# SCHEME & SYLLABUS OF

# III & IV SEMESTERS

# (160 Credits)

# B.E. BIOTECHNOLOGY 2025-26

## VISION AND MISSION OF THE DEPARTMENT

### VISION:

To be a center of excellence in education and research in Biotechnology to address the global challenges

### MISSION:

1. To offer industry relevant curriculum and research through industry collaborations.

2. To continuously upgrade the infrastructure to develop the facilities for training and research.

3. To provide a good learning environment to help students imbibe professional ethics, communication skills, team spirit and societal commitment.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives are as follows:

1. The graduates of the program are practicing engineering profession in IT sectors (IT system engineers, data analyst and computer programmer), and BT sectors (clinical data coordinator, clinical research associate, Quality controller and Quality assurance analyst, Molecular biologist and Business development executive)

2. The graduates of the program are engaged in higher studies leading to professional degree in specific domain such as biological sciences, computational biology and also engaged in life-long learning.

3. The graduates of the program practice profession with high ethical and moral values and have developed good communication skills and leadership qualities while working as a member of the team or as a team leader.

## PROGRAM SPECIFIC OUTCOMES (PSOs):

1. Students will be able to conduct the Upstream and Downstream experiments to produce, optimize, separate, purify and characterize biological compounds.

2. Students will be able to solve advanced biological problems with the technical skills of Bioinformatics, Biomolecular simulation, Proteomics and Genomics using computational techniques.

3. Students will be able to analyse Biopharmaceutical challenges of Biological systems by applying the concepts of Biological sciences

## PROGRAMME OUTCOMES (POs)

| | |
|---|---|
| **PO1** | **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization respectively to develop to the solution of complex engineering problems. |
| **PO2** | **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. |
| **PO3** | **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. |
| **PO4** | **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. |
| **PO5** | **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. |
| **PO6** | **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. |
| **PO7** | **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws |
| **PO8** | **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |
| **PO9** | **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences. |
| **PO10** | **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. |
| **PO11** | **Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. |

# SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU

(An autonomous institution affiliated to VTU, Belagavi, Approved by AICTE, New Delhi, Accredited by NAAC with 'A' grade & ISO 9001:2015 Certified)

## B.E. in Biotechnology

## SCHEME OF TEACHING AND EXAMINATION - (NEP II: batch 3) 2024-2028

### III Semester

| Sl. No. | Course and Course Code | | Course Title | Teaching / Paper setting Dept. | Teaching hrs./week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lecture | Tutorial | Practical/ Drawing | TW + SL Component | Duration in hrs. | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1. | PCC / BSC | S3BT01 | Biostatistics | Maths/BT | 28 | 28 | 0 | 34 | 3 | 50 | 50 | 100 | 3 |
| 2. | IPCC | S3BTI01 | Transport Processes | CH/BT | 42 | 0 | 28 | 50 | 3 | 50 | 50 | 100 | 4 |
| 3. | IPCC | S3BTI02 | Biochemistry | BT | 42 | 0 | 28 | 50 | 3 | 50 | 50 | 100 | 4 |
| 4. | PCC | S3BT02 | Microbiology | BT | 42 | 0 | 0 | 48 | 3 | 50 | 50 | 100 | 3 |
| 5. | PCCL | S3BTL01 | Microbiology Laboratory | BT | - | 0 | 28 | 02 | 3 | 50 | 50 | 100 | 1 |
| 6. | ESC | S3BTXX | ESC/ETC/PLC | BT/CH | 42 | 0 | 0 | 48 | 3 | 50 | 50 | 100 | 3 |
| 7. | UHV | SHS01 | Social Connect and Responsibility **(Board: ME)** | BT | - | 0 | 28 | 02 | - | 100 | - | 100 | 1 |
| 8. | AEC/ SEC | S3BTAXX | Ability Enhancement Course/ Skill Enhancement Course – III | BT | If offered as Theory Course | | | | 1½ | 50 | 50 | 100 | 1 |
| | | | | | If offered as Integrated Course | | | | 1½ | | | | |
| | | | | | 14 | | | 16 | | | | | |
| 9. | NCMC | SMC01 | National Service Scheme (NSS) | NSS | | | | | | 100 | - | 100 | 0 |
| | | SMC02 | Physical Education (PE) (Sports and Athletics) | PED | | | | | | | | | |
| | | SMC03 | Yoga | PED | | | | | | | | | |
| | | | **Total** | | **210** | **28** | **112** | **250** | | **550** | **350** | **900** | **20** |
| 10. | | AAP | AICTE Activity Points (Applicable for both Regular and Lateral Entry students) | 40 hours community service to be documented and produced for the examination | | | | | | | | | |

**Note: PCC**: Professional Core Course, **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC**: Non Credit Mandatory Course, **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **ESC**: Engineering Science Course, **ETC**: Emerging Technology Course, **PLC**: Programming Language Course. **TW + SL**: Term Work and Self learning.
**L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

**Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)**

| | | | |
|---|---|---|---|
| S3BT04 | Bioprocess Calculations (includes Tutorial) | S3BT08 | Plant Biotechnology |
| S3BT07 | Human Anatomy and Physiology (ESC) | S3BT09 | Medical Biotechnology |

**Ability Enhancement Course – III (Offered by the Department)**

| | | | |
|---|---|---|---|
| S3BTA03 | Analysis of Dairy Products Lab | S3BTA05 | Biolab Management and Risk Assessment |
| S3BTA04 | Biopesticides and Biofertilizers | S3BTA06 | Hydroponics, Aquaponics and Aeroponics |

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## B.E. in Biotechnology

**IV Semester** **(NEP II: batch 3) 2024-2028**

| | Course and Course Code | | Course Title | Teaching / Paper setting Dept. | Teaching hrs./week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lecture | Tutorial | Practical/ Drawing | TW + SL Component | Duration in hrs. | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1. | PCC | S4BT01 | Bioinformatics | BT | 42 | 0 | 0 | 48 | 3 | 50 | 50 | 100 | 3 |
| 2. | IPCC | S4BTI02 | Molecular Biology and Genetic Engineering | BT | 42 | 0 | 28 | 50 | 3 | 50 | 50 | 100 | 4 |
| 3. | IPCC | S4BTI03 | Upstream Process Technology | BT | 42 | 0 | 28 | 50 | 3 | 50 | 50 | 100 | 4 |
| 4. | PCCL | S4BTL01 | Bioinformatics Laboratory | BT | 0 | 0 | 28 | 02 | 3 | 50 | 50 | 100 | 1 |
| 5. | ESC | S4BTXX | ESC/ETC/PLC | BT/CH | 42 | 0 | 0 | 48 | 3 | 50 | 50 | 100 | 3 |
| 6. | BSC | S4CCA01 | Biology for Engineers **(Board: BT)** | BT, CHE, CH, EIE | 42 | 0 | 0 | 48 | 3 | 50 | 50 | 100 | 3 |
| 7. | UHV | SHS02 | Universal Human Values Course **(Board: IEM)** | BT | 14 | 0 | 0 | 16 | 1½ | 50 | 50 | 100 | 1 |
| 8. | AEC/ SEC | S4BTAXX/ S4CCA03 | Ability Enhancement Course/ Skill Enhancement Course – IV Advanced Technical Training (ATT) | T&P/BT/ CH | If offered as Theory Course | | | | 1½ | 50 | 50 | 100 | 1 |
| | | | | | | | | | | | | | |
| | | | | | If offered as Integrated Course | | | | 1½ | | | | |
| | | | | | 14 | | | 16 | | | | | |
| 9. | NCMC | SMC01 | National Service Scheme (NSS) | NSS | | | | | | 100 | - | 100 | 0 |
| | | SMC02 | Physical Education (PE) (Sports and Athletics) | PED | | | | | | | | | |
| | | SMC03 | Yoga | PED | | | | | | | | | |
| | | | **Total** | | **238** | | **84** | **278** | | **500** | **400** | **900** | **20** |
| 10 | | AAP | AICTE Activity Points (Applicable for both Regular and Lateral Entry students) | 40 hours community service to be documented and produced for the examination | | | | | | | | | |

**Note:** **PCC**: Professional Core Course, **IPCC**: Integrated Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC**: Non Credit Mandatory Course, **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **ESC**: Engineering Science Course, **ETC**: Emerging Technology Course, **PLC**: Programming Language Course **L**: Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TW + SL**: Term Work and Self learning.

**Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)**

| | | | |
|---|---|---|---|
| S4BT02 | Biological Thermodynamics (includes Tutorials) | S4BT06 | Soil Fertility and Nutrient Management |
| S4BT04 | Bioanalytical Techniques | S4BT07 | Biosensors |

**Ability Enhancement Course – IV (Offered by the Department)**

| | | | |
|---|---|---|---|
| S4BTA01 | Extraction methods and herbal products Lab | S4BTA05 | Biosafety and Hazard Management |
| S4BTA02 | Agitation and Aeration | S4BTA07 | Bioprocess Data analysis |

**Professional Core Course (IPCC)**: Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only

# BIOSTATISTICS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::2:2:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 28+28 | **CIE Marks:** | 50 |
| **Course Code:** | S3BT01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand different types of data and variables. |
| 2. | Appropriately choose, define probability distributions such as the Binomial, Poisson and normal distribution to solve engineering problems. |
| 3. | Understand the principles of various study designs used in epidemiological studies and explain their advantages and limitations. |
| 4. | Learn the different methods of DOE |
| 5. | Learn statistical methods for sample size estimation, sampling distribution and hypothesis testing |

## UNIT I

**Representation of Data and Descriptive Statistics:** Introduction to Biostatistics, classification of variables, types of data, data collection and sampling methods, data representation- diagrammatic methods (line diagram, bar diagram, pie chart), graphical methods (Histogram, frequency polygon, frequency curve, ogive). Measure of central tendency- mean, median, mode, quartiles, harmonic mean and geometric mean. Measure of dispersion- mean deviation, quartile deviation, standard deviation and coefficient of variation.

**6+6 Hours**

## UNIT II

**Bivariate analysis and probability distribution:** Correlation- types, reasons and methods of estimating correlation Spearman's Rank correlation coefficient. and Karl Pearson's coefficient of correlation. Linear Regression analysis, Curve fitting. Probability distribution-Binominal distribution, Poisson distribution and Normal distribution.

**6+6 Hours**

## UNIT III

**Epidemiological study designs:** Observational studies and experimental studies-case reports and case series, ecological study, cross- sectional, case-control, cohort study and nested design. Historically controlled studies, cross over studies, randomized controlled design, Selection of Cases and Controls, Types of Controls, Matching in a Case-Control Study. Measures of Association-Relative Risk & Odds Ratio, Risk difference, attributable risk, excessive risk incidence, prevalence and incidence rate, prospective and retrospective studies, Selectivity, specificity and sensitivity, Bias, and Confounding, multiple sources of variation, Ethical considerations. Replication and repetition, randomisation and blocking, single- and double-blind experiments.

**6+6 Hours**

## UNIT IV

**Design and analysis of Experiments:** Randomized complete block design (RCBD) and CRD analysis, Variants of RCBD such as Latin Square, Central Composite Design, etc., Full factorial experiments, Blocking and Confounding in 2k, Fractional factorial experiments, Plackett-Burman Designs, Response surface methodology (RSM.)

**5+5 Hours**

| UNIT V |
|---|
| **Inferential Statistics for Clinical Researchers:** Point estimation, interval estimation- mean and proportion, sample size estimation, sampling distributions of mean and its properties, testing of hypothesis, type 1 error and type II error, power of study, test statistics (two tailed only)- Z-test, t-test (Paired and unpaired), chi-squared test. Wilcoxon Signed Rank Test, Wilcoxon-Mann-Whitney Test, ANOVA- One-way and Two way. |
| **5+5 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | SC Gupta | Fundamentals Of Statistics, Himalaya Publications, 2018, 978-9351611738, 6th Edition |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Bradley Jones and Douglas C. Montgomery | Design of Experiments 1st Edition, Wiley publications, 2021, 978-1-119-74601-0 |
| 2 | V.B. Rastogi | Fundamentals of Biostatistics, ANE Books publishers, 2009. 10: 8180522555 |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Analyze the methods for data representation |
| **CO2** | Apply bivariate analysis and probability distribution techniques |
| **CO3** | Classify epidemiological studies and Measures of Association-Relative Risk |
| **CO4** | Apply DOE techniques for biological experiments |
| **CO5** | Draw inferences about the characteristics of population from the samples using parametric and non- parametric tests. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO2** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO3** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO4** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO5** | 3 | 2 | | | | | | | | | | | | 1 |

**1: Low, 2: Medium, 3: High**

# TRANSPORT PROCESSES

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:2 | **Credits:** | 4 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTI01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the concept of fluid statistics and its applications in addition to the fluid flow phenomena of different types of fluids. |
| 2. | Learn the basic equations used in different types of regions like laminar, intermittent and turbulent flow, pumps and its operation. |
| 3. | Know the mechanism of heat transfer and understand the working of heat transfer equipment |
| 4. | Understand the concepts of diffusion in mass transfer operations |
| 5. | Know the various types of equipment used in distillation, extraction and drying |

| **UNIT I** |
|---|
| **Fluid Statics and Its Applications:** Concept of unit operations, Concept of Momentum Transfer, Variation of pressure with height – hydrostatic equilibrium, Barometric equation, Devices of measurement of pressure. Fluid Flow Phenomena: Nature of fluids, Types of fluids – shear stress and velocity gradient relation, Newtonian and non – Newtonian fluids, Types of flow – laminar and turbulent flow, Reynolds number. |
| **9 Hours** |

| **UNIT II** |
|---|
| **Basic Equations of Fluid Flow:** Velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations, Modified equations for real fluids with correction factors. Pump work in Bernoulli equation. Numerical conceptual. Laminar flow through circular, Hagen Poiseuille equation. Metering of Fluids in Pipes, Measurement of liquid and gas flow rates by orifice meter, venturi meter, rotameter. Reciprocating and centrifugal pumps. |
| **9 Hours** |

| **UNIT III** |
|---|
| **Heat Transfer:** Various modes of heat transfer, Conduction, Convection, Radiation. conduction: Basic law of conduction, Fourier's law, Thermal conductivity, Steady state unidirectional heat flow through single and multiple layer slabs, Convection Elementary treatment of unsteady state heat conduction, Individual and overall heat transfer coefficient, LMTD, LMTD correction |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Mass Transfer: Diffusion:** Basics of Mass Transfer: Introduction to Mass Transfer Operations – Classification of the mass transfer operations. Methods of conducting the mass transfer operations. Diffusion – Molecular diffusion. Steady state diffusion of component A through non diffusing component B. Steady state equimolar counter diffusion. Gas-liquid mass transfer. Numerical conceptual. |
| **8 Hours** |

| UNIT V |
|---|
| **Distillation:** Batch, continuous, flash or Differential distillation (simple distillation),and Steam distillation, Packed column distillation, Distillation of binary mixtures – Raoults law, McCabe Thiele method. Numerical conceptual.<br>**Extraction and Drying:**<br>Extraction, Liquid-Liquid equilibria, Choice of solvent. Single stage extraction, Multistage cross current extraction.<br>Drying: Batch and continuous drying operations, Drying rate curve, Classification of drying equipment-Direct driers, Indirect driers, Freeze drying, Rotary driers, Drum driers, Spray Driers. |
| **8 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | McCabe W L, Peter Harriott , Julian C. Smith | Unit Operations of Chemical Engineering, McGraw Hill. New York, 2022, 978-8184959635, 7th Edition. |
| 2 | Kumar K L. | Engineering Fluid Mechanics, S Chand and company, 2016, 978-8121901000. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Coulson J. II and Richardson J.F. | Chemical Engineering, Butterworth-Heinemann Ltd, 6th Edition, 2010, 978-8181471444, 5th edition |
| 2 | Badger W.I. and Banchero J.T. | Introduction to Chemical Engineering, Tata McGraws-Hill. New York, 2001, 978-0074630501, 6th Edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Discuss different types of fluids, nature and flows and also calculate pressure using barometric equation and Reynolds number |
| **CO2** | Develop the Hagen Poiseuille's equation from the Bernoulli's equation |
| **CO3** | Classify various modes of heat transfer operations and its correlations |
| **CO4** | Apply the concepts of diffusion in various mass transfer operations |
| **CO5** | Apply the fundamental conceptual for distillation, extraction and drying in developing mass and energy balance equations |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | | | | | | | | 2 | | |
| | **CO2** | 3 | 2 | | | | | | | | | | 2 | | |
| | **CO3** | 3 | 2 | | | | | | | | | | 2 | | |
| | **CO4** | 3 | 2 | | | | | | | | | | 2 | | |
| | **CO5** | 3 | 2 | | | | | | | | | | 2 | | |

**1: Low, 2: Medium, 3: High**

# TRANSPORT PROCESSES LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::0:0:1 | **Credits:** | 0 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTI01 | **SEE Marks:** | 0 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Calibrate instruments used in unit operation. |
| 2. | Understand the principles of momentum, mass and heat transfer operation. |
| 3. | Know how to calculate coefficients, dimension numbers and mass transfer equipment/instrument. |
| 4. | Study the individual& overall H.T.C. of Heat transfer equipment. |
| 5. | Learn to determine the efficiency of distillation and extraction. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Study the variation of friction factor with Reynolds number and to plot the universal resistance graph. |
| 2. | Calibrate the given Orifice meter and to find out its coefficient discharge. |
| 3. | Calibrate the given Venturimeter and to find out its coefficient discharge. |
| 4. | Study the characteristics of a centrifugal pump. |
| 5. | Determine the percentage recovery of solute from a solution using a solvent in each stage of cross current extraction. |
| 6. | Determination of thermal conductivity of insulating powder |
| 7. | Verify application of Rayleigh's equation for simple distillation. |
| 8. | Estimate the critical moisture content and equilibrium moisture content by drawing the rate of drying curve for a given sample. |
| 9. | Determine the diffusivity co-efficient of a given liquid to air. |
| 10. | Estimation of individual and overall heat transfer coefficient in a double pipe heat exchanger. |
| 11. | Estimate individual and overall heat transfer coefficient in a shell and tube exchanger |
| 12. | Study the variation of friction factor with Reynolds number and to plot the universal resistance graph. |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | McCabe W L et. al. | Unit Operations of Chemical Engineering, McGraw Hill. New York, 2022, 978-9355321084, 7th Edition. |
| 2 | Kumar K L. | Engineering Fluid Mechanics, S Chand and company, 2016, 978-8121901000. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Coulson J. II and Richardson J.F. | Chemical Engineering, Butterworth-Heinemann Ltd, 6th Edition, 2010, 978-8181471444, 5th edition |
| 2 | Badger W.I. and Banchero J.T. | Introduction to Chemical Engineering, Tata McGraws-Hill. New York, 2001, 978-0074630501, 6th Edition. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Demonstrate understanding of working principles of momentum transfer, mass transfer and heat transfer devices. |
| **CO2** | Analyze the effect of experimental parameters of transport process devices and verify the same. |
| **CO3** | Application of appropriate relation in mass transfer equipment. |
| **CO4** | Evaluate the heat and mass transfer equipment. |
| **CO5** | Analyse the performance of centrifugal pump. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | | | | 2 | 1 | | 1 | 2 | | |
| | **CO2** | 2 | 2 | | | 1 | | | | 1 | | 1 | 2 | | |
| | **CO3** | 2 | 2 | | | 1 | | 2 | | 1 | | 1 | 2 | | |
| | **CO4** | 3 | 2 | | | | | | | 1 | | 1 | 2 | | |
| | **CO5** | 3 | 2 | | | | 2 | | 2 | 1 | | 1 | 2 | | |

**1: Low, 2: Medium, 3: High**

## BIOCHEMISTRY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:2 | **Credits:** | 4 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTI02 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Learn about concentration of solutions and physical & biochemical properties of carbohydrates. |
| 2. | Learn the basic structure, chemical and physical properties of biomolecules namely Lipids and Proteins. |
| 3. | Know the structural aspects of nucleic acids and Describe the metabolism of the same. |
| 4. | Understand the metabolism of carbohydrates and lipids in the biological system. |
| 5. | Understand the metabolic reactions of proteins. |

| **UNIT I** |
|---|
| **Carbohydrates:** Basic Concepts: Introduction, Concentration of solutions, Simple problems on Concentration of solutions. Introduction to carbohydrates, sources of carbohydrates, three major size classes of carbohydrates (mono, di and polysaccharides), classification of monosaccharides based on number of C-atoms (classification based on functional groups: aldoses and Ketoses). Structural aspects of sugars: pyranose and furanose structures, reducing and non-reducing sugars, anomers. Structural and functional aspects of biologically important sugars: maltose, lactose, cellulose, sucrose, starch, |

| |
|---|
| glycogen, chitin. |
| **9 Hours** |

| **UNIT II** |
|---|
| **Lipids, Proteins and Hormones:** Lipids: Introduction, types: storage, membrane and structural lipids (structure aspects and properties of each lipid). Proteins: Amino acids (Structure, classification, and properties of amino acids). Structural organization: Primary structure, Secondary structure, tertiary structure and quaternary structure of proteins. Important concepts related to amino acids: Zwitterions, pka and isoelectric point. Types of proteins: Globular, enzymatic, structural, transport proteins and others (Functional aspects only). Hormones: Biologically important hormones – vasopressin, oxytocin, erythropoietin |
| **8 Hours** |

| **UNIT III** |
|---|
| **Structure of Nucleic acids and its Metabolism:** Definition, purine & pyrimidines, nucleosides, nucleotides of DNA & RNA, base pairing, structure of DNA, Structure of RNA and types of RNA (m-RNA, r-RNA, t-RNA). Nucleic acid Metabolism: Biosynthesis and biodegradation of nucleotides. |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Metabolism & its regulation:** Carbohydrate Metabolism: Glycolysis- Metabolism & its regulation, aerobic and anaerobic pathway, TCA cycle, amphibolic role, anaplerotic reactions of TCA cycle. Gluconeogenesis and regulation. Biosynthesis & degradation of polysaccharides (glycogen). Lipid Metabolism: Oxidation of fatty acids- α, β and ω types, Biosynthesis of even number saturated fatty acids, Cholesterol biosynthesis. |
| **9 Hours** |

| **UNIT V** |
|---|
| **Amino acid metabolism:** Biosynthesis of amino acids starting from acetyl CoA (with reference to Oxaloacetate family)-Asparagine, Threonine, Methionine and Lysine. Biodegradation of amino acids, deamination, transamination & urea cycle.<br>**Transport mechanism**: Plasma membrane structure, types of transport; passive and active transport. |
| **8 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Nelson & Cox. | Lehninger's Principles of Biochemistry, W.H Freeman and Company, New York, 2018, 978-1319108243, 8th Edition. |
| 2 | U. Satyanarayana and U. Chakrapani | Biochemistry, Books and allied (Pvt) Ltd. Kolkata, 2021, 978-8131262535, 6th Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Stryer | Biochemistry, W.H Freeman and company, 2010, 978-1319026455, 5th Edition. |
| 2 | Donald Voet, Charlotte W. Pratt, Judith G. Voet | Principles of Biochemistry, Wiley Publication, 2013, 978-1319108243, 4th Edition. |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Classify biological macro-molecules like carbohydrates according to their structural and functional properties. |

| | |
|---|---|
| **CO2** | Categorize biological macromolecules like Proteins and lipids according to their structural and functional properties. |
| **CO3** | Classify and analyze Nucleic acids according to their properties and describe the metabolic reactions of nucleic acids. |
| **CO4** | Describe the anabolic and catabolic reactions of carbohydrates and lipids occurring in the cells. |
| **CO5** | Analyze the anabolic and catabolic reactions of amino acids occurring in the cells. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO2** | 3 | 2 | | | | | | | | | | | | 1 |
| | **CO3** | 3 | 2 | | | | | | | | | | | | 2 |
| | **CO4** | 3 | 2 | | | | | | | | | | | | 2 |
| | **CO5** | 3 | 2 | | | | | | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIOCHEMISTRY LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P:: 0:0:2 | **Credits:** | 0 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTI02 | **SEE Marks:** | 0 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Enhance the practical approaches in the estimation of biomolecules like carbohydrates and proteins. |
| 2. | Understand the concepts of biochemical processes in investigating the concentration of carbohydrate samples. |
| 3. | Study the biochemical methods to quantify the presence of proteins in the given samples. |
| 4. | Learn to determine the concentration of Urea and Iron in the given samples. |
| 5. | Learn to determine the concentration of hydrogen peroxide and Phenolic compound in the given samples. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Titration curve of amino acids. |
| 2. | Qualitative tests for carbohydrates. |
| 3. | Qualitative tests for proteins. |
| 4. | Estimation of blood sugar by O-Toluidine method. |
| 5. | Estimation of blood sugar by Folin-Wu method. |
| 6. | Estimation of inorganic phosphate by Fiske-Subbarao method. |
| 7. | Estimation of protein by Lowry's method. |
| 8. | Estimation of protein by Bradford's method |
| 9. | Estimation of urea by diacetylmonoxime (DAMO) method. |

| | |
|---|---|
| 10. | Estimation of iron from hemoglobin. |
| 11. | Estimation of total phenolic compounds. |
| 12. | Qualitative estimation of $H_2O_2$ by agar assay |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | G. Sattanathan, S.S.Padmapriya and B. Balamuralikrishnan | Practical manual of Biochemistry, Skyfox Publishing group, 2020, 978-81-939536-5-5, 1st Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | G. Sattanathan, S.S.Padmapriya and B. Balamuralikrishnan | Practical manual of Biochemistry, Skyfox Publishing group, 2020, 978-81-939536-5-5, 1st Edition. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Identify the presence of amino acids and carbohydrates in samples by qualitative estimation. |
| **CO2** | Asses the carbohydrate content in samples by performing various biochemical procedures. |
| **CO3** | Interpret and analyze the biochemical methods for quantifying protein and inorganic phosphate in the samples. |
| **CO4** | Apply appropriate biochemical methods to identify the presence of urea in the samples. |
| **CO5** | Demonstrate the method of estimating iron, phenol and hydrogen peroxide qualitatively. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
| **COs** | **CO1** | 3 | 2 | | | | | | 2 | 1 | | 1 | | | 2 |
| | **CO2** | 2 | 2 | | | 1 | | | | 1 | | 1 | | | 2 |
| | **CO3** | 2 | 2 | | | 1 | | 2 | | 1 | | 1 | | | 2 |
| | **CO4** | 3 | 2 | | | | | | | 1 | | 1 | | | 2 |
| | **CO5** | 3 | 2 | | | | 2 | | 2 | 1 | | 1 | | | 2 |

**1: Low, 2: Medium, 3: High**

## MICROBIOLOGY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S3BT02 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Know the basic structure of prokaryotes & eukaryotes, concepts of isolation and culturing of microorganisms. |

| | |
|---|---|
| 2. | Learn different types of microscopes and staining techniques. |
| 3. | Understand growth, reproduction and preservation of microbes. |
| 4. | Enumeration of microorganisms, control of microbes and disease caused by them. |
| 5. | Understand general characteristics of virus, its classification & reproduction of viruses. |

| **UNIT I** |
|---|
| **History of Microbiology**: Introduction, Scope of microbiology and branches, Origin of life: biogenesis and abiogenesis. Major contributions of Antony Van Leeuwenhoek, Louis Pasteur, Alexander Fleming, Robert Koch and Joseph Lister. Prokaryotes & Eukaryotes: Distinguishing features with diagrammatic illustrations. Types of microorganisms - Morphology and fine structure of Bacteria, viruses, Fungi, Algae, protozoa. Culturing of Microorganisms: Culturing of bacteria, Nutritional requirements – physical and chemical, Different types of media – Solid, semisolid and broth; synthetic media, Special media- blood agar, Selective media, complex media, indicator media, differential media, transport media; anaerobic media- (thioglycolate, Robertson's media, micro aerophilic). Pure culture techniques – Serial dilution method, pour plate, spread plate, streak plate, lawn culture and stab culture. |
| **8 Hours** |

| **UNIT II** |
|---|
| **Microscopy:** Study of microscopes and its types – construction, working principle, working method and its applications; Bright Field Microscopy, Dark Field Microscopy, Phase Contrast Microscopy, Fluorescence Microscopy, Electron microscopy (SEM, TEM).<br>**Staining of Microorganisms:** Types of Stains- Acidic, Basic and Neutral Stain. Staining of microorganisms-simple staining, negative staining, Differential Staining-Gram staining and Acid-Fast Bacilli Staining, structural staining (endospore, capsule, flagella). |
| **8 Hours** |

| **UNIT III** |
|---|
| **Reproduction and Growth of Microorganisms**: Reproduction in Prokaryotes, modes of Cell Division- Binary Fission, Budding and Fragmentation, Continuous culture-Chemostat and Synchronous culture, Direct and Indirect measurement of growth, Factors affecting growth - Nitrogen content, Turbidometric, Nucleic Acid content. Growth principles of nutrition influence of Environmental factors-pH, Temperature, Oxygen, Heavy metals and other compounds, Maintenance of cultures– periodic transfer, using mineral oil, lyophilization and low temperature. |
| **9 Hours** |

| **UNIT IV** |
|---|
| **Control of Microorganisms**: Definition used in microbial control methods, the pattern of microbial death.<br>**Sterilization methods:**Physical methods: Heat - dry heat – flaming, red hot and hot air oven, moist heat- Pasteurization, autoclave, tyndallization, filtration, radiation– ionizing and non-ionizing.<br>Chemical methods: phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes, Sterilizing gases, chemotherapeutic agents.<br>**Other Methods**: Broad and narrow spectrum antibiotics and mode of action, antifungal and antiviral agents.<br>Microbial pathogens and pathogenesis: Common diseases caused by microbes, etiology, transmission and symptoms of the disease - Bacterial diseases: Typhoid, Tuberculosis. |
| **9 Hours** |

| UNIT V |
|---|
| **Viruses:** Morphology, Classification and Replication: General Characteristics of viruses: Basic morphology of viruses - Helical capsids, icosahedral capsids, virus with capsids of complex symmetry, Classification and nomenclature of bacteriophages: Bacteriophage life cycle: The lytic Life cycle - Virulent phages. The lysogenic Life Cycle- Temperate phages; Cultivation of viruses, Viroids, Virusoids and Prions. Viral diseases: Ebola, Hepatitis, Zika, COVID-19. |
| **8 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Stanier, John Ingraham, Mark Wheelis. | General Microbiology, Mac-Millan, 9780333763643, 2008, 5th Edition |
| 2 | J. Michael Pelczar, E.C.S. Chan Nobel R. Krieg | General Microbiology, Tata McGraw-Hill, 2023, 978-8176711234, 5th Edition, |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Gerard Tortora , Berdell Funke Christine Case Derek Webe Warner Bair III | Microbiology: An Introduction, Pearson College Div, 2018, 978-0134605180, 13th Edition. |
| 2 | Ananthanarayan and Paniker's | Textbook of Microbiology, Universities Press, 2020, 978-9389211436, 11th Edition |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Describe characteristics of microorganisms and identify different types of media for culturing microbes. |
| **CO2** | Classify different types of microscopes and describe various types of staining techniques for observing microbes. |
| **CO3** | Describe the reproduction in microbes, factors affecting growth of microorganisms and their preservation methods. |
| **CO4** | Identify different types of microbial techniques for enumeration, control of microbes and identify microbes causing diseases. |
| **CO5** | Outline the morphology, life cycle and disease caused by viruses. |

**1: Low, 2: Medium, 3: High**

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 1 | | | | | | | | | | | | 2 |
| | **CO2** | 3 | 2 | | | | | | | | | | | | 2 |
| | **CO3** | 3 | 2 | | | | | | | | | | | | 2 |
| | **CO4** | 3 | 2 | | | | | | | | | | | | 2 |
| | **CO5** | 3 | 2 | | | | | | | | | | | | 2 |

# MICROBIOLOGY LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::0:0:2 | **Credits:** | 1 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTL01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the basic approaches of isolation, culturing and identification of microorganisms. |
| 2. | Study basic staining techniques of microorganism and observation under microscope. |
| 3. | Study enumeration of microbes by different methods. |
| 4. | Learn the importance of biochemical tests in classification of microbes. |
| 5. | Understand how to check the quality of water samples by Performing an MPN test. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Introduction: a. Aseptic techniques – Hot air oven, Autoclave, Laminar air flow, Incubator. |
| 2. | Media preparation – a. Broth and Agar b. Instrumentation, Handling and care of Microscope. |
| 3. | Isolation of microorganisms from soil sample by serial dilution method (Morphology – Bacteria and fungi - Mounting and identification.) A. Pour plate method, B. Streak plate method, C. Spread plate method. |
| 4. | Isolation of microorganisms from rotten fruits and vegetables by serial dilution method by pour plate method. |
| 5. | a. Gram staining of bacteria. |
| | b. Measurement of size of cells by Micrometry. |
| 6. | a. Enumeration of total count. (Haemocytometer) |
| | b. Motility of Bacteria by hanging drop technique. |
| 7. | a. Enumeration of total count (haemocytometer) and viable count of bacteria<br>b. Motility of bacteria by hanging drop method |
| 8. | Growth curve of bacteria by turbidometry. |
| 9. | Effect of temperature and pH on growth of bacteria. |
| 10. | Biochemical Tests- Catalase test, Starch hydrolysis, Gelatin liquefaction, Proteolytic activity |
| 11. | Biochemical tests- Carbohydrate fermentation test, IMVIC test |
| 12. | Antibiotic susceptibility testing of bacteria. |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Alfred Brown, Heidi Smith | Benson's Microbiological Applications, Laboratory Manual in General Microbiology, 2014, 978-0073402413, 13th edition. |
| 2 | Aneja R K. | Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Publisher, 2022, 978-9395161213, 6th Edition. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Apply microbiological techniques for isolation and identification of different types of microorganisms. |
| **CO2** | Demonstrate the procedures pertaining staining of microbes, identification and its movement. |
| **CO3** | Apply different types of enumeration techniques and determine the load of microorganisms present in samples. |

| | |
|---|---|
| **CO4** | Formulate media for production of bioactive molecules based on the nature of microbial growth |
| **CO5** | Interpret and analyze the potability of drinking water, food samples from different sources. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
| COs | **CO1** | 3 | 2 | | | | | | 2 | 1 | | 1 | | | 2 |
| | **CO2** | 2 | 2 | | | 1 | | | | 1 | | 1 | | | 2 |
| | **CO3** | 2 | 2 | | | 1 | | 2 | | 1 | | 1 | | | 2 |
| | **CO4** | 3 | 2 | | | | | | | 1 | | 1 | | | 2 |
| | **CO5** | 3 | 2 | | | | 2 | | 2 | 1 | | 1 | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIOPROCESS CALCULATIONS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::2:2:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 28+28 | **CIE Marks:** | 50 |
| **Course Code:** | S3BT04 | **SEE Marks:** | 50 |

**Course objectives:**
This course will enable students to:

| | |
|---|---|
| 1. | Introduce the principles and calculation techniques in bioprocess engineering. |
| 2. | Acquaint students with material and energy balance calculations. |
| 3. | Teach basic calculation techniques in bioprocesses involving cell growth and biochemical reactions. |
| 4. | Illustrate the significance of bypass, recycle, and purging operations in bioprocess engineering and introduce relevant calculations. |
| 5. | Introduce the concept of unsteady-state material and energy balance in bioprocess engineering and relevant calculations. |

**UNIT I**

**Units, Dimensions and Basic Chemical Calculations**: Steps in a typical Bioprocess development, need for engineering calculations. Introduction to engineering calculations: Physical variables, units and dimensions - Substantial and natural variables: volume, temperature, pressure, force, weight, density/specific gravity, specific volume, flow rate, mole, chemical composition, heat. Measurement conventions. Dimensional homogeneity in equations, equations without dimensional homogeneity. Unit conversion, conversion of equations. Std conditions, ideal gases.

**6+6 Hours**

**UNIT II**

**Material balance without reaction**: System, process, steady state and equilibrium. Law of conservation of mass. Introduction to material (mass) balance, types of material balance (differential & integral and total & component), concept of basis, tie components. Guidelines for material balance calculations. Material balance for mixing, filtration, extraction, evaporation, distillation, membrane separation, crystallization. Material balances with recycle, bypass, purge streams.

| |
|---|
| **6+6 Hours** |

| **UNIT III** |
|---|
| **Material balance with biochemical reaction**: Stoichiometry concepts: Limiting and excess reactants, fractional and % conversion, Yield (fractional and %), extent of reaction and selectivity. Stoichiometry of cell growth and product formation - Growth stoichiometry and elemental balances, electron balances, biomass yield, product stoichiometry, theoretical oxygen demand, maximum possible yield. Material balances with recycle, bypass, and purge streams with reaction. |
| **5+5 Hours** |

| **UNIT IV** |
|---|
| **Energy balance**: Basic energy concepts - Intensive and expensive properties, enthalpy. General energy balance equation. Procedures of enthalpy calculation. Enthalpy change in nonreactive processes - change of phase, mixing and solution. Energy balance calculations without reactions. Enthalpy change due to reaction - Heat of combustion, heat of reaction. Heat of reaction for processes with biomass production -thermodynamics of cell growth, heat of reaction with and without oxygen as electron acceptor, mixed aerobic-anaerobic metabolism, heat of reaction in different cell cultures. Energy balance equation for cell culture. |
| **6+6 Hours** |

| **UNIT V** |
|---|
| **Unsteady-state material balance without reaction:** Unsteady-state material balance with and without biochemical reaction. Unsteady-state energy balance with and without biochemical reaction. |
| **5+5 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Himmelblau, D.M. and Riggs, J.B. | Basic Principles and Calculations in Chemical Engineering, PHI Lear ning Pvt. Ltd., 2012, 978-81-203-3839-5, 8th Edition. |
| 2 | Narayanan, K.V., Lakshmikutty, B. | Stoichiometry and Process Calculations. PHI Learning Pvt Ltd., 2017. 978-81-203-2992-8, 2st Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Pauline M. Doran | Bioprocess Engineering Principles, 2013, 978-0-12-220851-5, 2nd Edition. |
| 2 | Shuler M L, Kargi & DeLisa M P | Bioprocess Engineering – Basic Concepts, Prentice-Hall Inc., 2017, 978-0-13-706270-6, 3rd Edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Demonstrate the knowledge of calculations in chemistry, physics, biology and mathematics and apply them to solve basic biochemical engineering unit operations and processes. |
| **CO2** | Analyze problems related to bioprocess calculations and provide conclusions using the first principles of material and energy balance. |
| **CO3** | Develop solutions to basic and complex bioprocess calculations problems. |
| **CO4** | Communicate the solutions to bioprocess calculations problems effectively in both oral and written form. |
| **CO5** | Demonstrate the ability of identify, analyze and solve bioprocess calculation problems individually and in a team. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
| COs | CO1 | 3 | 2 | | | | | | | | | | 2 | | |
| | CO2 | 3 | 2 | | | | | | | | | | 2 | | |
| | CO3 | 3 | 2 | | | | | | | | | | 2 | | |
| | CO4 | 3 | 2 | | | | | | | | | | 2 | | |
| | CO5 | 3 | 2 | | | | | | | | | | 2 | | |

**1: Low, 2: Medium, 3: High**

## HUMAN ANATOMY AND PHYSIOLOGY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S3BT07 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the fundamentals of Anatomy and Physiology. |
| 2. | Provide an in-depth instruction in the organization, structures, and functions of the human body. |
| 3. | Learn about the pathology of each body system and how they interrelate to maintain homeostasis. |
| 4. | Understand the concepts of respiration and circulation in human body. |
| 5. | Study the architecture and functioning of nervous and endocrine system. |

| **UNIT I** |
|---|
| **INTRODUCTION TO HUMAN BODY:** Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology. Skeletal system: Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system Organization of skeletal muscle. Lymphatic system: Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system. Peripheral nervous system: Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves. Special senses: Structure and functions of eye, ear, nose and tongue and their disorders. |
| **8 Hours** |

| **UNIT II** |
|---|
| **TISSUES, SKELETAL & MUSCULAR SYSTEM:** Epithelial tissue, Connective tissues (Blood, Bones, cartilages), Muscular tissues, Nervous tissue, Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement. Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers. |
| **8 Hours** |

| UNIT III |
|---|
| **DIGESTIVE SYSTEM:** Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, oesophagus, the stomach the small and large intestine. Digestive glands, Enzymes; Physiology of Digestion and Absorption.<br>**EXCRETORY SYSTEM**: Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy and physiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; Osmoregulation by kidney. |
| **8 Hours** |

| UNIT IV |
|---|
| **RESPIRATORY & CIRCULATORY SYSTEM:** Structure of respiratory organs; Mechanism of breathing; pulmonary air volumes, Gas exchange in the lungs. Kinds of respiration; Transport of respiratory gases in the blood Structure, Composition and functions of blood. Blood Groups and Rh factor. Blood clotting mechanism, Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and<br>cardiac arrhythmias. |
| **8 Hours** |

| UNIT V |
|---|
| **NERVOUS AND ENDOCRINE SYSTEM:** Role of nervous system; Types of neurons. Types of glial cells and its function. Main properties of nervous tissue Mode of action of nerves; Conduction of nerve impulses; Central nervous system; The brain; The spinal cord; Peripheral nervous system Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands. |
| **10 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Stuart Fox, Krista Rompolski | Human Physiology, McGraw-Hill eBook, 2021, 978-1260597660, 16th Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Susan Standring | Gray's Anatomy, 2020, Elsevier, 978-0702077067 |
| 2 | Lauralee Sherwood Brooks/Cole | Fundamentals of Human Physiology, Brooks/Cole 2015, 978-1285866932, 9th edition. |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Outline the basic knowledge of physiology as a process of various human anatomical systems. |
| **CO2** | Co-relate functioning of different tissue and organ systems in the context of health and disease. |
| **CO3** | Analyze the interface between different organ systems essential for maintenance of health & well-being |
| **CO4** | Describe the architecture and mechanism of respiration and circulation in human body. |

| | |
|---|---|
| **CO5** | Explain the e architecture and functioning of nervous and endocrine system. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | | | | | | | | | | | | 1 |
| | **CO2** | 3 | 1 | | | | | | | | | | | | 1 |
| | **CO3** | 3 | 1 | | | | | | | | | | | | 1 |
| | **CO4** | 2 | 1 | | | | | | | | | | | | 1 |
| | **CO5** | 2 | 1 | | | | | | | | | | | | 1 |

**1: Low, 2: Medium, 3: High**

## PLANT BIOTECHNOLOGY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S3BT08 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the basic principles of tissue culture, sterilization principles and tissue culture facility |
| 2. | Learn the media preparation, its composition and importance of plant hormones |
| 3. | Know how to select explants for tissue culture, methods of propagation & synthetic seed production |
| 4. | Learn different types of tissue culture methods and production of secondary metabolites |
| 5. | Understand the different types of bioreactor involved in crop improvement using PCR, RAPD and RFLP. |

| **UNIT I** |
|---|
| **Introduction:** Early attempts in tissue culture of plants. Basic principles of plant tissue - callus culture, Meristem culture, Organ culture, plasticity, Totipotency of cells, differentiation, dedifferentiation and redifferentiation. Sterilization Procedures – Fumigation, wet and dry sterilization, ultraviolet sterilization, ultra filtration and surface sterilization Design of laboratory and commercial tissue culture facility. Culture environment, growth regulators, media regulators, culture types, plant regeneration. |
| **9 Hours** |

| **UNIT II** |
|---|
| **Plant tissue culture media:** Media for in vitro culture; Types of media – Solid, liquid and commercial pre-packed media; Media composition – Macronutrients, Micronutrients and growth regulators - Classes of plant hormones: Abscisic acid, Auxins, Cytokinins, Ethylene, Gibberellins; Preparation of media; Selection of suitable media.<br>**Explants for Tissue Culture:** Shoot tip, axillary buds, anther culture, leaf discs, cotyledons, inflorescence and floral organs. Callus culture - initiation and maintenance of callus. Micropropagation: Proliferation of axillary buds, induction of adventitious buds and bulbs, immobilized cultures, estimation of growth and artificial seeds, somatic embryogenesis and synthetic seed production. |

**9 Hours**

**UNIT III**

**Suspension Culture** - Culture systems, Isolation of single and aggregate of cells and regeneration of plants; Immobilization of cells and use of bioreactors.

**Protoplast Culture** - Isolation of protoplast, culture of protoplast, regeneration and sub-protoplast; Somatic cell hybridization, selecting desired hybrids and their regeneration into plants. Production of secondary metabolites. culture cell viability test. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture.

**8 Hours**

**UNIT IV**

**Tissue culture and crop improvement** -

Agrobacterium mediated gene transfer technology - Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of T-DNA transfer, role of virulence genes, use of Ti and Ri-plasmids as vectors, binary vectors. Molecular maps of plant genomes: RFLP Genetic maps in plants, Linkage of major genes and QTLs to RFLPs, Uses of RFLPs maps, Cytogenetic RFLP maps using aneuploidy, RAPDs and SSRs. Crop improvement and gene tagging, physical maps using in- situ hybridization (ISH), Resolution gap. Molecular maps in Yeast and other fungi. Seaweed tissue culture - callus induction and plantlet regeneration, protoplast culture and somatic hybridization.

**8 Hours**

**UNIT V**

**Transgenic plants:** Transgenic plants: Transgenic plants for herbicide, pest resistance, Virus resistant, Insect resistant, Fungi and Bacteria resistant, plants, Transgenic plants with improved storage proteins, Stress- cold –drought tolerant plants, Fertility restoration and transgenic plants as bioreactors. BT approach to insect resistance and food safety. Molecular farming and GM crops future prospects: Introduction –carbohydrates and lipids production-molecular farming of proteins-regulations of GM crops. In vitro pollination, mentor pollen technique, Endosperm culture for polyploidy breeding, Embryo rescue. Advantages and limitations; Production of virus free plants- shoot meristem culture. Thermotherapy, cryotherapy and chemotherapy. Virus indexing. Maintenance of virus free stocks. Applications and limitations. Significance of in vitro propagation techniques in developing transgenic crops.

**8 Hours**

**TEXT BOOKS**

| | | |
|---|---|---|
| 1 | R.A. Dixon & Gonzales | Plant Cell Culture A Practical Approach, IRL Press at Oxford University. 1995, 9780199634026, 2nd Edition. |
| 2 | H. S. Chawla | Introduction to Plant biotechnology, Oxford & IBH Publishers Co., 2020, 10:8120417321, 3rd Edition. |

**REFERENCE BOOKS**

| | | |
|---|---|---|
| 1 | S.S. Bhojwani | Plant Tissue Culture: Applications and Limitations Elsevier, Amsterdam, 2013, ISBN: 978-81-322-1025-2 |
| 2 | M S Swamynathan | Biotechnology in Agriculture, McMillian India Ltd. 2009, 0333921925 |

**Course Outcomes:**

Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Explain the significance of micronutrients, macro nutrients, growth regulators, hormones |

| | |
|---|---|
| **CO2** | Distinguish types of tissue culture, Describe micro propagation, somatic embryogenesis, synthetic seed production |
| **CO3** | Outline various types of culture systems |
| **CO4** | Apply various gene technology for crop improvement and describe use of vector less gene transfer. |
| **CO5** | Analyse the resistance existent in transgenic plants. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | 1 | | | | | | | | | | | 2 |
| | **CO2** | 2 | 1 | 1 | | | | | | | | | | | 2 |
| | **CO3** | 2 | 1 | 2 | | | | | | | | | | | 2 |
| | **CO4** | 1 | 1 | 1 | | | | | | | | | | | 2 |
| | **CO5** | 1 | 1 | 1 | | | | | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## MEDICAL BIOTECHNOLOGY

| | | | |
|---|---|---|---|
| **Lab Hours/ Week** | : 3+0+0 (L+T+P) | **Credits** | : 3.0 |
| **Total Lecture Hours** | : 42 | **CIE Marks** | : 50 |
| **Course Code** | : S3BT09 | **SEE Marks** | : 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the concepts of animal cell culture and tissue engineering. |
| 2. | Know the chromosomal abnormalities and effect of mutation on oncogenes. |
| 3. | Understand the concepts of diagnostic techniques in various methods. |
| 4. | Learn the various types of preventive medicine and their mechanism of action. |
| 5. | Understand the different types of modern medicine in treating various diseases. |

| **UNIT I** |
|---|
| **Animal Cell Culture:** Animal cell culture-media, maintenance and culture of primary, secondary and continuous cell lines- organ culture –applications-cancer cell lines- apoptosis. Tissue Engineering - Skin, Liver, Pancreas. Assisted reproductive technology- Pregnancy diagnosis. |
| **8 Hours** |
| |

| **UNIT II** |
|---|
| **Chromosomal Abnormalities:** Chromosomal disorders –Gene controlled diseases -Identification of disease genes Haemophilia. DMD, Alzheimer's- Molecular basis of human diseases: Pathogenic mutations - Oncogenes - Loss of function - Tumour Suppressor Genes lmmunopathology: Hepatitis, Autoimmune Disorders. |
| **8 Hours** |

| **UNIT III** |
|---|
| **Prevention and Treatment**: Vaccines-conventional , recombinant, synthetic peptide, anti adiotype, |

| |
|---|
| DNA vaccines Deletion mutant and vaccinia vector vaccine- Antibiotics-mode of action-antibacterial, antifungal, antiviral, antitumor- antibiotics- synthetic Chemotherapeutic agent development of microbial resistance to antibiotics. |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Applications of animal biotechnology:** Use of cell culture for production of a regulatory protein, Use of cell culture for production of a hormone (e.g. Insulin), Use of cell culture for production of vaccines, Cell hybridization and human hybridization. Use of cell culture in Drug targeting and drug toxicity analysis. Transplantation of cultured cells. |
| **8 Hours** |

| **UNIT V** |
|---|
| **Modern Medicine:** Hybridoma technique for MCAb production and applications- Gene therapy; Exvivo, Invivo, and in situ- Cell and tissue engineering-.Stem cell therapy-Nano medicines-Gene products in medicine - Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon. |
| **8 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | RamaSwamy.P. | "Trends in Biotechnology", University of Madras, Pearl press, 2002. Tata McGraw-Hill, 2005. |
| 2 | Bitty Forbes | Danial SAHM Alics Weinfield, Bailey 2007. Scott's diagnostic microbiology, 12th edition Mosby. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Jogdand, S.N. | Molecular Biotechnology: Principle and applications of recombinant DNA. ASM Press, 2010. |
| 2 | B.R. and Pasternak | Medical Biotechnology, Himalaya Publishing house, Mumbai, 2005. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Describe various animal cell culture techniques for the tissue engineering applications. |
| **CO2** | Apply basics of genetics and cell biology concepts to understand chromosomal abnormalities in humans. |
| **CO3** | Analyze modern scientific tools for diagnosis of human diseases. |
| **CO4** | Apply the knowledge of vaccines and immunotherapy. |
| **CO5** | Analyze the successful engineering strategies like gene therapy used in modern medicines. |

**Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs)**

| | | **POs** | | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **COs** | CO1 | 3 | 2 | 2 | | | | | | | | | | | | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO2 | 3 | 2 | 2 | | | | | | | | | | | 2 |
| | CO3 | 3 | 2 | 2 | | | | | | | | | | | 2 |
| | CO4 | 3 | 2 | 2 | | | | | | | | | | | 2 |
| | CO5 | 3 | 2 | 2 | | | | | | | | | | | 2 |

1: Low, 2: Medium, 3: High

## SOCIAL CONNECT AND RESPONSIBILITY

| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
|---|---|---|---|
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 100 |
| **Course Code:** | SHS01 | **SEE Marks:** | 0 |

| **Course objectives:**<br>This course will enable students to: | |
|---|---|
| 1. | Enable the student to expose towards nature and tree plantation |
| 2. | Provide a formal platform for students to connect with their surroundings by doing heritage walk |
| 3. | Enable to create of a responsible connection with society by adopting traditional organic forming. |
| 4. | Understand about the importance of water conservation methods |
| 5. | Enable students about the importance of traditional foods |

| **UNIT I** |
|---|
| **Plantation and adoption of a tree:** Plantation of a tree by Miyawaki Method that will be adopted by entire semester by a group of students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature. |
| **3 Hours** |

| **UNIT II** |
|---|
| **Heritage walk and crafts corner:** Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms. |
| **2 Hours** |

| **UNIT III** |
|---|
| **Organic farming:** Definition of organic farming, Organically grown crops in India, Differentiate between conventional farming and organic farming, Necessity of organic farming, Key characteristics of organic farming, Four principles of organic farming (principle of Health, principle of ecology, principle of fairness and principle of care, Types of organic farming: 1) Pure organic farming, 2) Integrated farming (Integrated nutrient management and Integrated pest management), objectives of organic farming, benefits of organic farming, Basic steps in organic farming and limitations of organic farming. |
| **3 Hours** |

| **UNIT IV** |
|---|
| **Water Conservation:** Global Water Scarcity - Global water crisis and its implications; Rainwater Harvesting - Concept and benefits of rainwater harvesting; Water Audit – An approach to water conservation; Efficient Water Use - Optimizing water consumption in daily life . |
| **3 Hours** |

| UNIT V |
|---|
| **Food Walk:** City's culinary practices, food lore, and indigenous materials of the region used in cooking. |
| **3 Hours** |

**Activities:**

1. **Plantation and adoption of a tree:** Select suitable species in consultation with horticulture, forest or agriculture department. Interact with NGO/Industry and community to plant Tag the plant for continuous monitoring

2. **Heritage walk and crafts corner:** Survey in the form of questioner by connecting to the people and asking. Questions during survey can be asked in local language but report language is English.

3. **Organic farming:** Collect data on organic farming in the vicinity. Like types of crop, methodology etc.,

4. **Water Conservation:** Report on traditional water conservation practices (to minimize wastage)

5. **Food Walk**: Survey local food centres and identify itsspecialty, Identify and study thefood ingredients, Report on the regionalfoods, Report on Medicinal values of the local food grains, and plants.

**PEDAGOGY**

The pedagogy will include interactive lectures, inspiring talks by various departments, field visits, social immersion. Applying and synthesizing information from these sources to define the social problem with your group. Social immersion with NGOs/social sections will be a key part of the course.

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Tripathi A.N. | Human Values', New Age International Publisher, 2003, 81-224-1426-5 |
| 2 | Gaur, R.R. and Sangal R | 'Foundation Course in Human Values and Professional Ethics; Presenting a universal approach to value education through self-exploration', Excel Books, Bangalore, 2016, 978-8-174-46781-2 |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Understand the life of plants and its growth phases |
| **CO2** | Outline the significance of our heritage, culture and city. |
| **CO3** | Apply knowledge about organic farming and sustainable agriculture |
| **CO4** | Apply the knowledge of water conservation. |
| **CO5** | Appreciate the traditional food lore |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
| COs | CO1 | 2 | 2 | 2 | | 2 | 2 | 2 | | 2 | 2 | 1 | | | 1 |
| | CO2 | | | | | | 2 | | | 2 | 2 | 1 | | | 1 |
| | CO3 | 2 | | 2 | 2 | | 2 | 2 | | 2 | 2 | 1 | | | 1 |
| | CO4 | 2 | | 2 | 2 | | 2 | 2 | | 2 | 2 | 1 | | | 1 |
| | CO5 | | | | | | 2 | | | 2 | 2 | 1 | | | 1 |

**1: Low, 2: Medium, 3: High**

## ANALYSIS OF DAIRY PRODUCTS LAB

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTA03 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Learn the concept of the preparation of sample of various dairy products for analysis |
| 2. | Detect the ingredients and adulterants in milk and milk products |
| 3. | Determine the quality of milk |
| 4. | Learn the preparation of curd/butter and assessment of its quality |
| 5. | Estimate the total carbohydrates/proteins/fats in the milk products. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Preparation of sample for milks |
| 2. | Detection of adulterants in milk |
| 3. | Detection and quantification of starch in milk |
| 4. | Detection of cellulose in milk |
| 5. | Detection of added urea in milk |
| 6. | Detection of foreign fat in milk |
| 7. | Detection of gelatine in milk |
| 8. | Determination of pH in Whey powder. |
| 9. | Preparation sample of curd and determination of total solids, moisture and fats |
| 10. | Preparation sample of curd condensed/falvoured milk and determination of tradable acidity. |
| 11. | Preparation sample of dried milk and determination of carbohydrates, protein and ash |
| 12. | Preparation sample of butter and determination of free fatty acids and moisture |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Fidel Toldra, Leo M.L. Nollet, | Handbook of Dairy Foods Analysis, Tyler and Francis, 2021. 9780367343132 |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Robert Welch et al. | Milk composition, production and Biotechnology, CABI Publisher, 1997. 10: 08515991610, 1st edition. |
| 2 | Y. H. Hui | Dairy science and Technology Handbook, volume 1: Principles and properties, Wiley-VCH publishers, 2006. 10: 0470127066 |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Describe various milk and milk products for analysis. |
| **CO2** | Estimate the type of adulterants present in the milk and milk products |
| **CO3** | Outline the preparation of curd/butter and determination of fat content |
| **CO4** | Outline the preparation of dried milk and its analysis |
| **CO5** | Apply the knowledge of fats/oils to determine its quality |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | | 1 | | | | | 2 | | | 2 |
| | **CO2** | 2 | 2 | | | | 1 | | | | | 2 | | | 2 |
| | **CO3** | 2 | 2 | | | | 2 | | | | | 2 | | | 2 |
| | **CO4** | 2 | 2 | | | | 2 | | | | | 2 | | | 2 |
| | **CO5** | 2 | 2 | | | | 2 | | | | | 2 | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIOPESTICIDES & BIOFERTILIZERS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | Credits: | 1 |
| **Total Lecture Hours:** | 14 | CIE Marks: | 50 |
| **Course Code:** | S3BTA04 | SEE Marks: | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the types of pathogens and its management. |
| 2. | Know the classification and importance of Bio fertilizers in agriculture. |
| 3. | Understand the importance and concept of Nitrogen fixation. |
| 4. | Explore the types and importance of Bio pesticides in pest control. |
| 5. | Learn formulation and large-scale industrial production of bio fertilizers. |

| **UNIT I** |
|---|
| **Pathogens and pests management:** Natural Enemies, Reduviids and their Merits in Biological Control, Weaver Ants and Biocontrol of the Nuisance Pest Luprops tristis (Coleoptera: Tenebrionidae), Ground Beetles (Coleoptera: Carabidae): Their Potential as Bio-agents in Agroecosystems, Eco-friendly Control of Three Common Mosquito Larvae Species by Odonata Nymphs, Spiders as Potential Eco-friendly Predators Against Pests. |
| **2 Hours** |

| UNIT II |
|---|
| **Biofertilizers:** Types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production. |
| **3 Hours** |

| UNIT III |
|---|
| **Nitrogen fixation:** Concept of Nitrogen fixation. Structure and characteristic features of bacterial biofertilizers- Azotobacter, Bacillus, Rhizobium; Cynobacterial biofertilizers - Anabaena, and fungal biofertilizers - VAM. |
| **3 Hours** |

| UNIT IV |
|---|
| **Biopesticides:** General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Botanicals: botanical pesticides, and biorationales. Botanicals and their uses. Plant Essential Oils and Pest Management. |
| **3 Hours** |

| UNIT V |
|---|
| **Production and quality control:** Strain selection, sterilization, growth and fermentation, mass production of biofertilizers. Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers/Biopesticides, FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, etc. |
| **3 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Krishnendu Acharya, Surjit Sen, Manjula Rai | Biofertilizers and Biopesticides Kolkata Techno World, 2022, 978-93-88347-23-5. |
| 2 | H. D. Burges | Formulation of Microbial Biopesticides: Beneficial microorganisms, nematodes and seed treatments, Spinger link, 2012, 978-0412625206, 2nd edition |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. | Biofertilizer Technology, Marketing and Usage, Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995, 9788185116389, 1st edition, |
| 2 | Coppel H.C. and J.W. Martin. | Biological control of insect pest suppression. Coppel. Springer. 2011, 978-3642664892, 4th edition |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Describe the different types of pathogens and its management. |
| **CO2** | Analyze the classification and importance of Bio fertilizers in agriculture. |
| **CO3** | Explain the importance and concept of Nitrogen fixation in agriculture. |
| **CO4** | Analyze the types and importance of Bio pesticides in pest control. |
| **CO5** | Discuss the process of large-scale industrial production of bio fertilizers. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
| COs | CO1 | 3 | 2 | 2 | | | 2 | | | | | | | | 2 |
| | CO2 | 3 | 2 | 2 | | | 2 | | | | | | | | 2 |
| | CO3 | 3 | 2 | 2 | | | 2 | | | | | | | | 2 |
| | CO4 | 3 | 2 | 2 | | | 2 | | | | | | | | 2 |
| | CO5 | 3 | 2 | 2 | | | 2 | | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIO LAB MANAGEMENT AND RISK ASSESSMENT

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTA05 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Enable the students to develop an understanding biolab management and laboratory layout |
| 2. | Understand the risk and its different techniques of risk assessment. |
| 3. | Learn the basics of biosafety equipment |
| 4. | Enable students to understand the various risks associated with different biological products |
| 5. | Equip the students with legal issues concerned to biosafety |

| **UNIT I** |
|---|
| **BIO LABORATORY MANAGEMENT:** Essentials of lab management- Designing the lab, spacing, inventory organization and its management, automation via use of technology, documentation, safety requirements, Biosafety levels, planning experiments, storage space, waste generation and its disposal. Case studies. |
| **2 Hours** |

| **UNIT II** |
|---|
| **INTRODUCTION TO RISK ASSESSMENT:** Definition and meaning of Risk. Difference between risk and hazard. Probability of occurrence of risk. Risk assessment, risk control, risk review, risk management tools, HACCP, risk ranking and filtering. Case studies. |
| **3 Hours** |

| **UNIT III** |
|---|
| **BASICS OF BIOSAFETY:** Biosafety- meaning, levels of biosafety- BSL 1, BSL2, BSL 3 and BSL 4, examples, applications of each and hazards involved there in for products derived out of biotechnology. International protocols and Case studies. |
| **3 Hours** |

| UNIT IV |
|---|
| **BIOSAFETY AND RISK ASSESSMENT:** Principles of safety assessment (for infectious organisms, agents, microbes- genetically altered/ metabolically engineered, transgenic plants, GMOs /LMOs used in food, pharma, bioremediation etc., Sequential steps in risk assessment; concepts of familiarity and substantial equivalence; environmental risk assessment and food and feed safety assessment. Case studies. |
| **3 Hours** |

| UNIT V |
|---|
| **RISK MINIMIZATION AND/OR RISK MITIGATION:** Risk assessment through omics approach. Ethical, legal, and social implications of health privacy and policy laws for mitigation/minimization (Indian and Global contexts). risk characterization and development of analysis plan. Case studies. |
| **3 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Gerardus Blokdyk | Biotechnology risk: Complete Self-Assessment Guide, , 2018, 9781038811950 |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Reynolds M. Salerno, Jennifer Gaudioso | Biorisk Management Biosafety and Biosecurity, 2015, 978-1466593640 |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Apply principles of biology to understand risk and its assessment |
| **CO2** | Deduce methods to minimize and mitigate the risks |
| **CO3** | Evaluate risk-benefit analysis of different genetic engineering interventions based upon case studies. |
| **CO4** | Correlate laws pertaining to biological risk to the sustainable use of GMOs in different applications |
| **CO5** | Apply principles of biology to understand risk and its assessment |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 1 | 2 | | | | | | | | | | | | 1 |
| | **CO2** | 1 | | | | | | | | | | | | | 2 |
| | **CO3** | 1 | 2 | | | | | | | | 1 | | | | 1 |
| | **CO4** | 1 | 2 | | | | | | | | | | | | 2 |
| | **CO5** | 1 | 3 | | | | | | | | 2 | | | | 3 |

**1: Low, 2: Medium, 3: High**

# HYDROPONICS, AQUAPONICS AND AEROPONICS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 50 |
| **Course Code:** | S3BTA06 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Learn the basics of hydroponics to produce organic foods |
| 2. | Study the nutrient importance for hydroponics |
| 3. | Familiarize the applications of hydroponics |
| 4. | Learn the design, maintenance and nurture the aquatic life |
| 5. | Study the aeroponics, economic importance and current research |

| **UNIT I** |
|---|
| **HYDROPONICS:** History of hydroponics, General hydroponics, benefits, food production, organic foods versus hydroponics foods, Systems of Hydroponic/Soilless Culture. |
| **3 Hours** |

| **UNIT II** |
|---|
| **MEDIA FOR HYDROPONICS:** Build your own system, Media and supplies, Minerals, macro and micro Nutrients, mixing, Advanced nutrients, super nutrients, Mineral deficiencies, case studies of foods grown via hydroponics, Hydroponic Cropping. |
| **3 Hours** |

| **UNIT III** |
|---|
| **APPLICATION OF HYDROPONICS:** $CO_2$ utilization, Problems in hydroponics, Pest Control, post-harvest handling, hydroponic terminologies, Diagnostic Testing Procedures, The Hydroponic Greenhouse, Educational Role for Hydroponics. |
| **2 Hours** |

| **UNIT IV** |
|---|
| **AQUAPONICS**: History of Aquaponics, System design and management, Establishing and Maintaining the Fish Tank, Seed Germination and Planting, Plant Selection and Care, Plant Nutrient Requirements, Photosynthesis, Transpiration and Light, Plant Physiology & Light. |
| **3 Hours** |

| **UNIT V** |
|---|
| **AEROPONICS:** History of Aeroponics, The Aeroponic Value Proposition, Aeroponic Science. Aeroponics Innovations, Aeroponic Business, Practice of Aeroponics. Current research. Case studies. |
| **3 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Viktor Garden | Hydroponics and aquaponics for beginners, Thomas watergreen, 2021. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Sylvia Bernstein | Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together, Society Publishers, 2011. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Comprehend the importance of hydroponics in food industry |
| **CO2** | Apply the knowledge of media composition and preparation used in hydroponics technique |
| **CO3** | Apply the cultivation methods using hydroponics |
| **CO4** | Utilize the knowledge of aquaponics to cultivate plants with high nutritional content |
| **CO5** | Analyse the case studies by understanding the knowledge of aeroponics |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | | | | | | | | | | 2 |
| | **CO2** | 2 | 2 | | | | | | | | | | | | 2 |
| | **CO3** | 2 | 2 | | | | | | | | | | | | 2 |
| | **CO4** | 2 | 1 | | | | | | | | | | | | 2 |
| | **CO5** | 2 | 2 | | | | | | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

# IV Semester Syllabus
# 2025-26

# BIOINFORMATICS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4BT01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1 | Understand the concepts of storage, update and retrieval of data from biological databases. |
| 2 | Conceptualize the importance of database similarity searching, understand database similarity searching algorithms and use of Mathematical and statistical models for sequence analysis. |
| 3 | Study the importance of multiple sequence alignment, protein motif and domain prediction in establishing evolutionary relationships. |
| 4 | Understand the concepts of phylogenetic analysis to cluster the closely related sequences. |
| 5 | Study the various protein structure prediction tools, Protein structure visualization tools and application of Bioinformatics in the various fields of Biotechnology. |

## UNIT I

**Introduction to Biological databases**: Bioinformatics: (Definition of Bioinformatics, Goals, Scope, Application, Limitations and New Themes). Database: (Definition of database, Types), Biological database: Databases (Primary, Secondary and Specialized), Interconnection between the databases, Fit falls of Biological databases. Nucleotide and Protein sequence and structure databases (NCBI, EMBL, DDBJ, Uniprot and PDB) Format of databases: (GenBank flat file, PDB format) Other Important Databases: KEGG, PubMed, PubChem, ZINC and any other newly created databases of importance.

**8 Hours**

## UNIT II

**Sequence Alignment and Database Similarity Searching**: Sequence Alignment: Evolutionary Basis, Homology versus Similarity, Similarity versus Identity, Global alignment, Local alignment, Pairwise alignment: Alignment algorithm: Pairwise: Dot matrix method Dynamic programming Method (For both Local and Global Alignment. i.e. Needleman- Wunch & Smith Waterman), Gap Penalties.

Scoring Matrices: Nucleotide scoring matrices: Transitions and Transversions, Amino acid scoring matrices: PAM, BLOSUM, Comparison between PAM and BLOSUM,

Database Similarity Searching: BLAST. BLAST variants. Statistical significance. Low complexity Regions. FASTA and BLAST algorithms. Simple Dynamic programming Alignment problems.

**9 Hours**

## UNIT III

**Multiple sequence alignment:** Multiple sequence alignment, Protein Motif and Domain Prediction**,** Scoring Function, exhaustive algorithms and Heuristic algorithms. Profiles and Hidden Markov Models: PSSM, Markov Model and HMM. Zeroth, First and Higher order HMM.

Protein Motif and Domain Prediction: Identification of Motif and Domains in MSA. PROSITE. Motif and Domain Databases using Statistical Models (PRINTS, BLOCKS and Pfam), Protein Family databases (COG), Sequence Logos, Problems on 0th, 1st and Higher order HMM.

**8 Hours**

## UNIT IV

**Molecular Phylogenetics:** Phylogenetics Basics, Terminologies, Gene versus species phylogeny, Forms of tree representation. Tree Construction: Choosing Molecular Markers. Alignment.

| |
|---|
| Multiple Substitutions. Choosing Substitution Models (Jukes-Cantor Model). Tree Building Methods (Distance based: UPGMA and Neighbor joining. Character Based Methods: Maximum Parsimony, Maximum Likelihood.) Assessing tree reliability: Bootstrapping. Phylogenetics software: PAUP, Phylip. |
| **8 Hours** |

| **UNIT V** |
|---|
| **Protein structure prediction, comparison and Visualization:** Secondary structure prediction: Globular proteins: ab-initio, homology based.Protein structure comparison: intra-molecular method, intermolecular method. Protein structure building (Homology modelling), Protein structure comparison: SCOP and CATH Protein Structure Visualization: Pymol, Swiss PDB viewer, VMD and Discovery studio visualize.<br>Applications of Bioinformatics: Bioinformatics in pharmacy: drug discovery process, structure based and ligand-based drug design (CADD). |
| **9 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Basant K Tiwary, | Bioinformatics and Computational Biology: A Primer for Biologists, Springer Verlag, 2021, 978-981-16-4240-1 |
| 2 | Jin Xiong | Essentials Bioinformatics, Cambridge university press, 2006, 9789335657325, 3rd Edition, |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Paul A gagniuc | Algorithms in Bioinformatics: Theory and Implementation, , 2021, 978-1119697961 |
| 2 | Rajesh Kumar Phatak | Bioinformatics: Methods and Applications , 2021, 978-0323897754 |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Describe various biological databases and analyze file formats used in these databases. |
| **CO2** | Apply the concepts of sequence alignment algorithms to solve alignment problems to establish the relationship among various organisms. |
| **CO3** | Analyze various multiple sequence alignment tools to identify protein families, motifs and domains. |
| **CO4** | Identify suitable molecular marker to construct and assess phylogenetic tree using various methods. |
| **CO5** | Apply the concepts of Bioinformaticsin the area of drug discovery process, Pharmacokinetics and OMICS. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | | | | | | | | | | | 3 | |
| | **CO2** | 3 | 2 | | | | | | | | | | | 3 | |
| | **CO3** | 2 | 2 | | | | | | | | | | | 3 | |
| | **CO4** | 3 | 2 | | | | | | | | | | | 3 | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CO5** | 2 | 1 | | | | | | | | | | 3 | |

**1: Low, 2: Medium, 3: High**

## UPSTREAM PROCESS TECHNOLOGY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:2 | **Credits:** | 4 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTI01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Learn the fermentation process and components of fermenter. |
| 2. | Know the ingredients of fermentation media, requirements and types of sterilization techniques. |
| 3. | Understand the concepts of animal and plant cell culture; its scale up studies for the production of industrial products. |
| 4. | Learn different types of strain improvement techniques and understand the metabolic pathways for the biosynthesis of industrial products. |
| 5. | Understand the knowledge to produce fermented products |

| **UNIT I** |
|---|
| **Fermentation Concepts**: Introduction to fermentation History and development of fermentation, general requirements of the fermentation, range of fermentation processes, overview of fermenters, its types - concepts of upstream and downstream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation process with a suitable example. Immobilization of enzymes for the industrial application. |
| **8 Hours** |

| **UNIT II** |
|---|
| **Media preparation and inoculum development**: Microbial nutrition, types of media, Media ingredients for microbial cells, medium formulation, oxygen requirements, anti-foams. Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Microbial growth cycle, measurement of growth, Solid and liquid state fermentation. |
| **8 Hours** |

| **UNIT III** |
|---|
| **Introduction to animal/plant based industrial production**: Ingredients for mammalian cell culture, natural and synthetic media preparation, sterilization and storage. Development and maintenance of cell lines, invitro culture of cells/embryos, methods of cryopreservation,. Scale up studies; perfusion systems, Nunc cell factories, roller cultures. Plant cell culture requirements, media constituents, totipotency, organogenesis, somatic embryogenesis. Production of secondary metabolites using plant bioreactors (production of alkaloids and coloring pigments) |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Strain improvement:** The isolation and improvement of industrially important microorganisms: isolation methods utilizing selection of the desired characteristic. Improvement of industrial microorganisms. Metabolic Pathways for the Biosynthesis of Industrial Products: Industrial |

| |
|---|
| Microbiological Products as Primary and Secondary Metabolites, Trophophase-idiophase Relationships in the Production of Secondary Products, Role of Secondary Metabolites in the Physiology of Organisms/plants, Pathways for the Synthesis of microbial Primary and Secondary Metabolites of Industrial Importance. Carbon Pathways for the Formation of Industrial Products Derived from Primary Metabolism. |
| **9 Hours** |

| **UNIT V** |
|---|
| **Industrial production**: Scale up of the fermentation process, Fermentation economics. Bioprocess validation Safety considerations. Fermented products - Industrial processes and products: α-amylase, lactic acid, antibiotic (penicillin) production, ethanol fermentation. Health-care products: Hepatitis B vaccine, Insulin. Microbial biomass production (Manufacture of baker's yeast), spirulina production and Mushrooms, Bio-fertilizers and bio-pesticides. |
| **9 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | P. P. Stanburry and A. Whitaker | Principles of Fermentation Technology, Pergamon Press, 2003, Oxford UK, 0750645016, 2nd edition, |
| 2 | R Ian Freshney | Culture of Animal Cells, Wiley-Liss, 2021, 978-1202785858, 8th Edition. |
| 3 | S.S. Bhojwani | Plant Tissue Culture: Applications and Limitations,1990, Elsevier, Amsterdam, 2013, 978-81-322-1025-2 |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | M. L. Shuler and F. Kargi | Bio-process Engineering, 2002, Prentice Hall of India. New Delhi, 0-13-081908-5, 2nd edition |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Describe the knowledge of fermentation components, parameters and types for producing aerobic and anaerobic products |
| **CO2** | Outline the components and requirements of media. Classify the sterilization techniques. |
| **CO3** | Outline the strain improvement methods and classify metabolic pathways for the production of industrial products. |
| **CO4** | Apply appropriate strain improvement techniques and understand the metabolic pathways for the biosynthesis of industrial products. |
| **CO5** | Apply the fermentation process for the production of industrial products. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | | | | | | | | | | 2 | | |
| | **CO2** | 2 | 2 | | | | | | | | | | 2 | | |
| | **CO3** | 2 | 2 | | 2 | | | | | | | | 2 | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CO4** | 2 | 2 | | 2 | | | | | | | | 2 | | |
| | **CO5** | 2 | 2 | | | | | | | | | | 2 | | |

**1: Low, 2: Medium, 3: High**

## UPSTREAM PROCESS TECHNOLOGY LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::0:0:2 | **Credits:** | 0 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTI01 | **SEE Marks:** | 0 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Enhance the practical approaches in the media preparation and sterilization. |
| 2. | Understand the concepts of fermentation for the production of primary and secondary metabolites. |
| 3. | Learn the fermentation methods for the production of ethanol and wines. |
| 4. | Prepare the seed culture for fermentation. |
| 5. | Understand the effect of media for producing mushroom. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Media Preparation and sterilization |
| 2. | Preparation of inoculum for fermentation |
| 3. | Production of cellulase enzyme and estimation |
| 4. | Production of Secondary metabolite – Anthocyanin |
| 5. | Production and estimation of ethanol from fermented broth |
| 6. | Production and Estimation of citric acid from fermented broth |
| 7. | Production of amylase and estimation (from microbial species) |
| 8. | Production of Encapsulated artificial seeds |
| 9. | Production of wine from fruit waste |
| 10. | Comparison of biomass yield in defined and complex media in shake flask culture |
| 11. | Replica plating for screening of auxotrophs/antibiotic resistant strain |
| 12. | Preparation of media for raising of pure culture of mushroom. |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Michael C. Flickinger | Downstream Industrial Biotechnology: Recovery and Purification, Wiley, 2013, 978- 1118131244, 1st Edition. |
| 2 | S.S. Bhojwani and M.K. Razdan | Plant tissue culture- Theory and practice, 2003 Elsevier, 1996, 9780080539096, 1st Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Michael Butler | Cell Culture and Upstream Processing, Taylor & Francis, 2007, 0415399696, 1st Edition. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Demonstrate the Sterilization and media components |
| **CO2** | Production of primary and secondary metabolites. |

| | |
|---|---|
| **CO3** | Production and estimation of ethanol and wine using Fermentation method |
| **CO4** | Demonstrate on the production of artificial seeds. |
| **CO5** | Observe the growth of mushroom in solid state medium |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | | | | | | 1 | | | 2 | 2 | | |
| | **CO2** | 2 | 1 | | | | | | 1 | | | 2 | 2 | | |
| | **CO3** | 2 | 1 | | | | | | 1 | | | 2 | 2 | | |
| | **CO4** | 2 | 1 | | | | | | 1 | | | 2 | 2 | | |
| | **CO5** | 2 | 1 | | | | | | 1 | | | 2 | 2 | | |

**1: Low, 2: Medium, 3: High**

## MOLECULAR BIOLOGY AND GENETIC ENGINEERING

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:2 | **Credits:** | 4 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTI02 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Know the information flow in the biological system and understand the concept of gene replication. |
| 2. | Acquire the knowledge of transcription in prokaryotes and eukaryotes. |
| 3. | Learn about translation mechanisms in prokaryotes and eukaryotes and study gene regulation. |
| 4. | Explore the concept of gene transfer and gene transfer techniques. |
| 5. | Acquire the knowledge of Nucleic acid isolation, amplification and sequencing. |

**UNIT I**

**Replication**: Information flow in biological systems: Central dogma and its reversal. Introduction to replication, Replication of DNA - General features, semi- conservative DNA replication in E.coli, Meselson and Stahl‟s experiment. Mechanism of DNA replication in Eukaryotes, multiple replication forks, initiation, elongation & termination, Models of replication – Rolling circle model, and Cairn‟s model. DNA damage and repair: Introduction & types of damage; DNA repair – introduction, types- Photoreactivation & SOS repair.

**9 Hours**

**UNIT II**

**Transcription:** Introduction, Concept of sense and antisense strands. Structure and function of bacterial RNA polymerase, sigma factor cycle. Transcription in Prokaryotes - initiation, elongation, termination (rho dependent and rho independent) Transcription in Eukaryotes. Eukaryotic RNA Polymerases-I, II and III functions. Steps in transcription-initiation, elongation & termination (Pol II

only).
Post-transcriptional modification of mRNA-capping, polyadenylation, splicing- excision of introns & splicing of exons (Only splicing by spliceosome is included). Transcription inhibitors.

**8 Hours**

**UNIT III**

**Translation and Gene regulation:** Introduction, definition, steps- activation of amino acid, Initiation, elongation & termination (Prokaryotes) Protein synthesis in eukaryotes - Initiation, elongation and termination Differences in pro- & eukaryotic protein synthesis. Inhibitors of translation.
Concept of gene regulation: Gene regulation in prokaryotes: positive versus negative regulation. Induction and repression system. Operon model – Lac Operon- positive regulation and negative regulation, mutations in lac operon, Trp-Operon - by an allosteric repressor protein and by an attenuator.

**8 Hours**

**UNIT IV**

**Concept of Gene transfer and Gene Transfer Techniques:** Vectors: plasmids and Classification of plasmids: Natural plasmid (ColE1) and artificial plasmid (pBR322 and PUC). Gene Transfer: Definition, Gene transfer techniques: Biological (Conjugation, Transformation, ansfection and transduction), Chemical method of Gene transfer (Calcium phosphate, DEAE dextran) and Mechanical (Electroporation, Microinjection and Gene gun).

**8 Hours**

**UNIT V**

**Nucleic acid isolation, amplification and sequencing:** Isolation and purification of nucleic acids: (DNA, RNA and plasmids), Polymerase chain reaction: Introduction to Primer and Probe. Preparation Probes, mechanism of PCR, variants of PCR (only RT-PCR and Q-PCR)
DNA Sequencing Methods: Definition of Sequencing Concept, Methods: Maxam and Gilbert method and Sanger, Automated DNA sequencing. Advantages and disadvantages. Recent trends in DNA Sequencing.
Application of Genetic engineering: Introduction, methods of Gene therapy (Ex vivo and Invivo; only one type for each), Genome editing using CRISPR/CAS technology.

**9 Hours**

**TEXT BOOKS**

| | | |
|---|---|---|
| 1 | Freifelder | Molecular Biology, Narosa Publications, 2005, 978-9350356675, 2nd Edition. |
| 2 | David Freifelder | Freifelder‟s Essentials of Molecular Biology, Narosa Publications, 2009, 978-9350346624, 4th Edition. |

**REFERENCE BOOKS**

| | | |
|---|---|---|
| 1 | Darnell J Lodish& H Balitimore. | Molecular cell Biology, Scientific American books, USA, 2015, 923-9352546322, , 4th Edition |
| 2 | Gardener, Simmons, Snustad. | Principles of Genetics, Wiley publishers, 2005, 932-9352366314, 8th Edition. |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Apply the Knowledge of mechanism of DNA replication to explore the process of DNA damage and DNA repair in prokaryotes and eukaryotes. |
| **CO2** | Illustrate the mechanism of transcription in prokaryotes & eukaryotes. |
| **CO3** | Describe the mechanism of translation in prokaryotes & eukaryotes and analyze gene regulation. |
| **CO4** | Interpret and analyze various concepts of Gene transfer between the cells. |
| **CO5** | Classify various types of DNA Sequencing Methods and its application in genetic engineering. |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | | | | | | | | | | | | | 2 |
| | **CO2** | 2 | | | | | | | | | | | | | 2 |
| | **CO3** | 2 | | | | | | | | | | | | | 2 |
| | **CO4** | 3 | 2 | | | 3 | 1 | 1 | | | | | | | 3 |
| | **CO5** | 3 | 2 | | | 3 | 1 | 1 | | | | | | | 3 |

**1: Low, 2: Medium, 3: High**

## MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::0:0:2 | **Credits:** | 0 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTI02 | **SEE Marks:** | 0 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | View the divisional stages of a cell and learn about wild & mutant drosophila. |
| 2. | Learn the isolation of plant protoplast by enzymatic method. |
| 3. | Acquire the knowledge of isolation of genomic DNA from plant, animal and microbial sources. |
| 4. | Understand the various techniques used for DNA separation. |
| 5. | Learn gene transfer technique using chemical methods followed by selection of recombinants. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Study of divisional stages in mitosis (squash preparation and staining– specimen: Onion root tip). |
| 2. | Study of divisional stages in meiosis (Permanent slides only). |
| 3. | Study of Drosophila mutants, Barr eye, vestigial wings, yellow body, white eye. |
| 4. | Isolation of plant protoplasts by enzymatic method and its fusion. |
| 5. | Isolation of plasmid DNA from E.coli. |
| 6. | Isolation of genomic DNA from Plant |
| 7. | Isolation of genomic DNA from microbial sources. |
| 8. | Agarose gel electrophoresis and quantification of nucleic acids (260/280 method spectrophotometric method). |
| 9. | Restriction mapping (Single or double digestion). |
| 10. | Separation of protein mixture on SDS-PAGE. |
| 11. | Study of conjugation in E.coli – Kit method |
| 12. | Transformation of E.coli cells – Calcium chloride method (Kit may be used). Selection of recombinants (Blue-White screening). |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | H S Chawla | Introduction to Plant Biotechnology, Oxford and IBH Publication, New Delhi, , 2017, 945-0299108236, 3rd Edition |
| 2 | F.M. Ausubel, R. Brent, R.E. Kingston, D.Doore J.G.Seidman, J.A. Smith, and K. Struhl | Current Protocols in Molecular Biology, Green Publishing Associates, and Wiley- Interscience John Wiley and Sons, New York, 1987, 989-0299108245, 1st Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Primates | Principles of Gene Manipulation and Genomics, Wiley-Blackwell Publishers, 2006, 945-2599108245, 7th Edition, |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Identify and analyze the divisional stages of cells and Drosophila mutants. |

| | |
|---|---|
| **CO2** | Demonstrate the process of isolation of plant protoplast and its fusion. |
| **CO3** | Determine DNA isolation from plant, animal and microbial sources. |
| **CO4** | Interpret restriction mapping and amplification techniques on DNA samples. |
| **CO5** | Execute bacterial conjugation and transformation to identify the developed recombinants using specific techniques. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | 1 | | | 2 | | | 2 | | | 3 |
| | **CO2** | 3 | 2 | | | 1 | | 1 | 2 | | | 2 | | | 3 |
| | **CO3** | 3 | 2 | | | 1 | | | 2 | | | 2 | | | 3 |
| | **CO4** | 3 | 2 | | | 1 | | | 2 | | | 2 | | | 3 |
| | **CO5** | 3 | 2 | | | 1 | | | 2 | | | 2 | | | 3 |

**1: Low, 2: Medium, 3: High**

## BIOINFORMATICS LABORATORY

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::0:0:2 | **Credits:** | 1 |
| **Total Lecture Hours:** | 28 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTL01 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the concepts of data retrieval from bibliographic Data bases and biological databases. |
| 2. | Learn the concepts of database similarity searching. |
| 3. | Conceptualize the importance of phylogenetic tree construction and gene prediction methods. |
| 4. | Know the concepts of protein secondary, tertiary structure prediction and visualization. |
| 5. | Understand the concepts of ligand design and its molecular docking with proteins. |

| **LIST OF EXPERIMENTS:** | |
|---|---|
| 1. | Sequence retrieval from Nucleic Acid and Protein databases and Pairwise sequences comparison. |
| 2. | Sequence (BLAST) searches – Analysis of parameters affecting alignment. |
| 3. | Multiple sequences alignment and Protein motif analysis. |
| 4. | Evolutionary |
| 5. | Gene Prediction for Prokaryotes and Eukaryotes genome. |
| 6. | Biomolecules |
| 7. | Protein structure prediction and validation. |
| 8. | Ligand design using Marvin sketch and identification of biological activity using PASS Server. |
| 9. | ADMET and Drug likeliness Prediction for given ligand |

| | |
|---|---|
| 10. | Molecular Docking - Protein and Ligand. |
| 11. | Molecular Docking - Protein and Protein/Peptide & Post docking analysis |
| 12. | Open ended experiment |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | David W Mount | Bioinformatics sequence and Genome analysis, Cold Spring Harbor Laboratory Press, 2013, 978-8123912417, 2nd Edition. |
| 2 | Jin Xiong | Essentials Bioinformatics, Cambridge university press, 2006, 978047052812, 4th Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Paul A gagniuc | Algorithms in Bioinformatics: Theory and Implementation, ,2021,v978-1119697961 |
| 2 | Rajesh Kumar Phatak | Bioinformatics: Methods and Applications ,2021, 978-0323897754 |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Interpret physicochemical properties of biomolecules and biological sequence retrieval for comparison. |
| **CO2** | Identify tree building methods to construct and assess the reliability of the phylogenetic trees. |
| **CO3** | Construct protein secondary and tertiary structural units to analyze and evaluate protein models |
| **CO4** | Design ligand molecules for the molecular docking process. |
| **CO5** | Interpret the use of molecular docking results used in computer aided drug design |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 1 | | | 1 | | | 1 | | | 2 | | 3 | |
| | **CO2** | 3 | 1 | | | 2 | | | 2 | | | 2 | | 3 | |
| | **CO3** | 2 | 3 | | | 3 | | | 2 | | | 2 | | 3 | |
| | **CO4** | 2 | 2 | | | 2 | | | 1 | | | 2 | | 3 | |
| | **CO5** | 2 | 3 | | | 3 | | | 1 | | | 2 | | 3 | |

**1: Low, 2: Medium, 3: High**

## BIOLOGICAL THERMODYNAMICS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::2:2:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 28+28 | **CIE Marks:** | 50 |
| **Course Code:** | S4BT02 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Know Measurement of various types of energies and enthalpy. |
| 2. | Learn entropies of second law and third law of thermodynamics. |
| 3. | Understand the variation of Gibbs free energy and stability of nucleic acids and proteins. |
| 4. | Know response of equilibria in presence of catalyst and temperature. |
| 5. | Learn the thermodynamics of ion and electron transport |

| **UNIT I** |
|---|
| **The First Law :** Systems and surroundings, work and heat, measurement of work, measurement of heat, internal energy, enthalpy, enthalpy changes accompanying physical processes, bond enthalpy, thermochemical properties of fuels, combination of reaction enthalpies, standard enthalpies of formation, enthalpies of formation and computational chemistry, variation of reaction enthalpy with temperature. |
| **6+6 Hours** |

| **UNIT II** |
|---|
| **The Second Law**: The direction of spontaneous change, entropy and the second law, absolute entropies and the third law of thermodynamics, entropy changes accompanying chemical reactions, Gibbs free energy, hydrophobic interaction, work and the Gibbs free energy change. |
| **5+5 Hours** |

| **UNIT III** |
|---|
| **Phase Equilibria:** The condition of stability, the variation of Gibbs free energy with pressure, the variation of Gibbs free energy with temperature, phase diagrams, the stability of nucleic acids and proteins, phase transitions of biological membranes, the chemical potential, ideal and ideal–dilute solutions, the modification of boiling and freezing points, osmosis. |
| **5+5 Hours** |

| **UNIT IV** |
|---|
| **Chemical Equilibrium:** The reaction Gibbs free energy, the variation of reaction Gibbs free energy with composition, reactions at equilibrium, the standard reaction Gibbs free energy, the response of equilibria to the presence of a catalyst, the effect of temperature on equilibria, Brønsted–Lowry theory, protonation and deprotonation, polyprotic acids, amphiprotic systems, buffer solutions. |
| **6+6 Hours** |

| **UNIT V** |
|---|
| Thermodynamics of Ion and Electron Transport: Ions in solution, passive and active transport of ions across biological membranes, ion channels and ion pumps, half-reactions, reactions in electrochemical cells, the Nernst equation, standard potentials, applications of standard potentials - the determination of thermodynamic functions, the electrochemical series, the respiratory chain, and plant photosynthesis. |
| **6+6 Hours** |

| TEXT BOOKS | | |
|---|---|---|
| 1 | Atkins P. and de Paula J. | Physical Chemistry of the Life Sciences, W.H freeman and Company, New York, 2011, 978-1-4292-3114-5, 2nd edition. |

| REFERENCE BOOKS | | |
|---|---|---|
| 1 | Hammes G.G and Hammes-Schiffer S. | Physical Chemistry for the Biological Sciences, John Wiley & Sons, Inc., Hoboken, New Jersey, 2015, 978-1-118-85900-1, 2nd edition. |
| 2 | Allen J.P. | Biophysical Chemistry, Wiley-Blackwell, Chichester, West Sussex, UK, 2008, ISBN- 978-1-4051-2436-2, 3rd edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Discuss the various types of enthalpy and energy accountable in First law of Thermodynamics and its measurement. |
| **CO2** | Calculate the entropy changes and Gibbs free energy in chemical reactions. |
| **CO3** | Determine the stability of nucleic acids and proteins, chemical potential of biological systems. Explain conditions of stability and the modification of boiling and freezing points & osmosis. |
| **CO4** | Explain the effect of temperature on equilibria and Brønsted–Lowry theory and also Evaluate the standard Gibbs free energy for reactions. |
| **CO5** | Discuss the Ions transport in solution, across biological membranes, ion channels and ion pumps. And also determine standard potentials thermodynamic functions |

**Course Articulation Matrix**

| | **POs** | | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | | | | | | | | 3 | | |
| | **CO2** | 2 | 2 | | | | | | | | | | 3 | | |
| | **CO3** | 2 | 2 | | | | | | | | | | 3 | | |
| | **CO4** | 2 | 2 | | | | | | | | | | 3 | | |
| | **CO5** | 2 | 2 | | | | | | | | | | 3 | | |

**1: Low, 2: Medium, 3: High**

## BIO-ANALYTICAL TECHNIQUES

| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
|---|---|---|---|
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4BT04 | **SEE Marks:** | 50 |

| **Course objectives:**<br>This course will enable students to: | |
|---|---|
| 1. | Learn the basic concepts, principles of chromatographic separations and operation of modern chromatographic instrumentation. |

| | |
|---|---|
| 2. | Understand the basic principles of electronic spectroscopic techniques and explain the terminology of UV/Vis spectroscopies. Examine UV spectra based on the knowledge of different electron transitions. |
| 3. | Know the theory of IR absorption, types of vibrations, factors affecting the group frequencies and sample handling techniques. To analyze IR spectra based on knowledge of characteristic functional group frequencies. |
| 4. | Demonstrate the knowledge of the chemical shifts and coupling constants in NMR to study 1H NMR spectra and propose structures for compounds. |
| 5. | Learn characterization techniques: XRD and electron microscopy which interpret crystal structure and morphology. |

| **UNIT I** |
|---|
| **Chromatography:** Introduction to Chromatography - Classification - Theory - terminologies-distribution coefficient, retention time, corrected retention time, retention volume, corrected retention volume, retention factor, selectivity factor, column capacity, separation number, peak capacity, column efficiency, resolution and optimization of column performance. Types of chromatography-adsorption, partition, ion exchange and size exclusion chromatography. Numerical problems on retention factor.<br>Thin layer chromatography: Principle, mobile phase, sample application, development techniques evaluation and documentation, advantages, limitations and applications.<br>**Gas chromatography:** Principle, instrumentation, carrier gas, stationary phase, sample injection, columns, detectors (TCD, FID, ECD atomic emission detector). Applications.<br>High performance liquid chromatography: Principle, instrumentation, column, sample injection, detectors (UV, refractive index), mobile phase selection, isocratic and solvent gradient system. Demonstration of HPLC, Applications. |
| **9 Hours** |

| **UNIT II** |
|---|
| **General introduction to spectroscopy:** Introduction, Types of spectroscopy-atomic and molecular spectroscopy, nature and interaction of electromagnetic radiations with matter, energies corresponding to various kinds of radiations, spectral band width – definition and factors contributing spectral width, factors influencing positions and intensity of spectral lines.<br><br>**Electronic Spectroscopy:** Principles of electronic spectroscopy - Types of electronic transitions in organic molecules. Chromophores and auxochromes. Bathochromic shift or Red shift, hypsochromic shift or blue shift. Hyperchromic effect and hypochromic effect. Effect of solvent and extent of conjugation on □max and on the energies of and transitions. Instrumentation, qualitative and quantitative analysis. |
| **8 Hours** |

| **UNIT III** |
|---|
| **Infrared spectroscopy:** Principles of IR spectroscopy. Requirements for IR absorption. Types of vibrations - Stretching vibrations and bending vibrations. Fundamental modes of vibrations for linear and non linear molecules. Characteristic group frequencies for infrared absorption of organic molecules. Factors affecting the group frequencies – coupled interactions (Fermi resonance, aldehyde) electronic effects (carbonyl compounds) and hydrogen bonding (alcohols, carboxylic acids). Numerical problems on vibrational frequencies. Instrumentation-FTIR instrument and its advantages. Sample handling techniques – Nujol mull and KBr pellet. |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Nuclear magnetic resonance spectroscopy:** The nuclear spin, Larmor precession, the NMR |

| |
|---|
| isotopes, energy levels for a nucleus with spin quantum number I = ½, 3/2 and 5/2, theory of population of nuclear spin levels, spin-spin and spin-lattice relaxation, chemical shift – definition, causes, measurement. TMS as a reference compound and its advantages, factors affecting chemical shift, shielding and deshielding mechanisms, correlation of chemical shifts with chemical environment – aliphatic, alkenic, alkynic, aldehydic, ketonic, aromatic, alcoholic, phenolic, carboxylic, amino protons, spin – spin coupling, spin – spin splitting, intensity ratio of multiplet-Pascal's triangle method, chemical exchange, effect of deuteration, classification of spin systems (AX, AMX, AB, ABC), first order spectra, low and high resolution spectra, determination of peak areas, coupling constants-short and long range couplings, Instrumentation – FT NMR. Applications of electronic spectroscopy, IR and NMR to structural elucidation of simple organic molecules. |
| **8 Hours** |

| **UNIT V** |
|---|
| **Microstructures and morphological studies:** XRD: Production of X-rays; types of X-ray sources, Selection of radiation, Braggs Equation, Diffraction by Crystal - direction and intensity of diffracted beams, Calculation of particle size-Debye Scherrer equation proportional, scintillation, solid-state detectors. X-ray spectroscopy for elemental analyses - wavelength dispersive and energy dispersive analyses. AFM – principle and applications, Demonstration and Data analysis.<br>Microscopy: Concept of optical microscopy, uses, advantages and disadvantages, Electron microscopy, Introduction, Theory of electron diffraction, Scanning electron microscopy (SEM), Demonstration and Data analysis Transmission electron microscopy (TEM), indexing selected area electron diffraction pattern, HRTEM analysis, Comparison of XRD and TEM (HRTEM, SAED pattern). AFM – principle and applications |
| **9 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Wilson and Walkers by Andreas Hofmann | Principles And Techniques Of Biochemistry And Molecular Biology, 2018, Cambridge University Press, 978-1316614, 8th Edition. |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Skoog, D.A, S.J. Holler, T.A. Nilman, | Principles of Instrumental Analysis, Saunders college publishing, London, 2018, 4833702827, 7th Edition, |
| 2 | Jaffery, Gill, Basset. J | Vogel's Text Book of Quantitative Inorganic analysis, ELBS,1998, 0582442478, 5th Edition |

**Course Outcomes:**
Upon completion of this course the student will be able to:

| | |
|---|---|
| **CO1** | Describe the chromatographic techniques for the identification and purification of compounds |
| **CO2** | Illustrate the principles and methods of different spectroscopic technique. |
| **CO3** | Outline the theory of IR absorption, types of vibrations and analyse IR spectra. |
| **CO4** | Interpret and perform NMR spectra analysis for the identification of unknown organic molecules. |
| **CO5** | Describe the concepts, techniques and applications of XRD, SEM and TEM |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 1 | 2 | | | | | | | | | | | | 2 |
| | **CO2** | 2 | 2 | | | | | | | | | | | | 2 |
| | **CO3** | 2 | 2 | | | | | | | | | | | | 2 |
| | **CO4** | 1 | 2 | | | | | | | | | | | | 2 |
| | **CO5** | 2 | 2 | | | | | | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## SOIL FERTILITY AND NUTRIENT MANAGEMENT

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4BT06 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Enhance the knowledge on soil fertility and soil formation processes. |
| 2. | To impart knowledge on essential nutrients and its movements in soil-plant. |
| 3. | Study the transformation of nutrients and its formation and functions. |
| 4. | Study the manures and fertilizers application for the improvement of soil fertility. |
| 5. | Analyze understand the soil and plant samples for better crop production. |

| **UNIT I** |
|---|
| **Soil as a natural resource:** Definition of Soil-Soil Fertility and Soil Productivity-soil formation process-soil & land capability classification- soil acidity and alkalinity- soil erosion and its control-soil organisms-organic matter-modern views of humus formation -Plant Growth & Response Curves-liebig's law of minimum-Mitscherlich's law. |
| **9 Hours** |

| **UNIT II** |
|---|
| **Basic soil-plant relationships:** Essential plant nutrients- Definition of macro and micro nutrients -Functions and deficiency symptoms- Hidden hunger- Beneficial elements -Criteria of essentiality of elements- Luxury consumption of nutrients-SUPPLY OF NUTRIENTS FROM organic matter-movement of ions from soils to roots -Mass flow-diffusion-root interception-nutrient mobility in soil-ion absorption by plants. |
| **8 Hours** |

| **UNIT III** |
|---|
| **Nutrient transformation in relation to soil-plant systems:** The functions and forms of N, P, K in soil -Biological N2 fixation - losses of nitrogen from soils-leaching - denitification- forms of P in soil- P sources- Factors affecting K availability- sulfur, calcium and magnesium-cycle-forms and functions in plants. |
| **9 Hours** |

| **UNIT IV** |
|---|
| **Manures and fertilizers:** Definition- characteristics of manure -classification-sustainable |

| |
|---|
| agriculture- composts-methods of composting-organic farming-LEISA-fertilizer-classification-recommendations in agriculture crops -Calculation and application of fertilizers in soil -Nano fertilizer-soil testing and its importance. |
| **8 Hours** |

| **UNIT V** |
|---|
| **Soil fertility evaluation and maintenance of soil health:** Characteristics of a healthy soil -Measure of soil health-soil health indicators-soil health report-problem soils -Plant analysis- total analysis, rapid tissue test, enzyme test, DRIS method and critical levels of nutrients in plants-problem due to excessive use of chemical fertilizers-crop residue management. |
| **8 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | T.D. Biswas and S.K.Mukherjee | Text Book of Soil Science, PEARSON India education services, 2017, 978-0074620434, 2nd edition |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Dilip Kumar Das | Introductory Soil Science, Kalyani Publishers, 2013. 978-9327257540, 3rd Edition, |
| 2 | T.D. Biswas and S.K. Mukherjee | Text Book of Soil Science, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2001. 978-0074620434, 2nd Edition. |

| **Course Outcomes:** Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Determine the classification of soil and land capability, soil erosion and its control |
| **CO2** | Assess the functions and nutrients supply from soil to plant |
| **CO3** | Find nutrient transformation in relation to soil-plant systems |
| **CO4** | Determine the manure and fertilizers for crop production |
| **CO5** | Check the soil fertility by conducting the soil tests using different methods |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO2** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO3** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO4** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO5** | 2 | 2 | | | | | | | | | | | | 3 |

**1: Low, 2: Medium, 3: High**

## BIOSENSORS

| | | | |
|---|---|---|---|
| **Contact Hours/Week** | L+T+P:: 3+0+0 | **Credits** | : 3 |
| **Total Lecture Hours** | : 42 | **CIE Marks** | : 50 |
| **Course Code** | : S4BT07 | **SEE Marks** | : 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Understand the principle, operations and classification of biosensors |
| 2. | Introduce transducers and physiological property measurement using biosensor |
| 3. | Investigate the applications of biosensors in various fields |
| 4. | Understand the design of bio membrane fabrication |
| 5. | Know the engineering aspects in biosensing |

| **UNIT I** |
|---|
| **Electrochemistry -** classification and operation: Electrochemistry single electrode potential- Nernst equation Tafel plot. Desired characteristics of biosensors: reliability, simplicity, cost, and related parameters. Classification and components of Biosensor. Types of enzyme electrodes. Advantages and limitations, biocatalysis based biosensors. |
| **9 Hours** |

| **UNIT II** |
|---|
| **Transducers in Biosensors:** Types of transducers, principles and applications - Calorimetric, acoustic, optical (absorption, fluorescence, bio/chemiluminescence, surface Plasmon resonance (SPR)), potentiometric / amperometric, conductrometric / resistor metric, piezoelectric, semiconductor - ion sensitive field effect transistor (ISFET), enzyme field effect transistor (ENFET). |
| **8 Hours** |

| **UNIT III** |
|---|
| **Bioselective layers:** Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Microbial metabolism; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors. |
| **8 Hours** |

| **UNIT IV** |
|---|
| **Biosensor engineering and applications:** Detection of product content, allergic components, pathogens, pesticide residues. Monitoring of raw material conversions. Detection of crop diseases, pathogens in plants, Detection of soil nutrients, pesticide and its residual detection.; Industrial on-line monitoring, Environmental monitoring; Technological process control; veterinary, agriculture, Food quality control. |
| **8 Hours** |

| **UNIT V** |
|---|
| **Applications of biosensors in health and environment**: Biosensors and diabetes management, Microfabricated biosensors and point-of-care diagnostics systems, Noninvasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis. micro contact printing; Micro-electromechanical system (MEMS) in healthcare. |
| **9 Hours** |

| TEXT BOOKS | | |
|---|---|---|
| 1 | Gennady Evtugyn | Biosensors: Essentials, Springer, 2014, 978-3-642-40240-1 |
| 2 | D. A. Skoog, F. J. Holler and Nieman A. Timorthy | Principles of Instrumental analysis, Cengage India Private Limited, 2020, 978-9353506193, 7th edition, |

| REFERENCE BOOKS | | |
|---|---|---|
| 1 | D. G. Buerk | Biosensors: Theory and Applications, Technomic, Lancaster, 2008. 9780877629757, 1st Edition |
| 2 | Paolo Bollella, Evgeny Katz | Biosensors – Recent Advances and Future Challenges, MDPI AG, 2021, 9783039438877, 3039438875 |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Apply the knowledge of electrochemistry for the development of biosensors |
| **CO2** | Analyze the use of transducers for sensing applications |
| **CO3** | Evaluating the use of biomolecules in the preparation of biolayers for biosensing applications |
| **CO4** | Apply the knowledge of fabrication to develop biomembranes |
| **CO5** | Apply the knowledge of biosensors in sensing applications |

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | 1 | | | | 2 | | | | | | | 2 |
| | **CO2** | 2 | 2 | 1 | | | | 2 | | | | | | | 3 |
| | **CO3** | 3 | 3 | 2 | | | | 3 | | | | | | | 2 |
| | **CO4** | 3 | 3 | 2 | | | | 3 | | | | | | | 1 |
| | **CO5** | 3 | 3 | 2 | | | | 3 | | | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIOLOGY FOR ENGINEERS

| **Contact Hours/ Week:** | L:T:P::3:0:0 | **Credits:** | 3 |
|---|---|---|---|
| **Total Lecture Hours:** | 42 | **CIE Marks:** | 50 |
| **Course Code:** | S4CCA01 | **SEE Marks:** | 50 |

| **Course objectives:**<br>This course will enable students to: | |
|---|---|
| 1. | Familiarize the students with the basic concepts of both biology and engineering. |
| 2. | Enable the students with an understanding the concepts of biomolecules and its applications |
| 3. | Provide the students to understand naturally designed biological organs (Brain and Heart) and engineering solutions |

| | |
|---|---|
| 4. | Provide the students to understand naturally designed biological organs (Lungs, Kidney and muscular system) and engineering solutions |
| 5. | Motivate the students develop trends in interdisciplinary vision of biological engineering. |

| **UNIT I** |
|---|
| **Introduction to Biology:** The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each), Properties and functions), vitamins and hormones. |
| **8 Hours** |

| **UNIT II** |
|---|
| **Biomolecules and their Applications (Qualitative) :** Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/ detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching). |
| **8 Hours** |

| **UNIT III** |
|---|
| **Human Organ Systems and Bio designs (Qualitative):** Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). |
| **9 Hours** |

| **UNIT IV** |
|---|
| **Nature-Bioinspired Materials and Mechanisms (Qualitative):** Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes-hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs). |
| **8 Hours** |

| **UNIT V** |
|---|
| **TRENDS IN BIOENGINEERING (QUALITATIVE):**<br>Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self- healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic). |
| **8 Hours** |

| TEXT BOOKS | | |
|---|---|---|
| 1 | Human Physiology | Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 2022. 9781260720464, 16th Edition. |

| REFERENCE BOOKS | | |
|---|---|---|
| 1 | Fundamentals of Human Physiology | Lauralee Sherwood Brooks/Cole, Belmont 2012. 978-0840062253, 4th Edition. |
| 2 | Ross and Wilson Anatomy and Physiology in Health and Illness | Anne Waugh, Allison Grant. Churchill Livingstone 2010. 978-0702063411, 11th Edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Outline the basic biological concepts via relevant industrial applications. |
| **CO2** | Evaluate the concepts of biomolecules and its industrial applications. |
| **CO3** | Analyse the naturally designed biological organs (Brain and Heart) and engineering solutions. |
| **CO4** | Analyse naturally designed biological organs (Lungs, Kidney and muscular system) and engineering solutions. |
| **CO5** | Develop the trends in interdisciplinary vision of biological engineering. |

**Course Articulation Matrix**

| | | POs | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO2** | 2 | 2 | 3 | | | | | | | | | | | 3 |
| | **CO3** | 2 | 2 | 3 | | | | | | | | | | | 3 |
| | **CO4** | 2 | 2 | | | | | | | | | | | | 3 |
| | **CO5** | 2 | 2 | | | | 2 | 2 | | | | | | | 3 |

**1: Low, 2: Medium, 3: High**

## EXTRACTION METHODS AND HERBAL PRODUCTS LAB

| | | | |
|---|---|---|---|
| Lab Hours/ Week | L:T:P:: 1:0:0 | Credits | : 1 |
| Total Practical Hours | 14 | CIE Marks | : 50 |
| Course Code | S4BTA01 | SEE Marks | : 50 |

| **Course objectives:** The objectives of this course are to | |
|---|---|
| 1. | Understand the basics of Maceration followed by isolation of phyto-constituents using various solvents. |
| 2. | Learn the quantitative estimation of various compounds from the herbal extract. |
| 3. | Investigate the process of preparation and evaluation of turmeric cream. |

| | |
|---|---|
| 4. | Learn how analyze the phyto-chemicals from Neem extract. |
| 5. | Know the natural origins of excipients and further understand the antimicrobial activity |

| **List of Experiments:** | |
|---|---|
| 1. | Maceration of natural herbal. |
| 2. | Extraction of phyto-constituents from herbal resources using water (Reflux). |
| 3. | Extraction of phyto-constituents from herbal resources using alcohol (Soxhlet). |
| 4. | Determination of alkaloid content in herbal extract. |
| 5. | Determination of tannin content in herbal extract. |
| 6. | Determination of aldehyde content in herbal extract. |
| 7. | Determination of phenolic compounds in herbal extract. |
| 8. | Determination of flavonoid content in herbal extract. |
| 9. | Preparation and evaluation of turmeric cream. |
| 10. | Preliminary phyto-chemicals analysis aqueous extract of neem |
| 11. | Evaluation of excipient of natural origins such as acacia, starch, honey, tragacanth, jackfruit |
| 12. | Antimicrobial activity of the herbal extract |

**TEXT BOOKS:**

| | | |
|---|---|---|
| 1 | Biren Shah and AK Seth | Textbook Of Pharmacognosy And Phytochemistry, 2nd edition, ISBN No: 978-9386217738, CBS publisher (2019) |
| 2 | Willam C Evans | Trease and Evans Pharmacognosy, 16th edition, ISBN No: 978-0702029349, Elsevier Health Publisher - UK, (2009) |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| 1 | C.K.Kokate, A.P.Purohit, and S.B.Ghokhale | Pharmacognosy, ISBN No: 978-8196396152, Nirali Prakashan (2019). |
| 2 | Vinod D Rangari | Pharmacognosy and Phytochemistry V1 and V2: ISBN No: 978-8188739653 and 978-8188739981, Career Publications (2017) |

**Course outcomes:** Upon completion of this course the student will be able to

| | |
|---|---|
| **CO1** | Demonstrate Maceration process of natural herbal and Evaluate the presence of phyto-constituents using various solvents |
| **CO2** | Quantify the presence of alkaloid, tannin, aldehyde, phenolic, and flavonoid in the herbal extract. |
| **CO3** | Demonstrate the synthesis and evaluate the medicinal values of turmeric cream. |
| **CO4** | Analyze the phyto-chemicals from Neem extract |
| **CO5** | Interpret the natural origins of excipients and further estimate the antimicrobial activity |

**Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs)**

| | **POs** | **PSOs** |
|---|---|---|

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **CO1** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO2** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO3** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO4** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO5** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## AGITATION AND AERATION

| | | | |
|---|---|---|---|
| **Contact Hours/Week** | L:T:P:: 1:0:0 | **Credits** | : 1 |
| **Total Lecture Hours** | :14 | **CIE Marks** | : 50 |
| **Course Code** | : S4BTA02 | **SEE Marks** | : 50 |

**Course Objectives:** The objectives of this course are to

| | |
|---|---|
| 1 | Understand the principles and concepts of mixing in fermenters. |
| 2 | Learn different types of behavior of flow in fermenter at various conditions. |
| 3 | Know alternative impellers and power requirements in fermenter |
| 4 | Understand the mechanisms of mixing at real conditions of fermenter. |
| 5 | Learn the role of shear force during mixing operations in fermenter |

| **UNIT I** |
|---|
| **Functions of mixing:** Mixing Equipment, Vessel Geometry and Liquid Height, Baffles, Sparger, Stirrer shaft, Flow patterns in stirred tanks, Rotational flow, Radial flow, Axial flow and Gas flow patterns |
| **3 Hours** |

| **UNIT II** |
|---|
| **Impellers:** Rushton Turbine, Without gassing, With gassing, Solids suspension. Propellers, Pitched blade turbines, Downward pumping and Upward pumping |
| **2 Hours** |

| **UNIT III** |
|---|
| **Alternative impellers designs:** Curved blade disc turbines, Hydrofoil impellers, Stirrer power requirements and ungassed Newtonian fluids |
| **3 Hours** |

| **UNIT IV** |
|---|
| **Mechanisms of Mixing:** Assessing mixing effectiveness, Scale-up of mixing systems, Improving mixing in fermenters, Multiple impellers and Multiple Rushton turbines without gassing, |
| **3 Hours** |

| **UNIT V** |
|---|
| **Role of shear in stirred fermenters:** Studies with animal cell cultures, Interaction between microcarriers and turbulent eddies, Cell damage from bursting bubbles |
| **3 Hours** |

**TEXT BOOKS:**

| | | |
|---|---|---|
| 1 | Pauline M. Doron | Bioprocess Engineering Principles, Elsevier, 2nd Edition, 2013, 978-0-12-220851-5 |

**REFERENCE BOOKS:**

| | | |
|---|---|---|
| 1 | Shuler M L, Kargi and DeLisa M P | Bioprocess Engineering – Basic Concepts, Prentice-Hall Inc., Upper Saddle River, NJ, 3rd Edition, 2017, 978-0-13-706270-6 |
| 2 | Atkins P. and de Paula J. | Physical Chemistry of the Life Sciences, W.H freeman and Company, New York, 2nd Edition, 2011, 978-1-4292-3114-5. |

**Course outcomes:** Upon completion of this course the student will be able to

| | |
|---|---|
| **CO1** | Demonstrate the existence of different types of flow in specific geometry of fermenter. |
| **CO2** | Evaluate the type of impellers for specific applications. |
| **CO3** | Develop the power requirements for Newtonian fluids in stirred vessels. |
| **CO4** | Analyze the mechanisms involved in controlling rate of mixing in stirred tanks. |
| **CO5:** | Interpret the rate of shear in animal cell cultures, and damage of cells |

**Mapping of Course Outcomes (COs) to Program Outcomes (POs) & Program Specific Outcomes (PSOs)**

| | | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | 2 | 2 | | | | | | | | | 3 | | |
| | **CO2** | 3 | 2 | 2 | 2 | | | | | | | | | 2 | | |
| | **CO3** | 3 | 2 | 2 | 2 | | | | | | | | | 2 | | |
| | **CO4** | 3 | 2 | 2 | 2 | | | | | | | | | 2 | | |
| | **CO5** | 2 | 1 | 2 | 2 | | | | | | | | | 2 | | |

**1: Low, 2: Medium, 3: High**

## BIOSAFETY AND HAZARD MANAGEMENT

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTA05 | **SEE Marks:** | 50 |

**Course objectives:**
This course will enable students to:

| | |
|---|---|
| 1. | Identify potential hazardous biological materials and the risks associated with them. |
| 2. | Select appropriate means to minimize risk and to protect against or prevent exposure. |
| 3. | Recognize applicable legal requirements and prepare the necessary documents to obtain authorizations. |
| 4. | Understand how to run a biorisk management program |
| 5. | Study the importance of biocontainment and certification in biosafety. |

| **UNIT I** |
|---|
| **Need for biosafety:** Introduction; the history and incidence of laboratory-acquired infections (LAI), incidents of secondary transmission from the laboratory, Outline the types of laboratory accidents leading to LAIs, Explain the role of aerosols in LAIs. |
| **3 Hours** |

| **UNIT II** |
|---|
| **Risk analysis:** Overall risk analysis–emergency planning-on site &off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet firefire ball. |
| **2 Hours** |

| **UNIT III** |
|---|
| **Quality checks & biosafety guidelines:** Implementation of safety procedures – periodic inspection and replacement; Accidents -identification and prevention; promotion of industrial safety; Biosafety guidelines – Government of India; Definition of GMOs and LMOs. |
| **3 Hours** |

| **UNIT IV** |
|---|
| **Hazardous operations and safety audits:** Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies pumping system-reactor-mass transfer system. Hazard identification safety audits, checklist. |
| **3 Hours** |

| **UNIT V** |
|---|
| **Biocontainment and certification:** Progression of building a new biocontainment laboratory from conceptualization through to certification. Outline the concepts to be addressed during the laboratory programming phase, architectural and engineering biocontainment features. |
| **3 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | U S Health Dept | Biosafety in Microbiological and Biomedical Laboratories, 2010, 1839310006, 5th Edition |
| 2 | Diane O. Fleming and Debra L. Hunt | Biological Safety, Principles and Practices, ASM Press, 2014, 978-1-683-67177-0, 4th edition |

| **REFERENCE BOOKS** | | |
|---|---|---|
| 1 | Hyatt, N. | Guidelines for process hazards analysis, hazards identification and risk analysis, Dyadem Press, 2004, 978-1466593640 |
| 2 | Heinrich, H.W. Dan Peterson, P.E. and Rood, N. | Industrial Accident Prevention, McGraw-Hill Book Co., 1980. 978-0070280618, 5th edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Apply the insights into Biosafety guidelines |
| **CO2** | Analyze and Manage the Risks involved with GMOs |
| **CO3** | Evaluate the International Agreements and Regulations with respect to Biosafety |
| **CO4** | Analyze and gain Knowledge of working principles in a laboratory taking all safety measures, |
| **CO5** | Evaluate and handle the live cultures, disposal of infectious waste, care of the equipment requiring safety audit |

**Course Articulation Matrix**

| | | **POs** | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO2** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO3** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO4** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |
| | **CO5** | 2 | 2 | | | 1 | | 1 | | 1 | | | | | 2 |

**1: Low, 2: Medium, 3: High**

## BIOPROCESS DATA ANALYSIS

| | | | |
|---|---|---|---|
| **Contact Hours/ Week:** | L:T:P::1:0:0 | **Credits:** | 1 |
| **Total Lecture Hours:** | 14 | **CIE Marks:** | 50 |
| **Course Code:** | S4BTA07 | **SEE Marks:** | 50 |

| **Course objectives:** This course will enable students to: | |
|---|---|
| 1. | Introduce the importance and basics of data, errors in bioprocess data and data analysis. |
| 2. | Acquaint students with various mathematical procedures for bioprocess data analysis and engineering calculations. |
| 3. | Train and allow practice of MS Excel, MS Power point and MS Word for engineering calculations and reporting. |
| 4. | Illustrate and allow practice of basic laboratory skills, safety and good laboratory practices. |
| 5. | Understand the basic requirements in mathematical modelling |

| **UNIT I** |
|---|
| **Bioprocess Flow Diagrams:** Qualitative flow diagram of a fermentation process. Quantitative flow diagram of a downstream bioprocess. |
| **3 Hours** |

| **UNIT II** |
|---|
| **Mathematical Procedures:** Trial-and-error method, graphical method, graphical integration; Log-log plots, semi-log plots, triangular plots. |
| **2 Hours** |

| **UNIT III** |
|---|
| **Bioprocess Data and Uncertainty:** Introduction to data, significant figures, absolute and relative uncertainty, Propagation of errors, types of errors. |
| **3 Hours** |

| **UNIT IV** |
|---|
| **Statistical Analysis and Data Presentation:** Statistical analysis; Standard deviation, standard error, data scattering, outliers, and presentation of experimental data. |
| **3 Hours** |

| **UNIT V** |
|---|
| **Mathematical Models and Data Analysis:** Trends in data; Linear/nonlinear models; Testing mathematical models; Least-squares analysis. |
| **3 Hours** |

| **TEXT BOOKS** | | |
|---|---|---|
| 1 | Pauline M. Doran | Bioprocess Engineering Principles, 2013, 978-0-12-220851-5, 2nd Edition. |

| REFERENCE BOOKS | | |
|---|---|---|
| 1 | Himmelblau, D.M. and Riggs, J.B. | Basic Principles and Calculations in Chemical Engineering, PHI Learning Pvt. Ltd., 2009, 978-81-203-3839-5, 7th Edition, |
| 2 | Narayanan, K.V., Lakshmikutty, B. | Stoichiometry and Process Calculations. PHI Learning Pvt Ltd., 2011. 978-81-203-2992-8, 1st Edition. |

| **Course Outcomes:**<br>Upon completion of this course the student will be able to: | |
|---|---|
| **CO1** | Classify bioprocess data and related errors and apply them to solve basic engineering calculations and problems. |
| **CO2** | Analyze bioprocess data and provide conclusions. |
| **CO3** | Apply modern tools including computational techniques (MS Excel) for bioprocess data analysis and to solve mathematical functions. |
| **CO4** | Communicate bioprocess data analysis using MS Office in oral and written forms. |
| **CO5** | Apply the basic concepts in developing the modeling and its analysis. |

**Course Articulation Matrix**

| | **POs** | | | | | | | | | | | | **PSOs** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **1** | **2** | **3** |
| **COs** | **CO1** | 3 | 2 | | | | | | | | | | 3 | | |
| | **CO2** | 3 | 2 | 2 | | | | | | | | | 3 | | |
| | **CO3** | 3 | 2 | 2 | | | | | | | | | 3 | | |
| | **CO4** | 3 | 2 | 2 | | | | | | 2 | | | 2 | | |
| | **CO5** | 3 | 2 | 2 | | | | | | | | | 3 | | |

**1: Low, 2: Medium, 3: High**