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| M.sc., INDUSTRIAL BIOTECHNOLOY |
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|  |
| **SYLLABUS** |
|  |
| **FROM THE ACADEMIC YEAR**  **2023 - 2024** |
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| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** |
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| --- | --- |
| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
| **Programme** | **M.Sc. INDUSTRIAL BIOTECHNOLOGY** |
| **Programme Code** |  |
| **Duration** | **2 years for PG** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.  **PO2: Decision Making Skill**  Foster analytical and critical thinking abilities for data-based decision-making.  **PO3: Ethical Value**  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.  **PO4: Communication Skill**  Ability to develop communication, managerial and interpersonal skills.  **PO5: Individual and Team Leadership Skill**  Capability to lead themselves and the team to achieve organizational goals.  **PO6: Employability Skill**  Inculcate contemporary business practices to enhance employability skills in the competitive environment.  **PO7: Entrepreneurial Skill**  Equip with skills and competencies to become an entrepreneur.  **PO8: Contribution to Society**  Succeed in career endeavors and contribute significantly to society.  **PO 9 Multicultural competence**  Possess knowledge of the values and beliefs of multiple cultures and  a global perspective.  **PO 10: Moral and ethical awareness/reasoning**  Ability to embrace moral/ethical values in conducting one’s life. |
| **Programme Specific Outcomes**  **(PSOs)** | **PSO1 – Placement**  To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.  **PSO 2 - Entrepreneur**  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.  **PSO3 – Research and Development**  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.  **PSO4 – Contribution to Business World**  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.  **PSO 5 – Contribution to the Society**  To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Template for P.G., Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester–I** | **Credit** | **Hours** | **Semester-II** | **Credit** | **Hours** | **Semester-III** | **Credit** | **Hours** | **Semester–IV** | **Credit** | **Hours** |
| 1.1. Core-I | 5 | 7 | 2.1. Core-IV | 5 | 6 | 3.1. Core-VII | 5 | 6 | 4.1. Core-XI | 5 | 6 |
| 1.2 Core-II | 5 | 7 | 2.2 Core-V | 5 | 6 | 3.2 Core-VII | 5 | 6 | 4.2 Core-XII | 5 | 6 |
| 1.3 Core – III | 4 | 6 | 2.3 Core – VI | 4 | 6 | 3.3 Core – IX | 5 | 6 | 4.3 Project with viva voce | 7 | 10 |
| 1.4 Discipline Centric  Elective -I | 3 | 5 | 2.4 Discipline Centric  Elective – III | 3 | 4 | 3.4 Core – X | 4 | 6 | 4.4Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | 3 | 4 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 4 | 3.5 Discipline Centric Elective - V | 3 | 3 | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
|  |  |  | 2.6 NME I | 2 | 4 | 3.6 NME II | 2 | 3 | 4.6 Extension Activity | 1 |  |
|  |  |  |  |  |  | 3.7 Internship/ Industrial Activity | 2 | - |  |  |  |
|  | **20** | **30** |  | **22** | **30** |  | **26** | **30** |  | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System**

**for all Post – Graduate Courses including Lab Hours**

**First Year – Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **30** |

**Second Year – Semester – III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – VII | 5 | 6 |
| Core – VIII | 5 | 6 |
| Core – IX | 5 | 6 |
| Core (Industry Module) – X | 4 | 6 |
| Elective – V | 3 | 3 |
| Skill Enhancement Course - II | 2 | 3 |
|  | Internship / Industrial Activity [Credits] | 2 | - |
|  |  | **26** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – XI | 5 | 6 |
| Core – XII | 5 | 6 |
| Project with VIVA VOCE | 7 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

**M.Sc.INDUSTRIAL BIOTECHNOLOGY**

# Thecourseof studyandschemeof examination

1. Nameofthecourse:**M.Sc., Industrial Biotechnology**

# ChoiceBasedCreditSystem(CBCS)

Choicebasedcreditsystemisaflexiblesystemoflearning.

„Credit‟definesthequantumofcontents/syllabiprescribedforacourseanddeterminethenumberofhoursofinstructionrequired.

The CBCS has unique features such as enhanced learning opportunities, ability to matchstudentsscholasticneedandaspirations,interinstitutiontransferabilityofstudents,partcompletion of an academic program in the institution of enrollment and part completion inspecializedandrecognizedinstitution,improvementineducationalqualityandexcellence,flexibilityforworkingstudentstocompleteProgrammeoveranextendedtimeandstandardizationandcomparabilityofeducationalprogramsacrossthecountry.

# Thepreambleofthesyllabus

Master of Science (M.Sc.) inBiotechnology, the curricula, andcoursecontentweredesigned to meet the standards of UGC-CSIR (NET) and(SLET) examinations. The choice-based credit system of learning develops a strong base in the core subject and specializes in thedisciplines of his / her liking and abilities and develops an in-depth understanding of variousaspects of Biotechnology. The students develop experimental skills, design, and implementationof novel synthetic methods, and develop the aptitude for academic and professional skills, byacquiringbasicconceptsforstructuralelucidationwithhyphenatedtechniques,andunderstanding the fundamental biological process and rationale of the computer. The projectintroduced in the curriculum will motivate the students to pursue research and entrepreneurialskilldevelopment**.**

**FIRST SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **COURSE COMPONENTS** | **NAME OF THE COURSE** | **CREDITS.** | **INST. HRS** | **MAX MARKS** | |
| **CIA** | **EXT.** |
| Core-I | Microbial biochemistry | 5 | 7 | 25 | 75 |
| Core-II | Industrial microbiology | 5 | 7 | 25 | 75 |
| Core – III | Genetic engineering  Practical  Environmental Biotechnology &  Bioprocess technology Laboratory | 4 |  | 25 | 75 |
| Discipline Centric  Elective -I | 1. Statistics 2. Bio informatics | 3 | 5 | 25 | 75 |
| Generic Elective-II: | Nano biotechnology | 3 | 5 | 25 | 75 |

**SECOND SEMESTER**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **COURSE COMPONENTS** | **NAME OF THE COURSE** | **CREDITS** | **INST. HRS** | **MAX MARKS** | |
| **CIA** | **EXT.** |
| Core-IV | Fermentation Technology | 5 | 6 | 25 | 75 |
| Core-V | Downstream Process | 5 | 6 | 25 | 75 |
| Core –VI: | Enzyme engineering  \_Practical -II Tissue culture Agro Industrial and Immuno techniques&  Food Toxicology and waste Management.: | 4 | 6 | 25 | 75 |
| Elective- III | Bio entreprenerurship  Biopharmaceutical Technology | 3 | 4 | 25 | 75 |
| Elective – IV | Immuno technology | 3 | 4 | 25 | 75 |
| NME | Bio physics | 2 | 4 | 25 | 75 |
|  |  | **22** | **30** |  |  |

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**THIRD SEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **COURSE COMPONENTS** | **NAME OF COURSE** | **CREDITS** | **INST. HRS** | **EXAM HRS.** | **MAX MARKS** | |
| **CIA** | **EXT.** |
| Core-VII | Animal and plant biotechnology | 5 | 6 | 3 | 25 | 75 |
| Core-VII | Environmental biotechnology | 5 | 6 | 3 | 25 | 75 |
| Core – IX | Bio manufacturing principle and practise | 5 | 6 | 3 | 25 | 75 |
| Core – X | Molecular basis of disease I  Practical – III :  Environmental Monitoring and quantitative analysis & Environmental Monitoring using remote sensing. | 4 | 6 | 3 | 25 | 75 |
| Elective - V  Discipline Centric | 1. Microbiology   B. Good manufacturing Practise and quality assurance.\ | 3 | 3 | 3 | 25 | 75 |
| NME II | C. Applied and Industrial Microbiology | 2 | 3 | 3 | 25 | 75 |
| Internship | Industrial Activity | 2 | - | - | - | - |
|  |  | **26** | **30** |  |  |  |

**Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.**

**FOURTH SEMESTER**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **COURSE COMPONENTS** | **NAME OF COURSE** | **CREDITS** | **INST. HRS** | **EXAM HRS.** | **MAX MARKS** | |
| **CIA** | **EXT.** |
| Core-XI | Chemical reaction engineering | 5 | 6 | 3 | 25 | 75 |
| Core-XII | Biofuel | 5 | 6 | 4 | 25 | 75 |
| Project | Project with viva voce | 7 | 10 | 4 | 25 | 75 |
| 4.4Elective - VI | Bio polymer technology | 3 | 4 | 3 | 25 | 75 |
| Skill Enhancement course / Professional Competency Skill | Medicinal Biotechnology | 2 | 4 | - | - | - |
| Extension Activity |  | 1 |  |  |  |  |
|  |  | **23** | **30** |  |  |  |

**SEMESTER I**

**PAPER1:Microbial Biochemistry.**

Papercode:Subject:**Microbial Biochemistry.**

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of microbial diversity , introduction to bio molecules, microbial nutrition , cell membrane, bio energetic principles, major catabolic pathway.

**CourseObjectives**

1. Tolearnthebasic concept of Structural /physiological/biochemical difference between

basic microbial cell

1. Tolearn the concepts of bio molecules .
2. TodevelopknowledgeonMicrobial nutrition , types of culture medium
3. Tounderstand the basic of cell membrane, bio energetic principles.
4. Todevelopapieceofknowledgeinmajor catabolic pathways.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoidentifytheconcept in

basic microbial cell ,estimation of microbial biodiversity, diversity in some ecosystems.

1. Aftercompleting unit2,thestudentswillbeabletoknow about the methods in structure of proteins , nucleoside , nucleotide , nucleic acids
2. Aftercompletingunit3,thestudentswillbe know about the Microbial nutrition , different types of culture medium
3. AfterCompleting unit4,thestudentswillbe know about the cell membrane, types of transport

within the cell

1. Aftercompleting unit5,thestudentswillbe know about the cellular metabolism,role in microbial fermentation, the catabolic pathways.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Structural /physiological/biochemical difference between basic microbial cell type, biochemical / microscopic / molecular methods used to differentiate between archae, eubacteria and eukaryotes, estimation of microbial biodiversity, diversity in some ecosystems. | **18hours** |
| **Unit-II** | Sugar- mono , di and polysaccharides with specific reference to glycogen , amylose and cellulose , glycosylation of other biomolecules - glyco proteins and glyco lipids; amino acis - structures and functional group properties , peptides and covalent structure of proteins , nucleoside , nucleotide , nucleic acids- structure a historical perspective leading up to proposition of DNA double helical structure . | **18hours** |
| **Unit-III** | Microbial nutrition , different types of culture medium , C/N/P balance and making of culture medium | **18hours** |
| **Unit-IV** | Outer membrane of Gram -ve bacteria and control of its synthesis (potential targets for drug design ). different types of transport within the cell |  |
| **Unit-V** | Cellular Metabolism  Oxidation - reduction reaction , electron carrier and cellular metabolism , High energy compounds and their role in microbial fermentation , enzymes as a catalysts  Catabolic Pathways  Glycolysis , pentose phosphte pathway , citric acid cycle, oxidattve phosphorylation ; cellular metabolities and interconnectivity in biochemical pathway , respiration and electron pathway | **18hours** |
|  | Total Teaching Hours | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

* 1. M.T. Madigan and J.M. Martinko (2006), Brock biology of microorganism , 11 th

Ed, Pearson Prentice Hall.

2. Voet, D., &Voet , J. G. (2018) . Biochemistry(5th ed. Hoboken,NJ: J. Wiley & sons.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 |

**3–Strong,2–Medium,1– Low**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 2 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 |
| **Weightage** | 15 | 14 | 10 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 3 | 3 |

**3 –Strong,2–Medium,1– Low**

**SEMESTER I**

**PAPER2:Industrial microbiology**

Papercode:Subject:**Industrial microbiology**

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of characteristics of microbes , Isolation of microbes from nature and screening of biological activities, culture preservation and inoculum development, small scale liquid fermentation, small scale solid state fermentation, experimental design for improvement of fermentation.

**CourseObjectives**

1.Tolearnthebasic concept of Introduction to microbiology and microbes, cryopreservation

2.Tolearn the concepts of fermentation.

3.Todevelopknowledgeonsmall scale process control.

4.Tounderstand the basic of Experimental designs of fermentation.

5. TodevelopapieceofknowledgeinCulture preservation

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow the characteristics,

structure and growth of microbes .

1. Aftercompleting unit2,thestudentswillbeabletoknow about isolation and screening of microbes.
2. Aftercompletingunit3,thestudentswillknow about the culture preservation and inoculum development.
3. Aftercompletingunit4,thestudentswillknow about the fermentation.
4. Aftercompleting unit5,thestudentswillknow about the solid state fermentation,

production of enzymes , small scale process control.

1. Aftercompleting unit6,thestudentswillknow about the experimental design of fermentation.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Introduction to microbiology and microbes, morphology , structure and growth bacterial and other microbial growth curves | **18 hours** |
| **Unit-II** | Actinomycetes, bacteria, fungi, developing and semi automating , screening tests | **18hours** |
| **Unit-III** | Culture preservation , cryopreservation , inoculum development | **18 hours** |
| **Unit-IV** | Introduction and scope, fermentation vessels , shaker , media / composition and gas Exchange, sampling and analysis |  |
| **Unit-V** | Advantages / disadvantages of solid state fermentation, growth and production of enzymes, small scale process control. | **18hours** |
|  |  | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. M.T. Madigan and J.M.Martinko (2006), brock biology of microorganisms, 11 th Ed ,

pearson prentice - hall.

2. M. Wuilley , L. Sherwoolverton , L.M. Prescott , (2011) prescotts microbiology

Mc Graw Hill, New York.

A.L. Demain and J. DAvaines (2004), Manual of industrial microbiology and biotechnology ,

2 ndED. ASM press

**Web Sources**

https://nptel.ac.in/courses/102103015

https://onlinecourses.swayam2.ac.in/cec22\_bt18/preview

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**PAPER3:Genetic Engineering**

# Papercode:Subject:Genetic Engineering

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of genetic engineering in modern society, types of vector, types of PCR techniques, cDNA analysis and gene silencing.

**CourseObjectives**

1.Tolearnthebasic concept of Impact of genetic engineering in modern society,

hybridization techniques

2. Tolearn the concepts of vectors ,protein purification,plant based vectors..

3. TodevelopknowledgeonPrinciple of PCR,DNA sequencing ; RNA sequencing

4. Tounderstand the basic of transformation , electroporation , transfection ,

construction of libraries

5.TodevelopapieceofknowledgeinGene silencing techniques

# CourseOutComes

1. .Aftercompletingunit1,thestudentswillbeabletoknow the general requirements

for genetic engineering experiments , DNA ligase,radioactiveprobes,hybridization techniques

1. Aftercompleting unit2,thestudentswillbeabletoknow about .Plasmids,

bacteriophages,p Mal ; GST ; pET - based vector, protein purification ,Ti and Ri as vectors , yeast vectors, shuttle vectors

1. Aftercompletingunit3,thestudentswillbe know about the PCR cloning of PCR products,chemical sequencing of DNA.
2. AfterCompleting unit4,thestudentswillbe know about the isolation of mRNA,

c DNA and genome libraries, protein - protein interaction .

1. Aftercompleting unit5,thestudentswillbe know about the si RNA technology ;

Micro RNA,method of genetic manipulation in different model system,

.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Impact of genetic engineering in modern society ; general requirements for performing a genetic engineering experiments ; restriction endonuclease and methylase ; DNA ligase , Klenow enzyme , T 4 DNA polymerase , poly nucleotide kinase , alkaline phosphatase ; cohesive and blunt end lingation , linkers , adaptors ; homo-polymer tailing ; labeling of DNA ; nick translation , random priming , radioactive and no - radioactive probes ,hybridization techniques ; northern , southern , south - western and far - western and colony hybridization , fluorescence in situ hybridization. | **18 hours** |
| **Unit-II** | Plasmids, bacteriophages, M13mp vectors ; PUC 19 and p Blue-script vectors , phagemids ; Lambda vector; Insertion and Replacement vectors ; cosmids; Artificial chromosomes vectors (YACs; BACs); principle for maximizing gene expression vectors , p Mal ; GST ; pET - based vector, protein purification , His- tag , GST - tag ; MBP - tag etc. Intein based vectors ; inclusion bodies , methodologies to reduce formation of inclusion bodies ; mammalian expression and replicating vectors , Baulovirus and pichia vectors system , plant based vectors , Ti and Ri as vectors , yeast vectors, shuttle vectors | **18 hours** |
| **Unit-III** | Principle of PCR : primer design , fidelity of thermostable enzyme , DNA polymerases ; types of PCR - multiplex , nested , reverse transcription PCR , real time PCR , touchdown PCR Hot star PCR , colony PCR , asymmetric PCR , cloning of PCR products ; TA cloning vectors ; proof reading enzymes , PCR based site specific mutagenesis; PCR in molecular diagnostics ; viral and bacterial detection, sequencing methods, enzymatic DNA sequencing ; chemical sequencing of DNA ; automated DNA sequencing ; RNA sequencing , chemical synthesis of oligonucleotides, mutation detection : SSCP, DGGE , RFLP | **18 hours** |
| **Unit-IV** | Insertion of foreign DNA into host cells, transformation , electroporation , transfection , construction of libraries , isolation of mRNA and total RNA ; reverse transcriptase and c DNA synthesis , c DNA and genome libraries ; construction of micro-arrays - genomic array c DNA array and oligo arrays ; study of protein - DNA interaction ; electrophoretic mobility shift assay ; DNA ase foot printing ; methyl interference assay , chromatin immunoprecipitation ; protein - protein interaction using yeast two - hybrid system ; phage display. | **18 hours** |
| **Unit-V** | Gene silencing techniques ; introduction to si RNA technology ; Micro RNA ; construction of siRNA vectors, principle and application of gene silencing ; gene knockout and gene therapy , creation of transgenic plant ; debate over GM crops ; introduction to method of genetic manipulation in different model system e.g. fruit flies (Drosophila ), worms (C. elegans ), frogs (Xenopus ), fish ( Zebra fish ) and chick.  Transgenics - gene replacement ; gene targeting ; creation of transgenic and knock out mice , disease model ; introduction to genome editing by CRISPR - CAS with specific emphasis on Chinese and American clinical traits ; cloning genome targets into CRISPR /Cas9 plasmid, electroporation of Cas9 plasmid into cells ; purification of DNA from Cas9 treated cells and evaluation of Cas9 gene editing in-vitro synthesis of single guide RNA (sgRNA), using Cas9/sgRNA complexes to test for activity on DNA substrate ; evaluate Cas 9 activities by T 7E1 assay and DNA sequence analysis ; Application of CRISPR /cas9 technology. Application gene therapy/gene editing - antiviral strategies , cancer immunotherapy , hematologic disorder ; liver - targeted gene editing, neuromusclar disorder , ocular disorder etc ., examples of Chinese and American clinical trials . | **18 hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Old , R.W. , Primrose, S.B., &Twyman, R.M. (2001).Principles of gene Manipulation

and Genomics, 7th Edition: Oxford : Blackwell Scientific Publications.

1. FGreen , M.R., & Sambrook, J. (2018). Molecular cloning : a Laboratory Manual. Cold spring Harbor, NY : Cold spring Harbor Laboratory Press.
2. Brown , T.A. (2006). Genomes (3rd ed.). New york ; Garland Science Pub .
3. Selected papers from Scientific Journals, particularly Nature & science .
4. Technical Literature from Stratagene, Promega , Novagen, New England Biolabs

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 2 | 3 | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 2 | 3 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 3 | 3 | 3 | 3 |
| **Weightage** | 10 | 15 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 2 | 3 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**CORE ELECTIVE PAPER1 :Statistics**

Papercode:Subject: **Statistics**

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts of biological data base, standard deviation, probability, statistical hypothesis , statistical significance , and experimental designs.

**CourseObjectives**

1. Tolearnthebasic concept of types of biological database, frequency distribution, bar graphs.
2. Tolearn the concepts of Arthematic Mean, median, mode , range , Coefficient of Variation.
3. TodevelopknowledgeonPrinciple of probability and distribution.
4. Tounderstand the basic of hypothesis testing.
5. Todevelopapieceofknowledgein parametric and non parameteric test, sampling.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about the graphical

representation, biological data,frequency distribution.

1. Aftercompleting unit2,thestudentswillbeabletoknow aboutproperties

of Arthmetic Mean , medium , mode , range , Properties of Variance and Standard Deviation ,

Coefficient of Variation ,

1. Aftercompletingunit3,thestudentswillbe know about the laws of probability,

properties of binomial distribution,Poisson distribution and normal distribution .

1. AfterCompleting unit4,thestudentswillbe know about the calculation of covariance

and correlation,correlation coefficient from un grouped data person’s Rank Correlation

Coefficient , general concepts of regression.

1. Aftercompleting unit5,thestudentswillbe know about the Null and

alternative hypothesis , error hypothesis testing , confidence interval, the significance and

interpretation of results, sampling, distribution of mean and standard error, large sample tests ,

Parametric and Non parametric test.

.

**Matching Table (Put Yes/Nointheappropriatebox)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Types of biological data (ordinal scale , nominal scale, continuous and discrete data), frequency distribution and graphical representation (bar graph, histogram , box plot and frequency polygon ), cumulative frequency distribution , populations, samples, simple random , stratified and systematic sampling | **18 hours** |
| **Unit-II** | Measures of location, properties of Arthmetic Mean, medium , mode, range , Properties of Variance and Standard Deviation , Coefficient of Variation , Grouped Data, Graphic Methods , Obtaining Descriptive Statistics on Computer , case study. | **18 hours** |
| **Unit-III** | Introduction to probability and laws of probability , random events , events - exhaustive , mutually exclusive and equally likely (with simple exercise ), definition and properties of binomial distribution , Poisson distribution and normal distribution . | **18 hours** |
| **Unit-IV** | Correlation , covariance, calculation of covariance and correlation , correlation coefficient from un grouped data person’s Rank Correlation Coefficient , scatter and dot diagram , general concepts of regression, Fitting Regression lines , regression coefficient, properties of Regression coefficients , standard error of estimates. | **18 hours** |
| **Unit-V** | Making assumption, Null and alternative hypothesis , error hypothesis testing , confidence interval , one - tailed and two -tailed testing decision making. Steps in testing statistical significance , selection and computation of test of significance and interpretation of results, sampling, distribution of mean and standard error, large sample tests (test for an assumed mean and equality of two population means with known S.D.), z- test; small sample test (t-Test for an assumed mean and equality of means of two population when sample observation are independent ); Parametric and Non parametric test (Mann - Whitney test ); paired and unpaired t- test ;chi square test. | **18 hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Jaype Brothers, (2011), Methods in bio-statistics for medical students and Research workers (English ) ,

7th Edition

2. Norman T.J. Bailey , (1995), statistical Methods in biology , 3rd Edition , Cambridge University press.

3. P.N. Arora and P.K. Malhan , (2006), Bio-statics , 2nd Edition , Himalaya publishing House

4. Jerold Zar , Bio statistical Analysis , 4th Edition , Pearson Education .

5. Bio-statistics : A Foundation for analysis in the Health Science , 7th Edition , Wiley.

**Web Sources**

https://archive.nptel.ac.in/courses/102/106/102106051/

https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-bt01/

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low – 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 |
| **Weightage** | 15 | 15 | 15 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 3 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**CORE ELECTIVE 2:Bioinformatics**

# Papercode:Subject:Bioinformatics

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts of primary and secondary database, visualizing structural information, sequence alignment, phylogenetic analysis, structural biology,classification of 3D structure, and drug design.

**CourseObjectives**

1. Tolearnthebasic concept of primary&secondary database,Sequence file formats.
2. Tolearn the concepts of sequence alignment, Multiple Sequence Alignments.
3. Todevelopknowledgeon tree building and tree evaluation, DNA bar coding
4. Tounderstand the Basic concepts in molecular modeling different types of

computer representation of molecules

1. Todevelopapieceofknowledge3 D structure prediction (sequence similarity/ identity of

proteins of known structure .

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about Proteins Data Bank (PDb),

Molecular Modelling Database (MMDb ), structure file formats, Database of structure viewers.

1. Aftercompleting unit2,thestudentswillbeabletoknow about Evolutionary

basis of sequence alignment,Multiple Sequence Alignments,Motifs and patterns

1. Aftercompletingunit3,thestudentswillbe know aboutAlignments,Comparison and

application of Unweighted Pair Group Method with Arithmetic Mean,DNA bar coding,

Applications and limitations of bar coding.

1. AfterCompleting unit4,thestudentswillbe know about the Basic concepts in

molecular modeling different types of computer representation of molecules,

Ramachandran map,anatomy of proteins.

1. Aftercompleting unit5,thestudentswillbe know about the DNA & RNA secondary and
2. tertiary structure, Chemical database,

Structure based drug design, Structure Activity Relationship.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Introduction , primary &secondary database , Sequence file formats, Introduction to structure , Proteins Data Bank (PDb), Molecular Modelling Database (MMDb ), structure file formats, Visualizing structural information , Database of structure viewers , collection of sequence , sequence annotation , sequence description . | **15hours** |
| **Unit-II** | Evolutionary basis of sequence alignment , Optimal alignment methods, Substitution scores & gap penalties , statistical significant of alignments , Database similarly searching ., FASTA, BLAST, Low complexity regions , Repetitive elements , Multiple Sequence Alignments : Progressive alignments methods, Motifs and patterns , Clustral, Muscle, Scoring matrices , Distance matrices . | **18 hours** |
| **Unit-III** | Alignments , tree building and tree evaluation , Comparison and application of Unweighted Pair Group Method with Arithmetic Mean (UPGAMA), Neighbouring Joining (NJ), Maximum Parsimony (MP) , Maximum Like hood (ML ) methods , Bootstrapping , Jacknife , software for Phylogenetic analysis . DNA bar coding : Methods tools and database for bar coding across all species , Applications and limitations of bar coding , Consortium for Bar coding of Life (CBOL ) recommendation , Bar coding of Life Database (BOLD) | **18 hours** |
| **Unit-IV** | 1. D structure visualization and simulation , Basic concepts in molecular modeling different types of computer representation of molecules ; External coordinated and Internal Coordinates, Molecular Mechanisms, Force field etc. Secondary structure elucidation using Peptide bond, phi, psi and chi torsion angles, Ramachandran map, anatomy of proteins - Hierarchical organization of protein structure - like CATH (Class, architecture , topology , homology ), SXOP (structural classification of proteins ), FSSP (families of structurally similar proteins ) | **18 hours** |
| **Unit-V** | DNA & RNA secondary and tertiary structure , t- RNA tertiary structure ; protein secondary structure prediction : Algorithms viz Chou Fasman , GOR method Tertiary structure prediction : Fundamentals of the ,methods for 3 D structure prediction (sequence similarity/ identity of proteins of known structure , fundamentals of the method for 3D structure prediction (sequence similarity / identity of target proteins of known structure , fundamental principle of protein folding etc ) Homology/ comparative modeling , fold recognition , threading approaches and lab initio structure prediction methods; CASP (Critical Assesment of protein Structure Prediction ); Computational design of promoters , proteins enzymes. Chemical database like NCI/PUBCHEM ; Fundamentals of Receptors - ligands interactions; Structure based drug design : Identification and Analysis of Binding sites and viral screening ; ligand based drug design : Structure Activity Relationship - QSARs & Pharmacophore ; In silco prediction of drug activity and ADMET . | **21hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. A.D.Baxevanis and B.F.F .Outlette (Eds ). (2002), Bio-informatics : a Practical Guide to the

Analysis of Gene and Proteins , John Wiley and Sons .

1. D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring

Harbour Laboratory Press.

1. Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.
2. DovStekel , (2003); Microarray Bio-informatics ; Cambridge University Press.
3. Web - resource and suggested reviews/ research papers

**Web Sources**

**https://archive.nptel.ac.in/courses/102/106/102106090/**

**https://www.slideshare.net/nmicaelo/structure-based-drug-design?from\_search=0**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 |
| **Weightage** | 15 | 15 | 15 | 15 | 10 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 3 | 3 | 2 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**CORE ELECTIVE3:Nano Biotechnology**

# Papercode:Subject: Nano Biotechnology

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts ofNano architecture,Methods using solid precursors,Nano-structured materials,drug Delivery, Nanotechnology for Cancer Diagnostics and Treatment.

**CourseObjectives**

1.Tolearnthebasic concept of Strategies for Nano architecture,Sol. Gel methods.

2.Tolearn the concepts of Nanofluidics,Carbon Nanotubes.

3.Todevelopknowledgeondrug Delivery, Protein targeting.

4.Tounderstand the Basic concepts in Small Molecule-Protein Interactions.

5.TodevelopapieceofknowledgeMicro-array and Genome Chips, Tumor-targeted Drug Delivery Systems.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about Nano architecture,Sol. Gel methods
2. .Aftercompleting unit2,thestudentswillbeabletoknow about Nanofluidics,Carbon Nanotubes.
3. .Aftercompletingunit3,thestudentswillbe know aboutdrug Delivery, Protein targeting.
4. AfterCompleting unit4,thestudentswillbe know about Basic concepts in Small

Molecule-Protein Interactions

1. Aftercompleting unit5,thestudentswillbe know about Micro-array and Genome Chips,

Tumor-targeted Drug Delivery Systems, chemical database

.Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Introduction to nanotechnology: characteristic scale for quantum phenomena,nanoparticles,nano-clusters,nanocomposite,nanotubes,nanowiresemergenceofbionanotechnology.Characterizationofnanoparticles-UV-Vis  spectroscopy,electronMicroscopy-HRTEM,SEM,AFM,EDS,XRD. | **18 hours** |
| **Unit-II** | Microbialnanotechnology–Microbialsynthesisofnanodrugs-metalnanoparticlesanddrugdeliveryvehicles-Nanoshels–TectodentrimersNanoparticledrugsystems–diagnosticapplicationsofnanotechnology. | **18 hours** |
| **Unit-III** | Preparationofnanomaterialsbyphysical,chemicalandGreenmethods:Polymericscaffoldscollagen,elastin’s:Mucopolysaccharides,Proteoglycans,cellulose and derivate; dextran’s ; alginates; Pectin’s; Chitin. Nanoparticles –types, functions-Silver, Gold and Titanium. Physical and chemical properties ofnanoparticles. | **18 hours** |
| **Unit-IV** | Preparationofnanomaterialsbyphysical,chemicalandGreenmethods:Polymericscaffoldscollagen,elastin’s:Mucopolysaccharides,Proteoglycans,cellulose and derivate; dextran’s ; alginates; Pectin’s; Chitin. Nanoparticles –types, functions-Silver, Gold and Titanium. Physical and chemical properties ofnanoparticles. | **18 hours** |
| **Unit-V** | Nanoscaleapplicationsinbiologyandmedicine:nanotechnologyforbiologyand medicine –microandnano-fluides- scanning probe microscopy inbiologyand medicine- self –assembly of biological molecules .drug delivery – proteinmediatedandnanoparticlemediated.Hybridconjugatesofgoldnanoparticles–  DNAoligomers-useofDNAmoleculesinnanomechanicsandcomputing | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. A.D.Baxevanis and B.F.F .Outlette (Eds ). (2002), Bio-informatics : a Practical Guide to the

Analysis of Gene and Proteins , John Wiley and Sons .

2. D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring

Harbour Laboratory Press.

3. Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.

4. DovStekel , (2003); Microarray Bio-informatics ; Cambridge University Press.

**Web Sources**

https://archive.nptel.ac.in/courses/102/107/102107058/#

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# PracticalI( 4 CREDIT)

# Environmental Biotechnology

1. Sub cellular fractionation.

1. Titration of amino acids and determination of pKa.
2. Model building using space filling / ball and stick models.
3. Identification of amino acids, sugars and lipids by TLC and/ or color reactions.
4. Isolation and quantification of Nucleic acids.
5. Quantization of proteins, sugars and cholesterol by different methods.
6. Determination of iodine, saponification and acid no. of lipid/ oil samples.
7. Separation of proteins by gel filtration and ion exchange chromatography.
8. Microscopy: Bright field, phase contrast and fluorescence microscopy.
9. Microtomy and Histochemical techniques.
10. Peptide mapping.

18. Separation techniques (HPLC , GLC ,FPLC)

**Bio process technology**

1. Bacterial transformation
2. Study of mutation by Ames test.
3. Isolation of plasmids .
4. Isolation of genomic DNA and Southern blotting.
5. Isolation of RNA & Northern blotting.
6. Isolation of poly A RNA.
7. Preparation of probes.
8. Demonstration of transcription and translation.
9. Chemical modification of protein.

10. Enzyme: purification and kinetic analysis.

**SEMESTER I**

**VALUE ADDED COURSE**

**PAPER1: CANCER BIOLOGY**

# Papercode:Subject:Cancer Biology

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts ofcellcycle,Cancer screening,Chemical carcinogenesis,Signal targets and cancer.

**CourseObjectives**

1. Tolearnthebasic concept of ,detection using biochemical assays, tumor markers, molecular tools

for early diagnosis of cancer.

2.Tolearn the concepts of Chemical carcinogenesis

3.Todevelopknowledgeonidentification of oncogenes

4.Tounderstand the Basic concepts in heterogeneity of metastatic phenotype

5.TodevelopapieceofknowledgeGene therapy.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about regulation of cell cycle,

mutationsdifferent forms of cancers

1. .Aftercompleting unit2,thestudentswillbeabletoknow about Theory of

carcinogenesis, Chemical , metabolism , principles of physical carcinogenesis.

1. .Aftercompletingunit3,thestudentswillbe know aboutOncogenes, identification ,

detection of oncogenes. Oncogenes activity. Growth factors related to transformation. Telomerases

1. . AfterCompleting unit4,thestudentswillbe know about Basic concepts Clinical significance of

invasion, heterogeneity of metastatic phenotype, metastatic cascade.

1. Aftercompleting unit5,thestudentswillbe know about chemotherapy, radiation therapy,

detection of cancers, the InternalAssessment:Assignments,SeminarsandGuestlecturers

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **FUNDAMENTALS OF CANCER BIOLOGY**: Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. | **18hours** |
| **Unit-II** | **PRINCIPLES OF CARCINOGENESIS**: Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis. | **18 hours** |
| **Unit-III** | **PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER**: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases. | **18 hours** |
| **Unit-IV** | **PRINCIPLES OF CANCER METASTASIS**: Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion | **18 hours** |
| **Unit-V** | **NEW MOLECULES FOR CANCER THERAPY**: Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy. | **18 hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. DeVita VT Jr, Lawrence TS, Rosenberg SA. 2015. Cancer: Principles & Practice of Oncology: Primer of the Molecular Biology of Cancer. Ed.
2. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
3. McDonald, F etal., “ Molecular Biology of Cancer” IInd Edition. Taylor & Francis, 2004.

**Web Sources**

**https://nptel.ac.in/courses/102106025**

**https://www.slideshare.net/guest2f1d32/biologia-del-cance**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**VALUE ADDED COURSE**

**PAPER2: INDUSTRIAL HAZARD MANAGEMENT**

Papercode:Subject:**INDUSTRIAL HAZARD MANAGEMENT**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts of Industrial Hazard Management .

**CourseObjectives**

1.Tolearnthebasic concept of identify and causes of various Hazards

2.Tolearn the concepts of Enable the students to compare the hazards of chemicals with the permissible levels.

3.Todevelopknowledgeon Acquire knowledge about types of hazards arising out of physical, chemical and biological agents.

4.Tounderstand the Basic concepts in Demonstrate various techniques involved in Hazard waste Management.

5.TodevelopapieceofknowledgeRecognize the issues related to environment and safety.

# CourseOutcomes

1. Aftercompletingunit1,thestudentswillbeabletoknow about Physical hazard.

2..Aftercompleting unit2,thestudentswillbeabletoknow about Chemical hazard.

3.Aftercompletingunit3,thestudentswillbe know aboutBiological and Ergonomical hazards.

4. AfterCompleting unit4,thestudentswillbe know about Basic concepts in Hazardous Waste Management.

5. Aftercompleting unit5,thestudentswillbe know about Safety Management.

.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs-vibration, types, effects, instruments, surveying procedure, permissible exposure limit. | **18hours** |
| **Unit-II** | Recognition of chemical hazards-dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs. dose, TLV-Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapor monitors, dust sample collection devices, personal sampling | **18 hours** |
| **Unit-III** | Classification of Biohazardous agents–examples, bacterial agents, rickettsial and chlamydial agents,viral agents, fungal, parasitic agents, infectious diseases-Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets.Work Related Musculoskeltal Disorders–carpal tunnel syndrome CTS-Tendon paindisorders of the neck-back injuries | **18 hours** |
| **Unit-IV** | Waste generation, control and sustainable reuse of Biodegradable waste after segregation, Transportation of waste and identified areas with blocks marked out for separate categories. Identifying target application of processed waste and costs involved - Documentation procedures and understanding standard permissible waste limits as per statutory regulations. Storage and identification of processed waste. Evaluation of time and scope of reuse. Tabulation and documentation. Laboratory tests for potability of such reprocessed material. Health hazards-toxic and radioactive wastes-incineration and vitrification-hazards due to bio-process-dilution-standards and restrictions–recycling and reuse. | **18 hours** |
| **Unit-V** | Organising for safety, Health and Enviornment, Organisation : Structure, Function and responsibilities, Safety Committee : Structure and function,The competent person in relation to safety legislation - duties and responsibilities, Competence Building Technique (CBT), Concept for training, Employee participation in safety - Colour coding and its awareness, Types of fire and its control, SOPs for machinery and process, Packing and storage, Emergency preparedness procedures, Training towards risk elimination, Role of Trade union in safety, health and environment. Safety promotion and safety awards, safety, competitions, audio visual publication. | **18 hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**

1. S.P.Mahajan, “Pollution control in process industries”, 1 stEdition, Tata McGraw Hill Publishing Company, New Delhi, 1993.
2. Krishnan N.V. “Safety Management in Industry”, 1 stEdition, Jaico Publishing House, Bombay, 1997.

**REFERENCE BOOKS**

1. B.D. Singh, “Biotechnology”, Kalyani Publishers, 1st Edition,2003.

**WEB SOURCES**

slideshare id=249824553&doc=biohazard-210721180535

**https://www.slideshare.net/rajeevkashyap/waste-management-1832384**

**https://csumb.edu/risk/health-and-safety/chemical-and-laboratory-safety/biohazard-control-program-including-biohazardous-waste/**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 |
| **Weightage** | 15 | 15 | 15 | 15 | 10 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 3 | 3 | 2 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER I**

**VALUE ADDED COURSE**

**PAPER3: METABOLIC ENGINEERING**

Papercode:Subject:**METABOLIC ENGINEERING**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts ofTo provide a quantitative basis, based on thermodynamics, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level.  To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner.

**CourseObjectives**

1.Tolearnthebasic concept of quantitative basis

2.Tolearn the concepts of metabolic networks in single cells and at the organ level

3.Todevelopknowledgeon organisms to produce valuable substances on an industrial scale

4.Tounderstand the Basic concepts in thermodynamics,

5.Todevelopapieceofknowledge in enzyme kinetics,

# CourseOutComes

1..Aftercompletingunit1,thestudentswillbeabletoknow about To learn stoichiometry and

energetics of metabolism

2..Aftercompleting unit2,thestudentswillbeabletoknow about To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields

3. .Aftercompletingunit3,thestudentswillbe know aboutTo integrate modern biology with engineering principles

4. AfterCompleting unit4,thestudentswillbe know about Basic concepts in to design a system,

component, or process to meet desired needs.

5. Aftercompleting unit5,thestudentswillbe know about metabolic network

.

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **INTRODUCTION TO EXAMPLES OF PATHWAY MANIPULATION - QUALITATIVE TREATMENT**  Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties, Xenobiotic degradation. | **18hours** |
| **Unit-II** | **MATERIAL BALANCES AND DATA CONSISTENCY**  Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors. Introduction to MATLAB® | **18 hours** |
| **Unit-III** | **METABOLIC FLUX ANALYSIS**  Theory, over determined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis. | **18 hours** |
| **Unit-IV** | **METABOLIC CONTROL ANALYSIS**  Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations | **18 hours** |
| **Unit-V** | **ANALYSIS OF METABOLIC NETWORKS**  Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation. | **18 hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. A.D.Baxevanis and B.F.F .Outlette (Eds ). (2002), Bio-informatics : a Practical Guide to the

Analysis of Gene and Proteins , John Wiley and Sons .

2. D.W. Mount (2001), Bio-informatics : Sequence and Genome Analysis , Cold Spring

Harbour Laboratory Press.

3. Jones &Peuzer , (2004) ; Introduction to Bio-informtics Algorithms , Anc Books, India.

4. DovStekel , (2003); Microarray Bio-informatics ; Cambridge University Press.

**Web Sources:**

https://www.slideshare.net/guillermogaribay1447/stoichiometry-of-cellular-reactions

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER1:Fermentation technology.**

# Papercode:Subject:Fermentation technology.

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of basic reaction theory, general reaction kinetics for biological system.Types of sterilization, types of fermentation, bioreactor configuration,bioprocess scale up.

**CourseObjectives**

1.Tolearnthebasic concept of reaction Basic homologous reaction theory,general reaction

kinetic for biological system.

2.Tolearn the concepts of Types of sterilization,Various types of fermentation, Overview of

bio synthetic mechanism ; Metabolic stoichiometry.

3.Todevelopknowledgeon bioreactor configurations practical consideration

for bioreactor construction

4.Tounderstand the Heat and mass transfer issues in bioreactors,Various approaches to scale

up including regime analysis and scale down.

1. TodevelopapieceofknowledgeBulk organs,Biomass,Organic acids.

# CourseOutComes

1. .Aftercompletingunit1,thestudentswillbeabletoknow about Basic reaction theory,

calculation of reaction rates,cell growth kinetics , production kinetics , kinetics of cell death,

Concept of maintenance and calculation of maintenance coefficient.

2..Aftercompleting unit2,thestudentswillbeabletoknow about Types of sterilization,

Various types of fermentation.Overview of bio synthetic mechanism

3...Aftercompletingunit3,thestudentswillbe know about monitoring and

control of bioreactors,ideal reactor operations, batch operation of a mixed reactor .

4...AfterCompleting unit4,thestudentswillbe know about the Heat and mass transfer

issues in bioreactors,Scale up method by currently used rule,

Various approaches to scale up including regime analysis and scale down.

5. Aftercompleting unit5,thestudentswillbe know about the Commercial Product Processing..

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Homologous reaction Basic reaction theory, calculation of reaction rates , general reaction kinetics for biological system , yields in cell culture , cell growth kinetics , production kinetics , kinetics of cell death ; Continuous stirred tank reactor as a tool for calculating kinetics parameters for growth and production formation ; Concept of maintenance and calculation of maintenance coefficient. | **18 Hours** |
| **Unit-II** | Types of sterilization , thermal death kinetics of microorganisms; Heat sterilization of liquid medium in batch and continuous mode ; Air sterilization ; Inoculum development ; Various types of fermentation , submerged and solid state fermentation , aerobic and anaerobic fermentation ; Overview of bio synthetic mechanism ; Metabolic stoichiometry. | **18 Hours** |
| **Unit-III** | Bioreactor configurations practical consideration for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor | **18 Hours** |
| **Unit-IV** | Heat and mass transfer issues in bioreactors, Estimation of KLa , Scale up with constant parameter like oxygen transfer rate , mixing, shear stress,f low regime, Reactor volume , etc. Scale up method by currently used rules -of - thumb viz. Constant P/V, kLa, Various approaches to scale up including regime analysis and scale down ; Analysis of alternate bioreactor configuration including cell -cycle , air lift and immobilized - cell bioreactors, Problems on scale - up method | **18 Hours** |
| **Unit-V** | Bulk organs (ethanol ), Biomass (Bakers yeast ), Organic acids (Citric acid ), Amino acids (L- Lysine ), Microbial Transformation (steroids), Antibiotics (Penicillin ), Extra Cellular Polysaccharides (Xantham Gum ) , Nucleotide (5- GMP ), vitamins (B18) ,Pigments (Shikonim ) Production of cell biomass and some primary metabolites , e. g. ethanol , acetone - butanol, citric acid , dextran and amino acids ; Microbial production of industrial enzymes - glucose isomerase , cellulase & lipases. | **18 Hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. M.L.Schuler, F. Kargi& M. DeLisa , (2017), Bio-process Engineering -

Basic Concepts , 3rd Ed., Prentice Hall.

1. Pauline M. Doran, (2018), Bio-process Engineering Principles, 2 ndEdition Academic Pres.
2. C.Ratledge&B. Kristiansen, (2008). Basic Biotechnology, 3rd Ed., Cambridge University Press.
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, (2007), Principles of fermentation Technology ,

Elsevier India Pvt Ltd.

**Web Sources**

https://archive.nptel.ac.in/courses/102/106/102106086/

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER2:Down stream Process.**

Papercode:Subject:**Down stream Process.**

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of screening and design purification, low resolution protein purification method, protein purification and characterization,and also about animal based products.

**CourseObjectives**

1. Tolearnthebasic concept of Overview of down - stream processing,ion - exchange chromatography.

2.Tolearn the concepts ofAqueous two phase partitioning system,Chromatography.

3. Todevelopknowledgeon Protein Purification and characterization.

4. Tounderstand the proteins based therapeutic products.

5. Todevelopapieceofknowledgeon animal based products.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about deign space for

bio-pharmaceutical process,Media selection in ion - exchange chromatography in single micro-plate.

1. .Aftercompleting unit2,thestudentswillbeabletoknow about Aqueous two phase

partitioning system,purification refolding of protein by affinity precipitation.

1. Aftercompletingunit3,thestudentswillbe know about initial recovery of

protein,protein characterization ..

1. ..AfterCompleting unit4,thestudentswillbe know about the .general principleof impurities

potentially present in proteins based therapeutic products.

1. .Aftercompleting unit5,thestudentswillbe know about the Tissue Plasminogen activator,

insulin, erythropoietin.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Overview of down - stream processing ; Establishment of deign space for bio-pharmaceutical process, High - through out process development , Media selection in ion - exchange chromatography in single micro-plate , high - throughput screening of dye - ligand for chromatography. | **18hours** |
| **Unit-II** | .Aqueous two phase partitioning system , A platform for isolation of process related impurities from therapeutics proteins , Simultaneous purification refolding of protein by affinity precipitation and macro (Affinity ligand )- facilitate three- phase partitioning bacterial cytoplasm and periplasm , immunoglobulin purification by caprylic acid ; Filtration , Chromatography (comparison),rationale of choosing between quality and cost of different products . | **18hours** |
| **Unit-III** | Introduction , initial recovery of proteins , removal of whole cells and cell debris , concentrations and primary purification , protein inactivation and stabilization , protein characterization | **18hours** |
| **Unit-IV** | Some general principle , range and medical significance of impurities potentially present in proteins based therapeutic products , labeling and packing of finished products |  |
| **Unit-V** | General DSP, Case studies of : monoclonal antibodies ; Tissue Plasminogen activator, insulin, erythropoietin. .  General DSP, Case studies of : shikonin , Protein extract from Seed material and green tissues. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Nikolaos . E . Labrous (2014), Protein Downstream Processing : Design Development and

application of high and low Resolution Methods in Molecular Biology ,

Spinger protocols, Human Press.

2.Gary Walsh , (2002), Proteins : Biochemistry and Biotechnology , 2 nd Editions , Wiley Blackwell.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER3:Enzyme Engineering**

Papercode:Subject:**Enzyme Engineering**

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts of enzymes, nomenclature and classification of enzymes, types of specificity, mechanism of catalysis, enzyme kinetics, immobilization of enzyme, industrial application of enzymes, industrial enzymes.

**CourseObjectives**

1.Tolearnthebasic concept of Nomenclature and classification , Properties , structure of enzymes

1. Tolearn the concepts of Koshland “Induced fit “ hypothesis,Mechanism of catalysis,

Metal - activated enzyme and metalloenzyme

1. Todevelopknowledgeon Kinetics of enzymes,Specific activity of enzymes ,

Inhibition of enzymes activity, Regulation of enzymes activity .

4. Tounderstand the Concept, Methods of immobilization , kinetics of immobilized enzymes.

5. Todevelopapieceofknowledgeon Industrial enzymes.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about Properties of enzymes ,

structure of enzymes , active site of enzymes , factors influencing enzyme activity , enzyme assays

1. Aftercompleting unit2,thestudentswillbeabletoknow about Mechanism of catalysis,

Mechanism of reaction catalyzed by enzymes without co factor , Metal - activated enzyme and

metalloenzyme

1. Aftercompletingunit3,thestudentswillbe know about Kinetics of

enzymes - catalyzed reaction, Methods for investigation kinetics of enzymes - catalyzed reaction.

1. .AfterCompleting unit4,thestudentswillbe know about the Effect of immobilization on enzymes ,

Use of immobilized enzymes.

1. Aftercompleting unit5,thestudentswillbe know about the traditional (non- Recombinant

source of industrial enzymes , Impact of genetic engineering on enzyme production.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | What are enzymes , Brief history of enzymes , Nomenclature and classification of enzymes , Properties of enzymes , structure of enzymes , active site of enzymes , factors influencing enzyme activity , enzyme assays | **18hours** |
| **Unit-II** | .  Types of specificity , Koshland “Induced fit “ hypothesis , Strain or transition - state stabilization hypothesis; Mechanism of catalysis, Mechanism of reaction catalyzed by enzymes without co factor , Metal - activated enzyme and metalloenzyme, coenzyme in enzymes catalyzed reactions. | **18hours** |
| **Unit-III** | Kinetics of enzymes - catalyzed reaction, Methods for investigation kinetics of enzymes - catalyzed reaction , Interpretation of Km, Vmax , Turnover number and Kcat , Specific activity of enzymes , Enzyme units , Inhibition of enzymes activity, Regulation of enzymes activity | **18hours** |
| **Unit-IV** | Concept, Methods of immobilization , kinetics of immobilized enzymes , Effect of immobilization on enzymes , Use of immobilized enzymes , Bioreactor using immobilized enzymes |  |
| **Unit-V** | Industrial enzymes : Sales value of industrial enzymes , traditional (non- Recombinant source of industrial enzymes , Impact of genetic engineering on enzyme production, Engineered enzymes, Extremophiles, hyperthermophiles, Enzymes from hyperthermophiles, Enzymes from additional extremophiles, Enzymes in organic solvents  Protease and Carbohydrates , Proteolytic enzymes : Carbohydrates , Lingnocellulose degrading enzymes , Pectin and Pectin enzymes | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. T.Palmer and P.L. Bonner , (2007), Enzymes : Biochemistry, Biotechnology and Clinical Chemistry ,

Woodhead publishing limited .

1. N.C /Price and L. Stevens , (2002), Fundamentals of Enzymology , Oxford university Press.
2. Wolfgag, Aehle , (2004), Enzyme in Industry ; Production and appliction (Ed) Wiley - VCH

Verlag GmbH &Co.KGaA.

1. Branden and RTooze , (1999), Introduction to proteins structure , Garland Publishing Group
2. Gary Walsh, (2014), Proteins : Biochemistry and Biotechnology , John Wiley & Sons Ltd.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER4:Immuno technology**

# Papercode:Subject:Immuno technology

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts on lymphocyte maturation and cell mediated immune response, Immunoglobulins, Antigen antibody interaction, vaccinology, clinical immunology, Monoclonal antibodies.

**CourseObjectives**

1.Tolearnthebasic concept of innate and acquired immunity, haptens, major histo compatibility.

2.Tolearn the concepts of Immunoglobulins, cell signaling, B cell maturation.

3.Todevelopknowledgeon antigen antibody interaction, vaccinology..

4. Tounderstand the Concept of clinical immunology.

5. Todevelopapieceofknowledgeon Enzyme engineering .

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about Important organs and

cells of immune responses,Role of MHC in infectious disease and disease susceptibility ,

HLA typing .

2.Aftercompleting unit2,thestudentswillbeabletoknow about Immunoglobulins -

basic structure , classes & sub classes of immunoglobulins.cellsignaling.

3. Aftercompletingunit3,thestudentswillbe know about immunological

techniques,CMI techniques, Hybridoma and monoclonal antibodies.

4..AfterCompleting unit4,thestudentswillbe know about the Active and passive immunization,

proteins based vaccines ,vaccine technology - role and properties of adjuvants

Recombinant DNA and proteins based vaccines

5.Aftercompleting unit5,thestudentswillbe know about the autoimmunity;

types of autoimmune disease ,cancer immunotherapy,immunodeficiency.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **LYMPHOCYTE MATURATION AND CELL - MEDIATED IMMUNE RESPONSE**  Components of innate and acquire immunity ; Important organs and cells of immune responses, complement and inflammatory responses; pathogen recognition receptors (PRP) and pathogens associated molecular pattern (PAMP); innate immune response ; mucosal immunity ; antigens - imunogens , haptens ; Major histo- compatibility complex (MHC ) genes, Role of MHC in infectious disease and disease susceptibility , HLA typing | **18hours** |
| **Unit-II** | .**IMMUNOGLOBULINS** - basic structure , classes & sub classes of immunoglobulins , antigenic determinants ; multigene organization of immunoglobulins gene ; B - cell receptor ; Immunoglobulin super family; Principle of cell signaling ; basis of self & non - self discrimination kinetics of immune response , memory ; B cell maturation , activation and differentiation ; generation of antibody diversity ; T- cell maturation , activation and differentiation ; and T- Cell receptors ; functional T cell subset ; cell - mediated immune response , ADCC; cytokines - properties , receptors and therapeutics uses ; antigens processing and presentation - endogenous antigens , exogenous antigens, non - peptide bacterial antigens and super- antigens ; cell - cell co-operation. | **18hours** |
| **Unit-III** | **ANTIGEN - ANTIBODY INTERACTIONS**  Precipitation , agglutination and complement mediated immune reactions; advanced immunological techniques - RIA , ELISA , Western blotting , T- cells epitope prediction and ELISPOT assay, immunofluroscence, flow cytometry and immuno electron microscopy ; surface plasmon resonance , biosensor assay for assessing ligand - receptor interaction , CMI techniques - lympho proliferation assay, mixed lymphocytes reaction , cell cytotoxicity assay , apoptosis, micro arrays, transgenic mice , gene knock outs, Hybridoma and monoclonal antibodies , Applications of monoclonal antibodies ; HLA - tetramer complex, Application of HLA - tetramer complex in analyzing antigen / Peptide - specific T cell response using flow cytometer. | **18hours** |
| **Unit-IV** | **VACCINOLOGY**  Active and passive immunization ; live killed , attenuated , subuint vaccines ; vaccine technology - role and properties of adjuvants, Recombinant DNA and proteins based vaccines , reverse vaccinology ; peptide vaccine , conjugate vaccine ; antibody genes and antibody engineering ; chieric , hybrid monoclonal antibodies , catalytic antibodies and generation of immunoglobulin gene libraries ; idiotic vaccines and marker vaccines , viral - like particles (VLPS), dendritic cell based vaccines, vaccines against cancer, T cell based vaccine; edible vaccine and therapeutic vaccine , Success stories in vaccinology e.g. Hepatitis , Polio, Small pox , DPT. |  |
| **Unit-V** | **CLINICAL IMMUNOLOGY**  Immunity to infection : bacteria , viral, fungal and parasitic infections (Tuberculosis , HIV / AIDS , Schistosomiasis, Kala Azar, Chikungunya Dengue ); hypersensitivity reactions - Type I- IV ; autoimmunity; types of autoimmune disease ; mechanism and role of CD 4+ T cells; MHC and TCR in autoimmunity; transplantation - immunological basis of graft rejection ; clinical transplantation and immuno suppressive therapy ; tumor immunology - tumour antigens; immune response to tumour and tumour evasion of the immune system, cancer immunotherapy ; immunodeficiency - primary immunodeficiency , acquired or secondary immuno deficiencies , anaphylactis shock ; immuno deficiencies , acquired or secondary immunodeficiencies , anaphylatics shock; immuno senescence: a challenge for an aging population ; Immune exhaustion in the setting of chronic infections and malignancies ; chronic Inflammation (Inflammating ) and immune activation ; mucosal immunity and Gut Associated Lymphoid Tissue (GALT) in various gastrointestinal (GI) infections ; complement deficiencies and human health ; role of regulatory B cells (Bregs) in human disease  Monoclonal antibodies and their therapeutic role in reversing T cell Functionality , Fab , F (ab ) 2 Fragments; single - chain variable fragments (scFv), A tri functionality antibody ; Bi specific T -cell engagers (BiTEs) as artificial bi specific monoclonal antibodies for the use as anti cancer drug . | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Kindit , T. J., Goldsby , R.A., Osborne , B.A., &Kubly , J . (2006). Kuby Immunology .

Newyork : W.H. Freeman .

2 . Brostoff , J., Seaddin , J.K. Male , D., &Roitt, I. M. (2002). Clinical Immunology. London :

Gower Medicinal Pub

3.Murphy, K., Travers, P., Walport , M . & Janeway , C . (2018). Janeway ‘s Immuno biology.

New york : Garland science .

1. Paul . W.E. (1993). Fundamental Immunology . New york : Raven Press.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**CORE ELECTIVE: Bio entrepreneurship**

Papercode:Subject:**Bio entrepreneurship**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on innovation and entrepreneurship in bio business;Bio markets; finance and accounting; technology management.

**CourseObjectives**

1. Tolearnthebasic concept of Introduction and scope in Bio- entrepreneurship,Strategy and

operation of bio- sector firms,Factors shaping opportunities for innovation and

entrepreneurship in bio - sector.

2 . Tolearn the concepts of Pricing strategy,Challenges in marketing in bio business,

Basic contract principles

3 Todevelopknowledgeon Business plan preparation,Information technology.

4.Tounderstand the Concept Quality control & transfer of foreign technologies

5. Todevelopapieceofknowledgeon technology management.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about opportunities for

innovation and entrepreneurship in bio - sector , and the business implication of

entrepreneurship development progrmmes off public and private agenices.

2.Aftercompleting unit2,thestudentswillbeabletoknow about Challenges in

marketing in bio business,Basic contract principles , different types of agreements

and disputes resolution skills

3. Aftercompletingunit3,thestudentswillbe know about Business

plan preparation,financial managements issues,Collaboration & partnership ,

Information technology.

4..AfterCompleting unit4,thestudentswillbe know about the Quality control &

transfer of foreign technologies,Understanding of regulatory compliance

5 . Aftercompleting unit5,thestudentswillbeBusiness Sectorsand forms

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **INNOVATION AND ENTERPRENEURSHIP IN BIO BUSINESS**  Introduction and scope in Bio- entrepreneurship, Types of bio - industries and competitive dynamics between the sub - industries of the bio- sector (e.g pharmaceuticals vs Industrial biotech), Strategy and operation of bio- sector firms : Factors shaping opportunities for innovation and entrepreneurship in bio - sector , and the business implication of those opportunities , Alternative faced by emerging bio- firms and the revelent tools for startegic decisions, Entrepreneurship development progrmmes off public and private agenices (MSME, DBT, BRIAC , Make In India ), strategic dimension of patenting & commercialization strategies. | **18hours** |
| **Unit-II** | .**BIOMARKETS : BUSINESS STRATEGT AND MARKETING**  Negotiating the road from lab to the market (strategies and process of negotiation with finance-rs , government and regulatory authorities ), Pricing strategy , Challenges in marketing in bio business (market condition & segments ; developing distribution channels , the nature analysis and managements of customer needs ), Basic contract principles , different types of agreements and contract terms typically found in joint venture and development agreements , Disputes resolution skills | **18hours** |
| **Unit-III** | **FINANCE AND ACCOUNTING**  Business plan preparation including statutory and legal requirements , Business feasibility study, financial managements issues of procurement of capital and managements of costs, Collaboration & partnership , Information technology.  **TECHNOLOGY MANAGEMENT**  Technology - assessment , development &upgradation , Managing technology transfer , Quality control & transfer of foreign technologies , Knowledge centers and Technology transfer agencies , Understanding of regulatory compliance and procedure (CDSCO, NBA, GCP, GLA, GMP ). | **18hours** |
| **Unit-IV** | **Business Sectorsand forms**  Meaning and classifications - primary, secondary and tertiary sectors - Business Organisation – Forms of business organization, Sole Proprietorship, Partnership firms, Joint stock companies, Co-operative Society – their features, relative merits, demerits & suitability – Concept of Social Enterprise and Social Entrepreneurship, Social Entrepreneurs, Sustainability issues in Social Entrepreneurship – Entrepreneurial failure, issues, reasons and revamps. |  |
| **Unit-V** | .**Entrepreneurship Development and Government**: Role of Government in promoting Entrepreneurship, MSME policy in India – District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship Development Board (NEDB) – Recent initiatives by the Central and State Governments to boost startups and entrepreneurship in India , Startup India, Skill India, MSDE and NSDC– Financial Support System for entrepreneurship development | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation

and Entrepreneurship in the Bioscience , Bloxham : Scion .

1. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing ,

and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

1. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies :

Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

1. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.
2. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER6:BiopharmaceuticalTechnology**

Papercode:Subject:**BiopharmaceuticalTechnology**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on development of drugs,Pharmacokinetics.,dry and wet granulation,and also about biopharamaceuticals.

**CourseObjectives**

1. Tolearnthebasic concept of therapeutic agents.

2 . Tolearn the concepts of drug metabolism

3 Todevelopknowledgeoncapsule preparation

4.Tounderstand the categories of therapeutics

5. Todevelopapieceofknowledgeon Pharmacokinetics.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about the Pharmaceutical

industry &development of drugs

1. Aftercompleting unit2,thestudentswillbeabletoknow about Mechanism of drug action,

principles of drug metabolism.

1. Aftercompletingunit3,thestudentswillbe know aboutManufactureof drugs.
2. AfterCompleting unit4,thestudentswillbe know about the Compressed tablets; dry and wet

granulation; slugging

10 . Aftercompleting unit5,thestudentswillbeVarious categories of therapeutics

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **INTRODUCTION**: Pharmaceutical industry & development of drugs ; types of therapeutic agents and their uses; economics and regulatory aspects | **18hours** |
| **Unit-II** | **DRUG ACTION, METABOLISM AND PHARMACOKINETICS** Mechanism of drug action; physico-chemical principles of drug metabolism; radioactivity; pharmacokinetics  . | **18hours** |
| **Unit-III** | **MANUFACTURE OF DRUGS, PROCESS AND APPLICATIONS** Types of reaction process and special requirements for bulk drug manufacture | **18hours** |
| **Unit-IV** | .  **PRINCIPLES OF DRUG MANUFACTURE :** Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP. |  |
| **Unit-V** | **BIOPHARMACEUTICALS :** Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation

and Entrepreneurship in the Bioscience , Bloxham : Scion .

1. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing ,

and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

1. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies :

Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

1. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.
2. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

**Web Sources**

**https://nptel.ac.in/courses/104106106**

**http://www.nitttrc.edu.in/nptel/courses/video/102106070/lec39.pdf**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**PAPER6: BIO PHYSICS**

Papercode:Subject:**BIO PHYSICS**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on Atomic & Molecular structure, Physico-chemical Foundations,Physical Foundations of Biophysics, Biomolecules as molecular alphabets of life, Molecular Structure Of Biological Systems, Energetics& Dynamics Of Biological Systems.

**CourseObjectives**

1. Tolearnthebasic concept of Structure of atom.

2 . Tolearn the concepts of Physico-chemical and,Physical Foundations of Biophysics

3 . TodevelopknowledgeonBiomolecules as molecular alphabets of life,

4.Tounderstand the categories of dynamics of biological system.

5.Todevelopapieceofknowledgeon Molecular Structure Of Biological Systems

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeabletoknow about the Structure of atom,

Secondary bonding,Bonds within molecules.

2.Aftercompleting unit2,thestudentswillbeabletoknow about Biophysics of Water,

Acid & Bases,Redox potential.

3.Aftercompletingunit3,thestudentswillbe know aboutThermodynamics of

Biological system,Bioenergetics,

4.AfterCompleting unit4,thestudentswillbe know about the Nucleic acids,

Amino acids & Proteins,Carbohydrates

5.. Aftercompleting unit5,thestudentswillbeConcepts in thermodynamics

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **Atomic & Molecular structure**: Structure of atom-Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules; inductive effect; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole &dipoleinduced dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen, Electrostatic, Disulphide& peptide bonds, Van-der Waals forces Bond lengths & Bond energies , Bond angles, Structural isomerism; optical isomerism & optical activity | **18hours** |
| **Unit-II** | **.Physico-chemical Foundations Biophysics of Water**: Physicochemical properties of water, Molecular structure, Nature of hydrophobic interactions, Water Structure. Small-Molecule Solutes: Hydrophiles, Hydrophobes, Large Hydrophobic Solutes and Surfaces, Aqueous Environment of the Cell, State of water in bio- structures & its significance, Protein Hydration-Nonspecific Effects, The Hydration Shell. Acid & Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, Ampholyte, concept of pH,measurements of pH , Henderson–Hasselbatch equation , Titration curve &pK values, Buffers & Stability of their pH , numerical problems. Redox potential : Oxidation –Reduction, examples of redox potential in biological system. | **18hours** |
| **Unit-III** | **Physical Foundations of Biophysics Thermodynamics of Biological system**: First and second laws of thermodynamics, activation energy. Biological systems as open, non-equilibrium systems,Concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, Enthalpy, Negative entropy as applicable to biological systems. thermodynamics of passive and active transport, glycolytic oscillations, biological clocks. Bioenergetics: Concept of energy coupling in biological processors, Energy requirements in cell metabolism, structure and role of mitochondria, high energy phosphate bond, energy currency of cell, Biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis. Thermodynamic analysis of TCA cycle and oxidative phosphorylation. | **18hours** |
| **Unit-IV** | .  **Biomolecules as molecular alphabets of life Nucleic acids**: Purine and Pyrimidine bases, nucleosides, nucleotides, basic differences in structure and function of RNA and DNA Amino acids & Proteins: Amino acid general structure & types, peptide bond,Structure of Proteins - primary, secondary, tertiany and quarternary , Carbohydrates : Structure and function of mono, di ,oligo and polysaccharides, Structure of D-glucose & D-fructose; formation of glucosides & the cyclic structure of Dglucose; Structure and conformation of diasacharides and polysaccharides- cellulose, amylopectin &glycogen,Chitin. Lipids : Defination:Types of lipids; Triglycerides , fatty acids, Fats & oils ,Phospholopids, Glycolipids; lipoproteins, Structure, Function and Localization Vitamins & hormones: Structure, classification & function |  |
| **Unit-V** | **ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS**  Concepts in thermodynamics – force and motion – entropy and stability – analyses of fluxes – diffusion potential – basic properties of fluids and biomaterials – laminar and turbulent flows  **MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS** Intramolecular bonds – covalent – ionic and hydrogen bonds – biological structures -general features – water structure – hydration – interfacial phenomena and membranes – self assembly and molecular structure of membranes | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Adams, D.J., &Sparrow , J.C. (2008). Enterprise for life scientists : Developing Innovation

and Entrepreneurship in the Bioscience , Bloxham : Scion .

1. Shimaski , C. D (2014). Biotechnology Entrepreneurship: Starting , Managing ,

and Leading Biotech companies . Amsterdam : Elsevier . Academic Press is an imprint of Elsevier .

1. Onetti, A., &Zucchella , A. Business Modeling for life Science and Biotech Companies :

Creating Value and Competitive Advantages with the Miles tone Bridge . Routeldge

1. Jordan , J. F. (2014). Innovation , Commercialization , and Start - Ups in Life science London : CRC Press.
2. Desai, V. (2009) . The Dynamics of Entrepreneurial Development and Management.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**PRACTICALS –II (4 credit)**

**TISSUE CULTURE, AGRO-INDUSTRIAL AND IMMUNO TECHNIQUES &**

1. Micropropagation of ex-plant
2. Isolation of DNA from plant cells
3. Giemsa banding and Karyotyping of chromosomes by lymphocyte culture
4. Animal cell culture – MTT assay and COMET assay
5. Determination of doubling time of bacteria by plotting growth curve
6. Determination of specific growth rate of bacteria
7. Screening of microbes for antibiotic production
8. Isolation of bacteriophage
9. Hemagglutination
10. Blood film preparation and identification of cells

**FOOD TOXICOLOGY AND WASTE MANAGEMENT**

1. Detection of microbes from spoiled meat, egg and fish
2. Isolation and identification of Salmonella, E. coli, Listeria, Proteus, Shigella and Vibrio
3. spp.
4. Isolation and identification of Staphylococcus aureus using Baird parker agar.
5. To determine the LD50 value of common microbial toxin i.e. aflatoxin, enterotoxin
6. To study the antibiotic sensitivity pattern and MIC for different food pathogen
7. To isolate and determine the food spoilage psychrotrophs from frozen food
8. Biochemical characterization of purified bacterial strains for identification
9. Microbial analysis from the chemically preserve food material
10. Detection of microbial toxin from infected food/spoiled food
11. Estimation of pesticides in food brewages
12. Heavy metal analysis in contaminated food material

13. Study the biodegradation of waste discharged from food industry

**SEMESTER II**

**OPEN ELECTIVE : Bio information and Bio instrumentation**

# Papercode:Subject:Bio information and Bio instrumentation

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on to enable the students to understand the use of databases available, analysing biomolecules and apply the information for understanding biological system

**CourseObjectives**

1. Tolearnthebasic concept of to provide the information to understand the principles of analyzing

biological data.

2 . Tolearn the concepts of testing hypotheses

3 . Todevelopknowledgeonbuilding models using computerscience paradigms

4.Tounderstand the categories of basic instrumentations in biology

# 5.Todevelopapieceofknowledgeon Structural analysis of Biomolecules

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow about the Introduction to biological

databases -

2..Aftercompleting unit2,thestudentswillbeabletoknow about Protein structure prediction

3.Aftercompletingunit3,thestudentswillbe know aboutBioinstrumentations,

Separation of Bio molecules:

4.AfterCompleting unit4,thestudentswillbe know about the Structural analysis of Bio molecules

5. . Aftercompleting unit5,thestudentswillbeConcepts Cell analysis

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Bioinformatics - Definition, History, Web servers, computer systems, languages, - machine, high level and assembly. Internet basics – internet connection, web browsing and URL. Introduction to biological databases - Sequence databases, structural databases, specialized databases, sequence retrieval system from net - SRS, Entrez | **18hours** |
| **Unit-II** | Protein structure prediction –Similarity and database structure tools, FASTA, BLAST - Sequence and similarity – sequence alignment – local, global pairwise and multiple sequence, Introduction to phylogenetic trees | **18hours** |
| **Unit-III** | Bioinstrumentations: Separation of Biomolecules: Centrifugation-Preparative, Analytical and Density gradient centrifugation. Chromatographic Techniques-Theory andapplication of Paper Chromatography, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography. Electrophoretic Techniques: Theory and Application of PAGE, SDS PAGE. | **18hours** |
| **Unit-IV** | Structural analysis of Biomolecules: UV, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, Fluorescence Spectroscopy. |  |
| **Unit-V** | Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy. | **18hours** |
| **Unit-VI** | Biostatistics: Definition, Types of biological data, Representation of biological data. Measurement of central tendency; Measurement of dispersion; Data analysis – Student’s t-test, Chi-square test, F-test, ANOVA, Correlation and Regression, Probability | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**

1. Introduction to bioinformatics by T.A Atwood
2. Introduction to computers by Alexis Leon and Mathews Leon
3. Genomics: The Science and Technology Behind the Human Genome Project (2000). Edited by C.Cantor and C.L.Smith, Wiley -Interscience, New York
4. Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill
5. Biophysical chemistry – Upadhyay., Upadhyay and Nath
6. Practical Biochemistry – Principles and techniques -Wilson. K and Walker. J,
7. Biostatistics Basic Concepts And Methodology For The Health Sciences –Wayne W. Daniel, Chod L. Cross
8. Biostatistics: Basics and Advanced – Manju Pandey

**REFERENCE BOOKS**

1. Genome Mapping – A Practical Approach (1997) by P.H. Dear, Oxford University Press, Oxford.
2. Reviews and Articles from Journals such as Nature, Science, PNAS (USA), NucleicAcids Research, Trends Series & Current Opinion Series.
3. Protein Research: New Frontiers in Functional Genomics (1997). Edited by M.R. Wilkins, K.L. Williams, R.D.Appel and D.F. Hochstrasser, Springer – Verlag, NewYork2-D Proteome Analysis Protocols (1998). Edited by A.L. Link, Humana Press, Totowa, NJ.
4. Proteins and Proteomics. 2002. R.J. Simpson. Cold Spring Harbor Lab. Press. New York.
5. Instrumental methods of chemical analysis – P.K. Sharma

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER II**

**OPEN ELECTIVE:TEACHING TECHNIQUES IN SCIENCE**

# Papercode:Subject:TEACHING TECHNIQUES IN SCIENCE

**Hours/Week:5 Credits:2**

**Aim: To enable the students to understand the basic concepts on to Teaching Learning Process**

# Methods of Teaching SciencePedagogyMicro-teaching skills in Science , Teachingof Science

**CourseObjectives**

1. Tolearnthebasic concept of to provide the information to understand the Teaching Learning Process
2. Tolearn the concepts of Methods of Teaching Science
3. Todevelopknowledgeonbuilding models Pedagogy

# Tounderstand the categories of Micro-teaching skills in Science

# Todevelopapieceofknowledgeon Teachingof Science

# CourseOutComes

6.Aftercompletingunit1,thestudentswillbeabletoknow about the.Bloom‟s Taxonomy of Learning objectives in Science.

7.Aftercompleting unit2,thestudentswillbeabletoknow about Pedagogy: Meaning, concept

8.Aftercompletingunit3,thestudentswillbe know about Methods of Teaching in Science

9.AfterCompleting unit4,thestudentswillbe know about the Steps and Cycle. Skills of Micro-teaching

10 . Aftercompleting unit5,thestudentswillbeUnit Planning

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Teaching: Meaning, Scope, Importance. Learning: Meaning, Scope, Importance. Teaching Learning Process.Bloom‟s Taxonomy of Learning objectives in Science. | **18hours** |
| **Unit-II** | Pedagogy: Meaning, concept. Different pedagogy of teaching Science: Seminar, Conference, Symposium and Workshop | **18hours** |
| **Unit-III** | Methods of Teaching in Science: Lecture-cum-Discussion Method, Laboratory Method, Observation Method, Project Method and Problem Solving Method. | **18hours** |
| **Unit-IV** | Micro-teaching: Meaning, Importance, Steps and Cycle. Skills of Micro-teaching: Set Induction, Explaining, Stimulus variation, reinforcement and Closure. |  |
| **Unit-V** | Formulation of Instructional Objectives. Unit Planning: Meaning and Steps. Lesson Planning: Meaning and Steps. Improvised of teaching aids in general science.  Evaluation: Definition and Objectives. Types of Evaluation: Formative and Summative. Achievement test: Development and Construction. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**

1. Kumar, K.L. (1996). Educational technology. New Delhi: New Age International Publishers.
2. Srivastava, A.P. (1987). Teaching and learning in 21st century. New Delhi: Indian Books Centre. Vedanayagam, E.G. (1989).Teaching technology for college teachers. New York: Sterling Publishers.
3. Sharma, S.R. (2003). Effective classroom teaching modern methods, tools & techniques. Jaipur: Mangal Deep.
4. Neel A, GlasGow, Cathy & Hicks. What successful teachers do. Chennai: Tamil Nadu Book House. 
5. Sampath, K., Panneerselvam, A. &Santhanam, S. (1984). Introduction to educational technology. II revised Edition. New Delhi: Sterling Publishers. 
6. Witch, W.A. &Schulles, C.F. (1973). Instructional technology: Its nature and use New York: Harpu& Row.  Maheshkumar. (2004). Modern teaching of information technology. New Delhi: Anmol Publishers. 
7. Jaganath, Mohanty. (2003). Modern trends in educational technology. Hyderabad: Neelkamal. 
8. Rameshvarma, et al. (2005). Modern trends in teaching technology. New Delhi: Anmol Publishers. 
9. Janardan, P. et al. (2003). Advanced educational technology. New Delhi: Kanishka. 
10. Siidiqui. (2005).Challenges of educational technology. Coimbatore: Global Books Syndicate

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**PAPER1: Animal and Plant Biotechnology**

# Papercode:Subject:Animal and Plant Biotechnology

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on culture media , subculture and cell lines, cloning and hybridoma technology, cell separation, and quantitation, cell characterization and differentiation and application of animal biotechnology and related problems.

**CourseObjectives**

1. Tolearnthebasic concept of .Media and supplements,cell lines and its maintenance

2 . Tolearn the concepts of somatic cell fusion,organ culture, tumor genesis.

3 Todevelopknowledgeon antibody based techniques,Quantitation.

4.Tounderstand the basic concept on Differentiation , and cell morphology, cell matrix interaction

5.Todevelopapieceofknowledgeon Artificial animal , breeding,diagnosis of diseases and disorders,

gene therapy , forensic application .

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeabletoknow about Media and supplements ,

serum , serum free media , natural media,Gas phase for tissue culture .

2.Aftercompleting unit2,thestudentswillbeabletoknow about Cross contamination,

cell lines and its maintenance , subculture , growth cycle and split ratio.

3.Aftercompletingunit3,thestudentswillbe know about Vectors and cloning,

somatic cell fusion , HAT selection , selection of Hybrid clones, organ culture, tumor genesis.

4.AfterCompleting unit4,thestudentswillbe know about the antibody based techniques,cell

counting , cell weight , cell proliferation .

5. Aftercompleting unit5,thestudentswillbecell morphology, Karyotyping ,

chromosome banding,cell interaction

diagnosis of diseases.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **CULTURE MEDIA FOR ANIMAL CELL CULTURE**  Introduction and history : Media and supplements , serum , serum free media , natural media , feeder layer on substrate , Gas phase for tissue culture , source of tissue , Primary culture , Stages of commitments and differentiation , proliferation and malignancy  **SUBCULTURE AND CELL LINES**  Cross contamination , terminology, naming and choosing cell lines and its maintenance Criteria for subculture , growth cycle and split ratio, Propagation in suspension and attached culture. | **18hours** |
| **Unit-II** | **CLONING AND HYBRIDOMA TECHNOLOGY**  Vectors and cloning, somatic cell fusion , hybridoma, HAT selection, Medium suspension fusion , selection of Hybrid clones, organ culture, tumor genesis. | **18hours** |
| **Unit-III** | .  **CELL SEPARATION AND QUANTITATION**  Separation techniques based on density , size, sedimentation velocity , antibody based techniques - immuno panning magnetic sorting , fluorescence activated cell sorting ; Quantitation - cell counting , cell weight, DNA content, protein , rate of synthesis, measurements of cell proliferation . | **18hours** |
| **Unit-IV** | **CELL CHARACTERIZATION AND DIFFERENTIATION**  Authentication , record keeping , provenance , parameters of Characterization , lineage and tissue markers, cell morphology, Karyotyping , chromosome banding ; Differentiation - commitments , terminal differentiation ; Lineage selection ,proliferation and differentiation , commitment and lineage, markers of differentiation , induction of differentiation , cell interaction - homotypic and heterotypic , cell matrix interaction | **18hours** |
| **Unit-V** | .**APPLICATION OF ANIMAL BIOTECHNOLOGY AND RELATEDD PROBLEMS**  Artificial animal breeding , cloning and transgenic animals , medicines , vaccines , diagnosis of diseases and disorders, gene therapy , forensic application . | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Freshney , I., (2010), cultures of Animal Cells, John Wiley and Sons Inc.
2. Cibelli, J., Robert P. , Keith L.H.S ., Campbell H., and West M.D. (Editors ), (2002) Principles of Cloning,

St. Diego academic press.

1. J.Hammond et.al., Plant Biotechnology , Springer Verlag .
2. R.J Henry , Practical Application of Plant Molecular Biology ,Champman and Hall
3. Brun T.A. (2006) . Gene cloning and DNA Analysis . An Introduction , Oxford , Black well Pub.
4. Primrose S.B. and Twyman R.M . (2006 ). Principles of Gene Manipulation and Genomics ,

Maldem M.A. Blackwell Pub.

1. Gordon T, (2005), Reference Techniques in Farm Animals . Oxford . CAB International .
2. Porter R., Totowa N.J. (2007N), Animal Cell Biotechnology : Methods and Protocols, Human press.

**Web Sources**

https://www.biotechbug.in/2022/07/mcqs-on-cell-culture-technologies-nptel.html?m=1

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**PAPER2: Environmental Biotechnology**

# Papercode:Subject:Environmental Biotechnology

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts on nitrogen fixation, bio fertilizer, PGPR, environmental problems and monitoring, environmental problem and monitoring.

**CourseObjectives**

1. Tolearnthebasic concept of .Physiology and biochemistry of nitrogen fixing organisms,

and regulation of gene expression

1. Tolearn the concepts of Phosphate Solubilizing Microorganisms,Ecto - Endo - Mycorrhizae
2. . Todevelopknowledgeon mechanism in plant growth promotion , factors affecting rhizosphere

colonization

1. Tounderstand the basic concept on Pollution and its classification,Global environmental problems.

5.Todevelopapieceofknowledgeon Principles of biological treatments,Bioreactor design.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow Physiology and biochemistry of

nitrogen fixing organisms,genetics and regulation of gene expression.

1. .Aftercompleting unit2,thestudentswillbeabletoknow about the Phosphate

Solubilizing Microorganisms,phosphate mineralizers

1. Aftercompletingunit3,thestudentswillbe know about phosphate mineralizers.

. 4. AfterCompleting unit4,thestudentswillbe know about the Environmental monitoring

and audit ; Environmental and and policies in India .

5.Aftercompleting unit5,thestudentswillbe know about Principles of biological treatments ;

Biological treatments, the Bio-remediation principles and processes strategies and techniques of bio remediation in situ and ex situ of hydrocarbons.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **BIOLOGICAL NIITROGEN FIXATION**  Physiology and biochemistry of nitrogen fixing organisms, genetics and regulation of gene expression , signaling factors and molecular interaction in establishing rhizobia legume symbiosis. | **18hours** |
| **Unit-II** | **BIOFERTILIZERS**  Phosphate Solubilizing Microorganisms, inorganic phosphate solubilization and its mechanisms, phosphate mineralizers - phytate and organic phosphate hydrolyzing bacteria , Ecto - Endo – Mycorrhizae  **PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR)**  PGPR in improving plant growth , mechanism in plant growth promotion , factors affecting rhizosphere colonization | **18hours** |
| **Unit-III** | **ENVIRONMENTAL PROBLEMS AND MONITORING**  Pollution and its classification ; Effluent standards - examination of waste water , characteristics , municipal and industrial waste water , characteristics , municipal and industrial waste water ;Global environmental problems , global warming , acid rain , ozone depletion ; Sampling and analysis , Environmental monitoring and audit ; Environmental and and policies in India . | **18hours** |
| **Unit-IV** | **BIOTREATMENTS , KINETICS AND REACTOR DESIGN**  Principles of biological treatments ; Biological treatments - composting , suspended growth system, attached growth system ; Bioreactor design - activated sludge process, trickling filters , fluidized bed and packed bed reactor, rotating biological contractors , oxidation ponds and ditches , lagoons anaerobic reactors. | **18hours** |
| **Unit-V** | **BIOREEDIATION AND BIODEGRADATION**  Bio-remediation principles and processes, Bio absorption , bio-accumulation , bio-conversion , bio-transformation , bio-leaching , bio-degradation , detoxification , activation , accumulation and co- metabolism ; Strategies and techniques of bio remediation in situ and ex situ of hydrocarbons , pesticides and dyes ; G Mos in bio remediation and bio degradation , Microbial enhanced oil recovery. | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Atlas R.M. and Bertha , R (2009). Microbial Ecology , 4th Ed , Pearson Education .
2. Maier, R.M., Peppler I.I. and Gertha C.P. Environmental Microbiology , 2nd ED, Academic Press.
3. Olum E.P and Barrett G.W (2005). Fundamental of Ecology , 5th ed , Cenegage learning .
4. Wiley J.M., Sherwood , L.M. and Woolverton C.J. Prescott , Harley and Klein (20050, Microbiology ,

7th Edition Mc Graw Hill.

5 . Garrity , G.M, Brenner , D.J Kreig M.R. and Statey J.T . (2005), Bergey’s Manual of

Systematic Bacteriology , 2nd ed , Vol II spinger .

6.Lawrence K.W, Volodymyr Ivanow , Joo- Hwa Tay Yung - Tse Hung , (2010); Environmental

Biotechnology , Vol 10 , handbook of Environmental Engineering , Springier .

7.Hans - Joachim Jordening , Josef Winter , (2005), Environmental Biotechnology : Concepts and

Application, Wiley - Vch.

8.Christon Hurst , Ronald L.C. Guy R.K., Miachel J.M, Linda D.S, (2002) Manual of Environmental

Microbiology , 2nd edition , ASM press.

**Web Sources**

https://nptel.ac.in/courses/103107086

https://nptel.ac.in/courses/102105058

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**MESTER III**

**PAPER3: Bio Manufacturing Principle and Practise**

# Papercode:Subject:Bio Manufacturing Principle and Practise

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts on overview and design of bio manufacturing , quality system, principles and practice of GMP, Bio remediation and Bio degradation and principles of microbial diversity.

**CourseObjectives**

1. Tolearnthebasic concept of principles of bio manufacturing, Chromatography. ,
2. Tolearn the concepts of Introduction, practical implementation, and structure of quality system
3. Todevelopknowledgeon Principle and Practise of GMP.
4. Tounderstand the basic concept on Bio remediation and bio degradation.
5. Todevelopapieceofknowledgeon principle of microbial diversity.

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeabletoknow .about the life cycle of manufacturing ,

raw material consideration , compliance and quality in bio-manufacturing,(PAT),Standard

manufacturing operating procedure of biotechnology, Therapeutic proteins

,monoclonal antibodies , human vaccines .

2.Aftercompleting unit2,thestudentswillbeabletoknow about the Introduction to

quality system, Structure of quality manual

3. Aftercompletingunit3,thestudentswillbe know about Principles of human

resource managements,Pharmaceutical water.

4.AfterCompleting unit4,thestudentswillbe know about Information , national bodies and

pharmaceutical associates

5.Aftercompleting unit5,thestudentswillbe know about the concept of pharmaceutical water.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **BIOMANUFACTURING PRINCIPLES**  Overview and design of bio-manufacturing , quality by design approach , technical consideration , phases and scale up : life cycle of manufacturing , raw material consideration , compliance and quality in bio-manufacturing , lean bio-manufacturing ; Process analytical technology (PAT) during bio-manufacturing : background and need tools for data acquisitions (software in fermenters , flow filtration , chromatography , analysis and design process analyzers, process control tools and continuous improvement and knowledge managements ; Standard manufacturing operating procedure of biotechnology , including upstream and down stream processing of proteins , and quality control of proteins production , and final fill and finish of product; Case studies to be include at least ; Therapeutic proteins , monoclonal antibodies , human vaccines . | **18hours** |
| **Unit-II** | **QUALITY SYSTEM**  Introduction to quality system, main elements of a quality system : Essential of quality system ; Practical implementation of a quality system ; Structure of quality manual , correlation between GMP requirements (WHO) and ISO 9001: 2000. | **18hours** |
| **Unit-III** | **PRICIPLES AND PRACTICE OF GMP**  Personnel : Principles of human resource managements , duties of senior managements , organizational structures, qualification and profiles requirements , workplace and job descriptions , health monitoring and occupational health safety, training , function owners subject to public law ; Premises : official requirements , material & personnel flow and layout , air cleanliness class and grades , constructions elements , barrier system , isolators and safety cabinets, building services , heating ventilation air conditioning (HVAC) , Process gases , qualification of premises and HVAC system , pharma monitoring of HVAC system , particle monitoring ; Facilities and Equipment : Facility planning , material , hygienic design in solid handling , system controllers and process control system, technical documents , calibration , maintenance , cleaning of facilities , containment (personnel protection ) in solid handling ; | **18hours** |
| **Unit-IV** | **GMP IN REGULATION**  Information , national bodies and pharmaceutical associates ; Pharmacopoeia; EU directives and guidelines, USA : CFR and FDA guidelines , ICH - guidelines , PIC/S guidelines , GMP of other regions , WHO guidelines . |  |
| **Unit-V** | **Pharmaceutical water** : Water quality, generation of pharmaceutical water , distribution and storage of pharmaceutical water , qualification of water supplies , operation of water supplies , pure steam system ; Qualification: Official requirements , Preparation of qualification (IQ) , operational qualification (OQ) , Performance qualification (PQ), special cases of qualification ; Process Validation : Official requirements , Validations -a key elements of quality managements , validation planning and procedure , validation documentation , process validation and product life cycle; cleaning validation : Official requirements , how to validate cleaning procedure , cleaning validation master plan , establishing scope of validation , acceptance criteria and limit calculation , sampling procedures, analytical procedure , documentation , maintenance of validated status , cleaning validation documentation ;.Production : Sanitation , personal hygiene , Production Hygiene , sanitation Programme, environmental monitoring , GMP in production hygiene , sanitation programme, environmental monitoring , GMP in production process, weigh - in , identification , in -process control prevention of cross -contamination , empty chapter, reworking , warehouse and logistics; Sterile Production and Packaging : Introduction , Air lock concepts , manufacture of terminally sterilized products , sterilization process, aseptic processing , freeze - drying , testing for sterility ,testing for endotoxins, testing for leakage and for particles , microbiological monitoring , packaging process, qualification of a servo - controlled blister packaging line , blow- fill - seal -technology(BFS technology); Documentation : Official Requirements , GMP - compliant documentation , batch documentation , standard operating procedures (SOPs) , site master files , electronic batch recording and batch release , CAPA , document managements systems | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Introduction to Bio-manufacturing by Northeast Bio-manufacturing Center and Collaboration , 2018.
2. Introduction to Bio-manufacturing by , Mark WIitcher . In Encyclopedia of Industrial Biotechnology
3. Good Manufacturing Practice for Pharmaceuticals (e- resource ) : A plan for total Quality Control . Sidney Willing and James Stoker.
4. Biotechnology Operations : Principles and Practices ,by John .M. Centanni, Michael J.Roy ; CRC press
5. Learn Bio-manufacturing , 1 st Ed ., by Nigel Smart; Wood-head Publishing
6. GMP Manual ; Publisher Maas &Peither A America , Inc GMP Publishing .

**Web Sources**

**https://nptel.ac.in/courses/102105058**

**https://nptel.ac.in/courses/102106022**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**PAPER4:MOLECULAR BASIS OF DISEASE-I**

Papercode:Subject:**MOLECULAR BASIS OF DISEASE-I**

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts on Introduction to Human diseases,Introduction to infection,Viral Disease,:Bacterial diseases,Protozoan/Helminthic diseases,Fungal diseases.

**CourseObjectives**

1. Tolearnthebasic concept of Mode of transmission of infectious diseases-
2. Tolearn the concepts of Introduction to different pathogens
3. TodevelopknowledgeonIntroduction to virology
4. Tounderstand the basic concept on Host-bacterial pathogen interaction,
5. Todevelopapieceofknowledgeon Host-pathogen interaction

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeabletoknow about the Human diseases

2..Aftercompleting unit2,thestudentswillbeabletoknow about virus induced celltransformation

3.Aftercompletingunit3,thestudentswillbe know aboutIntroduction to virology-

general properties, Classification of viruses

4..AfterCompleting unit4,thestudentswillbe know about Host-bacterial pathogen interaction

5.Aftercompleting unit5,thestudentswillbe know about Host-pathogen interaction, Fungal diseases

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Causative agents-bacteria, fungi, viruses, parasites (helminthes and protozoan’s). Mode of transmission of infectious diseases- Air-borne, food and water-borne, sexually transmitted, zoonotic. Special insight on hospital born infections and opportunistic infectious diseases. | **18hours** |
| **Unit-II** | .  Introduction to different pathogens, recognition and entry processes of different pathogens (bacteria, Viruses, fungus) into animal host cells, host cell alteration by pathogens, virus induced cell transformation. | **18hours** |
| **Unit-III** | Introduction to virology- general properties, Classification of viruses (DNA/RNA virus, single and double stranded virus), virus-host interactions- viral infections, Biology and pathophysiology of major viral diseases- HIV, Japanese encephalitis, influenza, viral hepatitis | **18hours** |
| **Unit-IV** | Host-bacterial pathogen interaction, biology and pathophysiology of tuberculosis, typhoid and cholera |  |
| **Unit-V** | Host-pathogen interaction, biology and pathophysiology of malaria and filarial, Entamoeba histolytica, Giardia | **18hours** |
| **Unit-VI** | Host-pathogen interaction, biology and pathophysiology of cryptococcosis, candidiasis | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Jawetz, Melnick &Adelberg’s Medical Microbiology (26/E), Author: Geo. F. Brooks, Karen C.

Carroll, Janet S. Butel, Stephen A. Morse. Publisher: McGraw Hill Education. ISBN-10: 0071790314,

ISBN-13: 978-0071790314

2.Prescott, Harley and Klein’s Microbiology: Wiley JL, Sherwood LM and Woolverton CJ. 7 thEdn. Tata McGraw Hill

3.Textbook of Microbiology by Ananthanarayanan and Panicker, Seventh edition, Orient Longman.

4.Topley and Wilson`s, Microbiology and Microbial infections. Volume 1 to 4. Wiley Publications. 10 th edition

**Web Sources**

https://nptel.ac.in/courses/102103039

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**ELECTIVE PAPER1:MICROBIOLOGY**

# Papercode:Subject:MICROBIOLOGY

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts on classification of microbes. The paper also throws light on multifarious habitats of microbes and provides information about all the microbial cellular functions and various metabolic pathways in microbes.

**CourseObjectives**

1. Tolearnthebasic concept of classification of microbes

2. Tolearn the concepts of Microbial techniques

3.TodevelopknowledgeonStrain improvement methods

4.Tounderstand the basic concept on Microbial ecology

5.Todevelopapieceofknowledgeon Microbial taxonomy and physiology of growth

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeabletoknow classification and molecular systematic

2.Aftercompleting unit2,thestudentswillbeabletoknow classification and structure of viruses

3.Aftercompletingunit3,thestudentswillbe know aboutMicrobial techniques, Culture techniques:

4.Aftercompleting unit4,thestudentswillbe know about Strain improvement methods

5.Aftercompleting unit5,thestudentswillbe know about Microbial ecology, different culture techniques

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | **Classification and molecular systematic**: Classical, numerical, polyphasic and molecular (G+C analysis, DNA-DNA hybridization, 18S rRNA sequencing and construction of phylogenetic tree) techniques. Archae: Earliest life forms – halophiles, methanogens, hyper-thermophiles, thermoplasma. Bacteria and Actinomycetes: Classification and Characteristics. | **18hours** |
| **Unit-II** | **Viruses**: Classification and structure of viruses, positive, negative and double stranded; Bacterial, plant, animal and tumour viruses; replication – lytic and lysogenic. Fungi: Classification (Alexopoulose); salient features of each class – habitat, cell and thallus organization; nutrition and reproduction. Algae: Classification (Smith); salient features of each class – habitat, cell and thallus organization; pigmentation, nutrition and reproduction. | **18hours** |
| **Unit-III** | **Microbial techniques and Culture techniques**: Isolation of microbes from various sources, serial dilution technique, pure culture techniques , Anaerobic culture methods (chemical and physical) and culture préservation techniques. Microbial culture collection centres. Staining techniques – Gram, endospore, negative, flagellar and methylene blue staining. Biochemical characterization (IMVIC test). Microbiological media: Types and composition of media. Sterilisation techniques: Moist heat; dry heat, pasteurization, Richards‟ rapid method – HTST (high temperature/short time) treatments; filter sterilization, gas (ethylene oxide), chemical sterilization, radiation. | **18hours** |
| **Unit-IV** | **Strain improvement methods:** Non recombinant methods – mutation and protoplast fusion; Recombinant method – recombinant cell culture process – guidelines for choosing host, vector systems, plasmid stability in recombinant cell culture, limits to over expression. |  |
| **Unit-V** | **Microbial ecology**: Soil, aquatic and aerobiology; Influence of environment on microbial physiology – Physical factors – radiations, temperature, Ph and pressure; chemical factors. Antimicrobial compounds – principles and mechanism of action, Antibiotic resistance. Different culture techniques, media, pure culture technique, isolation of preservation. Biochemical, serological classification; DNA/RNA based classification. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

# ReferenceBook:

1. Microbiology, Pelczar, M.J., Jr., Chan, E.C.S., Krieg, N. R., 5th ed.,1996, TMH

2.Microbiology, Hames, B.D. (Ed.), 2nd ed. , Viva Books

3.Microbiology, Tortora, Pearson Education

**Web Sources**

https://www.slideshare.net/jeevaraj9/strain-improvement-techniques

https://archive.nptel.ac.in/courses/102/103/102103015/

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**ELECTIVE PAPER2:GOOD MANUFACTURING**

**PRACTICES AND QUALITY ASSURANCE**

Papercode:Subject:**Good Manufacturing Practices And**

**Quality Assurance**

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts on introduces definitions and requirements in GMP and gives knowledge about production of compounds for human use, and describes requirements from authorities on GMP, laws and regulations for production.

**CourseObjectives**

1. Tolearnthebasic concept of understanding of the principles and practice of GMP .

2.Todevelopknowledgeonthe importance of GMP and compliance of GMP.

3.Tounderstand the basic concept on Sanitation

4.Tounderstand the basic concept on Raw Material Testing

5.Todevelopapieceofknowledgeon Quality Control Department

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow Principles and Importance of GMP
2. Aftercompleting unit2,thestudentswillbeabletoknow Design, construction, and

maintenance of equipment

3..Aftercompletingunit3,thestudentswillbe know about Sanitation programs: sanitary manufacture.

4.AfterCompleting unit4,thestudentswillbe know about Raw Material Testing

5.Aftercompleting unit5,thestudentswillbe know about Good practices in production and control, Quality Control Department and Audits

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Principles and Importance of GMP – Definition of GMP, Quality management, Personnel, Risk management, Quality control, Documentation, Inspections. Public Health Protection - adulteration definition - approved chemicals (lubricants, steam additives, etc.) - toxic chemical control and storage - hazard review: chemical, physical, biological - potential sources (humans, animals, environment) and controls Premises - Design, construction, and maintenance of the production and staff areas in the facility, Layout (design) of the facility - separation from farm/animals/pets (small scale) - perimeter, entrances, drainage - construction, heating/ventilation, humidity control - separation raw versus. pasteurize; product flow - equipment / pipe layout / drainage - water source (treatment, hardness) monitoring | **18hours** |
| **Unit-II** | Equipment - Design, construction, and maintenance of equipment, Equipment arrangement and operation, cleaning-in-place process. Personnel - Ensuring facility personnel are qualified for their job responsibilities, personal health and disease control, personal hygiene; clothing, habits, hand wash, restrooms, plant traffic control. | **18hours** |
| **Unit-III** | Sanitation - Sanitation programs: sanitary manufacture, packaging/labeling, including: Establishing a hygiene program for the facility - documented cleaning procedures for premises and equipment - Employee health and hygiene - Documenting health requirements and following health-related procedures. Cleaning and sanitation compounds and their uses – for process equipments - for environmental cleaning (drains, coolers, etc.) - influence of water quality, formulation control - concentrations and time. Environment sanitation and monitoring - environmental monitoring / pathogen testing - pest control programs. | **18hours** |
| **Unit-IV** | Raw Material Testing - Testing raw materials - Identifying when product or raw materials must be tested - Accepting raw materials from a vendor without additional regular testing - Supplier certification. Good practices in production and control - Controlling the manufacturing process - Stages in the production cycle – contracting quality tools – R & D - Self-inspection programs for fabricators, packagers/labelers - Testing requirements for packaging materials including supplier certification. Finished Product Testing - Finished product testing - Writing product specifications - Conditions and options for finished product testing, distributors - product storage - packaging, distribution. Process Control - refrigeration (potential hazardous compounds), pasteurization - culture, pH, incubation temperature, aging temperature. |  |
| **Unit-V** | Quality Control Department and Audits - Establishing a QC department - Investigating product quality. Audits- Records -Maintaining accurate, clear, and precise documents - Identifying individuals responsible for maintaining documents. Validation - Qualification, Process validation, Cleaning validation and Computer validation. GMP regulations - US-FDA, Europe, Japan, ICH, PICS/S, WHO. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**

Compendium of Good Practices in Biotechnology, BIOTOL series

**REFERENCE BOOKS**

1. A WHO guide to good manufacturing practice (GMP) requirements: Volume 1,2,3,4,5. Part 2-Validation,

by Gillian Chaloner-Larsson, Ph.D, GCL Bioconsult, Ottawa

1. Good Manufacturing Practices for Pharmaceuticals, Sixth Edition by: Graham Bunn Publisher: Informa

Healthcare; 6 edition | 424 pages (2007) <http://ebookee.org/Good-Manufacturing-Practices-for-Pharmaceuticals-SixthEdition_859976.html#uPYoXd8huFeqqXB9.99>

1. A Primer – Good Laboratory Prcatices and current manufacturing practice, by Ludwig Huber, Published by

Agilent Technologies, Germany (2002) <http://www.chem.agilent.com/Library/primers/Public/59886197.pdf.>

1. GMPmanual:Good manufacturing practices and

implementation, <http://www.gmppublishing.com/media/ebooks/flyer/files/gmpmanual_eu_4c_online.pdf.>

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**ELECTIVE PAPER3:APPLIED AND**

**INDUSTRIAL MICROBIOLOGY**

Papercode:Subject:**APPLIED AND INDUSTRIAL MICROBIOLOGY**

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts on the principles of Microbiology to emphasize structure and biochemical aspects of various microbes

**CourseObjectives**

1.Tolearnthebasic concept of understanding of to provide to the students the fundamentals of

Microbiology and solve the problems in microbial infection and their control.

1. Todevelopknowledgeonthe importance of Basics of microbial existence
2. Tounderstand the basic concept on Structural organization and multiplication of bacteria, viruses,

algae and fungi

4.Tounderstand the basic concept on Nutritional requirements of bacteria;

5.Todevelopapieceofknowledgeon Physical and chemical control of microorganisms

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoknow classification and

nomenclature of microorganisms, microscopic examination of microorganisms

1. Aftercompleting unit2,thestudentswillbeabletoknow Microbes - Structure and Multiplication.
2. .Aftercompletingunit3,thestudentswillbe know about Microbial nutrition.
3. .AfterCompleting unit4,thestudentswillbe know about Growth and metabolism
4. Aftercompleting unit5,thestudentswillbe know about Control of microorganism, Industrial and environmental Microbiology

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining | **18hours** |
| **Unit-II** | Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages | **18hours** |
| **Unit-III** | Nutritional requirements of bacteria; different media used for bacterial culture; growth curve. Different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules | **18hours** |
| **Unit-IV** | Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms. |  |
| **Unit-V** | Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-18; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**REFERENCE BOOKS**

1.Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993

2.Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.

3.Prescott LM, Harley JP, Klein DA, Microbiology, 3 rd Edition, Wm. C. Brown Publishers, 1996.

**Web Sources**

https://archive.nptel.ac.in/courses/102/105/102105058/

[slideshare id=134710829&doc=antiviralsandantifungals-190305161929]

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4022204/

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**OPEN ELECTIVE 1:ANALYTICALTECHNIQUES**

**IN BIOTECHNOLOGY**

Papercode:Subject:**ANALYTICALTECHNIQUES IN BIOTECHNOLOGY**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on Basics of Measurement, Molecular spectroscopy, Electrophoresis, Chromatography, Thermal Methods, Magnetic Resonance Spectroscopy and Mass Spectroscopy.

**CourseObjectives**

1. Tolearnthebasic concept To analyse the research findings and interpretation can be ascertained

by the knowledge gained from this course.  

1. Todevelopknowledgeonthe importance of the structural behavior of molecule using molecular

spectroscopy.

1. Tounderstand the basic concept on to inculcate knowledge on the various separation and

purification methods

4.Tounderstand the basic concept on Molecular Spectroscopy

5.Todevelopapieceofknowledgeon Electrophoresis.

# CourseOutComes

1. .Aftercompletingunit1,thestudentswillbeabletoknow Basics of Measurements

,Classification of methods,Properties of electromagnetic radiations.

1. Aftercompleting unit2,thestudentswillbeabletoknow UV and visible light spectroscopy-Qualitative and Quantitative absorption.
2. Aftercompletingunit3,thestudentswillbe know about General principle of electrophoresis,
3. AfterCompleting unit4,thestudentswillbe know about Principles of chromatography
4. .Aftercompleting unit5,thestudentswillbe know about Differential thermal analysis techniques. Differential scanning calorimetry - instrumentation & application, NMR – environmental effects on NMR spectra – chemical shift

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Classification of methods – calibration of instrumental methods – electrical components and circuits -signal to noise ratio – signal – noise enhancement; Properties of electromagnetic radiations and their interaction with matter | **18hours** |
| **Unit-II** | UV and visible light spectroscopy-Qualitative and Quantitative absorption Measurement, BeerLambert law, Spectrofluorimetry, IR spectroscopy, Raman spectroscopy, NMR spectroscopy, Xray crystallography– principle, instrumentation and applications; X-Ray Photoelectron Spectroscopy | **18hours** |
| **Unit-III** | General principle of electrophoresis, support media (agarose and polyacrylamide gels), electrophoresis of proteins by SDS-PAGE, native PAGE, gradient gels, isoelectric focusing, two dimensional PAGE, electrophoresis of nucleic acids using agarose gel, PFGE, FIGE, CHEF, capillary electrophoresis. | **18hours** |
| **Unit-IV** | Principles of chromatography, distribution coefficient, retention time, capacity factor, plate height and resolution, peak broadening and van Deemter plot, TLC and column chromatography, matrix materials, HPLC, Affinity chromatography, ion exchange chromatography, gel exclusion chromatography and Gas chromatography |  |
| **Unit-V** | Differential thermal analysis techniques. Differential scanning calorimetry - instrumentation & application. Differential thermal analysis - instrumentation & application, DTA curve. Thermogravimetry – instrumentation & application, TG curve. | **18hours** |
| **Unit-VI** | Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation. | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS:**

1. Willard H.W., Merritt L.L., Dean J.A. & Settle F.A “Instrumental Methods of Analysis”, East West

Publishers, 6th Edition. 2004

1. Skoog, D.A. F. James Holler, and Stanky, R. Crouch “Instrumental Methods of Analysis”.

Cengage Learning, 2007

**REFERENCE BOOKS:**

1. Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. “Bioseparations: Science and Engineering”,

Oxford University Press, 2006.

1. Wilson K. and Walker J. “Principles and Techniques of Biochemistry and Molecular Biology”,

Cambridge University Press, 6th edition, 2005

**Web Sources**

**https://archive.nptel.ac.in/courses/104/106/104106075/**

https://nptel.ac.in/courses/104108078

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**OPEN ELECTIVE 2:BIOCHEMICAL THERMODYNAMICS**

Papercode:Subject:**BIOCHEMICAL THERMODYNAMICS**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on solve problem in realistic cases by applying thermodynamics,and to estimate thermodynamic properties of substances in gas and liquid states.

**CourseObjectives**

1. Tolearnthebasic concept laws of thermodynamics
2. TodevelopknowledgeonPartial molar properties

3.Tounderstand the basic concept on General criterion for equilibrium and their application

4.Tounderstand the basic concept on Equilibrium conversion in single and multiple reactions

5.Todevelopapieceofknowledgeon Stoichiometry.

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoIllustrate the application of thermodynamics

in design & operation of process industries

1. Aftercompleting unit2,thestudentswillbeabletoknow Design & solve problem in realistic cases by applying thermodynamics concepts
2. .Aftercompletingunit3,thestudentswillbe know estimate thermodynamic properties of substances in gas and liquid states
3. Aftercompleting unit4,thestudentswillbe know about interpret the phase equilibria concepts in multi-component systems
4. .Aftercompleting unit5,thestudentswillbe know about understand about biochemical equilibrium and able to calculate the kinetics of biological systems

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Review of laws of thermodynamics and their applications; thermodynamic analysis of processes. Thermodynamic properties of fluids and their interrelationship: PVT behavior of pure substances; Equation of state; Generalized correlations and acentric factor; Thermodynamics charts; Estimation of thermodynamic properties | **18hours** |
| **Unit-II** | Partial molar properties; Chemical potential; Gibbs-Duhem equation; Ideal and non-ideal solutions; Fugacity and fugacity coefficient; Activity and activity coefficient; Excess properties of mixtures. | **18hours** |
| **Unit-III** | General criterion for equilibrium and their application; Stability constraints; Gibbs phase rule and its derivation for reacting and non-reacting systems; Vapour-liquid, liquid-liquid, and vapour-solid equilibrium for ideal and non-ideal systems. | **18hours** |
| **Unit-IV** | Chemical equilibrium constants; Homogeneous and heterogeneous reactions; Standard Gibbs free energy change; Equilibrium conversion in single and multiple reactions. Thermodynamics of microbial growth stoichiometry, maintenance, Calculation of the Operational Stoichiometry of a growth process including Heat using the Herbert – Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation. |  |
| **Unit-V** | Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). GibbsHelmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids. | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**:

1. Smith J.M, Van Ness H.C, Abbott M.M, “Introduction to Chemical Engineering Thermodynamics”,

McGraw-Hill, 7th edition, 2005

1. Narayanan K.V, “A Text Book of Chemical Engineering Thermodynamics”, Prentice Hall of India,

2nd edition, 2013.

1. Christiana D Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”,

CRC Press Taylor & Francis, 1st edition, 2010.

**REFERENCE BOOKS:**

1. Hougen O.A., Watson K.M., and Ragatz R.A., “Chemical Process Principles Part II”, John Wiley & Sons,

2ndedition. 2004.

1. Sandler S.I. “Chemical and Engineering Thermodynamics”, John Wiley & Sons, 4thedition, 2006.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER III**

**OPEN ELECTIVE 3:BIOPROCESS PRINCIPLES**

Papercode:Subject:**BIOPROCESS PRINCIPLES**

**Hours/Week:5 Credits:2**

# Aim: To enable the students to understand the basic concepts on Production of Ethanol,Optimization of Amylase production by Plackett and Burman method,Stoichiometry of cell growth and product formation,Modes of operation.

**CourseObjectives**

# 1.Tolearnthebasic concept the basic principles of fermentation process

2.Todevelopknowledgeonthe basic configuration and parts of a fermentor.

3.Tounderstand the basic concept on the basics of metabolic stoichiometry and microbial kinetics in batch, fed-batch and continuous mode of operation.

4.Tounderstand the basic concept on Stoichiometry of cell growth and product formation.

5.Todevelopapieceofknowledgeon Modes of operation.

# CourseOutComes

1.Aftercompletingunit1,thestudentswillbeableto the general requirements of a fermentation process.

2.Aftercompleting unit2,thestudentswillbeabletoknow the basic configuration of a fermentor and

its ancillaries.

3.Aftercompletingunit3,thestudentswillbe know demonstrate an ability to design good media.

4.Aftercompleting unit4,thestudentswillbe know about explain the sterilization kinetics and design the sterilization equipment for batch and continuous process.

5.Aftercompleting unit5,thestudentswillbe know about able to model microbial growth, substrate utilization and product formation.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | General requirements of fermentation processes, Basic concepts of Upstream and Downstream processing in Bio process, Process flow sheeting – block diagrams, pictorial representation, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes | **18hours** |
| **Unit-II** | Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentation – medium optimization methods- OFAT, PB , RSM. Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, sterilization of air, design of sterilization equipment for batch and continuous process. | **18hours** |
| **Unit-III** | Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass and available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients, energetic analysis of microbial growth and product formation, Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth. |  |
| **Unit-IV** | Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth – Monod model, Growth of filamentous organisms and yeast, Product formation kinetics – Leudeking - Piret models, substrate and product inhibition on cell growth and product formation. | **18hours** |
| **Unit-V** | Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS:**

1. Peter F. Stanbur.,, Stephen J. Hall ., A. Whitaker., “Principles of Fermentation Technology”, Science & Technology Books. 2007.

1. Shuler., Michael L., FikretKargi . “Bioprocess Engineering”, Prentice Hall, 2008.
2. Doran M Pauline., “Bioprocess Engineering Principles”, Elsevier, 2 nd Edition, 2018.

**REFERENCE BOOKS:**

1. Bailey, James E., David F. Olli., “Biochemical Engineering Fundamentals”, 2 nd Edition. McGraw Hill, 1986.
2. Blanch H. W., Clark D. S., “Biochemical Engineering”, 2nd Edition, CRC Press. 2007.
3. Rajiv Dutt., “Fundamentals of Biochemical Engineering”, Springer, 2008.
4. Ghasem D. Najafpour., “Biochemical Engineering and Biotechnology”, Elsevier, 2007.

5. D.M. Himmelbla, “Basic principles and calculations in chemical Engineering”, 6th edition, Pearson education,2006.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**PRACTICALS –III (4 credits)**

**Environmental Biotechnology**

**Taxonomic characterization of individual micro-organisms or Metagenomic DNA analysis**

• Isolation of genomic DNA of an isolated micro-organism from environmental sample using kit and

manual method OR Isolation of metagenomic DNA from environmental sample (soil/water) using kit and manual method

• Quantitation of isolated DNA by spectrophotometer/nanodrop

• Designing of universal, bacteria or archaeal specific standard 18S rRNA primers by bioinformatics software and manual method

• Amplification of 18S rRNA sequence from isolated DNA by Polymerase Chain reaction (PCR) a) Bioinformatic analysis of obtained 18S rRNA sequence and construction of phylogenetic tree using MEGA 5.0 to obtain the taxonomic identification and closest neighbor or 18S rRNA based classification of soil microorganisms

• Characterization of isolated micro-organism for morphological, biochemical, physiological, chemotaxonomic and genotypic information for designation of taxonomic genus and species name.

• Amplified Ribosomal DNA Restriction Analysis (ARDRA) of the PCR amplified 18S rRNA using tetracutter restriction enzymes and pattern analysis by preparation of cladogram b) Bioinformatic analysis of obtained 18S rRNA sequence and construction of phylogenetic tree using MEGA 5.0 to obtain the taxonomic identification and 18S rRNA based classification of soil microorganisms

**2.Environmental Monitoring Techniques**

1. Water and waste water quality test methods:
2. Physical parameters: pH / conductivity / turbidity/colour, hardness/TDS / TSS
3. Chemical parameters: CO2 / alkalinity / chlorides /. Nitrate/Nitrite/NH4 + /PO4 2- / /F/Cl
4. Biological parameters: DO / BOD / COD /
5. Evaluation of bacterial count by calculating the MPN index and isolation of fecal coliform (byMPN methods using selective media) for water potability from drinking water and environmental sources

v. Estimation of total bacterial (microbial load) count, isolation of coliphage estimation of PFU/ml (plaque forming units) from sewage water.

b) Soil analysis (physical and chemical parameters): water holding capacity, moisture, above mentioned tests for water analysis, estimation of pesticides and chemicals, estimation of metal ions by atomic absorption spectroscopy (demo). c)Solid waste characterization (physical and chemical parameters)

3. Degradation of pesticides (organochlorine/organophosphate) in soil by microorganisms and analysis of degradation by gas chromatography/HPLC.

**ENVIRONMENTAL MONITORING AND QUANTITATIVE ANALYSIS. (3 credit)**

**QUANTITATIVE ANALYSIS**

Gas chromatographic techniques

Titrimetric methods

Colorimetric methods

AA Spectrophotometric analysis

HPLC techniques

Ion exchange chromatography

Electrophoresis methods

PCR technique

**ENVIRONMENTAL MONITORING USING REMOTE SENSING**

Remote Sensing – Raster Analysis

Remote Sensing – Vector Analysis

GIS Analysis

GPS in Remote Sensing Analysis

Modeling  Air Pollutant analysis

**Books/ Manuals Recommended:**

Sawyer C., McCarty, P. and Parkin G. (2003). Chemistry for Environmental Engg. & Science, Tata McGraw Hill PublishingPvtLmt (5th Edition). pp 752.

Swamy K. K. Env. Engineering Lab Manual-. PatnaikP(1997). Handbook of Environmental Analysis- Lewis Pub.

**SEMESTER IV**

**CORE PAPER 3:CHEMICAL REACTION ENGINEERING**

# Papercode:Subject:CHEMICAL REACTION ENGINEERING

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts on Process calculations and Heat transfer Biochemical Thermodynamics , Mass Transfer Operations

**CourseObjectives**

# 1.Tolearnthebasic concept thein reaction kinetics

2.Todevelopknowledgeonthe basic develop knowledge for design of ideal reactors

3.Tounderstand the basic concept on the basics understand the practical aspects of Non-Ideal flow.

4.Tounderstand the basic concept on Gas - Liquidreaction

5.Todevelopapieceofknowledgeon General characteristics and classification of catalysis

# CourseOutComes

1. .Aftercompletingunit1,thestudentswillbeableto Concentration and temperature dependent

term of rate equation

1. .Aftercompleting unit2,thestudentswillbeabletoknow Ideal batch reactors – steady

state MFR & PFR

1. .Aftercompletingunit3,thestudentswillbe know RTD of fluid in vessel
2. Aftercompleting unit4,thestudentswillbe know about Absorption combined with chemical reaction
3. Aftercompleting unit5,thestudentswillbe know about Catalysis-General characteristics and

classification of catalysis

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Concentration and temperature dependent term of rate equation – searching for mechanism – predictability of reaction rate from theory; Interpretation of batch reactor data – constant volume and variable volume batch reactors – temperature and reaction rate - development of rate equations for different homogeneous reactions (up to second order reactions both reversible and irreversible reactions) | **18hours** |
| **Unit-II** | Ideal batch reactors – steady state MFR & PFR – holding time for flow systems; Design for single reactions - performance equations for single reactors – size comparison of single reactors – MFR vs PFR for first and second order reactions – multiple reactor systems -graphical comparison; RTD of fluid in vessel – relationship between F,C& E curve – conversion from tracer information - non-ideal flow models – Dispersion model and Tanks in series Model. | **18hours** |
| **Unit-III** | Absorption combined with chemical reaction. Mass transfer coefficients and kinetic constants. Application of film penetration and surface renewal theories. Hatta number and enhancement factor for first order reaction |  |
| **Unit-IV** | Catalysis-General characteristics and classification of catalysis-Physical adsorption and chemisorptions- Adsorption isotherms-Determination of surface area of a catalyst-Classification of catalyst-catalyst preparation- Mechanism of Catalyst deactivation-Pore diffusion resistance combined with surface kinetics-performance equations for reactors containing porous catalyst particles | **18hours** |
| **Unit-V** | Thermal stability of reactors and optimal temperature progression for first order reversible reactions, Adiabatic and heat regulated reactions, Design of non-isothermal reactors, Effect of temperature on product distribution for series and parallel reactions. | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS**:

1. Levenspiel O, “Chemical Reaction Engineering”, John Wiley, 3rd Edition, 1999

2. Fogler H.S, “Elements of Chemical Reaction Engineering”, Prentice Hall of India, 4th edition, 2002.

**REFERENCE BOOKS**:

1. Missen R.W., Mims C.A., Saville B.A., “Introduction to Chemical Reaction Engineering and Kinetics”. John Wiley & Sons, 1st Edition, 1999.
2. Froment. G.F., Bischoff K.B., “Chemical Reactor Analysis and Design”, John Wiley and Sons, 3rd Edition, 2010.
3. James B.R., John G. E., “Chemical Reactor Analysis and Design Fundamentals”, Nob Hill Publishers, 1stEdition, 2002

**Web Sources**

**https://www.hindawi.com/journals/bmri/2020/1870807/**

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**MOOC-MASSIVEOPENONLINECOURSES**

**USRR(UNIVERSITYSOCIALRESPONSIBILITYREPORT)**

TheaimoftheFieldStudyistohelpstudentsconnectwiththesocietyintherespectivediscipline.FollowingaretheimportantfeaturesoftheFieldStudyandtheUSRR:

* 1. **Aim:** The Field Study must aim at relating the subject of study with the society in so far as theapplicationandtheusefulnessofthestudyareconcerned
  2. **Topic selection:** The topic for the Field Study must be chosen by the student in the second semester inthe month of February; the process for the same shall begin on 1st February and shall end on the lastworking day of the month of February. Students are free to select the topic for the Field Study inconsultation with the Experts and Faculty Members of their choice, both from within and outside theUniversity
  3. **Period and duration:** The Field Study shall be undertaken for a duration of 15 days in the summervacation that falls immediately at the end of the second semester of the program and the same should beaccountedfortheThirdSemesteroftheprogram
  4. **USRR:** The USSR (University Social Responsibility Report) must be prepared by every student of theprogramwrittenin50to75pages.Thereportshallbewrittenbasedonthestandardresearchmethodology.

# Reviewandevaluationschedule:

* + 1. ***ReviewingtheFieldwork:***FirstweekofJuly
    2. ***ReportReview:*** SecondweekofAugust
    3. ***Reportsubmission:***FirstweekofSeptember
    4. ***ReportEvaluation:*** ThirdweekofSeptember
  1. **Faculty Composition:** The following members may be nominated for confirming the topic and forevaluatingtheUSRR:
     1. ProfessorandHeadoftheconcernedDepartment
     2. OneFacultymemberwithrelatedfieldofspecializationfrom theconcernedDepartment
     3. OneseniorfacultymemberfromtheDepartmentofSociologyfromotherInstitution

**SEMESTER IV**

**CORE ELECTIVE 1:BIOFUELS**

# Papercode:Subject:BIOFUELS

**Hours/Week:5 Credits:4**

# Aim: To enable the students to understand the basic concepts to understand the fundamental concepts in biofuels/ bioenergy, the production mechanisms of different types of biofuels, the knowledge related to processing technologies of biofuels.

**CourseObjectives**

# 1.Tolearnthebasic concept the biofuels

2.Todevelopknowledgeonthe basic bioenergy

3.Tounderstand the basic concept on the basics different types of biofuel

4.Tounderstand the basic concept on processing technologies of biofuels,

5.TodevelopapieceofknowledgeonEnergy

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeableto Problems relating demand and supply of

various energy sources-Coal-Petroleum.

1. Aftercompleting unit2,thestudentswillbeabletoproduction mechanisms by microbes
2. Aftercompletingunit3,thestudentswillbe know Sources and processing of biodiesel
3. Aftercompleting unit4,thestudentswillbe know about Gasification processes
4. Aftercompleting unit5,thestudentswillbe know about Analysis of both current and future Indian regulations

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Introduction-resources-renewable and non-renewable resources (water, minerals, and energy) use and overexploitation; Classification and sources of energy; Problems relating demand and supply of various energy sources-Coal-Petroleum. | **18hours** |
| **Unit-II** | First generation biofuels-bioethanol – production mechanisms by microbes; Second generation biofuels-methane and hydrogen – production mechanisms by microbes; Factors affecting biogas yields; Third generation biofuels-biobutanol-biodesel from algae; Fourth generation biofuels- solar to fuel method to produce biofuels.  Sources and processing of biodiesel (fatty acid methyl ester); Sources and characteristics of lipids for use as biodiesel feedstock and conversion of feedstock into biodisel (transesterification); Biomethane or biogas-hydrolysis-anaerobic digestion-methanogenesis (acetoclastic, hydrogenotrophic) - rates of methane formation-one and two stage fermentation. | **18hours** |
| **Unit-III** | Gasification processes and the main types of gasifier designs-production of electricity by combining a gasifier with a gas turbine or fuel cell; Combined-cycle electricity generation with gas and steam turbines and generation of heat and steam; Fast pyrolysis technology to produce liquid bio oil or pyrolysis oil (synthetic oil) from biomass-refined to produce a range of fuels- chemicals and fertilizers |  |
| **Unit-IV** | Analysis of both current and future Indian regulations - directives on biofuels and bioenergy; Evaluation of different production alternatives to produce bioenergy; Evaluation of current and future R&D needs-legal framework to support sustainable development and increased use of biofuels; Government policies and programs with regard to biofuels and investment opportunities worldwide | **18hours** |
| **Unit-V** | Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feedstocks prior to production of the Biodiesel − Current technologies of biodiesel production − Purification of biodiesel; Industrial production of biodiesel − Biodiesel production from single cell oil. | **05hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS:**

1. Samir K. Khanal, “Bioenergy Production: Principles and Applications”, Wiley-Blackwell Publishing, 1st edition, 2018
2. David M. Mousdale, “Biofuels: Biotechnology, Chemistry, and Sustainable Development”, CRC Press Taylor and Francis group,1st edition, 2008

3. Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.), “Biofuel Technologies Recent Developments, Springer, 1st edition, 2013

**REFERENCE BOOKS:**

1. Robert C. Brown, “Biorenewable Resources: Engineering New Products from Agriculture”, Wiley-Blackwell Publishing, 2nd edition, 2014.
2. Pogaku, Ravindra, Sarbatly, RosalamHj. (Eds.), “Advances in Biofuels”, Springer, 2013.
3. Martin Kaltschmitt and Hermann Hofbauer, “Biomass Conversion and Biorefinery”, Springer Publishing, 2008.
4. B Pandya, “Conventional Energy Technology - Fuels and chemical Energy”, TMH(1987)

5. S.P. Sharma and Chander Mohan, “Fuels and Combustion”, TMH, 1stediton, 1984 6. Kash Kori, C, “Energy resources, demand and conservation with special reference to India”, TMH, 1st edition, 1975.

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER IV**

**CORE ELECTIVE 2:BIOPOLYMER TECHNOLOGY**

Papercode:Subject:**BIOPOLYMER TECHNOLOGY**

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts to understand the different types of biopolymers in biomedical applications, environmental protection, application of bio surfactant in food industry and to examine the different properties and market analysis through case studies

**CourseObjectives**

# 1.Tolearnthebasic concept the different types of bio polymers

2. Todevelopknowledgeonthe basic environmental protection

3.Tounderstand the basic concept on the basics surfactant in food industry

4.Tounderstand the basic concept on market analysis

5.Todevelopapieceofknowledgeon Fermentability of Biodegradable Materials

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletoemploy the greener technologies to

solve the environmental issues

2.Aftercompleting unit2,thestudentswillbeableto familiar the different types of plant and animal derived bio polymers and their application as commercial bio plastics

3.Aftercompletingunit3,thestudentswillbe know illustrate the synthesis and application of bio polymers in nanoscale drug delivery systems, as bio mimetic materials and waste water treatment methods.

4.Aftercompleting unit4,thestudentswillbe know about understand the properties of biosurfactants and their use in food industries

5..Aftercompleting unit5,thestudentswillbe know about to evaluate the tensile strength, hydration, viscoelastic properties using different testing methods.

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Biopolymers - definition, Plant and Animal biopolymers- poly nucleotide, poly amides, polysaccharides, poly isoprene, lignin, poly phosphate and polyhydroxyalkanoates. Application and chemical synthesis of super absorbent polymers-Polyethylene glycol, Polypropylene glycol, Polytetramethylene glycol, Poly glycerine. Bio plastics and environment, Commercial bio plastics. Natural fibers like silk, wool, flax, jute, linen, cotton, bamboo. Bio composite- properties and applications. | **18hours** |
| **Unit-II** | Industrial bio polymers: Production of poly phenol resins by the enzyme soybean per oxidase; Novel synthesis of Artificial Bio polymers in Biomedical Applications- An Overview, Hydro gel as potential Nano scale drug delivery system , Low cost foods and drugs using immobilized enzymes on Bio polymers, Physio chemical characteristics of bio polymers. Biodegradable polymers for medical purposes, Bio polymers in controlled release systems. Synthetic polymeric Membranes and their biological applications | **18hours** |
| **Unit-III** | Biosurfactants: Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and bio transformation routes; Production of Biosurfactants with immobilized cells; Integrated bio process for continuous production of Biosurfactants including downstream processing; Applications of Biosurfactants – Food Industry, Environmental Control. | **18hours** |
| **Unit-IV** | An Overview of Available Testing Methods, Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Evaluation of the properties of bio polymers to make good bio materials; Tensile strength (both elasticity and breaking strength); Hydration, visco – elastic properties; viscosity. Criteria used in the evaluation of Biodegradable polymers – petridish screen – environmental chamber method – soil burial tests etc. |  |
| **Unit-V** | Bio polymers: Synthesis from a simple biological monomer (i.e. Hyaluronate polymers); Dextran (used in chromatography columns); Rubber like materials produced by bacteria and fungi – Polyhydroxybutyrate (PHB), Polycaprolactone (PCL), Xanthan gum; Production of a co polymer of PHB and PHV(Polyhydroxyvaleric acid), sold as Bio pol by fermentation on Alcaligenes eutrophus; Biodegradable polymers. Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc. Different initiating systems such as free radicle polymerization, redox, cationic & anionic polymerization ( different terms such as living polymers, inifers, telechelics ). Their kinitics& control over structure of polymer | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS:**

1. Emo Chiellini , Helena Gil, “Bio related Polymers: Sustainable Polymer Science and Technology”, Springer 2001.
2. Johnson .R.M, L.Y. Mwaikambo and N. Tucker, “Bio polymers”, Rapra Technology, 2003

**REFERENCE BOOKS:**

1. Naim Kosaric (Ed)., “Biosurfactants”, Marcell Dekker Inc, 1993.

**Web Sources**

https://onlinecourses.nptel.ac.in/noc22\_ch28/preview

https://nptel.ac.in/courses/102104057

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 3 |
| **Weightage** | 15 | 10 | 15 | 15 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 2 | 3 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**SEMESTER IV**

**CORE ELECTIVE 3:MEDICAL BIOTECHNOLOGY**

# Papercode:Subject:MEDICAL BIOTECHNOLOGY

**Hours/Week:5 Credits:3**

# Aim: To enable the students to understand the basic concepts to understand the classification, diagnosis and therapy of pathogenic infections the concepts of stem cells and tissue engineering.

**CourseObjectives**

# Tolearnthebasic concept and to understand the classification, diagnosis and therapy for pathogenic infections

2. Todevelopknowledgeonthe stem cells and tissue engineering

3.Tounderstand the basic concept on the Monoclonal Antibodies

4.Tounderstand the basic concept on Embryonic and adult stem cells

5.Todevelopapieceofknowledgeon Vaccines

# CourseOutComes

1. Aftercompletingunit1,thestudentswillbeabletounderstand the classification, diagnosis and

therapy for pathogenic infections

1. Aftercompleting unit2,thestudentswillbeabletoexhibit knowledge on recent trends in

diagnosis of various disorders.

1. Aftercompletingunit3,thestudentswillbe know Learn the production of monoclonal antibodies

as diagnostic tools and therapeutic agents

1. Aftercompleting unit4,thestudentswillbe know about exhibit knowledge on stem cells, tissue

engineering and gene product

1. Aftercompleting unit5,thestudentswillbe know about to the types, preparation and testing of

vaccines, recombinant products and growth factors

# Matching Table (Put Yes/Nointheappropriatebox)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Unit | i.Remembering | ii.Understanding | iii.Applying | iv.Analyzing | v.Evaluating | vi.Creating |
| 1 | Yes | Yes | Yes | Yes | Yes | Yes |
| 2 | Yes | No | Yes | Yes | Yes | No |
| 3 | No | Yes | No | Yes | Yes | Yes |
| 4 | No | Yes | Yes | Yes | Yes | Yes |
| 5 | Yes | Yes | Yes | Yes | Yes | Yes |

|  |  |  |
| --- | --- | --- |
| **Units** | **CourseContents** | **Teaching hours** |
| **UnitI** | Classification of pathogenic microbes; Leptospira, Brucella, Bacillus anthraces; Medical Parasitology: Amoebiasis, Cryptoporidiosis, Giardiasis, Malaria, Toxoplasmosis; Viruses: Adenoviruses, Retroviruses; Medical Mycology: Superfical Mycoses, Subcutaneous Mycoses, Systemic Mycoses | **18hours** |
| **Unit-II** | Prenatal diagnosis: Invasive techniques - Amniocentesis, Fetoscopy; Non-invasive techniques – Ultrasonography, X-ray, Diagnosis using protein and enzyme markers, DNA/RNA based diagnosis; Hepatitis, HIV - CD 4 receptor; Microarray technology in cancer diagnosis. Genetic disease, type of inheritance, single-gene and multifactorial inheritance, example of genetic diseases. Therapeutic intervention in blood disorder by stem cell transplantation/gene therapy | **18hours** |
| **Unit-III** | Monoclonal Antibodies: Production, Target drug delivery using monoclonal antibodies; Gene Therapy: types, vectors used in gene therapy; Immunotherapy in cancer; Application of nano biosystems in diagnosis and therapy. | **18hours** |
| **Unit-IV** | Embryonic and adult stem cells: Totipotent, pluripotent and multipotent cells: Testing and generation of embryonic stem cells; Potential uses of stem cells: cell based therapies and clinical applications. Biomaterials: Characterization, Host reactions, Extracellular matrix, Scaffolds, Artificial organs, Applications. |  |
| **Unit-V** | Vaccines- Preparation and testing, standardization and storage study; New generation of vaccines: Hepatitis, AIDS, Malaria; Minicells as vaccine; Production of recombinant pharmaceutical products–Biotechnologically derived products (therapeutic proteins): Interferons, Interleukins, Insulin, Growth Hormones; Recombinant coagulation factors and thrombolytic agents, Somatostatin, Somatotropin, Ketopeptide | **18hours** |
| **TotalTeachinghours** | | **90** |

**InternalAssessmentMethods:(25 marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distributionfor  internals | Test(CIAI+CIA  II+CIAIII) | Seminars | Assignment | Totalmarks |
| Marks | 15 | 05 | 05 | 25 |

**TEXT BOOKS:**

1.JuditPongracz, Mary Keen, “Medical Biotechnology”, Elsevier Health Sciences, 2009.

2. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten, “Medical Biotechnology”, ASM Press, Washington DC, 2014

**REFERENCE BOOKS:**

1. Albert Sasson , “Medical biotechnology: achievements, prospects and perceptions”, United Nations University Press, 2005.
2. Yuan Kun Lee, “Microbial biotechnology: principles and applications”, World Scientific, Edition 2006.

**Web Sources**

# https://onlinecourses.nptel.ac.in/noc22\_bt39/preview

https://ocw.mit.edu/courses/7-013-introductory-biology-spring-2013/resources/lecture-23-stem-cells/

# MappingwithProgrammeOutcomes

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

**Strong - 3, Medium – 2, Low - 1**

# MappingwithProgramme SpecificOutcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CO/PSO** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 |
| **Weightage** | 15 | 15 | 10 | 10 | 15 |
| **Weighted percentage (rounded of) Course Contribution to POs** | 3 | 3 | 2 | 2 | 3 |

**Strong - 3, Medium – 2, Low - 1**

**PROJECT (8 credit)**

****