S81BLH11	BIOCHEMISTRY AND METABOLIC ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVE

By the end of the course, students should be able to

- Develop a strong foundation in biochemistry, cellular metabolism, and metabolic engineering principles.
- Critically analyze and apply their knowledge to real-world problems in the field of biochemistry and metabolic engineering.

UNIT 1 INTRODUCTION TO BIOCHEMISTRY 9 Hrs.

Overview of biochemistry and its importance in understanding cellular processes. Biomolecules: structure, function, and properties of carbohydrates, lipids, proteins, and nucleic acids. Enzymes: classification, kinetics, and regulation. Metabolism: an introduction to metabolic pathways, catabolism, and anabolism.

Lab exercise: Estimation of protein (Lowry method), Estimation of DNA.

UNIT 2 CELLULAR METABOLISM 9 Hrs.

Energy metabolism: ATP and its role as a universal energy currency. Glycolysis: pathway, regulation, and energy yield. Citric Acid Cycle (Krebs cycle): steps, regulation, and energy production. Oxidative phosphorylation: electron transport chain, ATP synthesis, and respiratory control. Photosynthesis: light reactions and carbon fixation.

Lab exercise: Enzyme kinetics studies.

UNIT 3 METABOLIC PATHWAYS AND REGULATION 9 Hrs.

Metabolic interconversions: gluconeogenesis, glycogen metabolism, and fatty acid metabolism. Amino acid metabolism: biosynthesis and degradation pathways. Nucleotide metabolism: synthesis and salvage pathways. Metabolic regulation: allosteric control, hormonal regulation, and signal transduction pathways.

Lab exercise: Kinetic model development in COPASI

UNIT 4 METABOLIC ENGINEERING PRINCIPLES 9 Hrs.

Introduction to metabolic engineering: goals, strategies, and applications. Rational strain design: optimization of metabolic pathways for improved production of desired compounds. Synthetic biology tools: genetic manipulation techniques and pathway engineering. Metabolic flux analysis: understanding and manipulating metabolic fluxes in engineered organisms. Case studies: examples of successful metabolic engineering projects.

Lab exercise: Chemostat cultivation for carrying out metabolic flux analysis

UNIT 5 EMERGING TOPICS IN BIOCHEMISTRY AND METABOLIC ENGINEERING 9 Hrs.

Systems biology: integration of computational modeling and experimental data for understanding complex biological systems. Metabolomics: techniques for studying small molecule metabolites and their role in cellular processes. Bioinformatics: computational approaches for analyzing and interpreting large-scale biological data. Bioprocessing and bioreactor design: scale-up strategies for industrial production of biofuels, pharmaceuticals, and other compounds. Ethical and societal considerations in biochemistry and metabolic engineering.

Lab exercise: Bioconductor package for metabolomics.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, the students should be able to

CO1 - Understand the fundamental principles of biochemistry, including the structure, function, and properties of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.

CO2 - Explain the key metabolic pathways involved in cellular metabolism, including glycolysis, the citric acid cycle, oxidative phosphorylation, and photosynthesis, and understand their regulation and energy production.

CO3 - Analyze and interpret the interconversions of metabolites in various metabolic pathways, including gluconeogenesis, glycogen metabolism, fatty acid metabolism, amino acid metabolism, and nucleotide metabolism.

CO4 - Apply the concepts of metabolic regulation to understand how enzymatic activity is controlled through allosteric control, hormonal regulation, and signal transduction pathways.

CO5 - Apply the principles of metabolic engineering to design and optimize metabolic pathways for the production of desired compounds, using rational strain design and synthetic biology tools.

CO6 - Discuss emerging topics in biochemistry and metabolic engineering, such as systems biology, metabolomics, bioinformatics, bioprocessing, and bioreactor design, and understand their applications and implications in the field.

TEXT / REFERENCE BOOKS

1. "Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox (2020, 7th edition)
2. "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer (2015, 8th edition)
3. "Metabolic Engineering: Principles and Methodologies" by Gregory N. Stephanopoulos, Aristos A. Aristidou, and Jens Nielsen (1998, 2nd edition)
4. "Principles of Biochemical Engineering" by James M. Lee and Michael L. Shuler (2018, 2nd edition)
5. "Biochemical Engineering and Biotechnology" by Ghasem Najafpour (2007, 1st edition)
6. "Metabolic Engineering" by Christina Smolke (2015, 1st edition)
7. "Biochemical Engineering: A Textbook for Engineers, Chemists, and Biologists" by Shigeo Katoh and Fumitake Yoshida (2016, 1st edition)
8. "Systems Biology: Properties of Reconstructed Networks" by Bernhard Ø. Palsson (2006, 1st edition)
9. "Metabolomics: From Fundamentals to Clinical Applications" by Ute Roessner and Coral Barbas (2007, 1st edition)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

S81BLH12	ENZYME AND PROTEIN ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVE

- To give an insight into the essential concepts of engineering proteins and enzymes and apply them for future research and solve problems in various fields.

UNIT 1 PROTEIN ARCHITECTURE AND CHARACTERIZATION 9 Hrs.

Hierarchical representation of proteins, structural classification of proteins, protein folding and protein stability. Peptide sequencing - Sanger and Edman methods. Characterization of Protein structure: Crystallography and X-Ray Diffraction, Spectroscopy (UV-VIS, NMR and Fluorescence Spectroscopy).
Lab Exercise: Separation and Identification of amino acids by circular paper chromatography, Molecular weight determination of proteins

UNIT 2 ENZYMES 9 Hrs.

Enzyme nomenclature, classification of enzymes, Specificity, Turn over number, Enzyme units (IU and Katal), Active site, Fischer's Lock and key model, Koshland's Induced fit hypothesis, Activation energy, Factors affecting enzyme activity, Mechanisms of catalysis - Acid base catalysis, electrostatic catalysis, covalent catalysis and enzyme catalysis, Role of co-enzymes and co-factors
Lab Exercise: Enzyme assay, Effect of pH on Enzyme activity, Effect of temperature on Enzyme activity

UNIT 3 ENZYME KINETICS 9 Hrs.

Michaelis Menten equation, Lineweaver, Burk plot, Eadie Hofstee, Hanes Woolf Plots – Km and Vmax, Bi-substrate reactions, Enzyme Inhibition - Irreversible, Reversible-Competitive, Uncompetitive and Non-Competitive inhibition
Lab Exercise: Determination of Km using MM Plot, Determination of Km using LB Plot

UNIT 4 ENZYME PURIFICATION AND APPLICATIONS 9 Hrs.

Production and purification of crude enzyme extracts from plant, animal and microbial sources; Specific activity. Techniques for Immobilization of enzymes and Overview of applications of immobilized enzyme system. Abzymes and their applications. Enzyme electrodes, biosensors and their applications in industry, healthcare and environment, ELISA, EMIT
Lab Exercise: Salting in, Salting out, Dialysis, Determination of specific activity of enzyme

UNIT 5 PROTEIN ENGINEERING AND COMPUTATIONAL STUDIES 9 Hrs.

Overview of protein engineering strategies: Random and site- directed mutagenesis, Various PCR based strategies. Antibody engineering, Industrial, Environmental and Biomedical applications.
Protein databases. Sequence Analysis, Structure prediction
Lab Exercise: Retrieval of protein sequence from database, Pair-wise sequence alignment, Multiple sequence alignment

Max.45 Hrs.

COURSE OUTCOMES

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

CO1 - Compare the levels of protein structure relating this information to the function of proteins
CO2 - Analyze the mechanism of action of various enzymes
CO3 - Elucidate the importance of Km and Vmax in enzyme kinetics and inhibition
CO4 - Interpret the vital role of enzymes in industry and medicine
CO5 - Apply appropriate computational databases and tools to predict the sequence and structure of proteins

CO6 - Appraise different protein design strategies used to design completely new proteins tailored to specific tasks

TEXT / REFERENCE BOOKS

1. Voet D. and Voet G., "Biochemistry", Third Edn. John Wiley and Sons, 2001
2. Trevor Palmer, P. B. (2007). Enzymes. Wood head Publishing - ISBN : 9780857099921, 0857099922
3. Meenakshi Meena, D. C. (2009). Fundamental of Enzymology. Aavinshankar Publisher 2009 - ISBN-10 : 8179102807 / ISBN-13 : 978-8179102800
4. Michael Gromiha M. Protein Bioinformatics: From sequence to Function, 1st Edition, Elsevier, 2010.
5. Kessel A and Ben-Tal N, Introduction to Proteins: Structure, Function and Motion, 1st Edn., CRC Press, 2010.
6. Krishna Mohan Poluri and Khushboo Gulati, Protein Engineering Techniques: Gateways to Synthetic Protein Universe, Springer, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBTB5101	BIOPROCESS ENGINEERING	L	T	P	EL	Credits	Total marks
		3	0	0	0	3	100

COURSE OBJECTIVES:

- To understand the fundamental principles of bioprocess engineering to gain the knowledge in downstream processing.

UNIT 1 PRINCIPLE OF BIOPROCESS 9 Hrs.

Rate law, zero and first-order kinetics, Ideal reactors– batch, mixed flow, and plug flow, Enzyme immobilization, diffusion effects – Thiele modulus, effectiveness factor, Dam Koehler number, Kinetics of Batch and continuous microbial growth.

UNIT 2 DESIN OF MEDIA AND STERILIZTION 9 Hrs.

Design of media- Plackett burman and Response Surface model, Types of media: microbial culture medium, plant and animal cell culture medium. Media sterilization; kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, sterilization of air and filter design, Radiation and chemical sterilization.

UNIT 3 DESIGN OF BIOREACTORS 9 Hrs.

Batch, fed-batch and continuous processes: Operation of batch, continuous and fed-batch processes and industrial applications, Comparison of batch, fed-batch and continuous processes, Multiple CSTR series.

UNIT 4 MASS TRANSFER 9 Hrs.

Rheology of fermentation fluids: Newtonian and non-Newtonian fluids, Aeration and agitation, power requirement for gassed and un-gassed systems, time calculation for mixing. Mass transfer in bioreactors: Oxygen transport from the bubble to the cell. Measurement of kLa, Factors influencing mass transfer.

UNIT 5 DOWNSTREAM PROCESSING 9 Hrs.

Downstream Process steps, salting out, Ultrafiltration principle and applications, dialysis and its applications, Chromatography: TLC, HPLC, Gel Permeation, Ion Exchange chromatography, Crystallization, Lyophilization and Drying.

Max.45 Hrs.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Understand the principle of bioprocess technology.
CO2 - Design of fermentation media for desired product.
CO3 - Interpret filtration and heat sterilization.
CO4 - Evaluate microbial growth kinetics by Monod model.
CO5 - Determine the mass transfer coefficient by dynamic gassing out method.
CO6 - Compare the working principle of Ion and Gel Permeation chromatography.

TEXT / REFERENCE BOOKS

1. Bioprocess Engineering Principles. By Paulin M. Doran. Elsevier Science & Technology Books, 2008.
2. Biochemical Engineering Fundamentals, Second Edition, James E. Bailey, David F. Ollis. Mc Graw Hill, 2004.
3. Bioprocess Engineering Basic Concepts 2nd Edition, Michael Shuler, Fikret Kargi. Prentice-Hall India, 2006.

4. Bioprocess Engineering: Kinetics, Mass Transport, Reactors and Gene Expression by Wolf. R. Vieth. A Wiley-Inter science Publication, 2009.
5. "Principles of fermentation technology" P F Stanbury and A Whitaker, Pergamon press, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBTB5102	RESEARCH METHODOLOGY AND IPR	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge on formulation of research problem, research methodology, and ethics involved in doing research and importance of IPR protection.

UNIT 1 RESEARCH METHODOLOGY 9 Hrs.

Meaning of research problem, Sources of research problem. Criteria characteristics of a good research problem. Errors in selecting a research problem. Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism. Research ethics.

UNIT 2 RESULTS AND ANALYSIS 9 Hrs.

Importance and scientific methodology in recording results. Importance of negative results. Different ways of recording, industrial requirement, artifacts versus true results. Types of analysis (analytical, objective, and subjective), outcome as new idea, hypothesis, concept, theory, model etc.

UNIT 3 TECHNICAL WRITING 9 Hrs.

Effective technical writing, how to write a manuscript/responses to reviewers comments, preparation of research article/research report, writing a research proposal, presentation and assessment by a review committee.

Unit 4 INTELLECTUAL PROPERTY RIGHTS 9 Hrs.

The concept of Intellectual property rights, Evolution and development of concept of IPR. Patents, Designs, Trade Mark, Copyright, Trade secrets, utility models, IPR and Bio diversity. Role of WIPO and WTO in IPR establishments. Functions of UNESCO in IPR maintenance. Protection of GMO's IP as a factor in R&D, IP's of relevance to biotechnology.

UNIT 5 PATENTS 9 Hrs.

Origin of the patent regime. Early patents act & Indian pharmaceutical industry. Types of patents, Patent Requirements, objectives and benefits. Concept, features of patent, Inventive step, Specification, Patentable subject matter. Application preparation, filing and process, E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CO2 - Understand research problem formulation & Analyze research related information and Follow research ethics

CO3 - Correlate the results of any research article with other published results. Write a review article in the field of engineering.

CO4 - Appreciate the importance of IPR and protect their intellectual property.

CO5 - Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D,

CO6 - Create the new and better products, and in turn brings about, economic growth and social benefits

TEXT / REFERENCE BOOKS

1. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.
3. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
4. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
5. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
6. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

SBTB6101	BIOPROCESS ENGINEERING LAB	L	T	P	EL	Credits	Total Mark
		0	0	4	0	2	100

COURSE OBJECTIVES:

- To understand the fundamental principles of bioprocess experiments
- To gain the knowledge in microbial kinetics.

LIST OF EXPERIMENTS

1. Design of media by Plackett Burman model.
2. Design of media by Response surface methodology.
3. Estimation of Microbial growth rate by Monod Model.
4. Thermal Death kinetics
5. Estimation of kLa by dynamic gassing out method,
6. Thin layer chromatography.
7. Column chromatography.
8. Effect of pH and temperature on acid phosphatase enzyme activity.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Understand the principle of placket burman model.
CO2 - Design of fermentation media by RSM.
CO3 - Determine the thermal death rate.
CO4 - Evaluate microbial growth kinetics by Monod model.
CO5 - Determine the mass transfer coefficient by dynamic gassing out method.
CO6 - Compare the working principle of TLC and column chromatography.

S81BLH21	ADVANCED PLANT AND ANIMAL BIOTECHNOOGY	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

This course will provide students with the recent knowledge of genetic engineering. At the end of the course, a successful student will be able to

- Understand and explain the concept of Plant & Animal Tissue culture techniques, applications and limitations.
- Apply learned knowledge to their future research.

UNIT 1 MOLECULAR BIOLOGY OF AGROBACTERIUM MEDIATED DNA TRANSFER 9 Hrs.

Ti plasmid Vectors- Binary and co-integrated vectors- Transformation strategies in plants – Agrobacterium tumefaciens & Agrobacterium rhizogenes. Plant viruses as vectors. Physical method of transfer-Biolistics –Electroporation. Transposons in transgenic plants – their uses – Terminator gene technology, RNAi, Metabolic Engineering – Modification of plant Nutritional content – Amino acids and lipids as Bioreactor- polymers and foreign proteins in seeds.

Lab Exercises: Plant tissue culture media preparation, Micropropagation,Agrobacterium mediated Transgenesis Isolation of genomic DNA from plant source, Isolation of plasmid DNA , Estimation of DNA by spectrophotometry, Agarose Gel Electrophoreis, Polyacrylamide Gel Electrophoresis, Detection of DNA in Polyacrylamide Gels by Staining.

UNIT 2 SELECTABLE MARKERS, REPORTER GENES 9 Hrs.

Promoters used in Plant vectors genetic engineering for - heat, drought and saline tolerance (Osmogenes) - Virus resistance. - Pest resistance - Herbicide resistance - Herbicide tolerance - Delayed fruit ripening - Fungal and bacterial resistance - Secondary metabolite production-Production of therapeutic proteins- antibodies- vaccines edible Vaccineshormones- Golden Rice- Biolistic in transgenic plants. Marker free transgenic plants. Cotransformation-Transgenic silencing. Molecular aspects of nitrogen fixation.

Lab exercise: Direct organogenesis, Indirect organogenesis, Anther culture Embryo culture

UNIT 3 CHLOROPLAST GENETIC ENGINEERING CHLOROPLAST GENOME 9 Hrs.

Transplastomic plants – Mitochondrial genome- Legal protection and IPR- patent Co-operation Theory (PCT) - Indian and International Agencies involving in IPR and Patenting – IPR in India- WTO agreement.

Lab exercise:. Somatic embryogenesis, Synthetic seeds Protoplast culture

Heat shock /UV stimulations and analyse the gene response studies using PCR Techniques

UNIT 4 HISTORY SCOPE AND PROSPECT OF ANIMAL CELL CULTURE 9 Hrs.

History of animal cell culture and development, Development of primary culture, Development of cell line by enzymatic disaggregation, Culture media and growth conditions.Cell type and characterization, origin of animal cell line, maintenance and characterization of different cell lines, Marker gene characterization. Growth and scale up: Cell growth characteristics and kinetics, Micro-carrier attached growth, Cell culture in continuous, perfusion and hollow fiber reactor, Mass transfer in mammalian cell culture. Technology – Present and future: Hybridoma technology/Monoclonal antibody technology, Vaccine production, Organ culture, Transfection of animal cells, Future tissue engineering.

Lab exercise:. Preparation of glasswares, cell culture medias, Additives and Reagents-PreparativeCalculations,.Prepartionof Primary cell culture/Cancer cells,.Estimation of viability by Dye exclusion studies.Subculturing of adherent and Suspension cells,.Preservation and Revival of celllines

UNIT 5 TRANSGENIC AND KONCK OUT ANIMALS 9 Hrs.

Methodology, Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Applications of transgenic animals Gene Therapy: Ex-vivo gene therapy, In vivo gene therapy, Viral gene delivery system,Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vectorsystem, Herpex simplex virus vector system, Non-viral gene delivery system, Prodrug activation therapy, Nucleic acid therapeutic agents. 6.In Vitro Fertilization and Embryo Transfer:Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. .Stem cells: Classification and types, Sources, Markers, Differentiation signals, application, IPSC

Lab exercise: Electroporation-Mediated Genome Editing of zebrafish embryos, Production of transgenic animals ,MTT Based Cytotoxicity assasy,Gene Expression techniques using qRT-PCR techniques.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the concepts and Molecular techniques of plant tissue culture
CO2 - Understand the basic methods of mapping and cloning plant genes.
CO3 - Generate the ability to create genetically modified plants by means of plant breeding and genetic engineering with improved quality traits.
CO4 - Learn about animal cell culture technique in laboratory & large scale.
CO5 - Learn about various techniques in animal biotechnology.
CO6 - Learn about IVF & Stem cells techniques and its importance

TEXT / REFERENCE BOOKS

1. Plant Biotechnology – New products and Applications by J.Hammond, P.McGarvey and V.Yusibov (eds), Springer 1999.
2. Transgenic Plants by Esra Gauln and Adena Breimann.
3. Engineering Chloroplasts: an alternative site for foreign genes, proteins, reactions and products. Trends in Biotechnology, 18, 253-263.
4. Molecular Biotechnology, Principles and applications of recombinant DNA technology. Bernard R.Glick and Jack J.Pasternak. ASM Press Washington DC 2001
5. Freshney RI. 2005. Culture of Animal Cells. Wiley Liss.
6. Portner R. 2007. Animal Cell Biotechnology. Humana Press.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBTB6201	ADVANCED GENETIC ENGINEERING LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES:

By the end of the course, students should be able to

- Develop a comprehensive understanding of advanced genetic engineering techniques and their applications.
- Conduct research and apply genetic engineering approaches in various biological contexts.

LIST OF EXPERIMENTS

1. **Gene Cloning and Recombinant DNA Technology:**
   - Cloning a gene of interest into a plasmid vector
   - Transformation of recombinant plasmids into host cells
   - Verification of successful gene cloning through DNA sequencing
2. **Gene Expression Analysis:**
   - RNA isolation from different tissues or under different conditions
   - Reverse transcription to convert RNA into cDNA
   - Quantitative polymerase chain reaction (qPCR) to measure gene expression levels
   - Analysis and comparison of gene expression patterns
3. **CRISPR-Cas9 Genome Editing:**
   - Design and generation of guide RNA (gRNA) sequences
   - Delivery of CRISPR-Cas9 components into target cells
   - Detection and verification of targeted genetic modifications
4. **Metabolic Engineering for Compound Production:**
   - Introduction of biosynthetic pathway genes into a microbial host
   - Optimization of gene expression for enhanced compound production
   - Analysis of culture samples for compound production using suitable techniques
5. **Protein Engineering:**
   - Design and generation of mutant proteins with altered properties
   - Expression and purification of mutant proteins
   - Characterization of mutant proteins through biochemical assays or structural analysis
6. **Transgenic Organism Creation:**
   - Introduction of foreign genes into the genome of an organism
   - Generation of transgenic plants or animals
   - Analysis of transgene expression and phenotypic effects in transgenic organisms
7. **Directed Evolution**:
   - Generation of genetic diversity using mutagenesis techniques
   - Selection or screening of mutants with desired properties
   - Iterative cycles of mutation and selection to improve protein or enzyme function
8. **DNA Barcoding:**
   - Amplification and sequencing of specific DNA regions for species identification
   - Creation of DNA barcode libraries for species classification
   - Analysis of DNA barcodes to identify unknown samples or assess biodiversity
9. **RNA Interference (RNAi):**
   - Design and synthesis of small interfering RNA (siRNA)
   - Delivery of siRNA into cells to silence target genes
   - Analysis of gene knockdown efficiency and downstream effects

10. Bioinformatics Analysis:

- Analysis of genomic or transcriptomic data using bioinformatics tools
- Identification of genes, regulatory elements, or functional motifs
- Comparative genomics or phylogenetic analysis

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Understand the principles and techniques of gene cloning and recombinant DNA technology, including the process of gene insertion into plasmid vectors and transformation into host cells.

CO2 - Apply molecular biology techniques to analyze gene expression patterns, including RNA isolation, cDNA synthesis, and quantitative analysis using methods such as qPCR.

CO3 - Demonstrate proficiency in using the CRISPR-Cas9 system for targeted genome editing, including the design of guide RNA (gRNA) sequences and the verification of genetic modifications.

CO4 - Apply principles of metabolic engineering to engineer microbial hosts for the production of specific compounds, including the introduction of biosynthetic pathways and optimization of gene expression.

CO5 - Design and implement protein engineering strategies to modify protein properties, including mutagenesis techniques, expression, purification, and characterization of mutant proteins.

CO6 - Utilize bioinformatics tools for the analysis of genomic and transcriptomic data, including gene identification, comparative genomics, and phylogenetic analysis.

TEXT BOOKS/ REFERENCES:

Textbooks:

1. "Principles of Gene Manipulation and Genomics" by Sandy B. Primrose and Richard Twyman (8th edition, 2019)
2. "Molecular Cloning: A Laboratory Manual" by Michael R. Green and Joseph Sambrook (4th edition, 2012)
3. "Genetic Engineering: Principles and Methods" by Jane K. Setlow (2010)
4. "Genome Engineering: Principles and Applications" by Krishnarao Appasani (2016)

References:

1. "CRISPR-Cas: A Laboratory Manual" edited by Jennifer Doudna and Prashant Mali (2018)
2. "Metabolic Engineering: Principles and Methodologies" by Gregory N. Stephanopoulos, Aristos A. Aristidou, and Jens Nielsen (1998)
3. "Protein Engineering and Design" by Nigel S. Scrutton, David S. Brocklehurst, and David J. Newman (2013)
4. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount (2004)

SBTB7001	INDUSTRIAL BIOTECHNOLOGY	L	T	P	EL	Credits	Total Mark
		3	0	0	0	3	100

COURSE OBJECTIVE

- To learn knowledge in Advanced Industrial Biotechnology and its applications,
- To gain knowledge protein express process and its outcomes.

UNIT 1 INTRODUCTION 9 Hrs.

An overview of Microbial diversity, Novel bioactive products from bacteria in food and agriculture, Screening of microbial isolates for bioactivity. Cultivation of hyper hermophilic and extremely thermo acidophilic microorganisms. Instrumentation and monitoring of bioreactors. Culture and analysis using gel microdrops.

UNIT 2 DESIGN EXPERIMENTS 9 Hrs.

Experimental design for improvement for media design: Plackett burman and Response surface methodology, Software applications in fermentation processes. Introduction to bioprocess simulation. Quality assurance and quality control. Concepts of anaerobic fermentation and contract fermentations.

UNIT 3 PROTEIN EXPRESSION 9 Hrs.

Introduction to genetic analysis of Streptomyces and Bacillus spp. using tools of recombinant DNA technology. Applications of rDNA technology in thermophiles. Design and assembly of polycistronic operons in Escherichia coli. In vivo folding of recombinant proteins in E. coli. Expression of G protein coupled receptors in microorganisms. Selection of suitable hosts for E. coli optimized for expression of proteins. Mechanism of mRNA degradation in bacteria and their implication for stabilization of heterologous transcripts. Filamentous fungi in industrial biotechnology. Genetics and genomics of Saccharomyces cerevisiae.

UNIT 4 BIOMARKERS 9 Hrs.

Cloning and analysis of genes for the biosynthesis of microbial secondary metabolites. Antibiotic resistance mechanisms of bacterial and fungal pathogens. Genetics of bacteriocins produced by Lactic acid bacteria and their use in novel industrial applications. Biomarkers and bioreporters to track microbes and monitor their gene expression. Biofilms. Future perspectives in industrial microbial technology.

UNIT 5 BIOPRODUCTS 9 Hrs.

Production of Spirulina, lactobacillus, Saccharomyces cerevisiae, Fusarium venenatum. Microbial fuel cell, Biofertilizers: Rhizobium, Azospirillum, Phosphobacteria. Plant: Plant bioreactors, applications – Primary and Secondary Metabolite production, zingiberene production, Biofuel Production - Botryococcus braunii,

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1 - Understand basic skills about screening of microorganisms.
CO2 - Learn basic steps involved in bioprocess simulation.
CO3 - Analyze protein expression between bacteria and fungi.
CO4 - Compare antibiotics and vaccines.
CO5 - Apply bacteriocin in food industries.
CO6 - Interpret the difference between low value and High value products.

TEXT / REFERENCE BOOKS

1. J. Dunn, E. Heinzle, J. Ingham, J.E. Pfenosil “Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples ”WILEYVCHVerlagGmbH&Co.KGaA, Weinheitn, 2003
2. J.R.Leigh, Modeling and Control of fermentation Processes, Peter Peregrinus, London, 2000
3. SyamS. Sablani et.al. Hand book off ood and bioprocess modelling techniques,Taylor& Francis Group,LLC,2006.

SBTB7002	DESIGN AND OPERATION OF BIOREACTORS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To develop knowledge in bioreactors and its types.
- To make understand the knowledge in microbial growth parameters

UNIT 1 INTRODUCTION 9 Hrs.

Fundamentals and classification of Bioreactors: bioreactor design- overview of bioreactor, its developments and types based on presence and absence of oxygen, type of process, type of microbe agent, mode of operation and method of generating microbes- mammalian cell culture, plant cell culture & environmental applications, Components of bioreactors and importance.

UNIT 2 DESIGN AND OPERATION 9 Hrs.

Basic mode of operation batch, fed-batch and continuous reactor, Kinetics of batch and continuous culture. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors mean residence time, washout condition; recycle bioreactors; combination of bioreactors. Heat transfer in bioreactors.

UNIT 3 IDEAL CONTINUOUS STIRRED TANK BIOREACTOR 9 Hrs.

Material balance-Evaluation of Monod Kinetic parameter, Alternatives to Monod equation-Blackman, Tessier, Moser, Contois equation -Comparison of batch and CSTB-Multiple CSTB connected in series-CSTB with cell recycling.

UNIT 4 GENERAL CHARACTERISTIC OF MODELS 9 Hrs.

Unstructured and structured models. Models with growth inhibitors- Substrate inhibition, Product Inhibition-Competitive and Noncompetitive product inhibition. Rate. Mass transfer and rheology: Rheology of broths - impact on transfer processes Oxygen transport from the bubble to the cell. Scale up criteria for bioreactors. Power requirements in mixing under aerated and non aerated conditions.

UNIT 5 DESIGN CONSIDERATIONS 9 Hrs.

Animal and plant cell bioreactors. Determination of kLa - Correlation for kLa. Introduction to Single Use, Bioreactors (SUBs),

Max.45 Hrs.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Learn basic working principle of bioreactors
CO2 - Design and operation of industrial bioreactors
CO3 - Evaluate the various microbial growth kinetics
CO4 - Discuss the microbial growth kinetics using models
CO5 - Critique on the validity of experimental data and measurements of mass transfer a rate
CO6 - Analyse various economical important products

TEXT / REFERENCE BOOKS:

1. Shuler.M.L. and Kargi.F, Bioprocess Engineering Basic concepts, Pearson Education India, 1st Edition, 2003.
2. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology, 2nd Edition, 1997.
3. Pauline M. Doran, Bioprocess Engineering Principles.2012.

SBTB7003	FERMENTATION TECHNOLOGY	L	T	P	EL	Credits	Total Mark
		3	0	0	0	3	100

COURSE OBJECTIVE

- To acquaint students with technical and biological aspect of microbial utilization for production of metabolites
- To learn how to design media for fermentation process.

UNIT 1 INTRODUCTION TO FERMENTATION TECHNOLOGY 9 Hrs.

History, Scope and Development of Fermentation technology; metabolic pathways and metabolic control mechanisms, Isolation and screening of industrially important microorganisms − primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology.

UNIT 2 DESIGN OF MEDIA 9 Hrs.

Natural and Synthetic media; Basic components of media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media; Process of aeration, and agitation. Plant and animal tissue culture medium. Design of Medium by Plackett burman and Response surface methodology.

UNIT 3 TYPES OF FERMENTORS 9 Hrs.

Basic designs of Fermentor; Type of fermentors: Bubble column Tower, Deep jet, Cyclone column, Packed tower and airlift fermenter; applications, Scale up study and Product development; Down-stream processing and Product recovery; Regulation and safety.

UNIT 4 INSTRUMENTATION CONTROL 9 Hrs.

Fermentation control systems – manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and concentration sensors, Computer applications in fermentation technology, Artificial neural network in fermentation process.

UNIT 5 PRODUCTION OF MICROBIAL PRODUCTS 9 Hrs.

Production of Protease, amylase, Lipase enzyme, alcohol, wine and beer, Bakers Yeast and its types, Organic acid − Citric acid; Antibiotic − Penicillin, Amino acid − Glutamic acid; Vitamin − B1; Single Cell Protein (SCP) – Spirulina, Fusarium Venenatum, Microbial production of therapeutic compounds (β-lactum, aminoglycosides, ansamycines (Rifamycin), Peptide antibiotics (Quinolinones),

COURSE OUTCOMES:

After completion of this course, student will be able to understand

CO1 - Understand the principle of downstream processing.
CO2 - Design of medium by statical methods.
CO3 - Apply engineering knowledge to design the fermentor.
CO4 - Interpret online and offline sensors mechanism.
CO5 - Apply artificial network knowledge in fermentation process.
CO6 - Evaluate various biotechnological products by fermentation process.

TEXT / REFERENCE BOOKS

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
2. Lancini, R. Lorenzetti. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. (2014). Springer publications, Germany.

SBTB7004	DOWNSTREAM PROCESSING	L	T	P	EL	Credits	Total Mark
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the principle of various downstream processing.
- Gaining knowledge in product separation process.

UNIT 1 CONCEPT OF BIOSEPERATION

An overview of bioseparation. Separation of cells and other insoluble from fermented broth, Scope of Downstream Processing: Importance of downstream Processing (DSP) in biotechnology, microbial protein expression and purification. Criteria for selection of bio-separation techniques. Cell disruption methods: Various cell disruption methods, need for cell disruption for intracellular products, cell disruption equipment. Applications in bio-processing.

UNIT 2 INSOLUBLE SEPERATION TECHNOLOGY

Centrifugation: Principles of centrifugation, centrifuge effect, various centrifuges; basket centrifuge, tabular centrifuge, disc-bowl centrifuge, Extraction methods: liquid-liquid, ATPE. Sedimentation, flocculation, filtration theory, types, applications. Adsorption: principle of adsorption, application and isotherm models.

UNIT 3 MEMBRANE AND ADSORPTION SEPERATION

Membrane separation processes: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes. Types and choice of adsorbents, Normal Adsorption techniques.

UNIT 4 PURIFICATION TECHNIQUES

Chromatographic separation and electrophoresis methods: Principles of chromatographic separation methods, different types of chromatographic methods, ion – exchange chromatography, gel chromatography, affinity chromatography etc. Applications in bio-processing. Principles of electrophoresis and electrophoresis mobility, Applications.

UNIT 5 DRYING

Various types of drying methods, Freeze drying technique and its advantages over other methods, Crystallization: principle of crystallization process, types, applications.

COURSE OUTCOMES:

After completion of this course, student will be able to

CO1 - Understand the difference between bioseparation and downstream processing.
CO2 - Distinguish between extra cellular and intracellular.
CO3 - Compare sedimentation and flocculation.
CO4 - Apply engineering knowledge in membrane separation process for product recovery.
CO5 - Design chromatography for separate the biomolecules based on biochemical category.
CO6 - Interpret drying and freeze drying products.

TEXT / REFERENCE BOOKS

1. Bioseparations: Downstream Processing for Biotechnology, Paul A. Belter, Wiley Blackwell, 2008
2. Bioseparations: Principles and Techniques, Sivasankar, Prentice Hall India Learning Private Limited,2005.
3. Downstream Process Technology, Prasad, Prentice Hall India Learning Private Limited, 2010.

4. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth –Heinemann, 2010.
5. Principles of Downstream processing, by Ronald & J.Lee, Wiley Publications, 2007.

SBTB7005	BIOPROCESS INSTRUMENTATION AND CONTROL	L	T	P	EL	Credits	Total Mark
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand basic knowledge in Bioprocess instrumentation control.
- Students can apply artificial intelligence knowledge in instrumentation control system.

UNIT 1 ONLIE AND OFFLINE CONTROL 9 Hrs.

Temperature measurement: Thermocouples, Resistance thermometers, Optical and Radiation pyrometers. Pressure measurement: Use of manometers, Bourdon gauge, Bellows type gauge. Flow measurement: Variable area meters. Positive displacement type meters. Liquid level measurement: Direct and differential method, measurement in open and pressure vessels. Measurement of Viscosity, Conductivity, pH and Humidity of gases.

UNIT 2 RESPONSE SYSTEM 9 Hrs.

Response of First order systems: Transfer Function, Transient Response, Forcing Functions and Responses. Physical examples of First and second order systems: Examples of First order systems, Linearization, Transportation Lag.

UNIT 3 CONTROL VALVE AND CONTROL SYSTEM 9 Hrs.

Control valves, Valve sizing Characteristics Control valve construction, Valve positioning. Introduction to industrial control systems - Programmable Logic Controllers (PLCs), Distributed Control Systems (DCS), Supervisory control and Data Acquisition (SCADA). Cascade control, Feed forward control and Feedback control. Components of a Control System, Block Diagram, Development of Block Diagram, Controllers and Final Control Elements. Closed loop Transfer functions: Standard Block-Diagram Symbols, Transfer Functions for Single-Loop Systems and Multi-loop Systems.

UNIT 4 CONTROLLERS 9 Hrs.

Transient response of simple control systems: Servo Problem, Regulatory Problem, Controllers: Proportional, Proportional-Integral, PID Controllers. Ziegler-Nichols Controller Settings. Stability: Routh Test for Stability, Root Locus.

UNIT 5 FREQUENCY RESPONSE 9 Hrs.

Introduction to frequency Response: Substitution Rule, Bode Diagrams. Control system design based on frequency response: Bode and Nyquist Stability Criterion, Gain and Phase Margins.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1 - Understand the basics of process dynamics principles and instrumentation
CO2 - Study various types of input functions and its response
CO3 - Perform computational modelling to study different types of controllers
CO4 - Analyze different control algorithms
CO5 - Apply artificial intelligence knowledge in Controllers.
CO6 - Design a frequency response in control system.

TEXT / REFERENCE BOOKS

1. Donald R.Coughanowr(2009), Process Systems Analysis and Control, Mcgraw-Hill,
2. Eckman, D.P (2007) Industrial Instrumentation. Wiley.
3. Shulerand Kargi(2002), Bioprocess engineering. Prentice Hall.
4. Baileyand Ollis (2006), Biochemical engineering fundamentals. McGrawHill

5. 5.Tarun Ghosh (2004) Biotechnology and bioprocess engineering: Proceedings, VII
6. international biotechnology symposium. Delhi.

SBTB7006	STEM CELLS AND THEIR APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

UNIT 1

Stem cells and their types, Types of Media required, Culturing of cell lines-monolayer and suspension types of cultures, Biology and characterization of cultured cells, Maintenance and management of cell lines. Embryonic and adult stem cells, Cell isolation and selection; cell preservation.

UNIT 2

Cell cell interactions , Extracellular matrices; Cell-matrix interactions. Cell synthetics surface interactions and the ensuing effects on cell growth, cell adhesion, cell migration, and cell-cell communication. Cell and Tissue Culture.

UNIT 3

Cell characterization, cell separations, Mechanical properties of biological tissues. Cell-Biomaterial Interactions and Host Integration. Biomaterial processing for Tissue Engineering. Natural and Synthetic Scaffolds for Tissue Engineering.

UNIT 4

Bioreactor for tissue engineering – Introduction, Design and scale up, Hollow fibre systems, Micro carrier based systems.

UNIT 5

Differentiation of Astocytes and Oligodentrocytes, stem cells and cloning. Artificial skin. Artificial blood vessels, Bone repair, Repair of cartilage, tendon and ligaments. Immunolabelling procedures, stem cells and cloning. Type of stem cell transplantation – Autologous, Allogeneic, Syngeneic, Nuclear transplantation, Transfection methods – Lipofection, Electroporation, Microinjection, Human stem cell research in India, Human embryonic stem cell ethics and Public policy.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1 - Classify stem cells
CO2 - Understand the construction of connective tissues
CO3 - Understand the process of isolation and identification of stem cells
CO4 - Understand the construction of biomaterials
CO5 - Review the human stem cell research

TEXT / REFERENCE BOOKS

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, R. Ian Freshney, 2011
2. Stem Cell Biology, David Gottlieb, Cold Spring Harbor, 2002
3. Essentials of Stem Cell Biology 3rd Edition, Robert Lanza Anthony Atala,2013
4. Principles of Tissue Engineering, Robert Lanza, Robert Langer and Joseph Vacanti, Elsevuer, 2013 5. Tissue Engineering, Academic Press, by Clemens van Blitterswijk, 2008

SBTB7007	BIOSENSORS USED IN TISSUE ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

UNIT 1

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

UNIT 2

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transducers. Biorecognition systems:

UNIT 3

Enzymes; Oligonucleotides and Nucleic Acids; Lipids (LangmuirBlodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

UNIT 4

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.
Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring;

UNIT 5

Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand biosensing and transducing techniques
CO2 - Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3 - Demonstrate appreciation for the technical limits of performance of biosensor
CO4 - Apply principles of engineering to develop bioanalytical devices and design of biosensors

TEXT / REFERENCE BOOKS

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003

SBTB7008	ONCOLOGY	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

UNIT 1

Introduction to cancers, classification and characterization of cancers, causes of cancer, properties of cancer cells, principles of therapies, targets of therapies;Tumor genetics: mutations, carcinogenic agents, inheritance, tumor genes, defects in DNA repair and predispositions to cancer;

UNIT 2

Tumor epigenetics: mechanisms of epigenetic inheritance, imprinting, DNA methylation, epigenetics of cell differentiation and tissue homeostasis.

UNIT 3

Oncogenes and tumor-suppressor genes; The cell cycle, apoptosis and senescence: checkpoints, therapeutic targets and inhibitors, molecular mechanisms of apoptosis, replicative senescence and its disturbances in human cancers; Signaling pathways in tumors: MAPK, PI3K, TP53 network, NFκB, TGFβ, STAT signaling.

UNIT 4

Invasion and metastasis: genes and proteins involved in cell-to-cell, cell-matrix adhesion, in extracellular matrix remodeling during tumor invasion; angiogenesis.The role of immune system in tumors: inflammation, infections, cancer vaccines, inhibition of the immune system;

UNIT 5

Stem cells and cancer: Wnt signaling, Hh signaling. Cancer prevention: nutrients, energy metabolism of tumors, hormones and gene interactions; Diagnosis of tumors: molecular diagnosis, molecular detection and classificationCancer therapy: cancer chemotherapy, targeted drug therapy, immunotherapy, gene therapy.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand ,classify cancer
CO2 - Understand principles behind cancer genetics
CO3 - Understanding the mechanism of cancer invasion etc .,
CO4 - Apply principles of engineering to develop bioanalytical devices and design of biosensors
CO5 - To know the early diagnostics
CO6 - To know the Various treatments and therpahies

READING:

1. Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.
2. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (2nd Edition) by Lauren Pecorino. Oxford University Press.
3. Molecular Biology of the Cell, by Bruce Alberts , Alexander D. Johnson , Julian Lewis

SBTB7009	BIOMATERIALS and their applications	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

Introduction to basic concepts of Materials Science; Salient properties of important material classes; Property requirement of biomaterials. Classes of materials in medicine.

Concept of biocompatibility; Structure and properties of biological cells & tissues; cell material interactions and host reaction to biomaterials and evaluation; Assessment of biocompatibility of biomaterials, in vitro biochemical assays (cellular adhesion, cellular viability using MTT osteogenic differentiation using ALP assay; Biomnuneralisation using Osteocalcin assay)

Degradation of Materials in Biological environment: Biodegradation of Biodegradable Polymeric Biomaterials, Degradative Effects of the Biological Environment on Metals and Ceramics.

Pathological Calcification of Biomaterials Applications of Biomaterials: Nonthrombogenlc Materials and Strategies: Case Study, Cardiovascular Medical Devices, Dental implantation, ophthalmic applications. Applications of Biomaterials in Functional Tissue Engineering, Bone Tissue Engineering, Cartilage and ligament Tissue Engineering, Blood Vessel Tissue Engineering, Heart Valve Tissue Engineering Design concept of developing new materials for bio-implant applications. Ethical and legal Issues in Biomaterials and Medical Devices. Entrepreneurship in Biomaterials.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Classify and understand the properties of biomaterials
CO2 - Understand the concept of biocompatibility
CO3 - Assess biocompatibility of materials using in vivo and in vitro techniques
CO4 - Understand the concepts for developing new materials for tissue engineering and bio-implant applications
CO5 - Understand the applications of Biomaterials
CO6 - Forecast the entrepreneurship opportunities in in Biomedical device industry

TEXT / REFERENCE BOOKS

1. Buddy D. Ratner, Biomaterials Science: An Introduction to Materials in Medicine 3rd Edition, Academic Press, 2014
2. Sujatha V. Bhat, Biomaterials, 2nd Edition , Narosa Publishing house,2010
3. Fredrick H. Silver Medical Devices and Tissue engineering: An integrated approach 1st edition , chapman and Hall Publications,1993
4. Biomaterials Science and Biocompatability, Fredrick H. Silver and David L. Christiansen, Piscataway, Springer, New Jersey.

SBTB7010	REPRODUCTIVE BIOTECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

UNIT 1

History, importance of assisted reproductive biotechnology in man and animal, introduction to embryo biotechnology, endocrine therapeutics.

UNIT 2

Biotechnological approaches to reproduction, methodology of super ovulation, in vitro fertilization, embryo culture and micromanipulation, preparation of sperm for IVF.

UNIT 3

Different method of gene transfer and their limitations, embryo splitting, embryo sexing by different methods, production of transgenic livestock by nuclear transfer and its application, regulatory issues.

UNIT 4

Stem cells and their types, Types of Media required, Culturing of cell lines-monolayer and suspension types of cultures, Biology and characterization of cultured cells

UNIT 5

Cloning of domestic animals.Conservation of endangered species.Characterization of embryonic stem cells.Different applications of embryonic stem cells.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understanding in-vitro reproductive techniques for ovum and embryo manipulation.
CO2 - Understand the IVF Techniques
CO3 - Assess biocompatibility of embryo transfer
CO4 - Understand the concepts for transgenesis and their manipulations
CO5 - Understand the applications of IVF
CO6 - to know the Stem cells and their applications

SUGGESTED READINGS

1. Ball PJH & Peter AR. 2004. Reproduction in Cattle. Blackwell. Gordon I. 2003.
2. Laboratory Production of Cattle Embryos.CABI.Gordon I. 2005.
3. Reproductive Techniques in Farm Animals.CABI.

SBTB70	VACCINE BIOTECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	*	0	0	3	100

UNIT 1

History of vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants,

UNIT 2

Instruments related to monitoring of temperature, sterilization, environment, quality assurance and related areas. Production techniques, growing the microorganisms in maximum titre, preservation techniques to maintain good antigen quality, freeze drying.

UNIT 3

Introduction to newer vaccine approaches namely sub-unit vaccines, synthetic vaccines, DNA vaccines, virus like particles, recombinant vaccines, edible vaccines, Nano particles in vaccine delivery systems, etc.

UNIT 4

Introduction to pharmacopeal requirement, disease security and biosecurity principles and OIE guidelines such as seed management, method of manufacture, in-Process control, batch control, tests on final product.

UNIT 5

Quality control, preservation and monitoring of microorganisms in seed lot systems.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understanding different approaches of vaccine development and production.
CO2 - Understand the viuses and their mode of actions
CO3 - To get knowledge on Purification procedure
CO4 - Understand the concepts for different large scale production of vaccines
CO5 - Understand the applications vaccines
CO6 - To know the large scale production of vaccines and their applications

TEXT / REFERENCE BOOKS

1. World Health Organization. The global eradication of smallpox. Final report of the global commission for the certification of smallpox eradication. In History of International Public Health No. 4. Geneva, World Health Organization, 1980. (pdf)
2. de Korte W E. Amaas or kaffir milk-pox. Lancet. 1904;1:1273–1276.
3. Chapin C V. Variation in type of infectious disease as shown by the history of smallpox in the United States 1895–1912. Infect Dis. 1913;13:171–196.
4. Fenner F, Henderson DA, Arita I, et al. Smallpox and Its Eradication. Geneva, World Health Organization, 1988. (Book)
5. McNeill WH. Plagues and People. Garden City, NY, Anchor Press/Doubleday, 1976.

SBTB7011	FOOD BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT 1 INTRODUCTION 9 Hrs.

History of Microorganisms in food, Historical Developments. The Role and significance of Microorganisms, Primary sources of Microorganisms found in foods. Microbial Intrinsic and Extrinsic parameters of foods. Microbiological quality testing of foods – enumeration and detection of food borne organisms - Culture, Microscopic and Sampling Methods, Conventional, SPC, Membrane Filters, Microscopic Colony Counts, Agar droplets, Dry films, MPN, DMC, Dye reduction, Roll Tubes, Microbiological Examination of surfaces and sampling, Metabolically Injured Organism, Enumeration and Detection of food borne organisms.

UNIT 2 FOOD MICROBIOLOGY 11 Hrs.

Microbiological role in food process operation and production: new protein foods: SCP; mushroom; food yeasts, algal proteins. Food Fermentation method of preparing and preserving foods -pickling, alcoholic beverages and other products. Food additives: Need for food additives, types of food additives. Development of novel food and food ingredients; SCP, polysaccharides, low calorie sweeteners, naturally produced flavor modifier, food coloring agent, food supplements and Nutraceuticals. Genetically modified foods and consumer preference – prebiotic and probiotic foods.

UNIT 3 STORAGE & PRESERVATION 9 Hrs.

General principle of spoilage, factors affecting spoilage; Spoilage of fruits and Vegetables, Spoilage of Miscellaneous Foods. Food preservation- Characteristics of Radiations of Interest in Food Preservation, Destruction of Microorganisms and Applications, Radappertization, Radicidation and Radurization of food, legal status of food irradiation. Storage and Stability of irradiated foods .Preservation: High and Low Temperature, Drying.

UNIT 4 FOOD PROCESSING 9 Hrs.

Mechanism of enzyme functions and reactions in process techniques: starch and sugar conversion process or baking by amylases; de-oxygenation and desugaring by glucose oxidase; beer mashing and chill- proofing and cheese making by proteases and various other enzymes, catalytic actions in food processing. Process wastes: whey; molasses; starch substances and other food wastes for bioconversion to useful products.

UNIT 5 PACKAGING 7 Hrs.

Introduction to Food Packaging, interaction of food material with packaging materials, preservation of food products. Genetically modified and transgenic food development, processing- nutritional and economic aspects.

Max.45 Hrs.

TEXT / REFERENCE BOOKS

1. James. M. Jay, Martin J. Loessner and David A.Golden, Food Microbiology, Springer Publication, 7th Edition, 2005.
2. Frazier, Food Microbiology, McGraw Hill Publication, 4th Edition, 2001
3. Shetty K., G. Paliyath et al. – Food Biotechnlogy – 2nd Edition- Taylor and francis, 2006.
4. Keshav Trehan, Biotechnology, New Age International (P) Ltd. Publishers, 2002.

COURSE OUTCOMES:

At the end of course, the students will

CO1 - SBT1602.1 Apply the knowledge to detect and enumerate the food borne pathogens
CO2 - SBT1602.2 Generalize about basic food fermentation and food production techniques.
CO3 - SBT1602.3 Analyze the food preservation and storage to avoid food spoilage
CO4 - SBT1602.4 Evaluate the various enzymes involved in food processing
CO5 - SBT1602.5 Categorize tbe appropriate food packaging techniques
CO6 - SBT1602.6 Create the different types of food products, packingand preservation techniques

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80 **Exam Duration: 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 12 marks	**60 Marks**

SBTB7012	FOOD AND NUTRACEUTICALS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To explore the bio sources for extraction of nutraceutical.

UNIT 1 INTRODUCTION TO NUTRACEUTICAL 9 Hrs.

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and Phyto nutraceuticals. Scope involved in the industry, Indian and global scenario

UNIT 2 NUTRACEUTICALS OF PLANT AND ANIMAL ORIGIN 9 Hrs.

Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Extraction and purification, applications with specific examples with reference to skin, hair, eye, bone, ,general health and stimulants. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides of animal origin, uses and applications in preventive medicine and treatment. Concept of cosmeceuticals and aquaceuticals.

UNIT 3 MICROBIAL AND ALGAL NUTRACEUTICALS 9 Hrs.

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - Extraction from plant sources : Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment.

UNIT 4 BIOTECHNOLOGY IN PHYTO NUTRACEUTICALS 9 Hrs.

Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, Biofortification and nutritional enhancement. GM foods with enhanced nutraceutical properties - Golden rice, GM Tomatoes.

UNIT 5 PRODUCT DEVELOPMENT AND CLINICAL TRIALS 9 Hrs.

Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, veterinary products, immune boosters, bioavailability, bioequivalence; use of animal models and pre-clinical and clinical trials. Basic Principles of toxicology – oral toxicity, sub-acute, acute toxicity and chronic toxicity. Toxic dose, toxic-kinetics, LD50, dose response relationships, local v/s systemic toxicity, antagonism and synergism.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - SBTB3015.1 - Classify the nutraceutical components.
CO2 - SBTB3015.2 - Explore the plant and animal source for nutraceutical compound.
CO3 - SBTB3015.3 - Investigate the microbial and algal source for nutrient value compound.
CO4 - SBTB3015.4 - Role of biotechnology in production of nutraceutical compound.
CO5 - SBTB3015.5 - Summarize the nutraceutical development process and clinical trials.
CO6 - SBTB3015.6 - Construct the biotechnology process for the production of nutraceutical compound .

TEXT . REFERENCE BOOKS

1. Debasis Bagchi, Francis C. Lau, Dilip K. Ghosh, Biotechnology in Functional Foods and Nutraceuticals, 1st Edition,CRC Press, 2010.
2. G. K. Jayaprakasha, Bhimanagouda S. Patil, Nutraceuticals and Functional Foods, 2015.
3. Robert E.C.Wildman, Handbook of Nutraceuticals and Functional Foods (Modern Nutrition), 1st Edition.
4. Shahidi and Weerasinghe (Ed.), Nutraceutical beverages Chemistry, Nutrition and Health Effects, American Chemical Society, Robert E.C.Wildman.
5. Richard Neeser & J. Bruce German, Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc., 2004.
6. H. Panda, Herbal beauty products with formulation & processes.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBTB7013	FOOD PROCESSING AND PRESERVATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To impart knowledge of various areas about the food processing and safety technology.

UNIT 1 PROPERTIES OF FOODS AND PROCESSING THEORY 9 Hrs.

Properties of Food – Intrinsic and Extrinsic properties - Effects of processing on sensory characteristics of foods –

Effects of processing on nutritional properties - Food safety, good manufacturing practice and quality assurance : HACCP,

Hurdle technology - Process control - Automatic control, Computer-based systems.

UNIT 2 AMBIENT-TEMPERATURE PROCESSING 9 Hrs.

Raw material preparation : Cleaning, Sorting, Grading, Peeling - Size reduction in solid and liquid foods – separation and concentration of food components – fermentation and enzyme technology – Irradiation – processing using electric fields, high pressure, pulsed light and ultrasound.

UNIT 3 PROCESSING BY APPLICATION OF HEAT 9 Hrs.

Heat processing using steam and water – Blanching – Pasteurization – Heat sterilization – Evaporation and distillation –

Extrusion : Heat processing using hot air – Dehydration – Baking and roasting : Heat processing using hot oils – Frying :

Heat processing by direct and radiated energy – Dielectric , ohmic and infrared heating.

UNIT 4 PROCESSING BY REMOVAL OF HEAT 9 Hrs.

Chilling – Controlled or modified atmosphere storage and packaging – Freezing – Freeze drying and Freeze concentration.

UNIT 5 POST – PROCESSING OPERATIONS 9 Hrs.

Coating or enrobing – Packaging – Types of packaging materials – printing – interactions between packaging and foods –

environmental considerations – Filling and sealing of containers – materials handling, storage and distribution.

Max.45 Hrs.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Learning of properties of food and food safety.
CO2 - Knowledge about the food processing by using ambient temperature
CO3 - Study of processing of food by using heat
CO4 - Processing of food by removal of heat using direct and radiant energy
CO5 - Scrutinizing of Post processing of food
CO6 - Gain wide knowledge about the processing technology of food

TEXT / REFERENCE BOOKS

1. Amit K Jaiswal , Food processing Technologies – impact on product attributes , CRC Press Taylor & Francis
2. Group, 2017.
3. Sivashakar B., Food processing preservation, Prentice Hall of India Pvt. Ltd., 2002.

4. Fellows P., Food processing and technology, Principles and Practice, 4th Edition, Woodhead Publishing Limited,
5. Cambridge – England, 2016.
6. Da-Wen Sun, Emerging Technologies for food, 2nd Edition, Academic Press, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 16 marks	**80 Marks**

SBTB7014	FOOD FERMENTATION TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To study the design and construction of fermentor and parameters to be monitored and controlled in fermentation process.

UNIT 1 INTRODUCTION TO FERMENTATION 9 Hrs.

Introduction to fermentation; History and development of fermentation industry; General requirements of fermentation processes; Isolation, preservation and improvement of industrially important micro-organisms.

UNIT 2 PREPARATION OF MICROORGANISMS (STARTER CULTURE) FOR FERMENTATION. 9 Hrs.

Development of starter culture for industrial fermentations; Biological agents responsible for fermentation (bacteria, yeasts, molds, enzymes). Kinetics of microbial growth and death; Air and media sterilization.

UNIT 3 BASIC DESIGN OF FERMENTOR 9 Hrs.

Fermentor; Basic design and construction of fermentor and ancillaries; Measurement and control of bioprocess parameters - Analysis of batch, fed-batch and continuous bio reactions. Different types of fermentations - Types of fermentation process - An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry.

UNIT 4 FERMENTED FOOD PRODUCTS 9 Hrs.

Production of fermented food products – Dairy products : Cheese , yogurt, curd, kefir – alcoholic beverages : Beer, Wine – meat products : Sausage and others – cereal and vegetable products : Pickles and sauerkraut .

UNIT 5 FERMENTED FOOD PRODUCTS 9 Hrs.

Producion of various fermentation products (vitamins,organic acids etc), Ethanol fermentation, acetic acid fermentation, lactic acid fermentation.

Max.45 Hrs.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Learning of fermentation process and strain improvement.
CO2 - Knowledge about the microorganisms used in food industry
CO3 - Study of processing and types of fermentor
CO4 - Knowledge of fermented food product production
CO5 - Scrutinizing the production of different foods
CO6 - Gain wide knowledge about the production of various food fermentation process and products

TEXT / REFERENCE BOOKS

1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.
2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication
3. Industrial Fermentations- Leland, N. Y. Chemical Publishers.
4. Prescott and Dunn's- Industrial Microbiology, 4 th, ed.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 16 marks	**80 Marks**

SBTB7015	FOOD SAFETY AND QUALITY MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To explore the food safety and quality assurance in national and international levels.

UNIT 1 GENERAL PRINCIPLES FOR FOOD SAFETY AND HYGIENE 9 Hrs.

Principles of food safety and quality - Food Safety System - Quality attributes - Total Quality Management. Good Hygienic Practices, Good Manufacturing Practices – HACCP - Risk Analysis, Risk Management, Risk Assessment, Risk Communication - Traceability and authentication.

UNIT 2 GENERAL PRINCIPLES FOR FOOD SAFETY REGULATION AT NATIONAL / REGIONAL LEVEL 9 Hrs.

The Structure of Food Law, Food Regulation , Laws and Regulations to Prevent Adulteration and Cross Contamination, Microbial Contamination, Hygienic Practice, Chemical and Environmental Contamination, Food Additives, Labeling, Food Laws and Regulations at the International Level for Harmonization.

UNIT 3 NATIONAL STANDARDS 9 Hrs.

Food Safety and Standard Authority of India regulations - Agricultural and Processed food Export Development Authority - Marine Product Export Development Authority - Export Inspection council and Export Inspection Agency.

UNIT 4 INTERNATIONAL BODIES DEALING IN STANDARIZATION 9 Hrs.

International Standardization Organization (ISO), Joint FAO/WHO Food Standards Program. Codex Alimentarius Commission (CAC), Other International Organizations Active in Food Standard Harmonization. Advantages of Utilizing International Standards. Rapid Alert system.

UNIT 5 COUNTRY SPECIFIC STANDARDS 9 Hrs.

European Committee for Standardization (CEN), PAN American Standards Commission (COPANT), Euro-Asian Council for Standardization, FDA, EPA, EU, ASEAN, EFSA (European Food Safety Authority)

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - SBTB3016.1 – understand the basic principles of food safety
CO2 - SBTB3016.1 – summarize the general principles of food safety at national and international levels
CO3 - SBTB3016.1 – explore national standards in food safety
CO4 - SBTB3016.1 – construct the knowledge about international standards in food safety
CO5 - SBTB3016.1 – role of country specific standards
CO6 - SBTB3016.1 – evaluate about the overall quality assurance.

TEXT . REFERENCE BOOKS

1. Neal D. Fortin. 2009. Food regulation, Wiley Publishers.
2. Naomi Rees. David Watson. 2000. International standards for food safety, An Aspen Publications.
3. O'Rourke. 2005. European Food law, 3rd Edition, Thomson, Sweet and Maxwell.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 16 marks	**80 Marks**

SBTB7016	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- This course aim to provide students with a comprehensive understanding of pharmaceutical biotechnology, including its principles, applications, and ethical considerations.
- Students will develop practical skills in molecular biology techniques, critical analysis of biopharmaceuticals and drug delivery systems, and an awareness of emerging trends and regulatory aspects in the field.

UNIT 1 INTRODUCTION TO PHARMACEUTICAL BIOTECHNOLOGY 9 Hrs.

- Overview of pharmaceutical biotechnology and its applications in the healthcare industry
- Introduction to drug development and regulatory aspects in pharmaceutical biotechnology
- Understanding the ethical and societal considerations in pharmaceutical biotechnology

UNIT 2 MOLECULAR BIOLOGY TECHNIQUES IN PHARMACEUTICAL BIOTECHNOLOGY 9 Hrs.

- Principles and applications of recombinant DNA technology in drug discovery and development
- Cloning and expression of therapeutic proteins in prokaryotic and eukaryotic systems
- Genomic and proteomic approaches in pharmaceutical biotechnology

UNIT 3 BIOPHARMACEUTICALS AND THERAPEUTIC PROTEINS 9 Hrs.

- Types and characteristics of biopharmaceuticals, including monoclonal antibodies, cytokines, and growth factors
- Production and purification strategies for therapeutic proteins
- Quality control and analytical techniques for biopharmaceutical products

UNIT 4 DRUG DELIVERY AND FORMULATION OF BIOPHARMACEUTICALS 9 Hrs.

- Overview of drug delivery systems and their importance in enhancing therapeutic efficacy
- Principles and applications of nanotechnology in drug delivery
- Targeted drug delivery systems and controlled release formulations

UNIT 5 ADVANCED TOPICS IN PHARMACEUTICAL BIOTECHNOLOGY 9 Hrs.

- Personalized medicine and pharmacogenomics
- Regulatory aspects and intellectual property rights in pharmaceutical biotechnology
- Future prospects and emerging trends in the field

Max.45 Hrs.

COURSE OUTCOMES:

By the end of the course, students should be able to:

CO1 - Understand the fundamental principles and concepts of pharmaceutical biotechnology, including the use of biological systems for the development of drugs and therapeutics.

CO2 - Gain knowledge of the regulatory frameworks and ethical considerations associated with pharmaceutical biotechnology.

CO3 - Develop proficiency in applying molecular biology techniques, such as recombinant DNA technology, for the production and expression of therapeutic proteins.

CO4 - Analyze and evaluate different types of biopharmaceuticals and their production strategies, including monoclonal antibodies, cytokines, and growth factors.

CO5 - Evaluate and compare various drug delivery systems used in pharmaceutical biotechnology, including nanotechnology-based approaches and targeted drug delivery systems.

CO6 - Gain an understanding of advanced topics in pharmaceutical biotechnology, such as personalized medicine, pharmacogenomics, and the impact of intellectual property rights and regulatory aspects on the industry.

TEXTBOOKS/REFERENCES

TEXTBOOKS

1. "Pharmaceutical Biotechnology: Concepts and Applications" by Gary Walsh (2019, 4th edition)
2. "Pharmaceutical Biotechnology: Fundamentals and Applications" by Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm (2019, 5th edition)
3. "Biopharmaceuticals: Biochemistry and Biotechnology" by Gary Walsh (2013, 2nd edition)
4. "Industrial Pharmaceutical Biotechnology" by Antonello A. Barone, Pietro P. Ciarlo, Giuseppe R. Paradisi (2021, 1st edition)
5. "Biopharmaceutics and Clinical Pharmacokinetics" by Notari, Robert E. (2015, 6th edition)

REFERENCES:

1. "Pharmaceutical Biotechnology: Fundamentals and Applications" by Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm (2013)
2. "Pharmaceutical Biotechnology: Concepts and Applications" by Gary Walsh (2013)
3. "Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications" by Oliver Kayser, Heribert Warzecha (2012)
4. "Introduction to Biotechnology and Genetic Engineering" by A. J. Nair (2019)
5. "Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs" by Rodney J. Y. Ho, Milo Gibaldi (2013)

SBTB7017	BIOPHARMACEUTICALS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES:

- These course objectives are designed to provide students with a comprehensive understanding of the principles, manufacturing processes, characterization, and regulatory aspects of biopharmaceuticals. By the end of the course, students should be able to critically analyze and apply their knowledge in the development, production, and evaluation of biopharmaceuticals.

UNIT 1 INTRODUCTION TO BIOPHARMACEUTICALS 9 Hrs.

- Overview of biopharmaceuticals and their significance in healthcare
- Classification of biopharmaceuticals: proteins, peptides, monoclonal antibodies, vaccines, etc.
- Biotechnology-based manufacturing processes for biopharmaceuticals
- Regulatory considerations and challenges in the development and approval of biopharmaceuticals

UNIT 2 BIOPHARMACEUTICAL PRODUCTION AND CELL CULTURE TECHNIQUES 9 Hrs.

- Cell culture techniques for biopharmaceutical production: mammalian cell culture, microbial expression systems, and transgenic plants and animals
- Media formulation and optimization for cell growth and protein expression
- Upstream processing: cell line development, fermentation, and bioreactor operation
- Downstream processing: purification, chromatography, filtration, and formulation of biopharmaceuticals

UNIT 3 PROTEIN ENGINEERING AND MODIFICATION 9 Hrs.

- Principles of protein engineering for improving biopharmaceutical properties
- Site-directed mutagenesis, protein fusion, and glycosylation engineering
- Post-translational modifications and their impact on biopharmaceutical function and stability
- Analytical techniques for characterizing engineered proteins and assessing product quality

UNIT 4 DRUG DELIVERY AND FORMULATION OF BIOPHARMACEUTICALS 9 Hrs.

- Challenges and strategies for formulating biopharmaceuticals for effective delivery
- Delivery systems for biopharmaceuticals: injections, inhalation, transdermal, and oral delivery
- Formulation considerations for stability, immunogenicity, and patient compliance
- Controlled release and sustained release formulations for biopharmaceuticals

UNIT 5 PHARMACOKINETICS, IMMUNOGENICITY, AND CLINICAL DEVELOPMENT OF BIOPHARMACEUTICALS 9 Hrs.

- Pharmacokinetic properties and challenges in the clinical development of biopharmaceuticals
- Immunogenicity and strategies to mitigate immune responses
- Clinical trial design and regulatory requirements for biopharmaceutical development
- Post-marketing surveillance and life-cycle management of biopharmaceuticals

Max.45 Hrs.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand the principles and manufacturing processes involved in the production of biopharmaceuticals.

CO2 - Apply cell culture techniques and upstream and downstream processing methods for biopharmaceutical production.

CO3 - Apply protein engineering strategies to improve the properties of biopharmaceuticals.
CO4 - Design and develop delivery systems and formulations for biopharmaceuticals.
CO5 - Analyze and assess the pharmacokinetic properties and immunogenicity of biopharmaceuticals.
CO6 - Understand the regulatory requirements and challenges in the clinical development and post-marketing surveillance of biopharmaceuticals.

TEXTBOOKS/REFERENCES

TEXTBOOKS

1. "Biopharmaceuticals: Biochemistry and Biotechnology" by Gary Walsh (2nd edition, 2013)
2. "Biopharmaceuticals: An Industrial Perspective" by G. Walsh and P. M. Jenkins (1st edition, 1998)

REFERENCES:

1. "Protein Formulation and Delivery" edited by Eugene J. McNally (1st edition, 1996)
2. "Biopharmaceutics and Drug Interactions" by R. A. Mehvar (2nd edition, 2012)
3. "Biopharmaceutical Production Technology" edited by Satish K. Singh and Ashok K. Singh (1st edition, 2011)
4. "Handbook of Pharmaceutical Biotechnology" edited by Shayne Cox Gad (1st edition, 2007)

SBTB7018	TARGETED DRUG DELIVERY SYSTEMS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- This course aim to provide students with a strong understanding of targeted drug delivery systems, including their design principles, applications, and future prospects. Students will develop skills in evaluating different targeting strategies, designing targeted drug delivery systems, and analyzing the regulatory landscape for clinical translation.

UNIT 1 INTRODUCTION TO TARGETED DRUG DELIVERY SYSTEMS 9 Hrs.

- Overview of targeted drug delivery systems and their importance in enhancing therapeutic efficacy
- Principles of drug targeting and different approaches for selective drug delivery
- Challenges and opportunities in targeted drug delivery

UNIT 2 PASSIVE TARGETING STRATEGIES 9 Hrs.

- Enhanced permeability and retention (EPR) effect in tumor targeting
- Strategies to exploit EPR effect for delivering drugs to solid tumors
- Passive targeting approaches for other disease sites, such as inflammation and infectious diseases

UNIT 3 ACTIVE TARGETING STRATEGIES 9 Hrs.

- Ligand-receptor interactions and their role in active targeting
- Design and optimization of ligand-targeted drug delivery systems
- Targeting strategies for specific diseases, such as cancer, cardiovascular diseases, and central nervous system disorders

UNIT 4 NANOTECHNOLOGY-BASED DRUG DELIVERY SYSTEMS 9 Hrs.

- Introduction to nanotechnology and its applications in drug delivery
- Design and characterization of nanoparticles for targeted drug delivery
- Targeting strategies using various types of nanoparticles, including liposomes, polymeric nanoparticles, and dendrimers

UNIT 5 EMERGING TECHNOLOGIES AND FUTURE PERSPECTIVES 9 Hrs.

- Advances in targeted drug delivery systems, such as stimuli-responsive systems and smart drug delivery
- Nanomedicine approaches for personalized medicine and theranostics
- Regulatory considerations and clinical translation of targeted drug delivery systems

Max.45 Hrs.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand the principles and importance of targeted drug delivery systems in enhancing therapeutic efficacy.

CO2 - Evaluate and compare different passive and active targeting strategies for specific disease sites.

CO3 - Analyze the design and optimization of ligand-targeted drug delivery systems.

CO4 - Assess the characteristics and applications of nanotechnology-based drug delivery systems.

CO5 - Discuss emerging technologies and future perspectives in targeted drug delivery.

CO6 - Critically analyze the regulatory considerations and challenges in the clinical translation of targeted drug delivery systems**.**

TEXTBOOKS/REFERENCES

TEXTBOOKS

1. "Targeted Drug Delivery: Concepts and Design" by Padma V. Devarajan (2019, 2nd edition)
2. "Drug Targeting and Delivery: Concepts in Dosage Form Design" by Anya M. Hillery, Lisa M. Jones, S. William Zito (2016, 3rd edition)
3. "Nanotechnology-Based Targeted Drug Delivery Systems for Brain Tumors" by Prashant Kesharwani (2019)
4. "Ligand-Targeted Therapeutics in Anticancer Therapy" by Gokul M. Das (2019, 2nd edition)
5. "Advanced Drug Delivery Systems: Nanotechnology, Controlled Release, and Novel Targeted Therapies" by Ashim K. Mitra (2020, 2nd edition)

REFERENCES:

1. "Targeted Drug Delivery: Concepts and Design" by Padma V. Devarajan (2015)
2. "Targeted Drug Delivery Systems: A Comprehensive Review" by Seungpyo Hong, You Han Bae (2019)
3. "Ligand-Targeted Therapeutics in Anticancer Therapy" by Gokul M. Das (2021)
4. "Nanomedicine for Drug Delivery and Therapeutics" by Ajay Kumar Mishra (2021)
5. "Stimuli-Responsive Drug Delivery Systems: From Introduction to Application" by Marek R. Osiński (2020)

SBTB7019	PHARMACOLOGY, TOXICOLOGY AND THERAPEUTICS	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- This course aim to provide students with a strong foundation in pharmacology, toxicology, and therapeutics. Students will develop the skills to analyze drug-receptor interactions, evaluate pharmacokinetic parameters, understand toxicity mechanisms, and apply therapeutic principles in various disease areas.

UNIT 1 INTRODUCTION TO PHARMACOLOGY AND DRUG DEVELOPMENT 9 Hrs.

- Overview of pharmacology, toxicology, and therapeutics
- Introduction to pharmacokinetics and pharmacodynamics
- Principles and stages of drug development

UNIT 2 DRUG-RECEPTOR INTERACTIONS AND DRUG TARGETS 9 Hrs.

- Mechanisms of drug-receptor interactions
- Classification of drug targets and their role in drug action
- Drug selectivity and specificity

UNIT 3 PHARMACODYNAMICS AND PHARMACOKINETICS 9 Hrs.

- Principles of pharmacodynamics: dose-response relationships, drug potency, and efficacy
- Introduction to pharmacokinetics: absorption, distribution, metabolism, and excretion of drugs
- Factors influencing drug response and individual variation in drug pharmacokinetics

UNIT 4 DRUG TOXICITY AND ADVERSE DRUG REACTIONS 9 Hrs.

- Principles of toxicology and dose-response relationships
- Types of toxic effects and their mechanisms
- Adverse drug reactions: classification, identification, and management

UNIT 5 THERAPEUTICS AND DRUG THERAPY 9 Hrs.

- Introduction to therapeutic principles and rational drug use
- Drug classes and their therapeutic uses in major disease areas
- Individualized and personalized medicine approaches

Max.45 Hrs.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand the fundamental principles of pharmacology, toxicology, and therapeutics.
CO2 - Explain the mechanisms of drug-receptor interactions and drug action.
CO3 - Analyze the pharmacodynamics and pharmacokinetics of drugs.
CO4 - Evaluate the toxic effects of drugs and understand adverse drug reactions.
CO5 - Discuss therapeutic principles and the use of drugs in major disease areas.
CO6 - Apply the principles of individualized and personalized medicine in drug therapy.

TEXTBOOKS/REFERENCES

TEXTBOOKS

1. "Pharmacology" by George M. Brenner, Craig W. Stevens (2022, 6th edition)
2. "Basic & Clinical Pharmacology" by Bertram G. Katzung, Anthony J. Trevor (2020, 15th edition)
3. "Medical Pharmacology at a Glance" by Michael J. Neal (2018, 8th edition)
4. "Toxicology and Risk Assessment: A Comprehensive Introduction" by Helmut Greim, Robert Snyder (2018, 3rd edition)

5. "Clinical Pharmacology and Therapeutics: Questions for Self Assessment" by Timothy G. K. Mant (2021, 5th edition)

REFERENCES:

1. "Goodman & Gilman's The Pharmacological Basis of Therapeutics" by Laurence L. Brunton, Bjorn C. Knollmann, Randa Hilal-Dandan (2020, 14th edition)
2. "Casarett & Doull's Essentials of Toxicology" by Curtis D. Klaassen (2019, 4th edition)
3. "Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy" by David E. Golan, Armen H. Tashjian Jr., Ehrin J. Armstrong, April W. Armstrong (2020, 5th edition)
4. "Pharmacology and Therapeutics: Principles to Practice" by Scott A. Waldman, Andre Terzic (2018)
5. "Toxicology: Principles and Applications" by Robert H. Smith (2018, 3rd edition)

SBTB7020	DRUG METABOLISM	L	T	P	Credits	Total Marks
		3	*	0	3	100

COURSE OBJECTIVES

- This course aim to provide students with a strong understanding of drug metabolism, including its principles, reactions, enzymes, and genetic factors. Students will develop skills in analyzing drug metabolism pathways, evaluating factors influencing drug metabolism, and understanding the implications of drug-drug interactions and pharmacogenomics in personalized medicine.

UNIT 1 INTRODUCTION TO DRUG METABOLISM 9 Hrs.

- Overview of drug metabolism and its significance in drug development and safety
- Phase I and Phase II drug metabolism reactions
- Factors influencing drug metabolism, including genetics and environmental factors

UNIT 2 PHASE I DRUG METABOLISM REACTIONS 9 Hrs.

- Oxidation, reduction, and hydrolysis reactions in Phase I metabolism
- Role and function of cytochrome P450 enzymes in drug metabolism
- Drug-drug interactions and their impact on Phase I metabolism

UNIT 3 PHASE II DRUG METABOLISM REACTIONS 9 Hrs.

- Conjugation reactions, including glucuronidation, sulfation, and acetylation
- Enzymes and transporters involved in Phase II metabolism
- Genetic polymorphisms and variations in Phase II metabolism enzymes

UNIT 4 DRUG METABOLISM ENZYMES AND REGULATION 9 Hrs.

- Overview of drug metabolism enzymes, including cytochrome P450s, UDP-glucuronosyltransferases, and sulfotransferases
- Regulation of drug metabolism enzyme expression and activity
- Factors influencing interindividual variability in drug metabolism enzyme levels

UNIT 5 PHARMACOGENOMICS AND DRUG METABOLISM 9 Hrs.

- Role of genetic variations in drug metabolism and response
- Application of pharmacogenomic knowledge in personalized medicine and drug therapy
- Ethical considerations and challenges in pharmacogenomics-based drug metabolism testing

Max.45 Hrs.

COURSE OUTCOMES:

At the end of the course students will be able to.

CO1 - Understand the fundamental principles and concepts of drug metabolism.
CO2 - Explain the different phases of drug metabolism and the reactions involved.
CO3 - Analyze the role and function of enzymes and transporters in drug metabolism.
CO4 - Evaluate the factors influencing drug metabolism, including genetic and environmental factors.
CO5 - Discuss the impact of drug-drug interactions on drug metabolism and drug response.
CO6 - Apply pharmacogenomic knowledge to understand interindividual variability in drug metabolism and its implications for personalized medicine.

REFERENCES

1. Principles of Drug Metabolism and Pharmacokinetics" by Stephen H. Curry, Robin Whelpton (2017, 2nd edition)
2. "Drug Metabolism: Chemical and Enzymatic Aspects" by Bernard Testa, Stefanie D. Krämer, Urs A. Meyer (2012)

3. "Handbook of Drug Metabolism" by Paul G. Pearson (2018)
4. "Drug Metabolism and Pharmacokinetics Quick Guide" by Siamak Cyrus Khojasteh, Han van de Waterbeemd (2019)
5. "Drug Metabolism: Current Concepts" by Michael D. Coleman (2015)

TEXT BOOKS:

1. "Drug Metabolism: Chemical and Enzymatic Aspects" by Bernard Testa, Stefanie D. Krämer, Urs A. Meyer (2020, 4th edition)
2. "Principles of Drug Metabolism and Pharmacokinetics" by Stephen H. Curry, Robin Whelpton (2021, 3rd edition)
3. "Drug Metabolism and Pharmacokinetics in Drug Discovery: A Beginner's Guide" by Min Li (2019)
4. "Introduction to Pharmacokinetics and Pharmacodynamics: The Quantitative Basis of Drug Therapy" by Thomas N. Tozer, Malcolm Rowland (2018, 5th edition)
5. "Fundamentals of Drug Metabolism and Drug Disposition" by D. S. R. Sarma (2021, 2nd edition)

	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
Theory	SBTB7021	MARINE BIOTECHNOLOGY	3	0	0	3	50	50	

COURSE OBJECTIVES

- The course introduces to the micro, macro flora and fauna of the marine environment with an emphasis on the aquaculture and production of marine products.

UNIT 1 MARINE ECOSYSTEMS AND MICROBIAL DIVERSITY 9 Hrs.

Physical and chemical properties of sea water. Zonation of sea: Euphotic zone, Bathyal zone, Abyssal zone, benthic zone, Deep-sea. Marine ecosystems and biodiversity**:** Estuary, Seagrass, Seaweed, Salt marsh, Mangroves and Coral reef. Marine microbial diversity: Marine microbial habitats, Microbial distribution in the ocean, Factors that impact marine microbial diversity. Interactions between marine microbes and other living organisms.

UNIT 2 AQUACULTURE 9 Hrs.

Aquaculture: Definition-Site selection, design and construction of aquaculture pond. Criteria for selecting the candidate species for aquaculture. Types and methods**:** Extensive, Semi-intensive and Intensive culture. Composite fish culture and Integrated fish farming. Types of culture systems**:** Pen culture, Cage culture, Raft culture and Pond culture. Culture practices of marine Fish, Shrimp, Crab, Lobster, Oyster, and Seaweed.

UNIT 3 ECONOMIC IMPORTANCE OF MARINE ORGANISMS 9 Hrs.

Live feed culture for marine organisms: culture of microalgae, rotifers, copepods and Artemia. Biofuel production. Marine enzymes, Production of omega-3 fatty acids from marine organisms. Marine pharmacology: New and novel antibiotics from marine organisms. Secondary metabolites from marine bacteria, actinomycetes and marine endophytic fungi. Prebiotics and Probiotics for aquaculture.

UNIT 4 FISH GENETICS AND MARINE BY-PRODUCTS 9 Hrs.

Fish genetics: Androgenesis, Gynogenesis, Polyploidy, Artificial insemination, Eye-stalk ablation and Cryopreservation of fish gametes.

Marine algal by-products: Chitin, Chitosan, Agar, Alginates, Carrageenan and Heparin. Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.

UNIT 5 MARINE ENVIRONMENT PROTECTION 9 Hrs.

Marine Pollution. Human impacts on marine microbial diversity - Usage of marine microbes to ameliorate environmental deterioration. Control of oil spills and bioremediation. Effects of bio-fouling and bio-deterioration on marine structures. Protection methods against corrosion and fouling. Red tides: Causative factors and effects on the organisms of marine environment, Treatment of Aquaculture effluents**.**

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Learn the importance of marine ecosystems and microbial biodiversity

CO2 - Develop the aquaculture practices of marine fish, shrimp, crab, lobster, edible oyster, pearl oyster and seaweeds

CO3 - Device the various techniques involved in aquaculture

CO4 - Formulate the production methodologies for economically and pharmaceutically important products from marine organisms

CO5 - Generate the techniques in fish genetics and to produce various seaweed and fishery by-products

CO6 - Evaluate the human impacted pollution in the marine environment and the usage of marine microbes to ameliorate environmental deterioration

TEXT / REFERENCE BOOKS

1. Marine Biotechnology (2011). Guest Editors: Song Qin,W. E. G. M¨uller, and Edwin L. Cooper. Hindawi Publishing Corporation. 299 pages.
2. Grand Challenges in Marine Biotechnology (2018). P. H. Rampelotto, A. Trincone (eds.). Springer International Publishing AG, part of Springer Nature. 616 pages.
3. Marine Biotechnology I & II (2005) Advances in Biochemical Engineering/Biotechnology Le Gal, Y., Ulber, R (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96. pp. 287 & Vol. 97. pp. 261.
4. Marine microbial diversity: The key to earth's habitability: A Report from the American academy of microbiology (2005). Jennie Hunter-Cevera, David Karl and Merry Buckley, Published by American Academy of Microbiology, held (April 8- 10, 2005) in San Francisco, California. pp. 28.
5. Advances in Marine and Brackishwater Aquaculture**.** (2015) Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India. 262 Pages.
6. Aquaculture. (2014) N.Arumugam. Saras Publication. 480 pages.
7. FAO (2018). The state of world fisheries and aquaculture. FAO, Rome, 210 pp.
8. Aquaculture: Principles and Practices. (2011) T.V.R. Pillay & M.. N.Kutty. Wiley India Pvt Ltd; Second edition. 640 pages.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A : 5 Questions of 6 marks each - No choice **30 Marks**

PART B : 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

No.	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
	SBTB7022	AQUACULTURE	3	0	0	3	50	50	

COURSE OBJECTIVES

- Development of existing water bodies and creation of additional water area for large scale fish production.

UNIT 1 INTRODUCTION TO AQUACULTURE 9 Hrs.

Aquaculture: Definition-Site selection, design and construction of aquaculture pond - Criteria for selecting the candidate species for aquaculture - Types and methods: Extensive, semi-intensive and intensive culture - Composite fish culture and integrated fish farming - Types of culture systems: pen culture, Cage culture, raft culture and Pond culture.

UNIT 2 HATCHERY AND GROW- OUT POND MANAGEMENT 9 Hrs.

Design and construction of a fish hatchery - Types of hatcheries and management practices - Live feed culture: culture of microalgae, rotifers and crustaceans (Artemia) - Selection of brooder, nutrition, gonadal changes, hormonal regulation.

Pond management: Nursery and grow-out pond maintenance, pond fertilization. Water quality management: Dissolved Oxygen, CO2, Ammonia, pH, salinity, temperature and turbidity.

UNIT 3 AQUCULTURE AND POST HARVEST TECHNOLOGY 9 Hrs.

Culture of economically important marine species*: Litopenaeus vannamei* (shrimp), *Lates calcarifer* (seabass), Crab, Lobster, Oyster, and Seaweeds - Culture practices of freshwater species: Prawns, Carps, Catfish, Murrel fish and Ornamental fishes.

Harvest and post-harvest technology: Types of harvest, sorting, cleaning, packing, transportation of live organisms and preservation. Fish processing: Types of processing and canning, Quality assurance: Standards of sanitation and hygiene. Implementation of HACCP (Hazard Analysis and Critical Control Point) concept and food safety in fish industry.

UNIT 4 CHROMOSOME MANIPULATION AND FISH BIOTECHNOLOGY 9 Hrs.

Genetic improvement: Inbreeding and cross breeding; Hybridization, Genetic manipulation: Sex-reversal and sex control; role of steroids in sex reversal, chromosomal manipulation, polyploidy, androgenesis and gynogenesis; cryopreservation of gametes. Fish Biotechnology: Production of transgenic fishes, micro injection technique, Cloning and expression of GnRH.

UNIT 5 FISH DISEASES AND CONTROL MEASURES 9 Hrs.

Disease diagnosis: Principles of disease diagnosis in finfish and shell fish. Microbial diseases: Diseases caused by bacteria (Vibriosis) - Fungi and viruses (WSSV). Parasitic diseases: Diseases caused by Protozoa and Metazoan parasites (crustaceans, helminths). Non–infectious diseases: Nutritional and environmental diseases. Aquafarm pollutants. Prevention and control of diseases: Symptoms, prevention, control and treatments (prophylactic and therapeutic).

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Apply their knowledge to cultivate the aquatic organisms in various methods

CO2 - Construct a hatchery with various facilities such as spawning, larval rearing and live-feed culture

CO3 - Design the aquaculture farm and apply their knowledge to cultivate various aquatic organisms

CO4 - Execute various breeding and genetic manipulation techniques for the maximum production

CO5 - Identify various fish diseases to apply the correct treatment methods
CO6 - Investigate the type of aquatic organisms and apply their knowledge to cultivate them in an artificial environment using biotech related technologies

TEXT / REFERENCE BOOKS

1. Pillay, T.V.R., Aquaculture Principles & Practices, Fishing News (Books) Limited, London, 1990
2. Santhanam R. N. Ramanathan and G. Jegatheesan, Coastal Aquaculture in India, CBS publishers, 1990
3. V. Sundararaj, M.J. Prince Jeyaseelan and S. Felix, Shrimp health Management, Mala Publishers, Chennai. 1993
4. T.V.R. Pillay, Coastal Aquaculture in the Indo-Pacific region, FAO, Rome, Italy. 1962
5. Donald R. Swift, Aquaculture training manual, Fishing News Books Ltd. 1993
6. Hand Book on aqua farming by MPEDA, Cochin. 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 16 marks	**80 Marks**

No.	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
	SBTB7023	SEAFOOD PROCESSING TECHNOLOGY	3	0	0	3	50	50	

COURSE OBJECTIVE

- This course will acquaint students with basic principles of common seafood preservation techniques, non-thermal food processing techniques, quality assurance and export of fish and fishery products.

UNIT 1 INTRODUCTION TO SEAFOOD PROCESSING 9 Hrs.

Importance of seafood in human diet; Chemical constituents in fish; Causes of fish spoilage; principles of fish preservation, Importance of processing; Handling of fish and transportation.

UNIT 2 TRADITIONAL METHODS OF FISH PROCESSING 9 Hrs.

Icing, Drying, Salting, Smoking, Pickling, Fermentation

UNIT 3 USE OF ICE AS A COOLING MEDIUM 9 Hrs.

Icing of fish, different types of ice and their manufacture. CSW, RSW. Freezing of fish – slow freezing and quick freezing, freezing curve. Different types of freezers. Quality changes during frozen storage. Theory of freezing damage. Basic refrigeration cycle,

UNIT 4 CANNING AND PACKAGING OF FISH AND FISHERY PRODUCTS 9 Hrs.

Unit steps in canning and their significance. Retort pouch, Can corrosion, Botulism, spoilage of canned fish.

Packaging materials; basic films and laminates, Technological aspects of packaging fishery products; packing of fresh and frozen fish for consumers; packaging for transport, shipping and institutional supplies;

UNIT 5 VALUE ADDED PRODUCTS AND QUALITY CONTROL 9 Hrs.

Minced based products, coated products, IQF products; Waste utilization: Fish meal, fish oil, Chitin and chitosan.

Important pathogenic microbes; Cross contamination; Hygiene in the fish processing factory – the HACCP principle.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To understand and develop skills on various seafood processing techniques and seafood export documentation.

CO2 - Capacity to analyze and interpret quality assurance and management of the system in seafood industries.

CO3 - To develop the skill to differentiate fresh and spoiled seafood.

CO4 - To understand the postmortem quality degradation in seafood.

CO5 - To understand the methods to prevent seafood spoilage.

CO6 - To have knowledge on advanced techniques of packaging and storing of seafood products.

TEXT / REFERENCE BOOKS

1. Balachandran KK. 2001. Post-Harvest Technology of Fish and Fish Products. Daya Publ.
2. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR. 198
3. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.

4. Venugopal V. 2006. Seafood Processing. Taylor & Francis.
5. Wheaton FW & Lawson TB. 1985. Processing Aquatic Food Products. John Wiley & Sons.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A :	5 Questions of 6 marks each - No choice	**30 Marks**
PART B :	2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBTB7024	AQUAPONICS AND SMART FISH FARMING	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES

- To produce more fish to feed the growing world population, while reducing the cost and environmental footprint of aquaculture operations through automation and digitalization.

UNIT 1 INTRODUCTION TO AQUAPONICS 9 Hrs.

Aquaculture - Aquaponic technology - Urban agriculture - Vertical aquaponics - Fish anatomy, health and welfare - Fish feeding and growth - Floating Raft Systems - Media Bed Systems - PVC & Bell Siphons - NFT Systems – Filtration - System Design - Gathering Parts – Aeration - Building and Sizing Filters - Aquaponic System – Microbiomes - System Build - Pumps and Pump Curves - Pressure and Flow, and Sizing pumps.

UNIT 2 WATER QUALITY AND FISH CARE 9 Hrs.

Nutrient water balance - Hydroponics - Plant varieties - Monitoring of parameters - Food safety - Scientific research methods - Probes, Sensors and Controls - Cleaning & Organizing Greenhouse - Decoupled Aquaponics: Innovation in Aquaponics - Mass Balances and Loading - Commercial Design - Energy Balances - Integrated pest management : Pest Control and Management: Insects and Pests - Maintenance and Troubleshooting: System Maintenance - Regulations, Permitting, and marketing. Social aspects of aquaponics.

UNIT 3 ARTIFICIAL INTELLIGENCE IN AQUACULTURE 9 Hrs.

Feeding a growing population with sustainable aquaculture - Legal regulations to increase food safety - Land-based farming - Combined land and sea-based farming - Aquaponics - Recirculating Aquaculture System (RAS) - Robotic cages - Drones in aquaculture - Sensors for aquaculture – eFishery sensor technology.

Artificial intelligence (AI) empowers aquaculture decision-making. Opportunity for AI in Aquaculture - Attracting Startups – Technical details and overall performance – Data – Algorithms - DO control - Temperature control - Biological filtration - Water management - Augmented reality (AR) - Internet of Things – sensors - Microcontroller with GSM module - Circuit diagram - check pH value and send SMS - Image processing for monitoring fishes.

UNIT 4 DATA ANALYTICS AND MACHINE LEARNING 9 Hrs.

Aquaculture goes digital - Generating added value for the aquaculture industry - From automation to digitalization - Domain and vertical know-how and expertise - Automation - Electrification – Digitalization - Practical examples of how electrification, automation and digitalization support aquaculture.

Fish farm closure prediction - Algae bloom prediction - Missing values estimation - Model relocation - Benthic habitat mapping - Sensor data quality assessment.

UNIT 5 DEEP LEARNING IN SMART FISH FARMING 9 Hrs.

Concepts of Deep Learning: Terms and definitions of deep learning - Learning tasks and models. Applications of deep learning in smart fish farming: Live fish identification - Species classification - Behavioral analysis - Size or biomass estimation - Feeding decision-making - Water quality prediction - Performance evaluation indexes and overall performance - Performance evaluation indexes - Performance comparisons with other approaches - Advantages of deep learning - Disadvantages and limitations of deep learning - Future technical trends of deep learning in smart fish farming.

COURSE OUTCOMES

On completion of course, student will able to

CO1 - Design and build a small-scale and commercial aquaponics system.
CO2 - Construct the artificial intelligence techniques in aquaculture
CO3 - Demonstrate the various data analytics for various aquaculture species
CO4 - Learn how to do machine learning methods to improve the quality of fish
CO5 - Monitor and analyze the water quality parameters of the pond in a smart way
CO6 - Formulate the deep learning methods for smart fish farming

TEXT / REFERENCE BOOKS

1. Eck, M., Sare, A.R., Massart, S., Schmautz, Z., Junge, R., Smits, T.H.M., Jijakli, M.H., 2019. Exploring bacterial communities in aquaponic systems. Water (Switzerland) 11, pp 1-16.
2. Kyaw, T.Y., Ng, A.K., 2017. Smart Aquaponics System for Urban Farming. Energy Procedia 143, 342-347.
3. Mamatha, M.N., Namratha, S.N., 2018. Design & implementation of indoor farming using automated aquaponics system. 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials. Proceding 2 pp 396-401.
4. Mandap, J.P., Sze, D., Reyes, G.N., Dumlao, S.M., Reyes, R., Yaw, W., Chung, D., 2018. Aquaponics pH Level, Temperature, and Dissolved Oxygen Monitoring and Control System Using Raspberry Pi as Network Backbone. TENCON 2018 – 2018 IEEE Reg. 10 Conf. 1381-1386.
5. Delaide, B., Delhaye, G., Dermience, M., Gott, J., Soyeurt, H., Hihakli, M.H., 2017. Plant and fish production performance, nutrient mass blanaces, energy and water use of the PAFF Box, a small-scale aquaponic system. Aquaculture Engineering 78 pp 130-139.
6. A Practical guide to use AI in Aquaculture. https://thefishsite.com/articles/a-practical-guide-to-using-ai-in-aquaculture

No.	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
	SBTB7025	VALURE ADDED FISHERY BYPRODUCTS	3	0	0	3	50	50	

COURSE OBJECTIVES:

- To give awareness on the principles and significance of value addition in the seafood industry. To prepare the number of value-added products for commercial gain.

UNIT 1 FISHERY BY-PRODUCTS CHARACTERIZATION 9 Hrs.

Physical and chemical properties of protein byproducts from seafood waste; Physical and chemical properties of lipid byproducts. On-board handling of marine by-products to prevent microbial spoilage, enzymatic reactions and lipid oxidation.

UNIT 2 FISHERY BY-PRODUCTS RECOVERY AND PROCESSING 9 Hrs.

Recovery of by-products from seafood processing streams; Increasing processed flesh yield by recovery from marine by-products; enzymatic methods for marine by-products recovery; Chemical processing methods for protein recovery from marine by-products and underutilized fish species.

UNIT 3 FOOD USES OF FISHERY BYPRODUCTS – I 9 Hrs.

By-catch, underutilized species and underutilized fish parts as food ingredients; Mince from seafood processing by-product and surimi as food ingredients; Aquatic food protein hydrolysates; Functional properties of protein powders from underutilized marine fish and seafood products.

UNIT 4 FOOD USES OF FISHERY BYPRODUCTS – II 9 Hrs.

Marine oils from seafood waste; Collagen and gelatin from marine by-products; Seafood flavour from processing by-products; Fish and bone as a calcium source; Chitin and Chitosan from marine by-products; Marine enzymes from seafood by-products; Antioxidants from marine by-products; Pigments from by-products of seafood processing.

UNIT 5 NON-FOOD USES OF FISHERY BYPRODUCTS 9 Hrs.

Byproducts from seafood processing for agriculture and animal feeds; Using marine byproducts in pharmaceutical, medical and cosmetic products; Bio-diesel and bio-gas production from seafood processing byproducts; Composting of seafood wastes.

Max.45 Hrs.

COURSE OUTCOMES:

On completion of the course, students will be able to:

CO1 - To provide sufficient knowledge on spoilage and quality evaluation
CO2 - Learn the preparation, packaging and storing of the fishery products.
CO3 - Prepare fish mince-based products with special emphasis on surimi production.
CO4 - Manufacture the various value-added products from fish or shrimp.
CO5 - Develop the various byproducts for commercial gain.
CO6 - Aware on the principles and significance of value addition in the seafood industry.

TEXT / REFERENCE BOOKS

1. Maximizing the Value of Marine By-Products. 2006. Fereidoon Shahidi (Editor), Woodhead Publishing, 560 pages.
2. Aquaculture: Principles and Practices. (2011) T.V.R. Pillay & M. N.Kutty. Wiley India Pvt Ltd; Second edition. 640 pages.

3. Advances in Marine and Brackishwater Aquaculture**.** (2015) Santhanam Perumal, Thirunavukkarasu A.R., Perumal Pachiappan. Editors. Springer India. 262 Pages.
4. Aquaculture. (2014) N.Arumugam. Saras Publication. 480 pages.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A :	10 questions of 2 marks each - No choice	**20 Marks**
PART B :	2 questions from each unit of internal choice; each carrying 16 marks	**80 Marks**

AUDIT COURSES (AC) AX5091

ENGLISHFOR RESEARCHPAPERWRITING L T P C 2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT 1 INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT 2 PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT 3 TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT 4 RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT 5 VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission.

OUTCOMES TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1 - Understand that how to improve your writing skills and level of readability
CO2 - Learn about what to write in each section
CO3 - Understand the skills needed when writing a Title
CO4 - Understand the skills needed when writing the Conclusion
CO5 - Ensure the good quality of paper at very first-time submission
CO6 - PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 CO1 Π Π CO2 Π Π CO3 Π Π CO4 Π Π CO5 Π Π

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

DISASTER MANAGEMENT L T P C 2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT 1 INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT 2 REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT 3 DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post- Disaster Diseases and Epidemics.

UNIT 5 DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT 5 RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Total : 30

PERIODS OUTCOMES

CO1 - Ability to summarize basics of disaster

CO2 - Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3 - Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4 - Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 - Ability to develop the strengths and weaknesses of disaster management approaches

CO6 - 88 PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 CO1 Π CO2 Π CO3 Π Π Π CO4 Π Π Π CO5 Π Π Π

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

VALUE EDUCATION L T P C 2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the student should know about the importance of character

UNIT 1

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism.Moralandnon-moralvaluation.Standards and principles. Value judgements.

UNIT 2

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love fornature, Discipline.

UNIT 3

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT 4

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

OUTCOMES

Students will be able to

CO1 - Knowledge of self-development.
CO2 - Learn the importance of Human values.
CO3 - Developing the over all personality.

Total: 30 Periods

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

CONSTITUTION OF INDIA
L T P C 2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT 1 HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition &Working)

UNIT 2 PHILOSOPHYOFTHE INDIANCONSTITUTION
Preamble, Salient Features

UNIT 3 CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT 4 ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT 5 LOCAL ADMINISTRATION
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT 6 ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

Total: 30 Periods

OUTCOMES
Students will be able to:
- **CO1 -** Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- **CO2 -** Discuss the intellectual origins of the frame work of argument that informed the conceptualization of social reform sliding to revolution in India.
- **CO3 -** Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- **CO4 -** Discuss the passage of the Hindu Code Bill of 1956. 91

SUGGESTED READING

1. TheConstitutionofIndia,1950(BareAct), Government Publication.
2. Dr. S. N. Busi, Dr. B. R.AmbedkarframingofIndianConstitution,1 stEdition,2015.
3. M.P. Jain,IndianConstitutionLaw,7 thEdn.,Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

PEDAGOGY STUDIES
L T P C 2 0 0 0

OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT 1 INTRODUCTION AND METHODOLOGY
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT 2 THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT 3 EVIDENCE ON THE EFFECTIVENESS OFPEDAGOGICALPRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT 4 PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT 5 RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Total:30 Periods

OUTCOMES
Students will be able to understand:
- **CO1 -** What pedagogical practices are being used by teachers informal and informal class rooms in developing countries?
- **CO2 -** What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- **CO3 -** How can teacher education(curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING
1. Ackers, HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare,31(2): 245-261.
2. AgrawalM (2004)Curricular reform in schools: The importance of evaluation, JournalofCurriculumStudies,36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.

4. Akyeampong K,LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learningtoread 'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

STRESS MANAGEMENT BY YOGA

L T P C 2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT 1

Definitions of Eight parts of yoga.(Ashtanga)

UNIT 2

Yam and Niyam - Do`s and Don't'sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayama.

Total: 30 Periods

OUTCOMES

Students will be able to:

CO1 - Develop healthy mind in a healthy body thus improving social health also

CO2 - Improve efficiency

SUGGESTEDREADING

1. 'YogicAsanasforGroupTarining-Part-I":JanardanSwamiYogabhyasiMandal, Nagpur
2. "Rajayogaorconquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT 1

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT 2

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT 3

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2- Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

Total:30 Periods

OUTCOMES:

Students will be able to

CO1 - Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life

CO2 - The person who has studied Geeta will lead the nation and man kind to peace and prosperity

CO3 - Study of Neetishatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti- sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

UNNAT BHARAT ABHIYAN (UBA)

Unnat Bharat Abhiyan is inspired by the vision of transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an Inclusive India.

- Organic Farming
- Water Management
- Renewable Energy
- Artisans, Industries and Livelihood
- Basic Amenities
- Convergence
- Sustainable agriculture
- Water resource management
- Artisans, industries and livelihood
- Basic amenities (infrastructure & services) and rural energy system
- Environment Controlled Automated Green House For High Valued Agro Produce (HVPM College of Engineering and Technology, Amravati)
- Revamping of Govt. schools in Vrindavan Cluster (IIT Delhi)
- Safe Drinking Water (NIT Manipur and IIT Jodhpur)
- Paper bag making (BITS Mesra)
- Cloth Bag making (Fatima College, Madurai)
- Agriculture drone system (Santhiram Engineering College, Nandyal, AP)
- Thread winding machine for weavers (Dr. B. R. Ambedkar University, Etcherla, AP)

OUTCOMES

CO1 - To build an understanding of the development agenda within institutes of Higher Education and an institutional capacity and training relevant to national needs, especially those of rural India.

CO2 - To re-emphasize the need for field work, stake-holder interactions and design for societal objectives as the basis of higher education.

CO3 - To stress on rigorous reporting and useful outputs as central to developing new professions.

CO4 - To provide rural India and regional agencies with access to the professional resources of the institutes of higher education, especially those that have acquired academic excellence in the field of science, engineering and technology, and management.

CO5 - To improve development outcomes as a consequence of this research. To develop new professions and new processes to sustain and absorb the outcomes of research.

CO6 - To foster a new dialogue within the larger community on science, society and the environment and to develop a sense of dignity and collective destiny.