biofuels, feedstocks for biofuel production, bioprocess strategies for production biobutanol, bioethanol, biodiesel, biogas, biohydrogen, bioelectricity, life cycle assessment of biofuels. Biorefineries- Raw materials, technologies and products. Bioplastics-Types, production, properties and applications.

Textbook

1. Murray Moo-Young (2019) Comprehensive Biotechnology, 3rd Edition, Elsevier.
2. Ashok Pandey (2016), Current Developments in Biotechnology and Bioengineering Series. Elsevier.
3. Indu Shekhar Thakur (2010) Environmental Biotechnology: Basic Concepts and Applications, I K Publishers.

References

1. Michael C. Flickinger (2013) Upstream Industrial Biotechnology, John Wiley & Sons, Inc.
2. Wittmann C et al. (2017) Industrial Biotechnology: Microorganisms & Products and Processes, John Wiley & Sons, Inc.
3. Hans-Joachim Jördening and Josef Winter (2004), Environmental Biotechnology Concepts and Applications, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
4. Gareth G. Evans, Judy Furlong (2011) Environmental Biotechnology: Theory and Application, John Wiley & Sons, Inc.

Course Outcomes (COs):

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

1. Describe the steps involved in the production of bioproducts and methods to improve modern biotechnology. (PO-2, 3; PSO-2)
2. Choose and manage appropriate mechanism of microbiological processes to produce industrially important products. (PO-2, 3, 4; PSO-2)
3. Apply the bioprocess technology in production of important products for better human health. ((PO-2, 3, 4; PSO-2)
4. Apply microbial technology for bioremediation and bioleaching processes. (PO-2, 4, 6; PSO-3)
5. Compare & analyse various forms of biofuels, microbial fuel cells and degradable varieties of plastic. (PO-2, 4, 6; PSO-3)

PLANT & AGRICULTURAL BIOTECHNOLOGY

Course Code	**:** BTE552	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Cell and Molecular Biology, Genetics and Genetic Engineering		
Course Coordinator(s)	**:** Dr. Bindu S and Dr. Priyadarshini Dey		

UNIT-I

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

UNIT-II

Plant Tissue and cell culture techniques: Organogenesis organ culture, Establishing callus and cell culture, Micropropagation for large scale production of plantlets: - banana, Acclimatization of micro propagated plant. Somaclonal variation, Somatic embryogenesis in plant. Synthetic seeds and their commercial potential. Protoplast isolation and culture. Cell suspension culture for production of secondary metabolites. Hairy root culture, Plant products of industrial importance.

UNIT-III

Genetic Engineering in Plants: 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, Plastid transformation. Transgenic plants and their importance, Transgenic crop plants: - herbicide tolerances, insect resistance. Selection of clones and maintenance of germplasm. Genetic fidelity testing. Marker assisted selection. Methods for crop improvement.

UNIT-IV

Introduction to Agricultural Biotechnology: Introduction, history and scope of agriculture in India. Agro-climatic zones and cropping pattern of India. Conventional crop improvement programs- Introduction, Selection and Hybridization, Mutation, Haploidy and Polyploidy Breeding. Soil less cultivation or hydroponics. Modern agriculture biotechnology for food security and national economy. Green-revolution. Industries that based on agricultural raw materials. Impact of biotech-products on national economy and trade. Improvements of raw material for food processing industry.

UNIT-V

Organic agriculture and genetic conservation: Modernization of agricultural practices and national food security. Sustainable food production: organic farming for improvement of food quality and soil fertility. Composting, Biofertilizers. Integrated pest management. Various renewable bio-fuels: Biogas an alternative fuel, Importance and strategies of Biodiversity Conservation. Impact of Biotechnology on Biological diversity and genetic conservation.

Textbooks

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.

Reference books

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, Oxfsord & 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.
6. Sathyanarayana B. N. and Varghese, D.B. (2007) Plant Tissue Culture: Practices and New Experimental Protocols. I. K. International Pvt Ltd.

Course Outcomes (COs):

On completion of this course student will have improved ability:

1. Understand the basic concept of plant tissue culture, media formulation, and its importance. (PO-2, 3, 4; PSO-2)
2. Understand the concept of different techniques involved in plant tissue culture. (PO-3, 4; PSO-2)
3. To analyze the developments of crop production by using plant breeding and hybridization techniques. (PO-3, 4, 7; PSO-2)
4. To apply knowledge of molecular markers for the identification of traits in various genomes. (PO-3, 4, 7; PSO-2)
5. Apply modern agricultural techniques and understand the importance of bioresources (PO-5, 7; PSO-2).

BIOMATERIALS

Course Code	**:** BTE553	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Krishna Murthy T P and Dr. Bindu S		

UNIT-I

Introduction to Biomaterials

Introduction to basic concepts of materials science, need and scope for biomaterials and biomedical devices, historical development in biomaterials, classes and properties of materials used in biology: metals (stainless steel, cobalt-chromium alloys, titanium alloys etc.), ceramics (alumina, zirconia, etc.), polymers (thermoplastics, thermosets, elastomers, hydrogels etc.), carbon (pyrolytic carbon, graphite, activated carbon, carbon nanotubes, etc.), composites (polymer matrix, ceramic matrix, metal matrix composites).

UNIT-II

Characterization of Biomaterials

Physical and chemical characterization (Microstructural characterization, scanning probe microscopy, XRD, FTIR, DLS technique, contact angle measurement, mercury intrusion porosimetry, gas adsorption measurements), mechanical characterization (measurement of load and deformation), surface characterization (XPS, SIMS, MALDI MS, IR, Raman, UV spectroscopy, microscopy, profilometry), *in vitro, ex vivo* and *in vivo* characterization of cell–biomaterials interactions.

UNIT-III

Concept of Biocompatibility

Fundamentals of human biology and anatomy: cell, tissues and systems. Tissue-biomaterial interactions: interaction between the biomaterial surface and the tissue, effect of biomaterials on cells, effect of biomaterials on the biological tissues, responses of the body to implantation. Biocompatibility and hemocompatibility. Sterilization of biomaterials: High-temperature sterilization, ethylene oxide, radiations, low-temperature plasma, ozone and filter sterilization. Degradation of polymeric materials (environmental ageing, oxidation, photoinduced degradation, pyrolysis, enzymatic, bacterial & chemical attack, mechanical degradation etc.,), metallic materials and ceramic biomaterials.

UNIT-IV

Applications of Biomaterials

Biomaterials and devices in soft and hard tissue augmentation, blood interfacing applications, controlled release systems: advantages of controlled drug delivery, methods to achieve prolonged or sustained drug delivery, heart valve protheses, total hip replacement, dental implants, intraocular lenses.

UNIT-V

Tissue Engineering and Regenerative Medicine

Components of tissue engineering, scaffolds, biomaterials in hard tissue replacement, biomaterials in 3D printing/bio-printing techniques. Bioreactors for tissue engineering. In vivo cell & tissue engineering case studies: artificial skin, artificial blood vessels, artificial pancreas, artificial liver, regeneration of bone, muscle, nerve regeneration. Regenerative medicine using cells and bioactive factors.

Ethics and safety: Moral and ethical issues in the development of biomaterials and medical products, role of standards for testing and performance requirements of biomaterials, regulatory constraints for medical products using biomaterials.

Textbooks:

1. Hasirci, V., & Hasirci, N. (2018). Fundamentals of biomaterials. Verlag: Springer New York.
2. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2013). Biomaterials Science: An Introduction to Materials in Medicine, 3rd Edition. Elsevier.
3. Bandyopadhyay, A., & Bose, S. (Eds.). (2013). Characterization of biomaterials. Newnes.

Reference Books:

1. Tanzi, M. C., Farè, S., & Candiani, G. (2019). Foundations of Biomaterials Engineering. Academic Press.
2. Dos Santos, V., Brandalise, R. N., & Savaris, M. (2017). Engineering of biomaterials. Berlin, Germany: Springer.
3. Ayoub, A. S., & Lucia, L. A. (Eds.). (2017). Introduction to renewable biomaterials: first principles and concepts. John Wiley & Sons.
4. Wong, J. Y., Bronzino, J. D., & Peterson, D. R. (Eds.). (2012). Biomaterials: Principles and Practices. CRC Press.
5. Reis, R. L. (2019). Encyclopedia of tissue engineering and regenerative medicine. Academic Press.

Course Outcomes (COs):

On completion of this course student will have improved ability:

1. Understand the need and scope of biomaterials in modern-day medicine (PO-1,2; PSO-1)
2. Describe the physical, chemical, mechanical and biological properties of natural and synthetic biomaterials (PO-1,2; PSO-1)
3. Analyse the significance of biocompatibility, hemocompatibility of the materials used in medicine (PO-1,2; PSO-1)
4. Apply the principles of biomaterial in solving problems in medical and heathcare sector (PO-1,2,3; PSO-1,2)
5. Apply the knowledge of biomaterials in tissue engineering and regenerative medicine (PO-1,2,3,8; PSO-1,2)

GENETIC ENGINEERING LAB

Course Code	**:** BTL56	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Genetics and Genetic Engineering		
Course Coordinator(s)	**:** Dr. Bindu S & Dr. Bhavya S G		

LIST OF EXPERIMENTS

1. Genomic DNA Isolation by Phenol chloroform Method
2. Preparation of DNA for PCR applications- purity & quantification
3. Amplification of specific DNA fragment by Polymerase Chain Reaction (PCR)
4. DNA Fingerprinting by RAPD/RFLP technique
5. Isolation and estimation of total RNA
6. Preparation of cDNA
7. Amplification of cDNA using Reverse Transcription Polymerase Chain Reaction (RT-PCR)
8. Multiplex Polymerase Chain Reaction
9. Preparation Of Competent Cells of *E. coli* By Calcium Chloride Method
10. Transformation of *E. coli* cells By Heat shock Method and Blue White Screening
11. Histochemical staining of GUS expression
12. Southern blotting
13. Southern hybridisation
14. Amplification and quantification of DNA using qPCR

Note: Any 12 experiments must be performed

Reference Books

1. Channarayappa (2010) Cell Biology: Universities Press (India) Pvt Ltd.
2. David S Latchman (1994) From Genetics to Gene Therapy – the molecular pathology of human disease by, BIOS scientific publishers.
3. Berger SL and Kimmel AR (1987) Methods in enzymology, Vol.152, Academic Press.
4. Sambrook J et. al. (2000) Molecular cloning: a laboratory manual. Volumes I - III. Cold Spring Harbor laboratory Press, New York, USA.
5. Old RW and Primrose SB (1993) Principles of gene manipulation, an introduction to genetic engineering. Blackwell Scientific Publications.

Course outcomes (COs):

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

1. Choose appropriate method to isolate & quantify DNA/RNA. (PO-1, 4; PSO-1)
2. Amplify DNA/gene(s) using PCR & RT-PCR. (PO-1, 2, 4; PSO-2)
3. Compare, analyse and interpret the agarose gel electrophoresis results (PO-3, 4; PSO-2)
4. Perform gene transformation using the appropriate method. (PO-3, 4, 5; PSO-3)
5. Identify of transformed cells by appropriate screening technique (PO- 4, 5; PSO-3)

IMMUNO TECHNOLOGY LAB

Course Code	**:** BTL57	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Biochemistry Lab		
Course Coordinator(s)	**:** Dr. P. Dhamodhar & Dr. Abhijith S R		

LIST OF EXPERIMENTS

1. ABO Blood grouping & Rh typing
2. Radial Immunodiffusion
3. Ouchterlony Double Immuno Diffusion (ODD)
4. Immunoelectrophoresis (IEP)
5. Counter Immunoelectrophoresis (CIEP)
6. Rocket Immunoelectrophoresis
7. Widal & VDRL tests
8. Total count of RBC.
9. Total count of WBC
10. Differential count of WBC
11. Enzyme linked Immunosorbent assay (ELISA)
12. Latex Agglutination
13. Flow cytometry demonstration (Instrumentation) and applications
14. Western blotting demonstration

Note: Any 12 experiments must be performed

Reference Books:

1. Barbara Detrick (2016) Manual of Molecular and Clinical Laboratory Immunology, 8th Edition. Wiley
2. Rastogi SC (1996) Immundiagnostics. New Age International
3. Frank C Hay (2002) Practical Immunology. Blackwell Science.

Course outcomes (COs):

On completion of the course, student will have improved ability to:

1. Design and analyse the key concepts in immunological reactions, and to interpret the data. (PO-1, 2, 3, 4; PSO-1)
2. Select the appropriate Immunological technique for diagnosis of infectious diseases. (PO-1, 2; PSO-2)
3. Analyse and interpret various components of blood sample.PO-1, 2, 4; PSO-2)
4. Apply the knowledge of Immunological techniques in implementing research projects. (PO-1, 2, 3; PSO-2)
5. Distinguish various types of blood groups in humans. (PO-1, 2, 3; PSO-2)

BIOKINETICS AND BIOREACTION ENGINEERING LAB

Course Code	**:** BTL58	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Unit Operations Lab		
Course Coordinator(s)	**:** Mr. Gokulakrishnan M & Dr. Chandraprabha MN		

LIST OF EXPERIMENTS

1. Analysis of batch reactor
2. Analysis of Plug flow reactor
3. Analysis of mixed flow reactor
4. RTD of Plug flow reactor
5. RTD of mixed flow reactor
6. Effect of temperature on reaction rate constant
7. Analysis of Semi Batch Reactor
8. Determination of Enzyme activity
9. Study the effect of substrate concentration on enzyme activity (K_m and V_{max})
10. Fermenter performance
11. Effect of temperature/pH on reaction rate kinetics
12. Enzyme immobilization kinetics
13. Batch growth kinetics (Evaluation of doubling time and decay time)
14. Effect of dissolved oxygen on growth kinetics

Note: Any 12 experiments must be performed

Reference Books:

1. Rao DG (2005) Introduction to Biochemical Engineering, Tata McGraw Hill.
2. Bailey JE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. McGraw- Hill.
3. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
4. Sadashivam and Manikam (1992) Biochemical Methods, Wiley Eastern Ltd, New Delhi.

Course Outcomes (COs):

Students will be able to:

1. Predict the kinetics of reaction using different reactors. (PO-1, 2, 3, 4; PSO-1)
2. Evaluate the residence time distribution of MFR & PFR. (PO-4, 9; PSO-1)
3. Predict the effect of pH and temperature on reaction rate kinetics. (PO-2, 3, 4; PSO-2)
4. Predict the kinetics of enzyme reaction and apply for reactor studies. (PO-3, 9; PSO-3)
5. Determine the batch growth kinetics and evaluate fermentor performance. (PO-3, 9; PSO-3)

OPEN ELECTIVE OFFERED BY THE DEPARTMENT

BIOLOGY FOR ENGINEERS			
Course Code	**:** BT0E01	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** None		
Course Coordinator(s)	**:** Dr. Bindu S & Dr. Krishna Murthy T P		

UNIT-I

Introduction

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Evolution

Genes Within Populations, Evidence for Evolution, Origin of Species, Systematics, Phylogenetics, and Comparative Biology, Genome Evolution, evolution of Development.

UNIT-II

Classification

Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilisation -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitataacquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups- *E. coli, S. cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus*

Genetics

Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but

how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

UNIT-III

Biomolecules

Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Enzymes

Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

UNIT-IV

Information Transfer

DNA as a genetic material. Hierarchy of DNA structure from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Macromolecular analysis

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

UNIT-V

Metabolism

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of K_{eq} and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to $CO_2 + H_2O$ (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

Microbiology

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilisation and media compositions. Growth kinetics.

Textbooks:

1. Peter Raven, George Johnson, Kenneth Mason, Jonathan Losos, Tod Duncan. Biology. 12th Edition, 2020, McGraw-Hill Education.
2. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V Minorsky, Dobbs Ferry, Jane B. Reece. Campbell Biology. 11th Edition, 2020, Pearson Education Ltd.
3. David L. Nelson; Michael M. Cox. Lehninger Principles of Biochemistry, 7th Edition|, 2017, McGraw-Hill Education.

References:

1. Joanne Willey and Linda Sherwood and Christopher J. Woolverton. Prescott's Microbiology, 10th Edition, 2017, McGraw-Hill Education.
2. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's GENES XII, 12th Edition, 2017, Jones and Bartlett Publishers, Inc.
3. Douglas J. Futuyma and Mark Kirkpatrick. Evolution, 4th edition, 2017, Sinauer Associates, INC.

Course Outcomes (COs):

After studying the course, the student will be able to:

1. Understand the relationship between science and engineering and describe how biological observations of 18th Century that lead to major discoveries. Understand that biology comprises areas of study that focus on life at a variety of levels and from a diversity of perspectives.
2. Understand the hierarchy of life forms and highlight the concepts of recessiveness and dominance during the passage of genetic information from one generation to another.
3. Understand the manifestation of diverse life forms from the same building blocks and Identify DNA as the molecular basis of information transfer.
4. Classify various enzymes and differentiate between and its mechanism of action
5. Analyse biological processes at the reductionistic level, apply thermodynamic principles to biological systems and identify and classify microorganisms.

ENZYMOLOGY AND ENZYME TECHNOLOGY

Course Code	**:** BT61	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Biochemistry		
Course Coordinator(s)	**:** Dr. P. Dhamodhar and Dr. Ahalya N		

UNIT-I

Introduction to Enzymology: Introduction to enzymes, Advantages of enzymes vs chemical catalysts, Classification, Active site, Mechanism of enzyme action, enzyme specificities, Strategies of purification of enzymes, specific activity, fold purification and % yield in purification, criteria of purity, Case studies, Determination of molecular weight of enzymes.

UNIT-II

Enzyme Kinetics: Enzyme substrate reaction, Derivation of Michaelis and Menten equation, Lineweaver Burk plot, Eadie-Hofstee plot, Units of enzyme activity, Factors affecting enzyme activity. Enzyme inhibition: Irreversible inhibition & Reversible inhibition: Competitive, Uncompetitive, Mixed inhibition. Multisubstrate reactions: Ordered, random and ping-pong reactions. Regulation of enzyme activity: Allosteric regulation, Feedback regulation, Covalent modification, Proteolytic cleavage.

UNIT-III

Enzyme Catalysis & Enzymatic Techniques: Mechanism of enzyme action: Acid-base catalysis, Covalent catalysis, Metal ion catalysis with examples. Introduction to coenzymes & co-factors: (NAD+/NADP+, FAD, PLP), Metalloenzymes and metal activated enzymes. Enzyme measurement methods with examples: Methods for investigating the kinetics of enzyme catalysed reactions: Initial velocity studies, rapid-reaction techniques. Design and construction of novel enzymes, Artificial enzymes.

UNIT-IV

Medical applications: Enzymes of Biological Importance, Importance of enzymes in diagnosis, Enzyme pattern in diseases like Myocardial infarctions (SGOT, SGPT, & LDH), Liver disease. Isoenzymes (CK, LD, ALP). Use of isozymes as markers in diseases. Enzymes in immunoassay techniques, Therapeutic enzymes.

UNIT-V

Industrial applications: Techniques of enzyme immobilisation, applications of immobilised enzyme technology, Economic argument for immobilisation. Enzymes

used in detergents, use of proteases in food and leather industries; methods involved in production of glucose syrup from starch (using starch hydrolysing enzymes), production of glucose from cellulose and sucrose, uses of lactase in dairy industry, glucose oxidase and catalase in food industry.

Textbooks:

1. Nicholas C. Price and Lewis Stevens (2006), Fundamentals of Enzymology, 3rd Edition, Oxford University Press.
2. Trevor Palmer and Philip Bonner (2008) Enzymes: Biochemistry, Biotechnology and clinical Chemistry. 2nd Edition, East West Press Pvt. Ltd.

Reference Books:

1. Nelson DL and Cox MM (2005) Lehninger Principles of Biochemistry. 3rd or 4th edition Pub WH Freeman Co
2. Chaplin MF and Bucke C (1990) Enzyme technology. Cambridge University Press.
3. Gerhatz W (1990) Enzymes in Industry Production and Applications, VCH publishers.
4. Dordrick JS (1991) Biocatalysts for Industry. Plenum Press.

Course Outcome (COs):

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

1. Classify the enzymes, understand their general properties and select the appropriate analytical technique for purification and characterisation of enzymes. (PO-1; PO-2; PSO-1)
2. Integrate the practical aspects of enzymology with the kinetic theories to provide a mechanistic overview of enzyme activity and regulation in cells. (PO-1; PO-3; PSO-1)
3. Apply enzymatic techniques for measurement of enzymes and methods for enzyme engineering. (PO-2; PO-3; PSO-1)
4. Identify the role and use of various enzymes in diagnosis and treatment of diseases. (PO-1; PO-2; PSO-2, PSO-2)
5. Identify the current and possible future industrial applications of enzymes. (PO-1; PO-2; PSO-2, PSO-3)

UPSTREAM AND DOWNSTREAM PROCESS TECHNOLOGY

Course Code	**:** BT62	**Credits:**	3:1:0
Contact Hours	**:** 42L+14T		
Prerequisite(s)	**:** Cell Biology, Microbiology		
Course Coordinator(s)	**:** Dr. Lokesh K N & Dr. Ahalya N		

UNIT-I

Upstream processing of microbial and plant cells: Overview of fermentation process. Microbial and plant media constituents, formulation and optimisation. Batch and continuous sterilisation process. Mode of cell culture & concept of dual culture system. Somatic embryogenesis & Artificial seed production. Bioprocess consideration in using plant cell cultures: Bioreactors for suspension cultures, immobilised cells reactor technology. Production of industrially important metabolites vinca alkaloids, Shikonin, penicillin, Vit B12, ethanol.

UNIT-II

Animal cell technology: Characteristics of animal cells. Media for culturing animal cells and tissues; development of animal cell lines, maintenance and cryopreservation of animal cell lines and viability assessment. Specialized animal cell culture techniques: Fibroblast cultures, lymphocyte culture, stem cell isolation and culture. Bioreactors considerations for animal cell cultures and reactors. Production of Monoclonal antibodies.

UNIT-III

Basics of downstream processing and Separation techniques: Role & Importance of downstream processing in biotechnological processes. Characteristics of biological mixtures, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high value products), physicochemical basis of bio separation processes. Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, centrifugation and filtration methods.

UNIT-IV

Product Enrichment operations and Membrane Separation: Precipitation methods with salts, organic solvents, and polymers, extractive separations. Aqueous two-phase extraction, supercritical extraction; In situ product removal/integrated bio processing. Solute polarisation and cake formation in membrane ultra-filtration – causes,

consequences and control techniques; enzyme processing using ultra filtration membranes; separation by solvent membranes.

UNIT-V

Final product formulation and finishing operations: Hybrid Separation Techniques (Membrane chromatography, Electro chromatography, etc). Crystallization – Principles, Nucleation, Crystal Growth – Kinetics, crystallization of proteins. Drying and lyophilization in final product formulation. Quality Assurance and Regulatory affairs in Downstream Processing.

Text Books:

1. Peter Stanbury, Allan Whitaker, Stephen Hall (2017) Principles of Fermentation Technology, 3rd Edition, Butterworth-Heinemann.
2. S.S. Bhojwani M.K. Razdan (1996) Plant Tissue Culture: Theory and Practice, Elsevier Science.
3. B Sivasankar (2005) Bioseparations: Principles and Techniques, Prentice Hall India Learning Private Limited.

Reference Books:

1. Mukesh Doble (2015), Principles of Downstream Techniques in Biological and Chemical Processes, Apple Academic Press.
2. Michael C. Flickinger (2013) Upstream and Downstream Industrial Biotechnology, 1st edition, John Wiley & Sons, Inc.
3. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides (2015) Bioseparations Science and Engineering, Oxford University Press.

Course Outcomes (COs):

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

1. Apply appropriate strategy for scale up of microbes, plants and animals to obtain product of interest. (PO-1, 2, 3, 4, 5,9 PSO-1, 2,3)
2. Identification and implementation of animal cell culture techniques for scale up. (PO-1, 3,4,9 12; PSO-2,3)
3. Identify appropriate unit operations based on nature of biomolecules or complex bioprocess parameters. (PO-1, 2, ,9, 12; PSO-1,3)
4. Apply appropriate unit operation for isolation, purification and characterization of bioproduct. (PO-1,2, 3, 9; PSO-1,3)
5. Evaluate different unit operations for product crystallization and drying. (PO-1, 2,9, 10; PSO-1,3)

BIOPROCESS ENGINEERING

Course Code	**:** BTE631	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Unit operations and Heat & Mass Transfer		
Course Coordinator(s)	**:** Dr. Krishna Murthy T P & Dr. Chandraprabha M N		

UNIT-I

Introduction to Bioprocess Engineering:

The origins and domains of (bio)process engineering, early history of (bio)process engineering, Industrial era of (bio)process engineering, green and clean technologies, sustainable bioprocessing, types of bioprocesses and bioproducts. Presentation and analysis of bioprocess data, conservation laws, steady and unsteady sate mass and energy balances. Analogies between transport of momentum, heat and mass, Solution of transport equations.

UNIT-II

Hydrodynamics in Bioprocess Systems:

Rheological properties of fermentation broths, factors affecting broth Viscosity-Functions of mixing, mixing equipment, flow patterns in stirred tank, impellers, stirrer power requirements, power input by gassing, impeller pumping capacity, suspension of solids, mechanism of mixing, assessing mixing effectiveness, scale up of mixing systems, improve mixing in bioreactors, multiple impellers, retrofitting effect of rheological properties on mixing, role of shear in stirred bioreactors.

UNIT-III

Gas-Liquid Mass Transfer in Bioprocessing:

Role of diffusion in bioprocessing, film theory, convective mass transfer, oxygen uptake in cell cultures-factors affecting oxygen transfer in bioreactors, measuring dissolved oxygen concentration, estimating oxygen solubility, mass transfer correlations for oxygen transfer, measurement of kLa, measurement of specific oxygen uptake rate, practical aspects of oxygen transfer in large bioreactors, alternative methods for oxygenation without sparging, oxygen transfer in shake flasks.

UNIT-IV

Mass Transfer in Heterogeneous Bioprocess systems:

Heterogeneous reactions in bioprocessing, concentration gradients and reaction rates in solid catalysts, mass transfer considerations in heterogeneous systems.

Heat transfer Applications in Bioprocess Engineering:
Heat transfer equipment, mechanism of heat transfer, heat transfer between fluids, design equations for heat transfer systems, applications of design equations, hydrodynamic considerations with cooling coils. Sterilisation of media, kinetics of thermal death of Microorganisms-Batch and Continuous Sterilisers-Heat transfer in agitated tank and Columns-Heat transfer to dense suspension.

UNIT-V

Cell Culture Bioprocessing & Biomanufacturing:
Brief review on biopharmaceutical industry, Cell culture, cell culture products, cellular properties critical to biologics production, nutritional requirements, cell line development, bioreactors, Overview of continuous biomanufacturing, Facility Design and Process Utilities, Quality, validation, and regulatory aspects in biomanufacturing. Scale up and scale down of bioprocess systems.

Textbooks:

1. Pauline M Doran (2013) Bioprocess Engineering Principles, 2nd Edition, Academic Press.
2. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). Principles of fermentation technology. 3rd Edition, Elsevier.
3. Ganapathy Subramanian (2017) Continuous Biomanufacturing: Innovative Technologies and Methods, 1st Edition, John Wiley & Sons, Inc.

Reference Books:

1. Koltuniewicz, A. B. (2014). Sustainable Process Engineering: prospects and opportunities. Walter de Gruyter GmbH & Co KG.
2. El-Mansi, E. M. T., Bryce, C. F., Allman, A. R., & Demain, A. L. (2018). Fermentation Microbiology and Biotechnology. 4th Edition, CRC press.
3. Gunter Jagschies Eva Lindskog Karol Lacki Parrish Galliher (2017) Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes, 1st Edition, Elsevier B.V.
4. Michael L Shuler, Fikret Kargi (2017) Bioprocess Engineering: Basic Concepts, 3rd Edition, Pearson publishers.
5. Wei-Shou Hu (2017) Engineering Principles in Biotechnology, John Wiley & Sons, Inc.

Course Outcomes (COs):

On completion of this course students will have improved ability to

1. Understand the role of bioprocess engineering in modern chemical technology for sustainable production of industrial products (PO-2, 3; PSO-2)
2. Apply knowledge of momentum transfer in solving complex problem in industrial bioprocess. (PO-2, 3, 4; PSO-2)
3. Apply the principles of mass transfer in bioprocessing. (PO-2, 4, 6; PSO-3)
4. Understand the importance of heat transfer in industrial bioprocess (PO-2, 4, 6; PSO-3)
5. Apply the principles of bioprocess engineering in manufacturing of biopharmaceuticals. (PO-2, 4, 6; PSO-3)

FOOD BIOTECHNOLOGY

Course Code	**:** BTE632	**Credits:**	3:0:0
Contact Hours	**:** 42L		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Dr. Bindu S & Dr. Roshni Ramachandran		

UNIT-I

Microorganisms in foods: History of microorganisms in food. The role and significance of microorganisms, Intrinsic & extrinsic factors of spoilage, Primary sources of microorganisms found in foods, Types of microorganisms in foods. Synopsis of common food-borne bacteria, Synopsis of genera of molds common to foods, Synopsis of genera of yeasts common to foods.

UNIT-II

Determining microorganisms and their products in foods: Culture, microscopic and sampling methods, Conventional; SPC, Membrane filters, Microscope colony counts, Agar droplets, Dry films, most probable Numbers (MPN), Dye-reduction, Roll tubes, Direct microscopic count (DMC), Microbiological examination of surfaces, Air sampling, Enumeration and detection of food-borne organisms.

UNIT-III

Food spoilage and preservation: Microbial spoilage of vegetables, fruits, fresh and processed meats, poultry, Food preservation using irradiation, Legal Status of Food Irradiation, Effect of Irradiation of food constituents; Food preservation with low temperatures: Slow & quick freezing, Effect of freezing on microorganisms. Food preservation with high temperatures: Blanching, Pasteurisation, Sterilisation, Aseptic Packaging, Canning, Factors affecting heat resistance in microorganisms thermal destruction-D, Z & F values. Preservation of foods by drying: Factors influencing evaporation, Factors of relevance in control of drying, Changes brought about in food by drying, Freeze drying.

UNIT-IV

Biotechnology in food industry: Common additives, Organic foods, Prevention of spoilage, Storage and preservation through biotechnological means, Food packaging: Packaging methods and materials: Controlled atmosphere packaging and Modified atmosphere packaging. Factors influencing food product development. Introduction to: Nutrition value, Basal metabolic rate, Dietary strategies for individuals, ecologically sustainable production, Risks and benefits of biotechnology to food industry.

UNIT-V

Nutraceuticals and Phytoceuticals: Water soluble and fat-soluble vitamins, Functions and nutritional importance of vitamins. Deficiency diseases, prevention. Estimation of vitamins from the sample, Assay of vitamins: Fat soluble & water soluble Essential amino acid, fatty acids, Electrolytes, Anti-obesity nutraceuticals, Golden rice.

Textbooks:

1. James M Jay Martin J Loessner and David A Golden (2006) Modern Food Microbiology. 7th edition, Springer, US.
2. Norman N. Potter and Joseph H.Hotchkiss (2007) Food Science , 5th edition, CBS publishers and distributors
3. King RD and Cheetham PSJ, Ed., (1988) Food Biotechnology - 2. Elsevier NY.

Reference Books:

1. Dietrick Knorr, Ed., (1987) Food Biotechnology. Marcel Dekker, Inc., NY.
2. Owen R. Fennema, Ed., (1985) Food Chemistry. Marcel Dekker, Inc., NY.
3. Rogers PL and Fleet GH, Ed., (1989) Biotechnology and the Food Industry.

Course Outcomes (COs):

On completion of the course, the student should be able to:

1. List, identify & distinguish the commonly found microorganisms in food, correlate them to their role & routes of entry into food. (PO-2; PSO-2)
2. Differentiate types of spoilages seen in various food categories & suggest methods of preservation. (PO-2, 3, 4, 5; PSO-2)
3. Identify & describe the processing & preservation methods practiced in the food industry (PO-2,3,4,5; PSO-2)
4. TO understand biotechnological methods of food preservation & sustainable food production. (PO-2, 3, 4, 5; PSO-2)
5. Identify & classify minor food components, nutraceuticals & relate them to their roles. (PO-2, 4, 5; PSO- 2)

TISSUE ENGINEERING

Course Code	: BTE633	**Credits:**	3:0:0
Contact Hours	: 42L		
Prerequisite(s)	: Cell Biology		
Course Coordinator(s)	: Dr. Prabha M & Dr. Abhijith S R		

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 organisation. 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, 2D and 3D models of cell culture; Microfluidics – Transport, Engineered Microvascular systems and Angiogenesis. 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 characterisation 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. 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. Analyse the mechanism and organisation of ECM and their applications in tissue engineering. (PO-1, 3, 4, 5, 9; PSO-2)

3. Utilise 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)

FORENSIC SCIENCE

Course Code	: BTE641	**Credits:**	3:0:0
Contact Hours	: 42L		
Prerequisite(s)	: Biochemistry		
Course Coordinator(s)	: Dr. Y S Ravikumar and Dr. 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 and optional service crime laboratories, Physical Science unit, Biological Unit, Firearms Unit, Document Examination unit - Function and Duties Performed by each unit, Evidence – Types, Nature and its Basis.

UNIT-II

Forensic Criminalistics: The Crime Scene Investigation- Making and recording observations (including notes, sketches, digital photographs and video recording), Crime Scene Investigation team – Members and their roles and responsibilities, Chain of Custody, Locard Exchange Principle, Evidences and Collection techniques with its significance – Physical and Trace evidences (Hair, fiber and Paint), Marks and impressions, IR Applications in Crime Scene Investigation.

UNIT-III

Forensic Biology: Forensic Pathology- Rigor mortis, Livor mortis, Algor mortis, Forensic Anthropology- Skeletal remain examinations and Developing Biological Profile (Identification of Species, Race and Sex), Forensic Pathology – Autopsy (External, Internal examination, Cause of Death), Forensic Entomology, Forensic Odontology, Forensics Engineering, Forensic Serology, DNA Fingerprinting, Fingerprints: History, Fundamental Principle of Fingerprints, Classification and patterns, AFIS, Methods of Detecting Latent Fingerprints.

UNIT-IV

Applications of Analytical Instruments in Forensic Toxicology: Alcohol & its ADME, Testing for Intoxication using Breathalyser, Analysis of Blood for Alcohol, Techniques used to detect Drugs and Poisons using pH, Acids, Bases, TLC, UV, GC, FTIR, MS, Immunoassay and Chemical tests, Drug of Abuse – Types, Psychological and Physical dependence, analysis using Qualitative (color, microcrystalline tests) and Quantitative tests.

UNIT-V

Forensic Digital Imaging: Introduction, Digital Image Processing- sharpening, contrast, blur, smoothing, Cyber Crime, Forgery and Hand Writing Analysis, Computerized Facial Reconstruction (Skull-Photo Superimposition, 2D and 3D Techniques).

Forensic Ethics: Introduction and Importance of Professional Ethics in Forensic Science, Organizational Forensic Science Ethics, Code of Ethics in Forensic Science Practice, Standards for Good Forensic Practice, Ethical problems in Ethical Forensic sciences, Ethical Dilemmas.

Text Books:

1. Jay Siegal, Geoffrey Knuper, Pekku Saukko (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. Richard Li (2015), Forensic Biology, 2nd edition, CRC Press, Taylor and Francis group, New York, USA.

Reference Books:

1. Richard Saperstein (2001): Criminalistics: An Introduction to Forensic Science –Prentice Hall.
2. David Ellen (2003) The Scientific Examination of Documents Methods and Techniques-, Taylor and Francis.
3. AynEmbar-Seddon, Allan D. Pals (2009) Forensic Science, Salem Press, Inc. Paradena, California.
4. Jami J. St Clair (2002) Crime Laboratory Management-Academic Press.

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, 5, 6, 9, 12; PSO-1)
2. Apply the principles of collection and analyse the different types of evidences in criminalistics. (PO–1, 3, 4, 5; PSO-2)
3. Understand the concepts in different areas of forensic biology. (PO – 1, 2, 4, 5, 9; PSO-2)
4. Apply the analytical instrumentation in forensic toxicological applications. (PO–1, 2, 4, 5; PSO-2)
5. Understand the concepts in forensic digital imaging and importance of forensic ethics. (PO – 3, 5, 6, 8; PSO-2)

RESEARCH METHODOLOGY

Course Code	: BTE642	**Credits:**	3:0:0
Contact Hours	: 42L		
Prerequisite(s)	: Biostatistics and Biomodelling		
Course Coordinator(s)	: Dr. Priyadarshini Dey and Dr. Ravi Kumar Y.S		

UNIT-I

Introduction to research methodology: Definition and meaning of research. Characteristics of research. Research method and methodology. Objectives of Research. Scientific method–Characteristics of scientific method. Types of research. Approach to Research- inter and multi-disciplinary research. Methods of research-Concept, Construct, Variable. Research Process-Various Steps in Research process.

UNIT-II

Research Formulation and design: Formulating a Research Problem-List the steps involved in formulating a research problem. Factors considered in formulating a research problem -Identification of research gaps. Reviewing the literature sources for research problems- (Web Search: using search engines: science direct, pubmed, Google Scholar and other advanced search tools). Constructing hypotheses and qualities of good hypothesis-logic and importance. Research design- Types of Research Designs, basic principles of research design, need of research design.

UNIT-III

Data collection: Sampling techniques -random sample and complex random sample design. Features of good sampling design. 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 with examples. Survey methods. Experimental research data collecting methods. Data processing and statistical analysis.

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. Writing project proposal (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, customising presentation (Tool used: Microsoft Power point). Research ethics. ISO audits and certification (Occupational Health and Safety Assessment Series) OHSAS. Plagiarism.

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 students will have improved ability to:

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

NANOBIOTECHNOLOGY

Course Code	: BTE643	**Credits:**	3:0:0
Contact Hours	: 42L		
Prerequisite(s)	: Nil		
Course Coordinator(s)	: Dr. Samrat K and Dr. Roshni Ramachandran		

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. Characterisation 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 synthesise and characterise 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)

MINI PROJECT/NPTEL COURSE

Course Code	**:** BT65	**Credits:**	0:0:4
Contact Hours	**:** 56P		
Prerequisite(s)	**:** Nil		
Course Coordinator(s)	**:** Project Coordinators		

Course content

A group of students will be assigned a guide in the beginning of sixth semester and they need to work on a case study or research topic. The group shall not contain more than four students. At the end of the semester, students are required to submit a technical report approved by respective guides. The project will be evaluated by the guide(s) and a project evaluation committee to award the CIE marks as per the rubrics designed by the committee.

Students who are unable to register for mini project can take up a 04 credit NPTEL course approved by the coordinator(s) of mini project and HoD. The student must write the examination and produce the certificate for the course.

Course outcomes (COs):

1. Able to analyse scientific data. (PO-1, 2, 8, 9; PSO-3)
2. Able to apply concepts in research work. (PO-1, 2, 4, 6, 8, 9, 10, 11; PSO-1)
3. To evaluate teamwork or independent work skills. (PO-1, 2, 4, 5, 6, 8, 10, 11; PSO-2)
4. Able to apply research methodology for the formulation of research design. (PO-6, 10, 11; PSO-3)
5. Develop effective communication and research report writing skills (PO-6, 10, 11; PSO-3).

UPSTREAM PROCESS TECHNOLOGY LAB

Course Code	**:** BTL66	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Microbiology		
Course Coordinator(s)	**:** Dr. Priyadarshini Dey & Dr. Lokesh K. N.		

LIST OF EXPERIMENTS

1. Media Preparation and sterilisation
2. Organ culture-Stem/node/internodes/Leaf
3. Callus Induction Techniques
4. Development of suspension culture from callus
5. Lycopene estimation
6. Production of Secondary metabolite – Anthocyanin
7. Encapsulation of artificial seed
8. Shake flask studies, Comparison of yield in synthetic and complex media
9. Estimation of DNA (by diphenyl method)
10. Preparation & validation of the Fermenter
11. Single Cell Protein (SCP) production
12. Preparation of seed culture
13. Study of effect of substrate inhibition on cell growth
14. Replica plating for screening of auxotrophs/antibiotic resistant strain

Note: Any 12 experiments must be performed

Reference Books:

1. Dixon RA and Gonzales (1989) Plant Cell Culture: A Practical Approach, IRL Press.
2. Channarayappa (2006) Molecular Biotechnology: Principles and practices. Universities Press (India) Private Limited and CRC Press World-wide.
3. John H. Dodds and Lorin W. Robert (1985) Experiments in Plant Tissue Culture, Second Edition Cambrige University Press.

Course Outcomes (COs):

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

1. Design plant tissue culture and microbiological technology experiments. (PO-1, 2,9; PSO-2)
2. To grow, screen and isolate auxotrophs. (PO-4, 5, 6, 10; PSO-2)

3. To isolate, estimate, and quantify secondary metabolites. (PO-1, 4, 6, 10; PSO-3)
4. Correlate the applications of biochemical and microbiological principles in upstream process technology. (PO-1, 2, 6, 8; PSO-3)
5. Apply appropriate methods for scale up of microbes and plants to obtain products of interest (PO-2, 4, 5, 6; PSO-2)

DOWNSTREAM PROCESS TECHNOLOGY

Course Code	: BTL67	**Credits:**	0:0:1
Contact Hours	: 14P		
Prerequisite(s)	: Unit Operations & Bioanalytical Techniques		
Course Coordinator(s)	: Dr. K N Lokesh & Dr. 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 % 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-1,2,9,12; PSO-1,3)
2. Choose appropriate unit operations for isolation and purification of biomolecules. (PO-1,2, 4, 9, 12; PSO-1)
3. Identify appropriate qualitative and quantitative analysis methods depending upon the chemical nature of analyte. (PO-1, 2, 4, 9, 12; PSO-3).
4. Enhance product output by selection of appropriate method of enrichment operation. (PO-1,2, 3, 9,12; PSO-3).
5. Enhance product quality by appropriate method of purification operation. (PO-1,2, 3, 9,12; PSO-3)

BIOINFORMATICS LAB

Course Code	**:** BTL68	**Credits:**	0:0:1
Contact Hours	**:** 14P		
Prerequisite(s)	**:** Genomics, Proteomics and Bioinformatics		
Course Coordinator(s)	**:** Dr. Bhavya S G & Dr. Y S Ravikumar		

LIST OF EXPERIMENTS

1. Biological data retrieval from bibliography database and working with referencing format
2. Pairwise sequence comparison of the sequences retrieved from nucleic acid/protein database
3. Sequence similarity search using BLAST tool and analysis of parameters affecting alignment
4. Multiple Sequence Alignment (MSA) and comparison of different MSA tools
5. Molecular Phylogenetics analysis
6. Gene prediction for prokaryotic and eukaryotic genome
7. Retrieval of protein structure, visualization and analysis
8. Prediction of secondary structures for protein sequences
9. Prediction of tertiary structure for protein sequence using homology modelling and structure validation
10. Construction of restriction map for given DNA sequence and analysis of restriction sites
11. Design of PCR primers and analysis of parameters affecting the primer
12. Retrieval and analysis of biological big datasets from NGS database
13. Bioinformatics analysis of proteomics data- Gene ontology, protein-protein interactions and pathway analysis
14. Prediction of ADME properties of ligands and performing molecular docking studies

Note: Any 12 experiments must be performed

Reference Books

1. Jonathan Pevsner, Bioinformatics and Functional Genomics, 3rd Edition, John Wiley & Sons, Inc, 2015.
2. Arthur Lesk., Introduction to Bioinformatics, 4th Edition, Oxford University Press, 2013.
3. Michael Agostino, Practical Bioinformatics, 1st Edition, Garland Science publisher, 2012.

Course outcomes (COs):

On completion of the course, student will have improved ability to:

1. Perform sequence alignment to identify the regions of similarity in DNA/RNA/protein sequences using appropriate sequence alignment methods (PO-2, 4, 5, PSO-2)
2. Construct and analyse the phylogenetic tree to understand the evolutionary relationships of organisms using appropriate phylogeny tools (PO-2, 4, 5, PSO-2)
3. Predict the functional sites in DNA sequence using online gene prediction tools (PO-4, 5, PSO-2)
4. Predict Secondary and tertiary structure of proteins and visualise using available open-source tools (PO-4, 5, PSO-2)
5. Apply the computational tools to address important problems of biotechnology (PO-4, 5, PSO-2)

OPEN ELECTIVE OFFERED BY THE DEPARTMENT

PRINCIPLES OF FOOD PROCESSING & PRESERVATION (Open Elective)			
Course Code	: BTOE02	**Credits:**	3:0:0
Contact Hours	: 42L		
Prerequisite(s)	: Nil		
Course Coordinator(s)	: Dr. Bindu S & Mr. M Gokulakrishnan		

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, pasteurisation and sterilisation 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-ionising and ionising 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. Shakuntla 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)