# NEHRU ARTS AND SCIENCE COLLEGE

**(Autonomous)**

**Reaccredited by NAAC with 'A' Grade, Certified by ISO 9001:2008 &14001:2004**
**Recognized by UGC & Affiliated to Bharathiar University**
Nehru Gardens, Coimbatore-641 105

## Scheme of Examination

**M. Sc. Biotechnology**
(Applicable to the students admitted during the Academic Year 2020-2021 onwards)

| Semester | Course Code | Name of the Course | Ins. Hrs / Week | Duration of Examination | Exam | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total | |
| I | 18PGBTC101 | Paper – I Molecular Biology and Genetics | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC102 | Paper – II Biochemistry | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC103 | Paper – III Microbiology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC104 | Paper – IV Bioinstrumentation & Biostatistics | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTQ201 | Practical – I Biochemistry and Industrial Biotechnology | 5 | - | - | - | - | - |
| | 20PGBTQ202 | Practical – II Microbiology and rDNA Technology | 5 | - | - | - | - | - |
| | 18PGBTE101/102/103 | Discipline Specific Elective Paper – I | 4 | 3 | 25 | 75 | 100 | 4 |
| | | | **30** | | | | **500** | **20** |
| II | 20PGBTC205 | Paper – V Plant Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 20PGBTC206 | Paper – VI Genetic Engineering | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC207 | Paper – VII Industrial Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC208 | Paper – VIII Bioethics, Biosafety & IPR | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTQ201 | Practical – I Biochemistry and Industrial Biotechnology | 5 | 6 | 40 | 60 | 100 | 4 |
| | 20PGBTQ202 | Practical – II Microbiology and rDNA Technology | 5 | 6 | 40 | 60 | 100 | 4 |
| | 18PGBTE201 / 202 / 203 | Elective Paper – II | 4 | 3 | 25 | 75 | 100 | 4 |
| | 20PGBTONLC | Online Course | - | - | - | - | - | - |
| | | | **30** | | | | **700** | **28** |
| III | 19PGBTC309 | Paper – IX Immunology and Immunotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 19PGBTC310 | Paper – X Animal Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 19PGBTC311 | Paper – XI Pharmaceutical Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| | 18PGBTC312 | Paper – XII Bioinformatics and System Biology | 4 | 3 | 25 | 75 | 100 | 4 |
| | I9PGBTQ403 | Practical III – Plant and Animal Biotechnology | 5 | - | - | - | - | - |
| | I9PGBTQ404 | Practical IV – Immunology and Pharmaceutical Biotechnology | 5 | - | - | - | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 19PGBTE301 / 302 / 18PGBTE 303 | Elective Paper – III | 4 | 3 | 25 | 75 | 100 | 4 |
| | 19PGBTT301 | *Internship Training | - | - | External | | 50 | 2 |
| | 20PGBTONLC | Online Course | - | - | - | - | - | - |
| | | | **30** | | | | **550** | **22** |
| IV | 19PGBTV401 | **Research Project and Viva-Voce | 16 | - | 80 | 120 | 200 | 8 |
| | 19PGBTE401 / 18PGBTE 402 / 18PGBTE403 | Elective Paper – IV | 4 | 3 | 25 | 75 | 100 | 4 |
| | I9PGBTQ403 | Practical III – Plant and Animal Biotechnology | 5 | 6 | 40 | 60 | 100 | 4 |
| | I9PGBTQ404 | Practical IV – Immunology and Pharmaceutical Biotechnology | 5 | 6 | 40 | 60 | 100 | 4 |
| | | | **30** | | | | **500** | **20** |
| | | | | | | **TOTAL** | **2250** | **90** |
| | Advanced Learners Courses for Additional Credits | | 2 Credits / Paper | | | | - | 8[$] |

[$] **Not included in CGPA calculation**

* **Internship Training:**

Industrial Training has to be undergone during II semester vacation period (15 days). Mark shall be given based on training report and presentation

** **Research Project and Viva-Voce:**

1) Project is pertain to the field of Biotechnology

2) Three review meetings should be conducted in the presence of HoD and respective guide.

| Project | Maximum Marks |
|---|---|
| Review I (Last week of December) | 20 |
| Review II (Last week of January) | 20 |
| Review III (Last week of February) | 20 |
| Document preparation and Implementation (First week of March) | 20 |

| | |
|---|---|
| Dissertation evaluation | 80 Marks |
| Viva-Voce | 40 Marks |

**List of Discipline Specific Elective Papers**

| Elective | Course Code | Group | Name of the Course |
|---|---|---|---|
| Elective – I | 18PGBTE101 | A | Environmental Biotechnology |
| | 18PGBTE102 | B | Bioentrepreneurship |
| | 18PGBTE103 | C | Research Methodology |
| Elective – II | 18PGBTE201 | A | Agricultural Biotechnology |
| | 18PGBTE202 | B | Down Stream Processing |
| | 18PGBTE203 | C | Applied Biostatistics |
| Elective – III | 19PGBTE301 | A | Food Biotechnology |
| | 19PGBTE302 | B | Quality Control and Assurance |
| | 18PGBTE303 | C | Bioinformatics and Molecular Biology Databases |
| Elective – IV | 19PGBTE401 | A | Clinical Pathology and Diagnosis |
| | 18PGBTE402 | B | Occupational Health and Industrial Safety |
| | 18PGBTE403 | C | Drug Designing and Molecular Modeling |

**List of Advanced Learners Course [Self study]**

| S. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | 18PGBTSS01 | Cell Communication and Cell Signaling |
| 2. | 18PGBTSS02 | Diversity of Life Forms |
| 3. | 18PGBTSS03 | Ecological Principles |
| 4. | 18PGBTSS04 | Applied Biology |
| 5. | 18PGBTSS05 | Histochemical and Immunological Techniques |

**Chairman**
**Board of Studies in Biotechnology Nehru**
**Arts and Science College Coimbatore**

## Programme Outcomes

**PO1 Science Knowledge:** Apply the knowledge of science, biological fundamentals, and a biotechnological specialization to the solution of complex biological problems

**PO2 Ethics:** Apply reasoning informed by the appropriate knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the biotechnology practice

**PO3 Effective Citizenship:** Understand the impact of the bioscience solutions in societal and environmental contexts, and demonstrate the knowledge, and need for sustainable development

**PO4 Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## Programme Specific Outcomes

**PSO1** Demonstrate the ability to design, conduct experiments and analyze data in the field of Biotechnology

**PSO2** Ability to apply Biotechnology tools in biological research

**PSO3** To make them independently carry out research & development work to solve practical problem

**PSO4** To have successful career as professional or a researcher through lifelong learning in the field of biotechnology

**PSO5** To make them capable in decision making at personal and professional level

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC101 | Paper – I Molecular Biology | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To provide knowledge of molecular biology and genetics of prokaryotic and eukaryotic organisms to the students.

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Tell about basic genetics concept the structure of genes and chromosomes |
| **CO2** | Explain the changes in genes and its phenotypic effects |
| **CO3** | Illustrate the process of replication and gene expression |
| **CO4** | Examine the process of recombination and mutation and infer its outcome |
| **CO5** | Distinguish the different models of recombination |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Gene Structure:** Fine structure of gene, split genes, pseudogenes, overlapping genes and multigene families. DNA and RNA as genetic material; Chemistry and structure of DNA. | 1 | 1 |
| | **Chromosome:** Structure, organization, banding, karyotyping, and labeling. Special types of chromosome - sex chromosomes, B-chromosome, polytene and lambrush chromosomes | 1 | 1 |
| | **Instructional Hours** | | **12** |
| II | **Genes for Development:** Genes for development in Drosophila and Arabidopsis, Fertilization and Development; genetic control of X inactivation; in vitro fertilization and embryo transfer. | 3 | 8 |
| | Numerical and structural changes in the chromosome, Techniques in the study of chromosomes and applications. | 3 | 9 |
| | **Epigenetics:** Gene expression without a change in DNA sequence changes in gene expression arising from chemical modification of DNA or histone proteins. | 4 | 3 |
| | **Instructional Hours** | | **12** |
| III | **DNA replication in prokaryotes and eukaryotes:** mechanism of replication, Meselson and Stahl experiment; Transcription – steps, eukaryotic promoters, enhancers, transcription factors, post transcriptional modifications. | 2 | 4 |
| | **Translation:** Prokaryotes and eukaryotes translation and their regulation, post translational modifications, | 2 | 4 |

| | | | |
|---|---|---|---|
| | Regulation of gene expression in prokaryotes and eukaryotes. | | |
| | **Instructional Hours** | | **12** |
| **IV** | **Gene Mutation and its mechanism:** Types of mutation: Forward; Reverse; Intragenic suppressor; Extragenic suppressor; point mutations; Missense; Nonsense; Somatic versus germinal mutation. Mutagenesis- spontaneous and induced. | 4 | 8 |
| | **DNA repair mechanisms:** Direct reversal; Excision repair (base excision, nucleotide excision and mismatch); recombinational repair; SOS response and SOS bypass. | 4 | 15 |
| | **Instructional Hours** | | **12** |
| **V** | **Recombination:** Models; Rec A, Rec BCD, Ruv ABC, and molecular mechanism of Recombination. | 4 | 18 |
| | Conjugation; transformation and transduction. Transposons - simple and complex in prokaryotic and eukaryotic systems. | 3 | 9 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Benjamin Lewin, **Genes VI,** Published by Oxford University Press, U.K., 6th Edition, 1997.
2. Darnell, Lodish, Baltimore, **Molecular Cell Biology,** Published by Scientific American Books, Inc., 1994.
3. Benjamin A Pierce, **Genetics: A Conceptual Approach** by Published by Freeman and Company, New York, 2nd Edition, 2005.
4. William S. Klug & Michael R. Cummings, **Essentials of Genetics,** Prentice Hall Internationals, 2nd Edition, 1996.

Unit I : Text Book 1, Chapter 1: 2-26, 98-189
Unit II : Text Book 3 & 4, Chapter 8 & 9: 240-272; Chapter 3: 53-73
Unit III: Text Book 2, Chapter 4: 259-309
Unit IV: Text Book 4, Chapter 8 & 15: 120-147
Unit V : Text Book 3 & 4, Chapter 18: 216-227; Chapter 9: 149-163


**Reference Book(s):**


1. Brown, T. A., **Genomes 2,** Published by Garland Science Publishing, New York. 2002.
2. Gerald Karp, **Cell and Molecular Biology,** Published by John Wiley, 6th Edition, 2009.
3. Bruce Alberts, **Molecular Biology of the Cell**, Published by Garland Science, Taylor & Francies, 2014.
4. https://pdfs.semanticscholar.org/a610/f4e5b9797218bd6ecbfd597787129deaf78f.pdf
5. https://www.youtube.com/watch?v=aWpAe3rc5BU

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Model | Viva voce | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | M | L | L | L | H | M | L | L | M |
| **CO2** | M | L | L | M | M | L | L | L | L | M | M | L | M |
| **CO3** | L | H | M | M | L | M | L | M | H | H | H | M | M |
| **CO4** | L | L | L | M | L | H | M | L | L | H | H | M | L |
| **CO5** | M | M | L | L | M | L | L | M | H | L | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC102 | Paper – II Biochemistry | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understand the structure of atoms, molecules and chemical bonds, enzyme kinetics, biochemical concepts and techniques which will be necessary for future scientific endeavors.

**Course Outcomes:**

On the successful completion of the course the students will be able to

| | |
|---|---|
| **CO 1** | Known phenomena, laws, rules, definitions and physical quantities related to biochemistry |
| **CO 2** | Have the knowledge of the biochemical bases of human motoricity |
| **CO 3** | Integrate the various aspects of metabolism and their regulatory pathways |
| **CO 4** | Have the ability to biochemical analysis of the basic forms human movement |
| **CO 5** | Find information related to the issues of biochemistry |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Structure of**: Atoms, molecules and chemical bonds | 1 | 1 |
| | Classes of organic compounds and functional groups | 1 | 1 |
| | **Covalent and Noncovalent interactions** - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions | 1 | 1 |
| | Respiration and photosynthesis. Energy metabolism (concept of free energy) | 1 | 13,14 |
| | Principles of thermodynamics | 1 | 11,13 |
| | Kinetics, dissociation and association constants | 1 | 5 |
| | **Instructional Hours** | | **12** |
| II | **Carbohydartes -** classification | 1,2 | 1,13 |
| | Glycolysis | 2 | 17 |
| | TCA cycle | 2 | 16 |
| | Glycogen breakdown and synthesis | 2 | 18 |
| | Gluconeogenesis | 2 | 19 |
| | interconversion of hexoses and pentoses | 2 | 20 |
| | Co-ordinated control of metabolism | 2 | 20 |
| | Oxidation of fatty acids | 2 | 22 |
| | **Biosynthesis of fatty acids:** Triglycerides; Phospholipids; Sterols | 2 | 21 |
| | **Instructional Hours** | | **12** |
| III | **Amino acids and peptides** - classification | 2 | 3 |
| | Peptide bond, protein synthesis. | 2 | 3 |
| | Classifications and functions of proteins. | 2 | 3 |

| | | | |
|---|---|---|---|
| | Structural organization of protein (primary, secondary, tertiary, quaternary and domain structure) | 1,2 | 4,5 |
| | Ramchandran map | 1,2 | 4,5 |
| | Purification and criteria of homogeneity | 1,2 | 3,4 |
| | **Instructional Hours** | | **12** |
| **IV** | **Nucleic acids:** chemical structure. | 2 | 33 |
| | Structure of double stranded DNA (B, A, C, D, T and Z DNA) | 1 | 8 |
| | Physical properties of double stranded DNA | 1 | 8 |
| | Biosynthesis of purines | 2 | 34 |
| | Biosynthesis of pyrimidines | 2 | 34 |
| | Types of RNAs and their biological significance | 1 | 8 |
| | DNA supercoiling | 1 | 24 |
| | Biochemistry and molecular basis of different disorders related to carbohydrate, protein. fat and nucleic acids | 3 | 5 |
| | Inborn errors of Protein - Phenyl ketonuria (PKU), Carbohydrate – Galactosemia, Fat - Medium & very long chain acylCoA dehydrogenase deficiency (MCAD & VLCAD) | 3 | 5 |
| | **Instructional Hours** | | **12** |
| **V** | **Enzymes and coenzymes:** Coenzymes interactions: activators and inhibitors | 2 | 7 |
| | **Mechanism of enzyme action:** Active sites, **Enzyme kinetics :** negative and positive cooperativity | 1 | 6 |
| | Kinetics of enzyme inhibitors | 1 | 6 |
| | Factors affecting enzymatic activity | 1 | 6 |
| | isoenzymes, allosteric enzymes; | 1,4 | 2,2 |
| | **Ribozyme**: hammer head, hair pin and other ribozymes, | 1,4 | 2,2 |
| | **Abzyme:** structure and drug targets (enzymes and receptors). | 4 | 8 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Albert L. Lehninger, David Lee Nelson, Michael M. Cox, **Lehninger principles of biochemistry**, Published by W.H. Freeman, 5th Edition, 2008.
2. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell, **Harper's Illustrated Biochemistry**, Published by McGraw-Hill Professional, 29th Edition, 2012.
3. Jeremy Mark Berg, John L. Tymoczko, Lubert Stryer, **Biochemistry**, Published by W. H. Freeman, 6th Edition, 2006.
4. Donald Voet, Judith G. Voet, **Biochemistry**, Published by J. Wiley & Sons, 4th Edition, 2010.


Unit I : Text Book 1, Chapter 1, 5, 11, 13, 14.
Unit II : Text Book 1, Chapter 1; Text Book 2, Chapter 13, 16, 17, 18, 19, 20, 21, 22.
Unit III: Text Book 1, Chapter 3, 4; Text Book 2, Chapter 3, 4, 5
Unit IV: Text Book 1, Chapter 8, 24; Text Book 2, Chapter 33, 34;

Text Book 3, Chapter 5.
Unit V : Text Book 1, Chapter 2, 6; Text Book 2, Chapter 7;
Text Book 4, Chapter 2, 8

**Reference Book(s):**


1. Geoffrey L. Zubay, Published by Wm.C, **Biochemistry**, Brown Publishers, 3rd Edition, 1993.
2. Burtis *et. al*., **Teitz Text book of Clinical Biochemistry**, 3rd edition, William Heinmann Medical Books, Ltd., 1999.
3. Trevor Palmer, **Enzymes: Biochemistry, Biotechnology and Clinical Chemistry**, Published by Horwood Publishing Limited, 5th Edition, 2001.
4. Varley *et. al*., **Practical Clinical Biochemistry**, volume I and II, CBS Publishers, 5th Edition, 1980.
5. Mayne, **Clinical Chemistry in Diagnosis and Treatment**, 6th Edition, ELBS Publications, 1994.
6. Mosby and Marshall, **Clinical Chemistry**, 5th Edition, 2004.
7. Bishop and Lipppincott, **Clinical Chemistry-Principles, Procedures and Correlations**, 2000.
8. https://archive.org/details/LehningerPrinciples of Biochemistry 7th Edition PDF_201803


**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Viva Voce | Model Preparation | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | M | L | M | H | L | H | L | M | M | M |
| **CO2** | M | L | M | L | L | H | L | M | H | L | M | H | M |
| **CO3** | L | M | L | M | L | L | L | L | L | H | M | L | L |
| **CO4** | M | L | M | L | L | M | H | M | H | H | M | M | L |
| **CO5** | L | L | M | L | M | L | L | L | M | L | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC103 | Paper – III Microbiology | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

Students will understand the basics of microbiology, with an emphasis on microbial growth and control.

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Recognize different types of microorganisms at the microscope |
| **CO2** | Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural similarities and differences among various physiological groups of bacteria/archaea |
| **CO3** | Apply appropriate microbiological techniques for purification |
| **CO4** | Differentiate structural and special differentiation in bacteria |
| **CO5** | Know the specific characteristic features of microorganisms |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Concepts of Microbiology:** Spontaneous generation conflict, Germ theory of diseases, Cell theory, Contributions: Antoni van Leeuwenhoek, Francesco Redi, Louis Pasteur, John Tyndall & Ferdinand Cohn, Robert Koch, Edward Jenner, Elie Metchnikoff, Joseph Lister, Paul Ehrlich, Alexander Fleming and Richard Petri. Purification of Microorganisms. Principle and nutritional requirements for Bacterial growth, Cuture media. | 1 | 1 |
| | **Instructional Hours** | | **4** |
| II | **Observing Microorganisms:** Microscopy – Introduction, Bright field, Dark Field, Phase contrast and Fluorescent. | 2 | 3 |
| | **Preparing and Staining Specimens:** Smear, Wet mount; Types of stains – Simple, Differential (Gram's and Acid fast), Special (Endospore and Flagella), Fungal staining. | | |
| | **Control of Microorganisms:** Physical methods – Heat, Filtration and Radiation; Chemical methods – Phenolics, Alcohols, Halogens and Gases | 2 | 12 |
| | **Instructional Hours** | | **16** |

| | | | |
|---|---|---|---|
| **III** | **Cell structure and Function:** Prokaryotes – Over view (Size, Shape and Arrangements), Plasma membrane, Internal membrane, Cytoplasmic inclusion bodies, Ribosomes, Nucleiod, Cell wall structure (Gram positive and Gram negative), Capsule, Slime layer, Flagella & motility, Pili and Fimbriae; Eukaryotes: Over view, Cytoplasmic matrix, Endoplasmic reticulum, Golgi apparatus, ribosomes, mitochondria, Chloroplast, Nucleus, Cilia and Flagella | 3 | 3 |
| | **Instructional Hours** | | **16** |
| **IV** | **Bacterial Taxonomy:** Outline Classification and General Characterization of Eubacteria and Archaebacterium | 1 | 20-22 |
| | **Instructional Hours** | | **12** |
| **V** | **Fungal Taxonomy**: General Properties, Classification (Alexopolus - up to class level) and Economic importance | 4 | 1-13 |
| | **Algal Taxonomy:** Classes, General characteristics and Economic importance | 5 | 18 |
| | **Classification of Protozoa** – Out line, General Characters and importance. | 5 | 19 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Joanne Willey and Linda Sherwood and Christopher J. Woolverton, **Prescott's Microbiology**, McGraw-Hill Publications, 3rd Edition, 2017.
2. Jacquelyn G. Black, Laura J. Black, **Microbiology: Principles and Explorations**, Wiley Publication, 9th Edition, 2015.
3. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, **Brock Biology of Microorganisms**, 15th Edition, Pearson Publication, 2018.
4. Constantine J. Alexopoulos, Charles W. Mims, Meredith M. Blackwell, **Introductory Mycology**, Wiley Publication, 4th Edition, 1996.
5. E.C.S. Chan, Michael J. Pelczar, Jr., Noel R. Krieg, **Microbiology**, McGraw-Hill Publications, 5th Edition, 2010.

Unit I : Text Book 1, Chapter 1: 1-17.
Unit II : Text Book 2, Chapter 3: 52-68 & Chapter 12: 346-357.
Unit III: Text Book 3, Chapter 3: 48-78.
Unit IV: Text Book 1, Chapter 20- 22: 469-538.
Unit V : Text Book 4, Chapter 1-29: 1-775 and 5, Chapter 18 & 19: 364-374


**Reference Book(s):**


1. Kathleen Park Talaro, **Foundation in Microbiology**, McGraw-Hill Publications, 9th Edition, 2015.
2. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, **Microbiology: An Introduction**, Pearson Publication, 20th Edition, 2015.
3. https://www.edx.org/learn/microbiology
4. https://study.com/articles/List_of_Free_Online_Microbiology_Courses_and_Training_Options.html
5. https://microbiologysociety.org/education-outreach/resources.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Case study | Viva voce | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | M | L | M | H | L | M | L | M | M | L |
| **CO2** | L | M | M | L | L | H | L | M | L | L | M | M | L |
| **CO3** | M | L | L | H | L | L | L | M | H | H | M | M | L |
| **CO4** | L | L | L | M | L | M | H | L | H | M | M | M | M |
| **CO5** | M | L | M | L | H | L | M | H | M | H | L | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC104 | Paper – IV Bioinstrumentation and Biostatistics | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

On successful completion of the subject, the student should have understood the analytical techniques in the field of Biotechnology

**Course Outcomes:**

After successful completion of this class, students will be able to:

| | |
|---|---|
| **CO1** | Remember specific facts, terms concepts and principles |
| **CO2** | Understand the purpose of instrumentation in bioscience |
| **CO3** | Apply concepts, calculation and principles of instruments |
| **CO4** | Critically review and analyze basic parameters of the equipment related to bioscience |
| **CO5** | Understand the application of statistical software for biological research |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Buffers and Spectrophotometry**: pH, pK, acids, bases and buffers | 1 | 1 |
| | Henderson - Hasselbach equation<br>pH meter, Colorimetry & Spectrophotometry: Principles, types and applications | 1 | 12 |
| | UV-VIS double beam spectrophotometry, Spectroflurometry, Mass spectroscopy, IR spectroscopy, Flame photometry, NMR Spectroscopy, Circular Dichroism, X- ray diffraction | 1 | 12 &13 |
| | **Instructional Hours** | | **13** |
| II | **Principles, types and applications of chromatography**: Paper chromatography, Thin layer chromatography (TLC), Size exclusion, Ion-exchange chromatography, affinity chromatography, High performance liquid chromatography (HPLC), Gas chromatography (GC), Mass spectrometry (MS). | 1 | 11 |
| | MALDI TOF | 1 | 9 |
| | **Instructional Hours** | | **12** |
| III | **Principles, types and applications of Centrifuges**: Various types of Centrifuges, Separation methods<br>**Principles, types and applications of Electrophoresis:** Agarose gel electrophoresis PAGE (SDS/Native), Gradient gel, Isoelectric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose, Capillary electrophoresis and Flow Cytometry | 1 | 3, 10 & 12 |
| | **Instructional Hours** | | **12** |

| | | | |
|---|---|---|---|
| IV | **Scope of Biostatistics And Measures of Central Tendency :**Scope of Biostatistics | 2 | 1 |
| | Measures of Central tendency – Arithmetic mean, Median and Mode. Calculation of mean, median, mode in series of individual observation discrete series, continuous open end classes | 2 | 5 |
| | **Instructional Hours** | | **11** |
| V | **Classification, tabulation and Representation of Data:** Classification and tabulation of data – Graphical and diagrammatic representations | 2 | 3 |
| | Scale diagrams – Histograms – frequency polygon - Frequency curves | 2 | 4 |
| | Measures of Dispersion, standard deviation and Range | 2 | 6, 14 |
| | Student t test | 2 | 13 |
| | Regression | 2 | 9 |
| | Correlation | 2 | 8 |
| | one way and two way ANOVA, Application of statistical software for biological research | 2 | 19 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Keith Wilson and John Walker, **Principles and Techniques of Biochemistry and Biology**, Cambridge University Press, Edition: 7, 2010.
2. Arora, P.N. and Malhan, P.K., **Biostatistics**, Himalaya Publishing House, 2006.
3. Das, H. K., **Text Book of Biotechnology**, Wiley India Pvt. Ltd, Edition: 3, 2007.

Unit I: Text Book 1, Chapter 1, 12 & 13.
Unit II: Text Book 1, Chapter 11& 9.
Unit III: Text Book 1, Chapter 3, 10& 12.
Unit IV: Text Book 2, Chapter 1& 5.
Unit V: Text Book 2, Chapter 3, 4, 6, 8, 9, 13, 14 & 19


**Reference Book(s):**


1. Sawhney, K. and Randhir Singh, **Introductory Practical Biochemistry**, Narosa Publishing House, 2010.
2. Gedder, A. and Balsar, L.E., **Principles of Applied Biomedical Instrumentation**, John Wiley and Sons, 2008.
3. Lee, T., **Introductory Biostatistics**, Wiley – Interscience, 2011.
4. Stephen W. Looney, **Statistical Methods**, Humana publications, 2009.
5. Modern Boyer, Rodney F. Benjamin and Cummins, **Experimental Biochemistry**, 2nd Edition, 1999.
6. http://www.itl.nist.gov/div898/handbook/prisection3/pri3.htm (online e book)
7. http://www.statease.com/de7_man.html (Software Tutorial Website)

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Quiz | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | M | L | M | H | M | H | M |
| **CO2** | M | L | L | M | M | L | L | L | H | H | H | H | H |
| **CO3** | L | L | M | M | L | L | L | M | M | L | M | M | L |
| **CO4** | L | L | M | M | L | L | M | H | H | M | H | M | L |
| **CO5** | M | M | L | L | L | M | M | M | H | H | M | H | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC205 | Paper –V Plant Biotechnology | | |
| Semester: II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understand the in vitro culture techniques & genetic engineering in plants, mechanism and uses of transgenic plants and Industrial applications of plant products

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Outline requirements for plant tissue culture lab construction |
| **CO2** | Illustrate the methods of *invitro* culture and transformation techniques |
| **CO3** | Illustrate the gene transfer technology for transgenic plant production |
| **CO4** | Realize the importance of phytochemical in industry |
| **CO5** | Appropriate transformation technologies for production of transgenic plants |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Conventional plant breeding methods:** Selection, hybridization, mutation and polyploidy. | 1 | 1 |
| | **PTC Requirements:** Design of Plant tissue culture laboratory. Nutritional requirements of plant tissue culture. Composition of MS media, Gamborgs media, Nitch's media, Whites media and their preparation. Plant growth regulators. Sterilization techniques. | 1 | 2,3 |
| | **Instructional Hours** | | **12** |
| II | ***Invitro* culture for plants:** Micropropagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture and fusion; Somaclonal variation; Artificial seeds; Green house conditions, hardening. | 1 | 8, 9 |
| | **Instructional Hours** | | **12** |
| III | **Gene Transfer Methods:** *Agrobacterium* mediated gene transfer, *Agrobacterium* based vectors (Ti plasmids and Ri plasmids), viral vectors and their applications. Direct gene transfer methods - electroporation, microinjection and particle bombardment. | 2 | 16, 23 |
| | Characterization of transgenics, screenable and selectable markers. Marker free methodologies and gene targeting. | 2 | 23 |
| | **Instructional Hours** | | **12** |
| IV | **Secondary metabolic pathways in plants:** Industrial phytochemical products from plants - Alkaloids, | 3 | 6,7 |

| | | | |
|---|---|---|---|
| | Biodegradable Plastics, Therapeutic proteins, biodegradable plastics, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel. | | |
| | **Instructional Hours** | | **12** |
| **V** | **Application of gene transformation in plant:** Insect resistance, fungus resistance, virus resistance, drought, cold resistance, saline resistance, Transgenic plant with vitamin A, Gene silencing in crop plants, Terminator seed technology, Production of therapeutic antibodies, edible vaccine. Heat Shock Proteins, Male Sterile Lines, Nitrogen Fixation, long shelf life of fruits & flowers.<br>**Bioethics on transgenic plants.** | 2 | 24 |
| | **Instructional Hours** | | **12** |
| | | **Total Hours** | **60** |

**Text Book(s):**


1. Razdan, M. K., **Introduction to Plant Tissue Culture,** Science Publisher Inc., UK.2003.
2. Chawla, H. S., **Introduction to Plant Biotechnology,** Science Publisher Inc., UK., 2002.
3. Srivatsava, S., and Narula, A., **Plant Biotechnology and Molecular Markers,** Springer, Netherlands, 2004.

Unit I : Text Book 1, Chapter 1, 2 & 3: 3-13, 22-35.
Unit II : Text Book 1, Chapter 8 & 9: 87-199.
Unit III: Text Book 2, Chapter 2: 359-394.
Unit IV: Text Book 3, Chapter 6 & 7: 78-128.
Unit V : Text Book 2, Chapter 24: 396-427.


**Reference Book(s):**


1. Mantel. S.H, Mathews. J.A. and Mickee, R.A., **An Introduction to Genetic Engineering in Plants**, Black well Scientific Publishers, London, 1985.
2. Pierik, R.L.M., ***Invitro* Culture of Plants,** Martinus Nijhoff Publishers, Dordrecht, 1987.
3. Dixon, R.A. and R.A. Gonzales. **Plant Cell Culture, A Practical Approach**, Oxford University Press, Oxford, 2nd Edition, 1994.
4. Grierson, D., and S.N. Covey, **Plant Molecular Biology.** Blackie & Sons. Ltd. Glascow, 1988.
5. Monica. A. Hughes, **Plant Molecular Genetics,** Pearson Education Ltd, England, 1999.
6. Mantell and Smith, **Plant Biotechnology,** Cambridge University Press, 1983.
7. http://www.biologydiscussion.com/plants/plant-breeding-steps-and-methods-of-plant-breeding-for-disease-resistance/1340
8. web.nchu.edu.tw/pweb/users/taiwanfir/lesson/1146.pdf

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Viva voce | Mini project | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | H | M | L | L | L | M | H | M | L | L | M |
| **CO2** | L | L | M | L | L | L | L | L | H | H | H | M | M |
| **CO3** | M | L | M | L | L | M | L | L | M | H | H | L | M |
| **CO4** | L | M | M | H | L | M | L | L | M | H | M | L | M |
| **CO5** | L | M | M | M | L | M | L | M | H | H | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC206 | Paper – VI Genetic Engineering | | |
| Semester: II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To provide the student with the relevant background information necessary to understand genetic engineering and in particular to gene cloning, recombinant protein manipulation and produce safely, stability and authentically using an appropriate cell based system

**Course Outcomes:**

On successful completion of the course, the student will

| | |
|---|---|
| **CO1** | Know different tools of Genetic Engineering |
| **CO2** | Understand the technical know-how on versatile techniques in Genetic Engineering |
| **CO3** | Apply Genetic Engineering Techniques in Basic and Applied Experimental Biology |
| **CO4** | Have Proficiency in designing and conducting experiments involving genetic manipulation |
| **CO5** | Understand the application of different types of PCR |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| **I** | **Genetic Engineering and Tools of Genetic Engineering:** Introduction, scope and importance. Enzymes used in manipulation - Polymerases and types; nucleases - endonuclease, exonuclease and restriction enzymes; ligase; topoisomerase, methylase; other modifying enzymes. Linkers and adaptors. | 1 | 4 |
| | **Instructional Hours** | | **12** |
| **II** | **Vectors:** general characteristics of vectors, Plasmid based-pBR 322, pUC vectors, Phage based-lambda, M13, Cosmids, Phagemids, **Viral vectors – AAV, Baculo virus vectors**, cloning and expression vectors, shuttle vectors, artificial chromosomes: YAC, PAC, BAC, HAC. Cloning and selection of individual gene, gene library and cDNA library. | 1 | 2, 6, 7 |
| | **Instructional Hours** | | **12** |
| **III** | **Transformation Techniques:** Methods of DNA transfer, exogenously supplied chemical methods, calcium phosphate precipitation method, liposome mediated method and electroporation, gene gun method; | 1 | 5 |

| | | | |
|---|---|---|---|
| | Determination of transformation / transfection efficiency. Lambda DNA based DNA recombinants: *In vitro* packaging of DNA using packaging extracts infection of bacteria using packaged lambda viruses containing recombinant DNA. | | |
| | **Instructional Hours** | | **12** |
| **IV** | **Plating, screening and selection:** Preparation of nutrient media with selection, marker antibiotics and additives for visual screening of recombinant clones, selection of clones, amplification and preservation. **Labelling of DNA, RNA and proteins:** Use of radioactive isotopes, Non-radioactive labelling relative advantages and disadvantages, *in vivo* labelling, Nick translation, random primer labelling, auto-radiography, auto-fluorography. | 2 | 5, 6, 7 |
| | **Instructional Hours** | | **12** |
| **V** | **Confirmation and analysis of expression of DNA:** Blotting techniques - Southern, Northern and Western blotting, *In situ* hybridization, PCR based techniques - RT PCR, Real Time PCR, Assay based techniques - DNA and protein microarray. **Genome analysis and genome editing technologies:** Gene silencing – siRNA, microRNA; principle and application of gene silencing; gene knockouts - Cre-Lox systems; CRISPR-Cas9 systems. | 3 | 6 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Brown T.A., **Introduction to Gene Cloning,** Stanley Thomas Publishing Ltd, London, 3rd Edition, 1998.
2. Primrose, S.B., **Principles of Gene Manipulation,** Blackwell Science Ltd, Germany, 6th Edition, 2003.
3. Glick and Pasternak, **Molecular Biotechnology, Principles and Application of Recombinant DNA**, AMS Publications, US, 4th Edition, 2010.

Unit – I: Text Book 1, Chapter 4, Page No. 47-74.
Unit – II: Text Book 1, Chapter 2, Chapter 6 and Chapter 7, Page No. 13-24, 93-110 and 111-134.
Unit – III: Text Book 1, Chapter 5 Page No. 75-92.
Unit – IV: Text Book 2, Chapter 5, 6 and 7 Page No. 59-62, 63-72 and 73-88.
Unit – V: Text Book 3, Chapter 6 Page No. 195-239.


**Reference Book(s):**


1. Old R.W. and S.B. Primrose, **Principles of Gene Manipulation**, Boston Blackwell Scientific Publications, 1994.

2. Kingsman, S.M and A.J. Kingsman, **Genetic Engineering: An Introduction to Gene Analysis and Exploitation in Eukaryotes**, Blackwell Scientific publications, Oxford. 1998.
3. Davies J.A. and Reznikoff, **Milestones in Biotechnology**, classic papers on genetic engineering. Butterworth-Heinemnn, 1992.
4. John M Walker and Ralph Raply, **Molecular Biology and Biotechnology**, RSC Publishing, 5th Edition, 2009.
5. http://nptel.ac.in/downloads/102103013/

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Viva voce | Mini Review | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | M | L | L | L | H | M | M | L | L |
| **CO2** | M | L | L | M | M | L | L | L | H | M | H | M | L |
| **CO3** | L | L | M | M | L | L | L | L | M | M | M | H | H |
| **CO4** | L | L | L | M | L | H | M | L | L | M | H | H | H |
| **CO5** | M | M | L | L | M | L | L | M | M | H | M | H | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC207 | Core Paper – VII Industrial Biotechnology | | |
| Semester: II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

On successful completion of the course the students should have understood the basics of fermentation technology and learnt the concept of screening, optimization and Maintenance of cultures.

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Recall the basis of fermentation technology |
| **CO2** | Know the types of fermentation and fermenter used in industries |
| **CO3** | Develop the transport phenomena in bioprocess technology |
| **CO4** | Analyse the mechanism of fermenter in industry |
| **CO5** | Design the production process for industrially important products |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Historical overview of industrial fermentation process**: traditional and modern Biotechnology. **Advantages of bioprocess over chemical process:** Basic function, design and body construction; Peripheral parts and accessories- Impellers types, sparger, temperature control; pH, control and foam, baffles. | 1 | 1 |
| | **Sterilization:** Types of sterilization – Heat, Radiation and Filtration methods, air sterilization, Aseptic inoculation and sampling methods. | 1 | 2 |
| | **Instructional Hours** | | **12** |
| II | **Types of fermentation** – Solid state fermentation – Tray fermenter, Column fermenter, and Drum fermenter, Submerged fermentation – Batch and continuous, fed batch. | 1 | 1 |
| | **Types of fermenters**- CSTR, Tower fermenter, Jet loop, Air lift, Bubble column, Packed bed, trickle bed reactor, Fluidized, Tubular fermenter. Immobilized enzyme and cells. | 2 | 7 |
| | **Instructional Hours** | | **12** |
| III | **Transport phenomena in bioprocess** – Mass transfer resistance, Rate of oxygen transfer, determination of oxygen transfer coefficients. Biological heat transfer for microbial cultivations, Microbial growth Kinetics. | 2 | 7 |

| | | | |
|---|---|---|---|
| | **Fermentors** – Continuous parameters, sampling systems – Chemostat, Turbidostat. Containment – Mechanism of foam fermentations and foam breaking. | 2 | 8 |
| | Computers in bioprocess control systems, Biosensor. | 2 | 9 |
| | **Instructional Hours** | | **12** |
| **IV** | **Up-steam processing** - Media formulation; Inocula development and Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters. | 2 | 10 |
| | **Down Steam processing** - Removal of microbial cells- Centrifugation, Sedimentation, Flocculation, Microfiltration, cell disruption – physical, chemical and enzymatic methods. | 2 | 10 |
| | **Purification of fermentation products** - precipitation methods, membrane process, centrifugation – Ultracentrifugation; Purification by chromatography techniques, crystallization, drying, lyophilisation and packaging. | 2 | 10 |
| | **Instructional Hours** | | **10** |
| **V** | **Industrial Fermentative products:** Production of secondary metabolites: Antibiotics - penicillin, Vitamin $B_{12}$, Production of enzymes: amylase, Production of organic acids: citric acid, Production of amino acids: Glutamic acid, Organic solvents - ethanol by Yeast, Production of recombinant and therapeutic proteins: Insulin, Interferon; Vaccines, and SCP and biofertilizers. | 3 | 22 |
| | **Instructional Hours** | | **14** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Michael L. Shuler FikretKarg, **Bioprocess Engineering Basic Concept,** Prentice Hall International Services, 2nd Edition, 2001.
2. Peter. F. Stanbury, Allan Whitaker, Stephen. J. Hall, **Principles of Fermentation Technology,** Published by Elsevier Science Ltd., reprinted, 2nd Edition, 2007.

Unit I : Text Book 1, Chapter 1, 2
Unit II : Text Book 1, Chapter 1; Text Book 2, Chapter 7
Unit III: Text Book 2, Chapter 7; Text Book 2, Chapter 7
Text Book 2, Chapter 8; Text Book 2, Chapter 9
Unit IV: Text Book 2, Chapter 10
Unit V : Text Book 3, Chapter 22

**Reference Book(s):**

1. E.M.T El-Mansi and C. F. A. Bryce, **Fermentation Microbiology and Biotechnology,** Published by Taylor & Francis, Reprinted, 2002.
2. Pauline M. Doran, **Bioprocess Engineering Principles,** Elsevier, Reprinted, 2006.
3. Basantarai, **Essential of Industrial Microbiology.** Lulu publisher, 4th Edition, 2012.

4. Karia, G.L. and Christian, R.A. Prentice, **Waste Water Treatment: Concepts and Design Approach,** Hall of India private Limited, New Delhi, 2006.
5. Allsopp D. and Seal, K.J., **Introduction to Biodeterioration,** ELBS/Edward Arnold, London, 1986.
6. Wulf Crueger and Anneliese Crueger, **Biotechnology-A Textbook of Industrial Microbiology,** Panima Publishing Corporation New Delhi. 2000. Reprinted, 2nd Edition, 2005.
7. De, A. K., **Environmental Chemistry**, Wiley Eastern Ltd. New Delhi, 1989.
8. P. R. Yadav and Rajn Tyagi, **Industrial Biotechnology,** Discovery Publishing House, New Delhi, 2005
9. Dr. Singh and Dr. S.K. Ghosh, **Industrial Biotechnology**, Global Vision Publishing House, 2004.
10. https://www.pdfdrive.net/modern-industrial-microbiology-and-biotechnology-d14938252.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Demonstration | IV* / Case Study | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

***Industrial Visit / Educational Tour:** Student may go for Industrial Visit and Educational Tour in any biotechnological industry or laboratories and observe their lab, infrastructure, products and lectures. After the visit students should submit the detailed reports about the programme with photos in an assignment.

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | L | L | L | L | L | H | M | H | M | L |
| **CO2** | L | L | M | M | M | L | L | M | H | M | M | H | M |
| **CO3** | L | M | L | L | M | L | L | L | M | M | L | H | H |
| **CO4** | L | L | M | L | L | L | L | L | H | M | H | H | H |
| **CO5** | L | L | M | M | L | L | L | M | M | M | L | M | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC208 | Core Paper – VIII Bioethics, Biosafety and IPR | | |
| Semester: II | Credits: 4 | CIA : 50 Marks | ESE: 50 Marks |

**Course Objective:**

To enable the students get an idea about the advantages and disadvantages of biotechnological applications ethical implications and intellectual property rights

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Understand the basics of Bioethics and ethical aspects |
| **CO2** | Outline the ethical implications of genetic modifications |
| **CO3** | Assess the risk management and biosafety guidelines to be followed at different situations |
| **CO4** | Analyze the intellectual properties and patent rules |
| **CO5** | Compare and contrast the IPR at different parts of the world |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Introduction to ethics/bioethics:** Framework for ethical decision making. | 1 | 1 |
| | **Biotechnology and ethics:** Benefits and risks of genetic engineering, ethical aspects of genetic testing, ethical aspects relating to use of genetic information. Genetic engineering and biowarfare | 1 | 1 |
| | **Instructional Hours** | | **12** |
| II | **Ethical implications of cloning:** Reproductive cloning, therapeutic cloning. | 1 | 5 |
| | **Ethical, legal and socioeconomic aspects:** Aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. | 1 | 5 |
| | GM crops and GMO's | 1 | 9 |
| | Biotechnology and biopiracy – ELSI of human genome project. | 1 | 5 |
| | **Instructional Hours** | | **12** |
| III | **Introduction to biosafety:** Biosafety issues in biotechnology. Risk assessment and risk Management, safety protocols: risk groups . | 1 | 7 |
| | Biosafety levels, biosafety guidelines and regulations (National and International). Operation of biosafety guidelines and regulations, types of biosafety containment. | 1 | 7 |
| | **Instructional Hours** | | **12** |

| | | | |
|---|---|---|---|
| IV | **Introduction to IPR:** Intellectual property and intellectual property rights. | 2 | 1 |
| | Types: patents, copy rights, Trade marks, design rights, geographical indications, importance of IPR. World intellectual Property rights organization (WIPO) | 2 | 3 |
| | **Instructional Hours** | | **12** |
| V | **Patents:** What can and what cannot be patented. Patenting life, legal protection of biotechnological Inventions. National and International Patenting. | 2 | 7 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Sateesh M.K., **Bioethics and Biosafety,** I.K. International Publishing House Pvt. Ltd. 2008.
2. Das, H.K., **Text Book of Biotechnology,** Edition: 3, Wiley India Pvt. Ltd. 2007.
3. Ramdass, P., **Animal Biotechnology Recent Concepts and Development**, MJP Publishers, 2008.

Unit I: Text Book 1, Chapter 1 & 2, Page Nos.: 1-13
Unit II: Text Book 1, Chapter 5, Page Nos.: 123-128; Chapter 9, Page Nos.: 217-241
Unit III: Text Book 1, Chapter 7, Page Nos.: 159-209
Unit IV: Text Book 2, Chapter 1, Page Nos.: 1-19; Chapter 3, Page Nos.: 47-60
Unit V: Text Book 2, Chapter 7, Page Nos.: 116-127

**Reference Book(s):**

1. Jose Cibelli, Robert P. lanza, Keith H. S. Campbell, Michael D. West, **Principles of Cloning,** Academic Press, 2002.
2. http://books.cambridge.org/0521384737.htm
3. http://online.sfsu.edu/%7Erone/GEessays/gedanger.htm
4. http://www.actahort.org/members/showpdf?booknrarnr=447_125
5. http://www.cordis.lu/elsa/src/about.htm
6. Das, H.K., **Text Book of Biotechnology,** Edition: 3, Wiley India Pvt. Ltd. 2007

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Assignment | Case study | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | L | M | M | L | L | H | H | M | M | L |
| **CO2** | L | L | M | L | L | L | M | L | M | H | H | L | L |
| **CO3** | L | L | L | M | L | M | M | L | M | H | H | H | H |
| **CO4** | L | M | L | L | L | M | L | L | L | M | H | H | H |
| **CO5** | L | L | M | L | M | M | L | L | M | H | M | M | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTQ201 | Practical – I Biochemistry and Industrial Biotechnology | | |
| Semester: I & II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understand the principles behind the qualitative, quantitative estimation of biomolecules, production of industrial important products, purification and its kinetics analysis.

**Course Outcomes:**

On the successful completion of the course the students will get an overall understanding of

| | |
|---|---|
| **CO 1** | Biosafety guidelines |
| **CO 2** | Principal and quantification of biomolecules in unknown sample |
| **CO 3** | Biomolecules separation through various chromatographic techniques. |
| **CO 4** | Production of industrial important enzymes and its kinetic analysis. |
| **CO 5** | Purification of industrial important enzyme |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 5**

| S. No | Experiment |
|---|---|
| **Biochemistry** | |
| 1. | Safety guidelines in Biochemistry laboratory practices. |
| 2. | Estimation of reducing sugars by Nelson - Somogyi method |
| 3. | Estimation of total carbohydrates by Anthrone method |
| 4. | Estimation of acid value, saponification value, Iodine number of fat |
| 5. | Estimation of total free amino acids |
| 6. | Estimation of DNA by DPA Method |
| 7. | Estimation of RNA by Orcinol method |
| 8. | Protein estimation by Absorbance at 280nm and Lowry's method |
| 9. | Paper Chromatography - separation of sugars |
| 10. | Thin Layer Chromatography - separation of amino acids |
| 11. | Estimation of ascorbic acid and riboflavin |
| 12. | Estimation of calcium and iron |
| **Industrial Biotechnology** | |
| 13. | Production and estimation of biomass (SCP) – dry weight and wet weight method. |
| 14. | Production of wine and Estimation of alcohol. |
| 15. | Fermentation of wheat bran xylan by *Trichoderma* sp., |
| 16. | Isolation/extraction of industrially important enzyme (Amylase) and assay of amylase activity. |
| 17. | Enzyme immobilization – Gel entrapment. |
| 18. | Partial purification of amylase enzyme –ammonium sulphate precipitation, Dialysis, Gel permeation Chromatography. |

| | |
|---|---|
| 19. | Determination of enzyme kinetic parameters – pH, Temperature, Km, Vmax and Kcat. |
| 20. | Separation of proteins by SDS-PAGE. |
| **Total Hours** | **150** |

**Tools for Assessment (50 Marks)**

| Technical skill | Analytical Skill | Lab Performance | Test I | Test II | Observation note book | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 8 | 10 | 10 | 6 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | M | L | M | H | L | L | L | M | L | M |
| **CO2** | L | L | M | L | L | H | L | L | L | M | L | L | H |
| **CO3** | L | L | L | M | L | L | L | L | L | L | M | L | L |
| **CO4** | L | L | L | M | L | M | H | L | L | L | M | L | M |
| **CO5** | L | L | M | L | M | L | L | L | L | M | L | M | L |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTQ202 | Practical – II Microbiology and rDNA Technology | | |
| Semester: I & II | Credits: 4 | CIA : 50 Marks | ESE: 50 Marks |

**Course Objective:**

To make the student should able to demonstrate practical experience of selected microbiological and molecular techniques.

**Course Outcomes:**

At the end of the course the students will able to

| | |
|---|---|
| **CO1** | Know the importance of steps involved in microbiology and rDNA practicals |
| **CO2** | Understand the safety measure and regulations in handing the macromolecules |
| **CO3** | Demonstrate laboratory tools in rDNA technology |
| **CO4** | Exhibit techniques related to microbiology and molecular biology |
| **CO5** | Troubleshoot the problem related to molecular techniques |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 5**

| S. No. | Experiment |
|---|---|
| **Microbiology** | |
| 1 | Orientation to the Microbiology Laboratory (Safety Procedures and Precautions, General Laboratory Directions) |
| 2 | Microscope : Bright-Field Light, Dark Field and Phase Contrast |
| 3 | Handling and Examining Cultures |
| 4 | Bacterial Motility |
| 5 | Gram Staining |
| 6 | Capsule Staining |
| 7 | Endospore Staining |
| 8 | Negative Staining |
| 9 | Measurement of bacterial cell size |
| 10 | Enumeration of bacteria from soil |
| 11 | Morphology of fungi (Lactophenol Cotton Blue Technique) |
| **rDNA Technology** | |
| 12 | Isolation of genomic DNA from bacteria |
| 13 | Isolation of plasmid DNA from bacteria |
| 14 | Restriction digestion of DNA |
| 15 | Separation of DNA fragments using agarose gel electrophoresis |
| 16 | Polymerase chain reactions |
| 17 | **Cloning, transformation and Screening recombinants** |
| | **Total Hours 150** |

**Tools for Assessment (50 Marks)**

| Technical skill | Analytical Skill | Lab Performance | Test I | Test II | Observation note book | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 8 | 10 | 10 | 6 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | M | L | M | H | L | M | M | L | L | M |
| **CO2** | L | L | M | L | L | H | L | M | H | M | L | H | M |
| **CO3** | M | L | L | L | L | L | L | M | M | M | H | H | L |
| **CO4** | L | L | L | M | L | M | H | L | H | H | M | H | M |
| **CO5** | M | L | M | L | M | L | M | H | M | H | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC309 | Paper – IX Immunology and Immunotechnology | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

The objectives of this course are to make students learn about the structural features of the components of the immune system as well as their function. The major emphasis of thiscourse will be on the development of the immune system and mechanisms by which our body elicit the immune response.

**Course Outcomes:**

On the successful completion of the course the students will get an overall understanding of

| | |
|---|---|
| **CO 1** | Basic knowledge of the organization and function of the immune system |
| **CO 2** | Types of cells and organs involved in the process of immune response |
| **CO 3** | Apply key immunologic concepts and methods to diagnose disease and immune disorders |
| **CO 4** | Emphasize and describe antigen and antibodies as well as the interaction between them |
| **CO 5** | Familiarize with immunization practices and strategies for manipulating the immune system to benefit the patient |

**Offered by:** Biotechnology

**Course Content** **Instructional hours / week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Overview of Immune system:** | | |
| | History and scope of immunology. | 1 | 1 |
| | Types of Immunity: Innate and Acquired immunity | 1 | 1 |
| | Humoral, Cell Mediated immunity | 1 | 1 |
| | Hematopoiesis | 1 | 2 |
| | **Cells and Organs of the Immune system:** | | |
| | Cells of immune system | 1 | 2 |
| | Lymphoid organs (primary and secondary) | 1 | 2 |
| | Antigen processing and presentation-endogenous antigens, exogenous antigens, | 1 | 8 |
| | **Instructional Hours** | | **12** |
| II | **Generation of B-Cell and T- Cell Responses:** | | |
| | **Antigens -** Immunogenicity versus Antigenicity, Epitopes, Haptens, adjuvants and Super antigens | 1 | 3 |
| | Factors that influence Immunogenicity | 1 | 3 |
| | **Antibodies –** Basic structure, Classes, functions and biological activities. | 1 | 4 |
| | Organization and expression of Immunoglobulin Gene. | 1 | 5 |
| | Maturation, Activation and Differentiation of B and T lymphocytes | 1 | 10,11 |
| | MHC molecules – General organization and Inheritance | 1 | 7 |
| | **Instructional Hours** | | **14** |

| | | | |
|---|---|---|---|
| III | **Immune Effector Mechanism:** | | |
| | **Complement system:** Structure, components, functions, Regulation and Biological Consequences | 1 | 13 |
| | **Cytokines:** Secretion, Properties and Therapeutic uses. | 1 | 19 |
| | Hyper sensitivity reactions and Cooms clasification | 1 | 16 |
| | ABO blood glrouping, RH typing, Erythroblastosis fetalis | 1 | 16 |
| | Auto immune disorders, deficiencies (Primary and secondary) | 1 | 19,20 |
| | Immuno tolerance | 1 | 21 |
| | **Instructional Hours** | | **14** |
| IV | **Antigen antibody interactions**: Precipitation, Agglutination | 1 | 6 |
| | **Immuno Precipitation :** Immunodiffusion, immunoelectrophoresis | 1 | 6 |
| | **Advanced immunological Technique:** RIA, ELISA | 1 | 6 |
| | Western blotting, ELISPOT assay | 1 | 6 |
| | FlowCytometry, Immuno – Fluorescence | 1 | 6 |
| | Hybridoma technology | 1 | 6 |
| | Immunoelectron microscopy | 1 | 4 |
| | **Instructional Hours** | | **10** |
| V | **Tissue and organ transplant:** Mechanism of graft rejection, HLA typing | 1 | 21 |
| | Tumor immunology: tumor antigens | 1,2 | 22,16 |
| | immune responses and therapy | 1 | 22 |
| | **Vaccinology:** Active and passive immunization | 1 | 18 |
| | **Types of vaccines**: Live, Heat killed, Inactivated, attenuated | 1 | 18 |
| | **Vaccine technology:** Recombinant Vaccines, Peptide and DNA vaccines | 1 | 18 |
| | Synthetic vaccines, catalytic antibodies, Plant- based vaccines | 1 | 18 |
| | **Instructional Hours** | | **10** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Richard A. Goldsby, Thomas J. Kindt, Janis Kuby, Barbara A. Osborne.,**Immunology,** WH Freeman & Company, New York, 5thEdition, 2003.
2. Arthur Rabson, Ivan M.Roitt, Peter J. Delves., **Really Essential Medical Immunology,**Blackwell Publishing Pvt. Ltd., 2ndEdition, 2005.

Unit I: Text Book 1, Chapter 1, Chapter 3: Page No. 57 - 73, Chapter 7: Page No. 161 – 174,Chapter 8: Page No. 185 – 196

Unit II: Text Book 1, Chapter 2: Page No. 24 – 53, Chapter 4: Page No. 76 – 99, Chapter 5: Page No. 106 – 115, Chapter 10: Page No. 221 - 244, Chapter 11:Page No. 247 – 263,Chapter 12: Page No. 278 - 292

Unit III: Text Book 1, Chapter 13: Page No. 299 - 317, Chapter 16: Page No. 363 - 386, Chapter 19: Page No. 431 – 458, Chapter 20: Page No. 462 – 479, Chapter 21: Page No. 481 – 498

Unit IV: Text Book 1, Chapter 4: Page No. 99 –101, Chapter 6: Page No. 137

– 155,
Unit V: Text Book 1, Text Book 1, Chapter 18: Page No. 413 – 427,
Chapter 21: Page No. 481 – 498, Chapter 22: Page No. 502 – 523
Text Book 2, Chapter 17:Page No. 177-182.

**Reference Book(s):**


1. Roitt, I. M. and P. J. Delves.,**Roitt's Essential Immunology,** Oxford: Blackwell Science, 10th Edition, 2001.
2. William E.Paul., **Fundamental Immunology,** Raven Press, New York, 2nd Edition 1993.
3. Edward Harlow and David Lane.,**Antibodies A laboratory Manual,**Cold Spring harbor Laboratory Press, 2nd Edition, 1999.
4. Chakravarthy, A.K., **Immunology,** Tata McGraw Hill Publishing Co. Ltd., New Delhi. 1996.
5. Ian R. Tizard., **Immunology,** Saunders college publishers, New York, 4th Edition, 1995.
6. http://ebooks.bharathuniv.ac.in/gdlc1/gdlc1/Libraries/Bio%20Technology%20Library/Janis%20Kuby/Immunology,%20kuby.%205%20edition%20(260)/Immunology,%20kuby.%205%20edition%20-%20Janis%20Kuby.pdf
7. http://dl.mehrsys.ir/pdf-books/Roitt_s%20Essential%20Immunology%20Thirteenth%20Edition(www.myuptodate.com).pdf
8. http://www.m5zn.com/newuploads/2013/02/02/pdf/m5zn_ceecc60a799fcd6.pdf


**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Model | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | L | L | M | L | H | H | H |
| **CO2** | M | L | M | L | L | M | L | L | H | L | M | H | M |
| **CO3** | L | L | H | M | L | L | M | M | M | H | H | H | H |
| **CO4** | M | L | M | L | L | H | L | L | H | H | H | M | H |
| **CO5** | L | L | M | M | L | H | M | L | H | H | M | M | L |

H-High; M-Medium; L-Low

| Countersigned by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC310 | Paper – X Animal Biotechnology | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To provide students with a scientific and technical understanding of animal biotechnology.

**Course Outcomes:**

On successful completion of this course, the student will be able to

| | |
|---|---|
| CO1 | Understand the limitations and challenges facing the animal husbandries. |
| CO2 | Describe the various biotechnologies available to the animal related fields. |
| CO3 | Explain how developments in biotechnology may have applications in those fields. |
| CO4 | Evaluate the public and ethical concerns over the use of animal cells. |
| CO5 | Analyze the possible utilization of animal cell culture. |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Introduction and lab requirements:** Early history of cell culture. The use of animal cell culture - Tissue culture, organ culture and cell culture, applications for animal cell cultures. | 1 | 1 |
| | **Media:** Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media. | 2 | 8, 9 |
| | **Instructional Hours** | | **14** |
| II | **Cell culture and characterization:** Primary Culture-Isolation of Tissue, Steps involved in primary cell culture and Establishment of Cell culture. | 2 | 11 |
| | **Cell Lines-** Nomenclature, Subculture and Propagation, Immortalization of cell lines. | 2 | 12 |
| | Cell counting, Cell Proliferation, Plating Efficiency, Labeling Index. | 2 | 15 |
| | **Instructional Hours** | | **12** |
| III | **Contamination and assay:** Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. | 2 | 18 |
| | Cytotoxicity: measurement of cell death; Apoptosis and its determination; Cytotoxicity assays. | 2 | 21 |
| | **Instructional Hours** | | **12** |
| IV | **Cryopreservation & Stem cell culture:** Need of Cryopreservation, Preservation, Cell banks, Transporting Cells. | 2 | 19 |

| | | | |
|---|---|---|---|
| | Stem cell culture, embryonic stem cell and their applications. | 2 | 23 |
| | **Instructional Hours** | | **12** |
| **V** | **Application of animal cell culture:** Viral vaccines, and monoclonal antibodies, Transgenic animals, | 1 | 12 |
| | Ethical issues in animal biotechnology | 1 | 06 |
| | **Instructional Hours** | | **10** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Michael Butler, **Animal Cell Culture and Technology,** BIOS Scientific Publishers, Tailor& Francis Group, London, 6th Edition, 2004.
2. Ian Freshney. R., **Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications,** John Wiley & Sons, Inc., Hoboken, New Jersey, 6th Edition6, 2010.

Unit I : Text Book 1, 2 Chapter 1, 8, 9, pages – 5, 42,52
Unit II : Text Book 2, Chapter 11, 12, 15, pages -65, 78-90, 137
Unit III : Text Book 2, Chapter 18, 21, pages – 212, 311-327
Unit IV : Text Book 2, Chapter 9, 23, pages – 242, 362 - 371
Unit V : Text Book 1, Chapter 12, 6, pages 89-92, 38 - 39

**Reference Book(s):**

1. Jennie P. Mather (Editor), David Barnes (Editor), **Animal Cell Culture Methods,** Volume 57 (Methods in Cell Biology), Academic Press, 1st Edition, 2001.
2. Butler, M., **Mammalian Cell Biotechnology: A Practical Approach,** Oxford University Press, New York, 2005.
3. https://www.saasta.ac.za/Media-Portal/download/bio_fs01.pdf
4. https://www.kopykitab.com/Textbook-of-Animal-Biotechnology-by-B-Singh
5. https://www.elsevier.com/books/animal-biotechnology/verma

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Quiz | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | L | L | L | L | L | M | L |
| **CO2** | M | L | M | L | L | M | L | L | L | M | L | H | S |
| **CO3** | L | L | H | M | L | L | M | M | M | L | M | S | H |
| **CO4** | M | L | M | L | L | H | L | L | M | M | M | H | H |
| **CO5** | L | L | M | M | L | H | M | L | M | M | M | H | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC311 | Paper – XI Pharmaceutical Biotechnology | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understanding the principles of drug development and drug manufacturing Processes, pharmaceuticals of plant, animal and microbial sources, the quality control and ethics in bio pharmaceutical industries.

**Course Outcomes:**

On successful completion of this course, the student will be able to

| | |
|---|---|
| **CO1** | Recall the drug developmental process and drug discovery |
| **CO2** | Understand the guidelines of drug manufacturing process |
| **CO3** | Develop novel drugs and vaccine development. |
| **CO4** | Implement the knowledge in Quality control of drug manufacturing companies. |
| **CO5** | Evaluate the process of novel drug development |

**Offered by:** Biotechnology

**Course Content** **Instructional Hours/Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | History of pharmaceutical industry | 1 | 1 |
| | Drug discovery and development | 4 | 18 |
| | Pre-clinical and clinical trails | 1 | 7 |
| | Definition: Generics and its advantages .Bio generics and Bio-similars. Protein-based biopharmaceutical | 1 | 7 |
| | **Instructional Hours** | | **12** |
| II | Introduction to pharmaceuticals of animal, plant and microbial origin. | 1 | 2, 3 |
| | Pharmacological, Microbial, Recombinant, Biochemical and Molecular level screening systems and their construction strategies. | 4 | 18 |
| | Hematopoietic growth factors, coagulation factors. Interferon and cytokines for anti-infective and cancer therapy. Insulin growth hormones-production and applications. | 1 | 7 |
| | Vaccine: genetically improved vaccines, synthetic peptide based vaccines, nucleic acid vaccines. | 5 | 3 |
| | **Instructional Hours** | | **12** |
| III | **Recombinant thrombolytic agents:** Tissue type plasminogen activator, First and second generation of thrombolytic agents. Xenotransplantation in pharmaceutical biotechnology. | 1 | 6 |
| | The role of biotechnology in forensic sciences. | 1 | 7 |
| | Estimation of toxicity: LD50 and ED50. | 1 | 7 |
| | **Instructional Hours** | | **12** |

| | | | |
|---|---|---|---|
| IV | **Introduction to pharmacopoeia**: Good microbiological techniques and good laboratory practice (GLP). | 5 | 11 |
| | Basic principles of quality control (QA) and quality assurance (QC): Guidelines for QA and QC. | 2 | 3 |
| | Products Validation. Concept of biotech process validation, Cell lines culture process validation and characterization. Purification process for viral clearance, validation of recovery, Purification, Cleaning and Filtration. | 2 | 4 |
| | **Instructional Hours** | | **12** |
| V | **Analytical methods in protein formulation**: concentration, size, purity, surface charge, identity, structure / sequence, shape, activity. Introduction to drug designing and Search of database. | 3 | 2 |
| | Bio safety guidelines. Risk and risk assessment. Bio safety levels. | 5 | 17 |
| | Basics of bioethics principles. International codes and guidelines in India. | 5 | 17 |
| | Ethics in post-genomic era. | 5 | 17 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Oliver Kayser, Rainer. H. Muller, **Pharmaceutical Biotechnology,** WILEY-VCM, Gmbh and co, Weincom, 2009.
2. **Hand Book of Good Laboratory Practices,** UNDP/World Bank/WHO Publications, 2010.
3. KithWilson and John Walker, **Principles and Techniques of Biochemistry and Biology,** Cambridge University Press, 7th Edition, 2010.
4. Ramdass, P., **Animal Biotechnology Recent Concepts and Development,** MJP Publishers, 2008.
5. Sateesh, M. K., **Bioethics and Biosafety,** I. K. International Publishing House Pvt.Ltd.2008.

Unit I : Text Book 1, chapter 1, pages: 1-3, chapter 7, pages 119-122, Text book 4, chapter 18, pages 180-200.

Unit II : Text Book 1, Chapter 2,3, pages 103-118, Chapter 7, 129-154, Text book 4, chapter 18, 180-200, Test book 5,chapter 3, pages 41-80.

Unit III : Text Book 1, Chapter 6, pages 120-138, Chapter 7, pages 127-135

Unit IV : Text Book 2, Chapter 3, pages 6 -8, chapter 4, pages 10-20, Text Book 5, Chapter 1, pages 263-281.

Unit V : Text Book 3, Chapter 2, pages 20-25, Text book 5, chapter 17, pages 405 - 425

**Reference Book(s):**

1. Gareth Thomas, **Medicinal Chemistry: An introduction**, John Wiley, 2000.
2. Katzung, B.G., **Basic and Clinical Pharmacology,** Prentice Hall, 2004.
3. Ramabhadran T.V., **Pharmaceutical Design and Development- A Molecular Biology Approach,** Ellis Horwood Publishers, New York, 2005.

4. Goodman & Gilman's, **The Pharmacological Basis of Therapeutics**, McGraw-Hill Medical Publishing Division, New York, 11th Edition, 2006.
5. Sarfaraz K. Niazi, **Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues,** CRC Press, 2006.
6. Rodney J Y Ho, MILO Gibaldi, **Biotechnology& Biopharmaceuticals Transforming Proteins and Genes into Drugs,** Wiley Liss, 1st Edition, 2010.
7. Brahmankar, D.M., and Jaiswal, S.B., **Biopharmaceutics and Pharmacokinetics: A Treatise,** Vallabh Publisher, 2008.
8. https://benthamscience.com/journals/current-pharmaceutical-biotechnology/

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Group Discussion | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | L | L | M | M | M | L | L |
| **CO2** | M | L | M | L | L | M | L | L | M | H | M | M | L |
| **CO3** | L | L | H | M | L | L | M | M | M | H | H | H | L |
| **CO4** | M | L | M | L | L | H | L | L | M | L | M | H | H |
| **CO5** | L | L | M | M | L | H | M | L | L | H | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTC312 | Paper – XII Bioinformatics and System Biology | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To know the computational analysis of genes and genomes, protein sequences, analyzing proteins in lab and protein and gene sequence modification methods.

**Course Outcomes:**

On successful completion of the course thee students will able to

| | |
|---|---|
| CO1 | List the importance of bioinformatics in systems biology |
| CO2 | Explain computational analysis the sequences for gene prediction |
| CO3 | Identify the use of genes and metabolic pathways in systems biology |
| CO4 | Infer the appropriate tools in systems biology for modeling |
| CO5 | Recognize the various concepts of OMICS technology |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Biological Databases:** Introduction to bioinformatics - classification of biological databases, Biological data formats, Application of bioinformatics in various fields. | 1 | 12 |
| | **Systems Biology:** Understanding Biology at system level, requirement of system level understanding, computing and system biology. | 1 | 12 |
| | **Instructional Hours** | | **14** |
| II | **Introduction to Sequence alignment:** Substitution matrices –PAM and BLOSUM. Pairwise alignment methods; Multiple sequence alignment methods. Evolutionary analysis: distances - clustering methods – rooted and unrooted tree representation – Bootstrapping strategies. | 1 | 4,10 |
| | **Instructional Hours** | | **14** |
| III | **Genes and Genomes:** Interpreting expression data using Gene Ontology; Evolution of modularity and transcriptional networks, metabolite sensing and translational control; Microarrays-types and applications. | 3 | 5 |
| | **Instructional Hours** | | **10** |
| IV | **Metabolic pathway database:** KEGG pathway database, Concept of metabolome and metabolomics. Gene networks - Integration of Networks. | 4 | 24 |
| | **Instructional Hours** | | **10** |
| V | **OMICS Concepts:** Genomics, Proteomics, transcriptomics, interactomics, Phenomics, localizomics; Combination of omics approaches: data integration, modeling; Synthetic biology | 3 | 7 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Rastogi, C. S., Namita Mendiratta, **Bioinformatics-Methods and Applications,** PHI Learning Pvt. Ltd., 4th Edition, 2013.
2. https://**nptel.ac.in**/courses/102106035/Module%201/Lecture%201/Lecture%201.pdf
3. Harisha, S., **Fundamentals of Bioinformatics**, I. K. International Publishing House, 1st Edition, 2007.
4. Sandy Primrose and Richard Twyman., **Principles of Gene Manipulation and Genomics**, Blackwell Publishing, 2010.

Unit – I: Text Book 1, Chapter 1, Page No. 1-26.
Unit – II: Weblink 2 – NPTEL notes
Unit – III: Text Book 3, Chapter 5, Page No. 106-126.
Unit – IV: Text Book 4, Chapter 24, Page No. 472-479.
Unit – V: Text Book 3, Chapter 7, Page No. 153-168.

**Reference Book(s):**

1. Teresa Attwood., **Introduction to Bioinformatics**, Pearson Publications, 1st Edition, 2007.
2. Andreas D. Baxevanis, B.F. Francis Ouellette., **Bioinformatics**, Wiley Publishers, 3rd Edition, 2011.
3. Dov Stekel., **Microarray Bioinformatics**, Cambridge University Press, 1st Edition, January 2010.
4. David Mount., **Bioinformatics: Sequence and Genome Analysis,** Cold Spring Harbor Lab Press, 2nd Edition, 2004.
5. https://www.ncbi.nlm.nih.gov/books/NBK143764/
6. https://www.expasy.org/links
7. https://ww2.chemistry.gatech.edu/~lw26/course_Information/4581/labs/tbp/rasmol/rasmol_tbp_fset.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Assignment | Interpretation | Computation | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | H | M | M | M | L | H | M | M | L | L |
| **CO2** | L | L | L | M | M | L | L | L | H | H | H | M | L |
| **CO3** | H | M | M | L | L | L | L | M | M | H | H | M | M |
| **CO4** | M | L | L | H | L | L | M | M | M | H | M | H | M |
| **CO5** | L | M | L | M | L | L | L | L | M | L | L | L | H |

H-High; M-Medium; L-Low.

| Course Designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 20PGBTQ403 | Practical III - Plant and Animal Biotechnology | | |
| Semester: III & IV | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To provide the student with the relevant practical knowledge on maintenance and preservation of animal cells in vitro, plant propagation and production of transgenic plants

**Course Outcomes:**

On successful completion of the course the students will be able to

| | |
|---|---|
| **CO 1** | Understand different tissues culture media, micropropagation methods and transgenic plant production technology |
| **CO 2** | Establish, maintain and preserve animal cells *in vitro* |
| **CO 3** | Qualitative and quantitative analysis of plant genomic DNA |
| **CO 4** | Isolate plasmid DNA from *Agrobacterium* sp. |
| **CO 5** | Analyze the plant transformation techniques |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 5**

| S. No. | Experiment |
|---|---|
| **Plant Biotechnology** | |
| 1. | Composition and preparation of media and sterilization |
| 2. | *In vitro* Seed Germination |
| 3. | Micropropagation - Nodal and apical meristems. |
| 4. | Callus induction, regeneration and acclimatization |
| 5. | Suspension cultures |
| 6. | Anther culture |
| 7. | Embryo culture and somatic embryogenesis |
| 8. | Protoplast Isolation and Viability Testing |
| 9. | Synthetic Seeds |
| 10. | Isolation of plant genomic DNA |
| 11. | Qualitative and quantitative analysis of plant genomic DNA |
| 12. | *Agrobacterium* mediated transformation |
| **Animal Biotechnology** | |
| 13. | Sterilization techniques – Glasswares and Media. |
| 14. | Preparation of culture media and sera |
| 15. | Preparation of primary cell culture |
| 16. | Trypsinizing and subculturing cells from a monolayer |
| 17. | Passaging cells in suspension culture |
| 18. | Determining cell number and viability with Trypan blue staining |
| 19. | Cell Cytotoxicity assay - MTT |
| 20. | Cryopreservation of cells |
| | |
| | **Total Hours 150** |

**Tools for Assessment (50 Marks)**

| Handling Skill | Analytical Skill | Lab Performance | Test I | Test II | Observation note book | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 8 | 10 | 10 | 6 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | L | L | M | L | L | L | H | M | L | L |
| **CO2** | L | L | M | L | L | L | L | L | L | M | L | M | M |
| **CO3** | L | L | l | L | L | L | L | L | M | H | H | M | L |
| **CO4** | L | L | M | L | L | M | L | L | M | L | H | H | H |
| **CO5** | L | L | M | L | L | L | M | L | L | H | M | M | M |

H-High; M-Medium; L-Low

| Course designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTQ404 | Practical – IV Immunology and Pharmaceutical Biotechnology | | |
| Semester: III & IV | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

The objectives of this laboratory course is to make students to develop an understanding about practical aspects of the components of the immune system, drug development and how they can be used in drug designing.

**Course Outcomes:**

On the successful completion of the course the students will get an overall understanding of

| | |
|---|---|
| **CO1** | Basic knowledge regarding general methods to identify immune response |
| **CO2** | Fundamental knowledge on disease diagnosis and treatment |
| **CO3** | Apply their knowledge to develop a novel drug |
| **CO4** | Toxicological aspects of active ingredients and finished products |
| **CO5** | Evaluate the usefulness of immune techniques in different pharmaceutical companies. |

**Offered by:** Biotechnology

**Course Content** **Instructional Hours / Week: 5**

| S. No | Experiment |
|---|---|
| | **Immunology** |
| 1. | **Preparation of antigens – protocol of immunization, methods of bleeding.** |
| 2. | **Study on Blood Cells** |
| | Identification of blood cells |
| | Differential count of blood cells |
| 3. | **Agglutination test** |
| | ABO Blood grouping |
| | Widal test for typhoid fever (qualitative test) |
| 4. | **Passive agglutination test** |
| | Anti - Streptolysin O (ASO) test |
| | C-Reactive Protein (CRP) test |
| 5. | **Agglutination inhibition test** - Pregnancy test for detection of HCG |
| 6. | **Flocculation test** - Rapid Plasma Reagin Test (RPR) |
| 7. | **Precipitation test** |
| | **Immuno diffusion** |
| | Ouchterlony's Double Immunodiffusion Technique (ODD) |
| | Radial Immuno Diffusion (RID) |
| | **Immunoelectrophoresis** |
| | Rocket Immuno Electrophoresis (RIE) |
| | Counter Current Immunoelectrophoresis (CIE) |
| 8. | ELISA (demonstration) |
| | **Pharmaceutical Biotechnology** |
| 9. | Various modes of administration of drugs: Intravenous, Intramuscular, Intra-peritoneal, Interadermal |
| 10. | Immunization and generation of antiserum in animals against antigen |

| | | |
|---|---|---|
| 11. | Separation of IgG using affinity chromatography | |
| 12. | Identification, purification of Lead compounds from plant source. | |
| 13. | Optimization of Lead compounds from plant source. | |
| 14. | Experiments on $LD_{50}$ and $ED_{50}$ of biomolecules in animal model | |
| 15. | Microbial sensitivity of some human pathogens against lead compound | |
| 16. | Microbial analysis of pharmaceuticals (syrups) | |
| | **Total Hours** | **150** |

**Tools for Assessment (50 Marks)**

| Handling Skill | Analytical Skill | Lab Performance | Test I | Test II | Observation note book | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 8 | 10 | 10 | 6 | 50 |

**Mapping**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | L | L | M | L | L | H | H | M | L | L |
| **CO2** | L | L | L | L | M | L | L | L | H | M | L | M | M |
| **CO3** | L | L | M | L | L | L | L | M | H | H | H | M | L |
| **CO4** | M | L | L | L | L | M | L | L | M | L | H | H | H |
| **CO5** | L | L | M | L | L | L | M | L | H | H | M | M | M |

H-High; M-Medium; L-Low

| Course designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTV401 | Research Project & Viva-Voce | | |
| Semester: IV | Credits: 8 | CIA: 100 Marks | ESE: 100 Marks |

## Project Guidelines

### 1. ARRANGEMENT OF CONTENTS:

The sequence in which the project report material should be arranged and bound is as follows:

1. Cover Page & Title Page
2. Table of Contents
3. List of Tables
4. List of Figures
5. List of Symbols, Abbreviations
6. Chapters
7. References
8. Appendices

The table and figures shall be introduced in the appropriate places.

### 2. PAGE DIMENSION AND SIZE OF THE PROJECT REPORT:

a) The size of the project report for undergraduate and post graduate degree should contain a minimum of 40 and 60 pages of content respectively. The pages will be counted from the first page of Chapter I. The dimension of the project report should be in A4 size.

b) The project report should be bound using flexible cover of thick art paper. The cover should be **printed in black letters** and the text for printing should be identical.

**c) Page Numbering**

All page numbers **(whether it is in Roman or Arabic numbers)** should be typed without punctuation on the central bottom of each page. The preliminary pages of the reports (such as Title page, Acknowledgement, Table of Contents, etc.) should be numbered in lower case Roman numerals. The title page will be numbered as (i) but this should not be typed. The page immediately following the title page shall be numbered as (ii) and it should appear at the top right hand corner as already specified. Pages of main text, starting with Chapter 1 should be consecutively numbered using Arabic numerals.

### 3. PREPARATION FORMAT:

**Cover Page & Title Page** – A specimen copy of the Cover page & Title page of the project report are given in **Appendix 1.**

**Table of Contents –** The table of contents should list all material following it as well as the Abstract which precedes it. The Title page and Bonafide Certificate will not find a place among the items listed in the Table of Contents. **One and a half** spacing should be adopted for typing the matter under this head.

**List of Tables –** The list should use exactly the same captions as they appear above the tables in the text. **One and a half** spacing should be adopted for typing the matter under this head.

**List of Figures –** The list should use exactly the same captions as they appear below the figures in the text. **One and a half** spacing should be adopted for typing the matter under this head.

**Table and figures -** By the word Table, is meant tabulated numerical data in the body of the project report as well as in the appendices. All other non- verbal materials used in the body of the project work and appendices such as charts, graphs, maps, photographs and diagrams may be designated as figures.

**List of Symbols, Abbreviations**– One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.

**Chapters** – The chapters may be broadly divided into 3 parts introductory chapter,

(i) Chapters developing the main theme of the project work

(ii) Conclusions and scope

The introductory chapter will have sections covering a general introduction and importance of the research project.

The main text will be divided into several chapters and each chapter may be further divided into several divisions and sub-divisions.

- ❖ Each chapter should be given an appropriate title.
- ❖ Tables and figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.

**Appendices** – Appendices are provided to give supplementary information, which if included in the main text may serve as a distraction.

- Appendices should be numbered using Arabic numerals, e.g. Appendix 1, Appendix 2, etc.
- Appendices, Tables and References appearing in appendices should be numbered and referred at appropriate places just as in the case of Chapters.

- Appendices shall carry the title of the work reported and the same title shall be made in the contents page also.

**List of References** –The listing of references should be typed 4 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. The reference material should be listed in the alphabetical order of the first author.The name of the author / authors should be immediately followed by the year and other details.

**(i)** If more than one paper by the same first author and same year of publications, the year of citation will be followed by a, b etc to differentiate them.

**(ii)** While citing the paper in the text, the name of the first author and year alone must be cited. e.g Samson (2004) or Jeyaraj (2007a). The reference numbers should not be used in the text of the paper

**(iii)** A paper, a monograph or a book may be designated by the name of the first author followed by the year of publication, placed inside brackets at the appropriate places in the Thesis.

**4. TYPING INSTRUCTIONS:**

The impression on the typed copies should be black in colour.

**One and a half** spacing should be used for typing the general text. The general text shall be typed in the **Font style „Times New Roman" and Font size 13.**

**APPENDIX 1**

**TITLE** <Font Size 18> <1.5 line spacing>

***a project report submitted by***

<Font Size 14> <Italic>

**NAME OF THE STUDENT (REGISTER NUMBER)**<Font Size 16>

***in partial fulfillment for the award of the degree***

<Font Size 14> <Italic> <1.5 line spacing>

***in***

**NAME OF THE PROGRAMME** <Font Size 16>

***under the supervision of* <Font Size 14> <Italic>**

**NAME OF THE SUPERVISOR** <Font Size 16>

**NAME OF THE DEPARTMENT**<Font Size 14>

**NEHRU ARTS AND SCIENCE COLLEGE**
(An Autonomous Institution affiliated to Bharathiar University)
(Reaccredited with "A" Grade by NAAC, ISO 9001:2015 & 14001:2004 Certified
Recognized by UGC with 2(f) &12(B), Under Star College Scheme by DBT, Govt. of India)
Nehru Gardens, Thirumalayampalayam, Coimbatore - 641 105, Tamil Nadu.

**MONTH & YEAR** <Font Size 14>

**EVALUATION PROCESS**

Review – I has to be conducted during the Last week of December

Review – II has to be conducted during the Last week of February

**Viva-Voce examination will be conducted at the end of the semester by both Internal (Respective Guides) and External Examiners, after duly verifying the Project Report available**

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE101 | Elective Paper – I (A) Environmental Biotechnology | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

On successful completion of the course the students should have understood the relationship of environment and biota, solve pollution problems, water process technology.

**Course Outcomes:**

On successful completion of the course, the students will be able

| | |
|---|---|
| **CO1** | To recall the basic concepts of the environment and biota |
| **CO2** | To demonstrate the dynamics and management of the ecosystem |
| **CO3** | To develop methodology to solve pollution problems |
| **CO4** | To plan the management of liquid waste |
| **CO5** | To create the role of microbes in waste process technology |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Basic concepts:** Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and tropic levels. | 1 | 1 |
| | Ecological pyramids and recycling, **biotic community** - concept, structure, dominance, fluctuation and succession; **Concepts and theories of evolution** - Population ecology - community structure. | 1 | 3 |
| | **Instructional Hours** | | **12** |
| II | **Ecosystem dynamics and management:** Stability and complexity of ecosystems; Speciation and extinctions; environmental impact assessment; Principles of conservation. | 1 | 6 |
| | Conservation strategies; sustainable development. Global environmental problems: ozone depletion, UV-B green house effect and acid rain, their impact in biotechnological approaches for management. | 2 | 5 |
| | **Instructional Hours** | | **12** |
| III | **Environmental pollution:** Types of pollution, Methods for the measurement of pollution; **Methodology of environmental management** – the problem solving approach, its limitations. Air pollution and its control through Biotechnology. Water Pollution and control: Need for water management, Measurement and sources water pollution. | 3 | 2 |

| | | | |
|---|---|---|---|
| | Kind of aquatic habitats, (fresh and marine), distribution and impact of environmental factors on the aquatic biota, productivity, mineral cycles and biodegradation different aquatic ecosystems. | 3 | 4 |
| | **Instructional Hours** | | **12** |
| **IV** | **Liquid waste management**. Composition, BOD, COD and DO. | 3 | 6 |
| | Physical, Chemical and Microbiological treatment. Water borne diseases. | 3 | 6 |
| | **Instructional Hours** | | **11** |
| **V** | **Role of Microbes in waste process technology** – Bioremediation, Bioleaching, Degradation of xenobiotics. Utilization of waste as food (SCP, Yeast and Mushroom), as fuel (Ethanol and Methane) as fertilizer (Algae) and as feed (Algae and Yeast). | 4 | 5 |
| | Ecological considerations, decay behaviour and degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. | 4 | 7 |
| | **Instructional Hours** | | **13** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Sharma, P.D., **Ecology and Environment**, Rastogi Publications, 2007
2. Paulsamy, S., **Introduction to Environmental Biology**, Emkay publications, 1998. Revised 2016.
3. Goel, P.K., **Water Pollution** (Causes, effects and control), New age international publishers, 2011.
4. Joseph, C. Daniel, **Environmental aspects of Microbiology**, Humana Press, 2013.

Unit I : Text Book 1, Chapter 1, 3.
Unit II : Text Book 1, Chapter 6; Text Book 2, Chapter 5.
Unit III : Text Book 3, Chapter 2, 4.
Unit IV : Text Book 3, Chapter 6.
Unit V : Text Book 4, Chapter 5, 7.


**Reference Book(s):**


1. Rao, C.S., **Environmental Pollution Control engineering**, New Age International, 2007
2. Vasudevan, N., **Essentials of Environmental Science**, Alpha Science International, 2006
3. Vijaya Ramesh, K., **Environmental Microbiology**, MJP Publishers, 2008.
4. Dr. Sushmitha Baskar and R. Baskar – **Environmental science for engineering under graduates**, 1970.
5. Sunakar Panda, **Environmental and Ecology**, Vrinda Publications, 2007
6. Arumugam, N. and Kumaresan, V. **Environmental Biology**, Sara's publishers, 2013.
7. http://www2.hcmuaf.edu.vn/data/quoctuan/8122418481%20Environmental_Science.pdf
8. http://marno.lecture.ub.ac.id/files/2012/05/BIOLOGI-LINGKUNGAN.pdf

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Short test | Viva voce | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | L | L | M | M | L | M | M | L | H | L |
| **CO2** | L | L | M | L | M | L | L | M | H | H | M | H | H |
| **CO3** | M | L | L | H | L | L | L | M | L | H | H | L | M |
| **CO4** | L | M | L | L | L | H | M | L | H | L | H | L | M |
| **CO5** | M | M | L | M | L | L | L | M | H | M | H | M | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE102 | Elective Paper – I (B) BioEntrepreneurship | | |
| Semester: I | Credits: 4 | CIA : 50 Marks | ESE: 50 Marks |

**Course Objective:**

This course will help students to recognize a business opportunity that fits the individual student and also to demonstrate the understanding of how to launch the individual's entrepreneurial career.

**Course Outcomes:**

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

| | |
|---|---|
| **CO1** | Gaine Knowledge on how to assess business opportunities and an in – depth understanding of what typically characterize success and failures |
| **CO2** | Understand the key and the most effective processes in bringing different types of products or services to markets |
| **CO3** | Transform an initial idea in to a fully – fledged business opportunity and effectively communicate this opportunity through a business plan and pitch |
| **CO4** | Learn Technology and Entrepreneurship in a cross – disciplinary- fashion to identify and develop attractive opportunities within their field of experience |
| **CO5** | Identification of project selection and business opportunities |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Management and Practices:** Introduction, definition – Management | 2 | 1 |
| | Principles of Henry Fayol | 2 | 2 |
| | Setting and Managing Biotechnology Industry: principles and decisions on starting a venture | 5 | 7 |
| | Sources of financial assistance | 5 | 7 |
| | Making a business proposal | 1 | 7 |
| | Approaching loan from bank and other financial institutions | 1 | 11 |
| | Budget planning and cash flow management | 1 | 10 |
| | Basics in accounting practices | 3 | 29 |
| | **Instructional Hours** | | **13** |
| II | **Process and Marketing:** Recruitment and selection process | 4 | 4 |
| | Leadership skills and Managerial skills | 2 | 2 |
| | Organization structure | 2 | 2 |
| | Training | 4 | 8 |
| | Team Building | 4 | 8 |
| | Marketing Definition and Functions | 1 | 8 |

| | | | |
|---|---|---|---|
| | Assessment of market demand for potential product (s) of interest | 1 | 8 |
| | Market conditions, segments; prediction of market changes | 1 | 8 |
| | Identifying needs of customers including gaps in the market. | 1 | 8 |
| | **Instructional Hours** | | **13** |
| **III** | **Entrepreneur:** Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur types of entrepreneur | 1 | 1 |
| | Evolution of entrepreneurship | 1 | 1 |
| | Development of entrepreneurship, stages in entrepreneurial process | 3 | 9 |
| | Role of entrepreneurs in economic development entrepreneurship in India | 3 | 1 |
| | Entrepreneurship - its barriers | 3 | 7 |
| | **Instructional Hours** | | **13** |
| **IV** | **Small Scale Industry:** Definition, characteristic and Need and rationale | 5 | 2 |
| | Objectives, Scope, Role of SSI in economic development, Advantages of SSI | 5 | 5 |
| | Steps to start an SSI | 5 | 6 |
| | Govt. policy towards SSI, different policies of SSI, Govt. support for SSI during 5 year plans | 5 | 6 |
| | Impact of liberalization, privatization, globalization on SSI | 5 | 17 |
| | Effect of WTO/ GATT, Supporting agencies of Govt for SSI, meaning; nature of support, objectives, and functions | 5 | 17 |
| | Types of help, Ancillary industry and Tiny industry | 5 | 8 |
| | **Instructional Hours** | | **11** |
| **V** | **Projects and Application:** TECKSOK, KIADB, KSSIDC, KSIMC, DIC single window Agency SISI, NSIC, SIDBI, KSFC | 3 | 18 |
| | Preparation of Project-Meaning of Project; Project Identification Project Selection. Project Report | 3 | 11 |
| | Need and significance of Report, Contents, Formulation Guidelines by Planning Commission for Project report | 3 | 12 |
| | Network Analysis; Errors of Project Report, Project Appraisal | 3 | 13 |
| | Identification of Business Opportunities. Market Feasibility Study, Technical Feasibility study, Financial Feasibility Study & Social Feasibility study. | 3 | 30 |
| | **Instructional Hours** | | **10** |
| | **Total Hours** | | **60** |

**Text Book(s):**


1. Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, **Entrepreneurship,** Tata McGraw Hill, 2007.
2. Tripathy, P.C. and P. N. Reddy, McGraw Hill, **Principles of Management,** 2008.
3. Khanka, S.S., and S. Chand sons, **Entrepreneurial Development,** 2008.
4. Gary Desseler, **Human Resource Management**, Prentice Hall, Edition: 10, Prentice Hall Publishers, 2005.
5. Vasant Desai, Himalaya Publishing, **Dynamics of Entrepreneurial Development and Management,** 2007.


Unit I: Text Book 1 (Chapter 7, 10 & 11), 2 (Chapter 1 & 2), 3 (Chapter 29), & 5 (Chapter 7).
Unit II: Text Book 1 (Chapter 8), 2 (Chapter 2) & 4 (Chapter 4 & 8).
Unit III: Text Book 1 (Chapter 1) & 3 (Chapter 1, 7 & 9).
Unit IV: Text Book 5 (Chapter 2, 5, 6, 8 & 17).
Unit V: Text Book 3 (Chapter 11, 12, 13, 18 & 30)

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Viva voce | Seminar | Class Room Exercise | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | M | M | L | L | L | L | H | H | L | H |
| **CO2** | M | L | L | M | L | L | M | L | M | L | H | L | H |
| **CO3** | L | L | M | L | L | L | H | M | M | H | L | H | L |
| **CO4** | L | M | M | M | L | L | H | L | H | H | H | H | H |
| **CO5** | L | L | L | M | L | L | H | M | L | M | H | M | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE103 | Elective Paper – I (C) Research Methodology | | |
| Semester: I | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

The primary objective is to develop a research orientation among the students and to acquaint them with fundamentals of research methods. Specifically, introducing them to the basic concepts used in research and to scientific social research methods and their approach.

**Course Outcomes:**

On successful completion of this course, the student will be able to understand the

| | |
|---|---|
| **CO1** | Basic framework of research process |
| **CO2** | Various research designs and technique |
| **CO3** | Various sources of information for literature review and data collection |
| **CO4** | Ethical dimensions of conducting applied research<br>Appreciate the components of scholarly writing and evaluate its quality |
| **CO5** | Procedure for writing research proposal and grant |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Objective and Steps in Research process**: Definition, objectives of research. Types and its significance. Steps in research process. Criteria for good research. | 1 | 1 |
| | Defining and formulating a research problem. Literature survey, Development of working hypothesis. | 1 | 2 |
| | **Instructional Hours** | | **11** |
| II | **Research design:** Definition and related concepts, Basic principles of experimental designs- Informal and formal experimental designs | 1 | 3 |
| | Sampling design: Steps in sample design, Non-probability sampling and Probability sampling -random sampling; Measurement and scaling techniques- Methods of data collection. | 1 | 4<br>5 |
| | **Instructional Hours** | | **13** |
| III | **Sources of Data:** Primary Data, Secondary Data; Procedure Questionnaire: Sampling Merits and Demerits - Experiments - Kinds - Procedure; Procedure Schedules: Sampling Merits and Demerits - Experiments - Kinds - Procedure; | 1 | 6 |
| | Control Observation: Merits - Demerits - Kinds - Procedure - Sampling Errors: Type-I Error, Type-II Error | 1 | 9 |
| | **Instructional Hours** | | **13** |
| IV | **Research report writing:** steps in report writing layout of the Research Report, Types of Reports, Styles of reporting. Editing and evaluation of final draft, evaluating the final draft; Editing and | 1<br>2 | 14<br>10<br>20 |

| | | | |
|---|---|---|---|
| | evaluation of final draft, evaluating the final draft | | |
| | **Instructional Hours** | | **12** |
| **V** | **Research proposal/Grant**: Presentation of data - preparation of master's thesis for oral presentation; Presenting the research findings in open defense. Research proposal/Grant- definition, structure, budget allocation, specific aims, background and significance. Hierarchy of funding agencies in India and their operations. | 2 | 20 |
| | **Instructional Hours** | | **11** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Kothari, C.R., **Research Methodology: Methods and Techniques,** New Age International Publishers, 2nd Edition, 2010.
2. Chawla Deepak & Sondhi Neena., **Research Methodology: Concepts and Cases**, Vikas Publishing House Pvt. Ltd. Delhi, 2011.

Unit I: Text Book 1, Chapter 1 & 2
Unit II: Text Book 1, Chapter 3-5
Unit III: Text Book 1, Chapter 6 & 9
Unit IV: Text Book 2, Chapter 10 & 20; Text Book 1, Chapter 14
Unit V: Text Book 2, Chapter 20

**Reference Book(s):**

1. Gurumani, N., **Research Methodology for Biological Science,** MJP Publishers, Chennai, 2006.
2. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118763025
3. https://mtechlib.files.wordpress.com/.../researchmethodology_stepbystepguide_R.kumar.
4. Rt. Kumar, **Research Methodology: A Step-by-Step Guide for Beginners**, SAGE pub., 2010.
5. C. R. Kothari, **Research Methodology: Methods and Techniques**, New Age Intl., 1985.

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Viva voce | Case study | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | M | L | H | L | L | M | H |
| **CO2** | M | L | L | M | M | L | L | L | H | M | M | M | H |
| **CO3** | L | L | M | M | L | L | L | M | L | M | M | M | L |
| **CO4** | L | L | M | M | L | L | M | H | L | L | M | M | H |
| **CO5** | M | M | L | L | L | M | M | M | H | M | H | M | L |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE201 | Elective Paper – II (A) Agricultural Biotechnology | | |
| Semester: II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

The primary objective is to develop a research in agriculture practices and crop improvement startergies.

**Course Outcomes:**

On successful completion of this course, the student will be able to

| | |
|---|---|
| **CO1** | Understand the basic concept of biotechnology in Agriculture |
| **CO2** | Different techniques of Agriculture Biotechnology in Plant Breeding Methods |
| **CO3** | Sympathetic crop plantings through model biotechnological approach |
| **CO4** | Analyze the applications and environmental risk assessment on transgenic Plants |
| **CO5** | Apply biotechnology in agricultural field for crop improvement |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Scope of Biotechnology in agriculture**: Biotechnology in Agriculture, growth and historical perspective of agriculture biotechnology; Science of Genetic leading to modern biotechnology to agriculture. | 1 | 1, 15, 16 |
| | **Instructional Hours** | | **10** |
| II | **Central Concepts in Plant Breeding**: Simple versus complex Inheritance, Phenotype versus Genotype, Mating System, Varieties, Landraces and Pure Lines; Plant Breeding is a numbers Game; Plant Breeding is an Iterative and Collaborative process; Diversity; Adaptation and Ideotypes.<br>**Methods of Plant Breeding**: Methods of Hybridization-Self-pollinated species, Out crossing species, Synthetic varieties, Hybrid varieties, Clonally propagated species.<br>**Breeding**: enhancements: Double Haploidy, Marker-Assisted Selective, Mutation Breeding. | 1<br>2<br>1<br>2 | 3<br>6,7<br>3<br>4, 7 |
| | **Instructional Hours** | | **14** |
| III | **Biotechnology Crops Plantings**: Farmers Use Biotech Crops; Herbicide Tolerant Crop, Insect Resistant Crops, Pathogen Resistance Crop; Environmental impact from changes in Insecticide and Herbicide use; Improved **Products and Food Quality**: Nutritional Improvements, Modified Plant Oils, Pharmaceutical Products, Biofuels. Impact on Green house (GHS) Emissions- Impact of Biofertilizers in agriculture - advantage and current status - Applying Biotechnology in Resource Poor Areas. | 1 | 1, 8 |
| | **Instructional Hours** | | **13** |

| | | | |
|---|---|---|---|
| IV | **Field Testing of Transgenic Plants:** Environmental Risk Assessment (Era) Process- Initial Evaluation (ERA Step 1), Problem Formulation (ERA Step 2), Controlled Experiments and Gathering of Information (ERA Step 3), Risk Evaluation (ERA Step 4), Progression through a Tiered Risk Assessment.<br>**Risk Assessment**: Bt Maize Pollen on Non-target Caterpillars, Statistical analysis and Relevance for Predicting; Potential Adverse Effects on Butterflies. | 1 | 13 |
| | **Instructional Hours** | | **13** |
| V | **Intellectual Property** in Agricultural Biotechnology Research; Anticommons – Transformation methods, Selectable Markers, Constitutive Promoters, Tissue or Development Specific Promoters. Freedom to Operate (FTO), Strategies for Open Access.<br>**Future of Agriculture Biotechnology** – Site specific Recombination System, Zinc-Finger Nucleases; Future of Food, Fuel and Pharmaceuticals. | 1 | 16 |
| | **Instructional Hours** | | **10** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Stewart, C. Neal. **Plant Biotechnology and Genetics; Principles, Techniques and Applications.** John Wiley & Sons, Inc. Canada, 2008.
2. Acquaah, George, **Principles of Plant Genetics and Breeding** - 2nd Edition, John Wiley & Sons, Inc. Canada, 2012.

Unit I : Text Book 1, Chapter 1, 15, 16
Unit II : Text Book 1, Chapter 3; Text Book 2, Chapter 4, 6, 7
Unit III: Text Book 1, Chapter 1, 8
Unit IV: Text Book 1, Chapter 13
Unit V: Text Book 1, Chapter 16

**Reference Book(s):**

1. Kumar H.D., **Agricultural Biotechnology**, Daya Publishing House, 2005.
2. Arie Altman, **Agricultural Biotechnology**, CRC Press, 1997.
3. Ahindra Nag, **Agricultural Biotechnology**, PHI Learning Pvt.Ltd. 2008
4. Ashok Kumar, **Agricultural Biotechnology,** Discovery Publishing House, 2005.
5. https://www.pdfdrive.net/plant-mutation-breeding-and-biotechnology-d18117949.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Viva voce | Mini project | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | L | L | M | M | L | H | L | L | M | H |
| **CO2** | L | L | M | L | M | L | L | M | H | M | M | M | H |
| **CO3** | M | L | L | H | L | L | L | M | H | M | M | M | H |
| **CO4** | L | M | L | L | L | H | M | L | H | M | M | M | H |
| **CO5** | M | M | L | M | L | L | L | M | H | M | H | M | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE202 | Elective Paper – II (B) Downstream Processing | | |
| Semester: II | Credits: 4 | CIA : 50 Marks | ESE: 50Marks |

**Course Objective:**

To realise the importance of basics in assemblage of small molecules and to utilise in retrieving meaningful conclusion through problem based learn. Understand the methods to obtain pure proteins, enzymes and in general about product development R & D. Have depth knowledge and hands on experience with on downstream processes

**Course Outcomes:**

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

| | |
|---|---|
| CO1 | Explain the fundamentals of downstream processing for product recovery |
| CO2 | Understand the requirements for successful operations of downstream processing |
| CO3 | Confess the components of downstream equipment and explain the purpose of each steps |
| CO4 | Apply principles of various unit operations and enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion |
| CO5 | Formulation of final product |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Introduction:** Principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pretreatment and stabilisation of bioproducts | 1,4 | 2,5 |
| | **Instructional Hours** | | **12** |
| II | **Separation and Purification:** Unit operations for solid-liquid separation – filtration and centrifugation | 2,1 | 7,3,4 |
| | **Instructional Hours** | | **9** |
| III | **Separation and Purification:** Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods | 1,2 | 5 |
| | **Instructional Hours** | | **15** |
| IV | **Chromatography:** principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromato graphic techniques, Paper and TLC – Separation of flavanoids, proteins, Phytosterols, Nucleic acids, nanoparticles and functionalised nanoparticles. Purification chart to assess purity. | 3,4 | 8,7 |
| | **Instructional Hours** | | **15** |
| V | **Lyophilisation:** Crystallization, drying and lyophilisation in final product formulation | 1 | 16 |

| Instructional Hours | 9 |
|---|---|
| Total Hours | 60 |

**Text Book(s):**

1. Sivasankar, B., **Bioseparations - Principles and Techniques**, PHI, 2005.
2. Erwin H. Segel, **Biochemical calculations**, 2nd Edition, John Wiley & Sons, 2004.
3. David Freifelder, **Physical Biochemistry**, W.H. Freeman & Company, 2nd Edition, 2008.
4. Simon Roe**, Protein purification techniques**, 2nd Edition, Oxford Press, 2004

Unit I: Text Book 1 (Chapter 2, 13-25), Text Book 4 (Chapter 5, 83-108)
Unit II: Text Book 2 (Chapter 7, 193-213), Text Book 1 (Chapter 3, 4, 26-53)
Unit III: Text Book 1, 2 (Chapter 5, 54-67; 150-152)
Unit IV: Text Book 3 (Chapter 8, 216-271), Text Book 4 (Chapter 7- 155-182, Chapter 8- 187-208)
Unit V: Text Book 1 (Chapter 15, 255-265)

**Reference Book(s):**

1. https://www.researchgate.net/publication/227176832_Downstream_processing_of_biotechnological_produced_succinic_acid
2. Chunlian Tian, Peng Zhang, Caixia Yang, Xiang Gao, Hong Wang, Yuru Guo, and Mingchun Liu, **Extraction Process, Component Analysis, and In Vitro Antioxidant, Antibacterial, and Anti-Inflammatory Activities of Total Flavonoid Extracts from Abutilon theophrasti Medic. Leaves** Mediators of Inflammation, Volume 2018, Article ID 3508506, https://doi.org/10.1155/2018/3508506
3. Fernandes, J.M.S. Cabral, **Phytosterols: Applications and recovery methods**, Bioresource Technology, 98 (2007) 2335–2350.
4. Belter, P.A. E.L. Cussler and Wei-Houhu, **Bioseparations – Downstream Processing For Biotechnology**, Wiley Inter-science Pun, 1988.

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Group Discussion | Viva voce | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | L | L | M | M | L | H | H | M | M | L |
| **CO2** | L | M | M | L | M | L | L | M | H | H | M | M | L |
| **CO3** | M | L | L | H | L | L | L | M | L | H | H | H | H |
| **CO4** | L | L | L | M | L | H | M | L | H | M | H | M | L |
| **CO5** | L | L | L | M | M | L | L | M | M | H | M | H | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE203 | Elective Paper – II (C) Applied Biostatistics | | |
| Semester: II | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

This course provides an introduction to applied statistics, with an emphasis on medical and epidemiological data.

**Course Outcomes:**

At the end of the course a student should be able to

| | |
|---|---|
| **CO1** | Demonstrate an organized approach to the analysis of data collected to answer a scientific question |
| **CO2** | Refine a scientific question into a statistical framework.<br>Identifying the response variable and an appropriate summary measure of that variable.<br>Identifying the predictor of interest |
| **CO3** | Ascertaining and computing appropriate summary statistics and graphical displays. |
| **CO4** | Analyze the sampling distribution statistic and application of basic tools in research |
| **CO5** | Apply the Categorical Data and Chi-Square Tests in sample analysis |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Types of Studies:** Surveys and Cross-Sectional Studies, Retrospective Studies, Prospective Studies, Experimental Studies and Quality Control, Clinical Trials | 1 | 1 |
| | **Instructional Hours** | | **13** |
| II | **Basic Epidemiological Concepts:** Introduction to basic epidemiological concepts, such as study designs as well as the difference between observational studies and randomized clinical trials. | 1 | 1& 2 |
| | **Instructional Hours** | | **13** |
| III | **Selecting Proper Statistical Tests:** Simple Random Sampling, Bootstrap Sampling, Convenience Sampling, Systematic Sampling, Cluster Sampling | 1 | 2 |
| | **Instructional Hours** | | **13** |
| IV | **Correlation and Regression:** Correlation, Linear Regression, and Logistic Regression | 2 | 11 |
| | **Instructional Hours** | | **11** |
| V | **Categorical Data and Chi-Square Tests:** Understanding Chi-Square, Chi-Square Distributions and Tables, Testing Independence between Two Variables, Testing for Homogeneity, Testing for Differences between Two Proportions, The Special Case of 2 × 2 Contingency Table, Simpson's Paradox in the 2 × 2 Table, McNemar's Test for Correlated Proportions, | 1 | 11 |

| | |
|---|---|
| Relative Risk and Odds Ratios, Goodness of Fit Tests- Fitting Hypothesized Probability Distributions, Limitations to Chi-Square and Exact Alternatives. | |
| **Instructional Hours** | **10** |
| **Total Hours** | **60** |

**Text Book(s):**

1. Michael R. Chernick and Robert H. Friis, **Introductory Biostatistics for the Health Sciences** (Modern Applications Including Bootstrap), John Wiley & Sons, Inc. Canada, 2003.
2. Gerald Van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley., **Biostatistics** (A Methodology for the Health Sciences), John Wiley & Sons, Inc., 2004.

Unit I : Text Book 1, Chapter 1: 8-19.
Unit II : Text Book 1, Chapter 1 and 2: 14-45.
Unit III: Text Book 1, Chapter 2: 14-45.
Unit IV: Text Book 2, Chapter 11: 428-519.
Unit V : Text Book 1, Chapter 11: 231-250

**Reference Book(s):**

1. Stephen C. Newman, **Biostatistical Methods in Epidemiology**, John Wiley & Sons, Inc., 2001.
2. Lee, T., **Introductory Biostatistics,** Wiley - Interscience, 2011
3. Stephen W. Looney**, Statistical Methods,** Humana publications**,** 2009.
4. https://catalyst.harvard.edu/services/biostatscertificate/
5. https://www.edx.org/course/introduction-applied-biostatistics-osakaux-med101x-0
6. https://www.statistics.com/biostatistics/

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Mini model | Viva voce | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | M | L | H | L | L | M | H |
| **CO2** | M | L | L | M | M | L | L | L | H | M | M | M | H |
| **CO3** | L | L | M | M | L | L | L | M | H | M | M | M | H |
| **CO4** | L | L | M | M | L | L | M | H | H | M | M | M | H |
| **CO5** | M | M | L | L | L | M | M | M | H | M | M | M | L |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HOD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE301 | Elective Paper – III (A) Food Biotechnology | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To know about various staining process of biomolecules in tissues and its implications

**Course Outcomes:**

At the end of the course a student should be able to

| | |
|---|---|
| CO1 | Bring together the role of microorganisms in food spoilage and its analysis. |
| CO2 | Know the process of food upholding through different techniques. |
| CO3 | Classify food borne pathogens and microbial food processing. |
| CO4 | Perform different hazardous analysis and their limitations. |
| CO5 | Analyze the cleaning, processing and food safety standards |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Food Microbiology:** Important genera of food borne microorganisms, factors affecting the growth and survival of microorganisms in food, Microbiological examination of food, Principles of food preservation **Microbial spoilage of food:** common food borne diseases, bacterial agents of food-borne illness, non-bacterial agents of food borne illness, Prevention and remedies. | 1 | 1,10 13-19 |
| | **Instructional Hours** | | **12** |
| II | **SSF processes for Food Enzymes** and their downstream processing: Amylases, Lipases, Proteases, Pectinases, L-Glutaminase, Inulinase, Tannase. Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructooligosaccharides | 4 | 4 |
| | **Instructional Hours** | | **12** |
| III | Germination- basic process and use for nutrients and nutraceutical production. Immobilization- Basics and applications in food processing Microencapsulation- Basics and applications in food processing. | 2 | 22-28 |
| | **Instructional Hours** | | **12** |
| IV | **Fermented food:** Microorganisms in food fermentations, Bacteriocins and antimicrobial ingredients. Milk, fermented meat, fish products, oriental foods. Utilization of food waste for production of valuables. | 3 | 9 |

| | | | |
|---|---|---|---|
| | **Enzymes as processing aids:** Role of enzymes in cheese making and whey processing; fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanses and pentosanases as dough conditioners; lipases for dough conditioning. | | |
| | **Instructional Hours** | | **12** |
| **V** | **HACCP:** Cleaning and disinfection, Code for good manufacturing practices, microbial and chemical safety of food products, indicator organisms, ISO, hazard analysis and critical control points, sterility testing, CCP'S. | 3 | 11 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. James, M.J., **Modern Food Microbiology**, 6th Edition, CBS Publishers & Distributors, 2000.
2. James, M.J., **Modern Food Microbiology**, 7th Edition, CBS Publishers & Distributors, 2005.
3. Adams M.R. and Moss M.O., **Food Microbiology,** 2nd Edition, The Royal Society of Chemistry, 2005.
4. Avanthima **Sharma., Textbook of Food science and Technology,** 3rd Edition, International Book distributing Company, 2019.

Unit I : Text Book 1, Chapter 1, Page No. 10: 1-4, Page No. 177-243; Chapter 13-19: Page No. 251-381
Unit II : Text Book 4, Chapter 4: Page No. 109-132.
Unit III: Text Book 2, Chapter 4: Page No. 22-28.
Unit IV: Text Book 3, Chapter 9: Page No. 311-369.
Unit V : Text Book 3, Chapter 11: Page No. 395-433

**Reference Book(s):**

1. Pederson, C. S., **Microbiology of Food Fermentations**, AVI Publishing Company, Westport, Connecticut, 1971.
2. Joshi V.K. and Ashok Pandey, **Biotechnology: Food Fermentation**, Educational Books Publications, 1999.
3. Pelczar, M.J., Chan E.C.S. and Krieg, N.R., **Microbiology**, McGraw-Hill, New York, 1988.
4. http://technology.tki.org.nz/Resources/Case-studies/Classroom-practice-case-studies/Food-and-biotechnology
5. https://www.foodinsight.org/education/food-biotechnology-communicators-guide-improving-understanding

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Group discussion | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | M | M | L | L | L | L | M | M | L | L |
| **CO2** | M | L | L | M | L | L | M | L | H | M | H | M | M |
| **CO3** | L | L | M | L | L | L | H | M | H | L | M | M | M |
| **CO4** | L | M | M | M | L | L | H | L | M | H | H | M | M |
| **CO5** | L | L | L | M | L | L | H | M | M | H | H | M | M |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE302 | Elective Paper – III (B) Quality Control and Assurance | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To know about various staining process of biomolecules in tissues and its implications

**Course Outcomes:**

At the end of the course a student should be able

| | |
|---|---|
| CO1 | To acquire basic laboratory regulation and operation in quality declaration. |
| CO2 | To improve a quality in laboratories by way of approved standards. |
| CO3 | To assess level or degrees of quality in laboratory operation. |
| CO4 | To assess level or degrees of quality by statistical methods. |
| CO5 | To train good laboratory practices and laboratory management |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Quality Assurance in the Laboratory I:** History of Regulation and the Laboratory, An Overview of Key Parameters for Evaluating a Laboratory, Critical Laboratory Operations, Training in the Laboratory, Chemical Handling. | 1 | 1-4 |
| | **Instructional Hours** | | **12** |
| II | **Quality Assurance in the Laboratory II:** Sample Control and LIM Systems, Laboratory Equipment Qualification, Equipment Calibration and Maintenance, Regulatory Standards. | 1 | 6-8 |
| | **Instructional Hours** | | **12** |
| III | **An FDA Approach to Laboratory Inspections:** FDA(Indian) Guide to Inspections of Pharmaceutical Quality Control Laboratories, FDA Guide to Inspections of Microbiological Quality Control Laboratories | 1 | 1 |
| | **Instructional Hours** | | **12** |
| IV | **Quality Evaluation:** Statistical Evaluation and Terminology, Graphical Analysis of Quality Control Results and Control Rules | 2 | 2,3 |
| | **Instructional Hours** | | **12** |
| V | **Good laboratory practices:** Hazards, Types, Management of laboratory hazards and knowledge in First aid procedures. Handling hazardous wastes. | 2 | 13 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Donald C. Singer, **A Laboratory Quality Handbook of Best Practices**, ASQ Quality Press, 2001.
2. Shubhangi Tambweker, **Handbook of Quality Assurance in Laboratory Medicine**, BI Publications Pvt. Ltd., 2009.

Unit I : Text Book 1, Chapter 1-4: Page No. 1-15.
Unit II : Text Book 1, Chapter 6-8: Page No. 39-216
Unit III: Text Book 1, Chapter 1: Page No. 299-336.
Unit IV: Text Book 2, Chapter 2, 3: Page No. 111-144.
Unit V : Text Book 2, Chapter 13: Page No. 156-162

**Reference Book(s):**

1. Rajesh Bhatia, **Quality Assurance in Microbiology**, CBS Publishers & Distributors, 2000.
2. http://www.appliedclinicaltrialsonline.com/quality-control-and-assurance-clinical-research
3. https://c.ymcdn.com/sites/www.ahdionline.org/resource/resmgr/WhitePapers/QA_Best_Practices.pdf

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Quiz | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | M | M | L | L | L | L | L | M | L | M |
| **CO2** | M | L | L | M | L | L | M | L | M | M | H | M | H |
| **CO3** | L | L | M | L | L | L | H | M | H | M | H | M | H |
| **CO4** | L | M | M | M | L | L | H | L | H | M | M | H | H |
| **CO5** | L | L | L | M | L | L | H | M | H | M | M | H | H |

H-High; M-Medium; L-Low

| Course Designed by | Verified by HoD | Checked by | Approved by |
|---|---|---|---|
| | | | |
| | | | |

| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE303 | Elective Paper – III (C) Bioinformatics and Molecular Biology Databases | | |
| Semester: III | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understand mechanism of storage, retrieval and handling of biological data

**Course Outcomes:**

On successful completion of the course students will able to

| | |
|---|---|
| CO1 | Define different types of biological databases and data formats |
| CO2 | Explain the nature of data handled by different databases |
| CO3 | Make use of different search engines to retrieve data |
| CO4 | Analyze the structure of macromolecules using visualization tools |
| CO5 | Know about structure prediction tools |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Introduction to Databases:** Types of biological data, data formats, search engines, access to distributed data, integrated information retrieval systems: EnTrez, Sequence databases, NCBI and beyond, sequence submission tools. | 3 | 2 |
| | **Instructional Hours** | | **14** |
| II | **Relational databases for biological information:** Types of databases, object-oriented databases, CORBA, Linux file systems and directories, PERL applications in Bioinformatics. | 2 | 7,8 |
| | **Instructional Hours** | | **12** |
| III | **Protein Databases:** Protein Data Bank, file format of PDB, Secondary databases – SCOP, CATH. Protein Analysis Server – ExPaSy, Pattern Recognition databases. | 1 | 5 |
| | **Instructional Hours** | | **10** |
| IV | **Nucleic Acid Databases:** NDB, GenSCAN, FGENESH, FLYBASE, OMIM, DDBJ, EMBL. RNA structure prediction tools – MFOLD. | 1 | 3 |
| | **Instructional Hours** | | **12** |
| V | **Structure Visualization Tools:** Rasmol, Swiss PROT, Cn3D. Structure Prediction tools – i-TASSER, PhyMol. | 2 | 16 |
| | **Instructional Hours** | | **12** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. Andreas D. Baxevanis, B. F. Francis Ouellette., **Bioinformatics**, Wiley Publishers, 3rd Edition, 2011.
2. Rastogi, C. S., Namita Mendiratta., **Bioinformatics-Methods and Applications,** PHI Learning Pvt. Ltd., 4th Edition, 2013.
3. Harisha, S., **Fundamentals of Bioinformatics**, I. K. International Publishing House, 1st Edition, 2007.

Unit – I: Text Book 3, Chapter 2, Page No. 14-55.
Unit – II: Text Book 2, Chapter 7 and Chapter 8, Page No. 109-131
Unit – III: Text Book 1, Chapter 5, Page No. 83-103.
Unit – IV: Text Book 1, Chapter 3, Page No. 45-58.
Unit – V: Text Book 2, Chapter 16, Page No. 248-285.

**Reference Book(s):**

1. Teresa Attwood., **Introduction to Bioinformatics**, Pearson Publications, 1st Edition, 2007.
2. David Mount., **Bioinformatics: Sequence and Genome Analysis,** Cold Spring Harbor Lab Press, 2nd Edition, 2004.
3. https://www.ncbi.nlm.nih.gov/books/NBK143764/
4. https://www.expasy.org/links
5. https://ww2.chemistry.gatech.edu/~lw26/course_Information/4581/labs/tbp/rasmol/rasmol_tbp_fset.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Group discussion | Seminar | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | M | M | M | M | L | H | M | M | L | L |
| **CO2** | L | L | L | M | M | L | L | L | H | H | M | L | L |
| **CO3** | H | M | M | L | L | L | L | M | M | H | H | H | L |
| **CO4** | M | L | L | M | L | L | M | M | M | H | H | M | M |
| **CO5** | L | M | L | M | L | L | L | L | M | H | H | H | L |

H-High; M-Medium; L-Low.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE401 | Elective – IV (A) - Clinical Pathology and Diagnosis | | |
| Semester: IV | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

This paper is introduced to impart advanced knowledge to the post graduate students in the field of Medical Biotechnology to carry out diagnostic experiments and to acquire requisite skills for the design and development of novel diagnostic methodology.

**Course Outcomes:**

On successful completion of the course students will able to

| | |
|---|---|
| **CO1** | Understand the basics of medical science and the molecular concepts of pathogenesis. |
| **CO2** | Apply their knowledge in clinical diagnosis |
| **CO3** | Acquire the knowledge of modern trends in medical biotechnology. |
| **CO4** | Identify the mode of diagnostic tests and kit development |
| **CO5** | Know about biotechniques in clinical medicine |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Disorders of Kidney:** Acute renal failure, chronic renal failure, proteinuria and nephriticsyndrome and urinary calculi. | 1 | 1 |
| | **Disorders of Liver:** Liver diseases acute hepatitis, Chronic hepatitis, acute liver failure, cirrhosis, alcohol and liver.<br>**Disorders of Brain and Neurons.**<br>**Diseases of Heart** -Myocardial infarction, Heart failure and Hypertension. | 2 | 8, 9 |
| | **Instructional Hours** | | **12** |
| II | **Disorders of Hypothalamus and Pituitary: Disorders** of anterior pituitary hormones: Hypopituitarism Anorexia nervosa, Growth hormone deficiency, Growth hormone excess: acromegaly and gigantism.<br>**Disorders of poster pituitary hormones:** Vasopressin and Diabetes incipidus.<br>**Disorders of Adrenal glands**:<br>Disorders of Adrenal cortex: Adrenal hypo function (Addison's disease).<br>**Adrenal hyperfunction:** Cuushing'ssyndrome, Conn's syndrome congenital adrenal hyperplasiam (CAH), Disorders of adrenal medulla: catecholamine. | 2 | 11 |
| | **Disorders of Thyroid gland:** Hyperthyroidism, hypothyroidism, thyroiditis, goiter and thyroid cancer. | 2 | 12 |
| | **Disorder of Gonads:** Disorders of male gonadal function: Delayed puberty and hypogonadismin females, | 2 | 15 |

| | | | |
|---|---|---|---|
| | Amenorrhea and oligomernorrhoea.Hirsutism and virillism andinfertility. | | |
| | **Instructional Hours** | | **14** |
| **III** | **Inherited metabolic diseases:**<br>Glucose -6phosphatase deficiency, Galactisaemia, cystic fibrosis.<br>Inherited abnormalities of bilirubin metabolism: Gilber'sCrigler – Najjar, Dubin-johnson, jaundice and Rotor. | 2<br>2 | 21<br>21 |
| | **Instructional Hours** | | **12** |
| **IV** | **Infections of Bacteria and Parasites:**<br>Infectious diseases, host pathogen interactions.<br>**Toxins of Bacteria:** serotoxins and Endo toxins.<br>**Parasites of biomedical importance**: Malarial parasite, Filarial worm, *Trypanosome gambience andEntmoebahistolytica.* | 2<br>2 | 19<br>23 |
| | **Instructional Hours** | | **12** |
| **V** | **An introduction to bio techniques in clinical medicine:** Sampling, analysis, reporting and interpretation of results.<br>Role of DNA analysis for prenatal diagnosis of metabolic diseases.<br>Drugs and the liver. Biotechnological approaches to liver diseases: Biochemical assessment of liver function.<br>Molecular biological methods of diseases diagnosis.<br>Diagnosis of viral infections.<br>Diagnosis of fungal infections. | 2<br><br><br>2 | 18<br><br><br>8,9 |
| | **Instructional Hours** | | **10** |
| | **Total Hours** | | **60** |

**Text Book(s):**

1. William J.Marashall, **Clinical Chemistry,**5th edition, Mosby Publications, 2010.
2. Allen Gaw Robert A.Cowan**, An Illustrated Color Text Book of Clinical Biochemistry**, 2nd Edition, Churchill Living Stone Press, 2009.

Unit I : Text Book 1, 2Chapter 1, 8, 9, pages 10,88-89,98-102
Unit II : Text Book 2, Chapter 11, 12, pages 122-145,157-168
Unit III : Text Book 2, Chapter 21, pages 217- 221
Unit IV : Text Book 2, Chapter 19,23, pages 196-210, 247-261
Unit V : Text Book 2, Chapter 8, 9, 18, pages 96-97, 103-115, 191-194

**Reference Book(s):**

1. JanKoolman and Klaus – Heinrich Roehm, **Color Atals of Biochemistry,** 2nd Edition, Thieme Publications, 2007.
2. Colleen M,**Marks' Basic Medical Biochemistry: A Clinical Approach,**2nd edition, 2010.
3. Jawetz,**Medical Microbiology**, 2011.
4. http://www.ncbi.nlm.nih.gov/sites/entrez?=books(NCBI ?Book Shelf)
5. http://web.instate,edu/theme/mwking /subjects.html (e.book)
6. http:www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mmed.TOC&depth=2(e-book)

7. http:66.99.255.20/cms/biochem/medbiochem/medbiochem.htm
8. http:home.net/~dbc/cic_hamilton/clinical.html

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Group discussion | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | L | L | M | L | L | M | L |
| **CO2** | M | L | M | L | L | M | L | L | L | M | L | H | M |
| **CO3** | L | L | H | M | L | L | M | M | M | L | M | M | H |
| **CO4** | M | L | M | L | L | H | L | L | M | M | M | H | H |
| **CO5** | L | L | M | M | L | H | M | L | M | M | M | H | H |

H-High; M-Medium; L-Low.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE402 | Elective Paper – IV (B) Occupational Health & Industrial Safety | | |
| Semester: IV | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To impart knowledge on various occupational health hazards and also safety measures to be taken in the work place.

**Course Outcomes:**

On successful completion of the course students will able to

| | |
|---|---|
| **CO1** | get an idea about the advantages and disadvantages of health and safety |
| **CO2** | Know about occupational & Industrial safety applications, principles & functions in safety management. |
| **CO3** | Knowledge on occupational diseases. |
| **CO4** | Exposure on work design for suitable environment. |
| **CO5** | Analyze the principles and Management. |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | Introduction of Occupational Health and Safety. Factors affecting the conditions of occupational and Industrial safety. Parameters of safety. | 1 | 1 |
| | Concept of safety organization and Management - Safety Regulations. | 1 | 4 |
| | Definition and Role of Ergonomics in Designing Work-Place. | 1 | 4 |
| | **Instructional Hours** | | **13** |
| II | Work Environment - Effects of Light, Ventilation, Vibration, Noise etc. | 1 | 1 |
| | The Work Physiology and their Relevance to Safety. | 1 | 2 |
| | Performance Evaluation of Man - Environment systems. | 1 | 6 |
| | **Instructional Hours** | | **12** |
| III | Occupational Health and Safety – Occupational Health and Hazards – Physical, Chemical and Biological hazards. | | |
| | Occupational Diseases and their Prevention and Control. | 2 | 3 |
| | Health Protection Measures for Workers. | 2 | 39 |
| | Principles of Arthropod Control. | | |
| | **Instructional Hours** | | **13** |
| IV | Health Education Medical First-Aid and Management of Medical Emergencies. | 2 | 7 |
| | Industrial Safety management Techniques - Industrial Safety Standards. Accidents-Definition, Frequency Rate, Prevention and Control. | 2 | 8 |
| | Work Study - Method of Study and Measurement. Measurement of Skills. Safety - Cost of Expenses. | | |
| | **Instructional Hours** | | **12** |

| | | | |
|---|---|---|---|
| V | Principles of Functions in Safety Management Case Study.<br>Visit to an Industry.<br>Preparation of report on safety measures followed in Airport/Industry. | 2<br><br>2 | 8<br><br>11 |
| **Instructional Hours** | | | **10** |
| **Total Hours** | | | **60** |

**Text Book(s):**

1. WHO, Occupational Health, **A Manual for Primary Health Care Workers**, WHO-EM/OCH/85/E/L distribution Ltd., 2009.
2. **Industrial Safety, Health and Environment Management Systems,** R.K. Jain, Khanna Publishers, 2010.

Unit I : Text Book 1, Chapter 1, 4
Unit II : Text Book 1, Chapter 1, 2, 6
Unit III : Text Book 2, Chapter 3, 39
Unit IV : Text Book 2, Chapter 7, 8
Unit V : Text Book 2, Chapter 8, 11

**Reference Book(s):**

1. Kolluru R. V., **Environmental Strategies–Hand Book,** McGraw Hill Inc., New York, 2013.
2. Walsh, W and Russell, L., **ABC of Industrial Safety**, PitmaPublishing, United Kingdom, 2005.
3. Hommadi, A. H., **Environmental and Industrial Safety**, I.B.B Publication, New Delhi, 2008.
4. https://www.crcpress.com › Occupational Health & Safety

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Seminar | Group discussion | Assignment | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | H | M | L | M | M | L | M | L | H | L | L |
| **CO2** | M | L | L | M | M | L | L | L | L | M | H | L | L |
| **CO3** | L | L | M | M | L | L | L | M | L | L | H | H | M |
| **CO4** | L | L | M | M | L | L | M | H | M | H | M | M | M |
| **CO5** | M | M | L | L | L | M | M | M | M | H | M | M | M |

H-High; M-Medium; L-Low.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTE403 | Elective Paper – IV (C) Drug Designing and Molecular Modeling | | |
| Semester: IV | Credits: 4 | CIA: 50 Marks | ESE: 50 Marks |

**Course Objective:**

To understand drug structures and its interactions, dosage effects and designing procedures

**Course Outcomes:**

On successful completion of the course students will able to

| | |
|---|---|
| **CO1** | Tell drug absorption mechanism and administration methods |
| **CO2** | Outline receptor interactions with target and metabolism of drug |
| **CO3** | Develop drug discovery protocols |
| **CO4** | Analyze structure-activity relationship of drugs |
| **CO5** | Explore about types of descriptors |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: 4**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| **I** | **Classification of drugs:** Routes of drug administration. Absorption & Distribution of drugs. Role of kidney in drug interaction with biomolecules. Binding of drugs to plasma proteins. | 1 | 1 |
| | **Instructional Hours** | | **10** |
| **II** | **Drug receptors:** Drug-receptor interaction, Drug action not mediated by receptors. Structural based drug design, mechanism of their action. Lipinski's rule of 5, Clinical trials 1-4 phases. | 1 | 3 |
| | **Instructional Hours** | | **12** |
| **III** | **Effect of drug doses on the rate of metabolism:** Mechanisms and importance of Phase I and Phase II biotransformation. Role of cytochrome p450. Enzyme inhibition strategies, enzyme induction and pharmacological activity, LD50 and IC50. | 1 | 4 |
| | **Instructional Hours** | | **14** |
| **IV** | **Drug design:** Drug discovery process. Target identification and validation, lead optimization and validation. Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore. | 2 | 10 |
| | **Instructional Hours** | | **10** |
| **V** | **QSAR:** Quantitative Structure Activity Relationship (QSAR). Types of descriptors-constitutional, topological, charge, quantum chemical, walk and path counts, geometric descriptors. Types of QSAR methods-In static contour plot, in electro static contour plots, 3DQSAR. | 2 | 12 |

| Instructional Hours | 14 |
|---|---|
| Total Hours | 60 |

**Text Book(s):**

1. Singh. H and Kapoor, V.K., **Organic Pharmaceutical Chemistry**. Vallabh Prakashan Publishers. New Delhi, 6th Edition, 2016.
2. Andrew Leach R., **Molecular Modeling: Principles and Application**. Harlow, 2nd Edition, 2010.

Unit – I: Text Book 1, Chapter 1, Page No. 1-30.
Unit – II: Text Book 1, Chapter 3, Page No. 33-47.
Unit – III: Text Book 1, Chapter 4, Page No. 51-66.
Unit – IV: Text Book 2, Chapter 10, Page No. 509-549.
Unit – V: Text Book 2, Chapter 12, Page No. 640-719.

**Reference Book(s):**

1. Alan Hinchliffe., **Molecular Modelling for Beginners**, John Wiley & Sons Ltd. 2nd Edition, 2013.
2. Tamar Schlick., **Molecular Modeling and Simulation – An interdisciplinary Guide**, Springer Verlag, 2nd Edition, 2010.
3. Patrick Bultinck., **Computational Medicinal Chemistry for Drug Discovery**, Marcel Dekker Inc., 1st Edition, 2004.
3. https://www.omicsonline.org/drug-discovery-jaa.1000025.pdf
4. https://www.biophys.mpg.de/fileadmin/user_upload/pics_tb/Lecture-2-QSAR.pdf

**Tools for Assessment (50 Marks)**

| CIA I | CIA II | CIA III | Group discussion | Assignment | Seminar | Total |
|---|---|---|---|---|---|---|
| 8 | 8 | 10 | 8 | 8 | 8 | 50 |

**Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | L | L | M | M | M | M | L | M | H | M | L | L |
| CO2 | L | L | L | M | M | L | L | L | H | H | H | M | L |
| CO3 | H | M | M | L | L | L | L | M | H | H | H | H | M |
| CO4 | M | L | L | M | L | L | M | M | M | H | H | M | M |
| CO5 | L | M | L | M | L | L | L | L | H | H | H | M | L |

H-High; M-Medium; L-Low.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTSS01 | Advanced Leaner Course - I Cell Communication and Cell Signaling | | |
| Semester: I – IV | Credits: 2 | CIA: -- | ESE: 100 Marks |

**Course Objective:**

To understand various inter and intra cellular communications, cell signaling molecules and its significations.

**Course Outcomes:**

On the successful completion of the course the students will know

| | |
|---|---|
| **CO1** | Cell receptors |
| **CO2** | Cell signaling molecules |
| **CO3** | Signal inductions between and within cells |
| **CO4** | Maintenance of these processes for homeostasis |
| **CO5** | Aberration and its implications for diagnosis |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: -**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Introduction**: Types of cell signaling-inter and intra signaling molecules. | 1 | 41 |
| | **Instructional Hours** | | -- |
| II | **Host-parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, virus-induced cell transformation | 2,3 | 13,13 |
| | Alteration of host cell behavior by pathogens, | 2,3 | 13,13 |
| | Pathogen-induced diseases in animals and plants, | 2,3 | 13,13 |
| | Cell-cell fusion in both normal and abnormal cells. | 2,3 | 13,13 |
| | **Instructional Hours** | | -- |
| III | **Cell signaling:** Categories of cell signaling, Animal and plant hormones, Hormones and their receptors, cell surface receptor, signalling through G-protein receptors, signal transduction pathways. | 2,3 | 13,13 |
| | cAMP, cGMP, calcium ion flux and its role in cell signaling, second messengers including lipid derived second messengers, regulation of signaling pathways. | 2,3 | 13,13 |
| | Bacterial and plant two-component signalling systems, bacterial chemotaxis, and quorum sensing. | 2,3 | 13,13 |
| | **Instructional Hours** | | -- |
| IV | **Types of receptors** –Internal receptors, Cell surface receptors, ion channel linked receptors, G protein coupled receptors, Enzyme linked receptors. | 2,3 | 13,13 |

| | | | |
|---|---|---|---|
| | **Instructional Hours** | | -- |
| **V** | **Cellular communication:** Types of cellular communication, Regulation of hematopoiesis, general principles of cell communication, Cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. | 2, 3 | 13,13 |
| | **Instructional Hours** | | -- |
| | | **Total Hours** | -- |

**Text Book (s):**

1. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell, **Harper's Illustrated Biochemistr** Published by McGraw-Hill Professional, 26th edition.
2. Carl Branden and John Tooze, **Introduction to Protein structure,** Garland publishers, NY, 2nd edition.
3. Alberts et al., **Molecular Biology** of the Cell 6thedition, Garland Science
   Unit 1 : Book 1: Pages 415- 456
   Unit 2-4: Book 2: Pages 251-279
   Unit 1-5: Book 3: Pages 813-888

**Reference Book(s):**

1. https://www.youtube.com/watch?v=qOVkedxDqQo
2. https://www.youtube.com/watch?v=qOTsa5xDd88
3. https://www.youtube.com/watch?v=FQFBygnIONU
4. https://www.youtube.com/watch?v=zGNrF7EXBd0
5. https://www.youtube.com/watch?v=XOukpgUMOGY
6. https://www.golifescience.com/cells-of-immune-system/
7. https://nptel.ac.in/courses/102103012/29
8. https://mcb.berkeley.edu/courses/mcb110spring/nogales/mcb110_s2008_4signaling.pdf
9. https://www.youtube.com/watch?v=XuM0YBL-bCA
10. https://www.thebiomics.com/notes/cell-communication-cell-signaling
11. https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/types-of-receptors/
12. https://www.youtube.com/watch?v=-dbRterutHY&vl=en

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTSS02 | Advanced Leaner Course – II Diversity of Life Forms | | |
| Semester: I to IV | Credits: 2 | CIA : -- | ESE: 100 Marks |

**Course Objective:**

The course will look at the origins of life, its diversity, and the way that the environment has shaped the evolution of organisms over geological time.

**Course Outcomes:**

At the end of the course a student should be able to

| | |
|---|---|
| **CO1** | Appreciate the origin of diversity of life, covering the three domains and classification of Eukaryotic groups. |
| **CO2** | Have a knowledge of the terminology used to describe species' form and function |
| **CO3** | Appreciate why certain species are studied and research methodologies used |
| **CO4** | Understand of the sequence of the development of life on earth |
| **CO5** | Know about importance of agriculture. |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: --**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Principles & methods of taxonomy:** Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms. | 1 | 1 |
| | **Instructional Hours** | | -- |
| II | **Levels of structural organization:** Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications. | 1 | 4 |
| | **Instructional Hours** | | -- |
| III | **Outline classification of plants, animals & microorganisms:** Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. | 1 | 6 |
| | **Instructional Hours** | | -- |
| IV | **Natural history of Indian subcontinent:** Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent. | 1 | 8 |
| | **Instructional Hours** | | -- |
| V | **Organisms of health & agricultural importance:** Common parasites and pathogens of humans, domestic animals and crops.Organisms of conservation concern: Rare, endangered species. Conservation strategies. | 2 | 7 |
| | **Instructional Hours** | | -- |
| | Total Hours | | |

**Text Book(s):**

1. Raven Johnson, **Biology**, Campbell Biology, McGraw-Hill Education, 6th Edition, 2005.
2. Kato, M., **The Biology of Biodiversity**, Springer Japan, 1st Edition, 2000.

Unit I : Text Book 1, Chapter 1: 1-18.
Unit II : Text Book 1, Chapter 4: 58-73.
Unit III: Text Book 1, Chapter 6: 421-476.
Unit IV: Text Book 1, Chapter 8: 569- 610.
Unit V : Text Book 2, Chapter 7: 625-646.

**Reference Book(s):**

1. Edward O.Wilson, **The Diversity of Life**, illustrated, reprint, reissue, W. W. Norton, 1999.
2. 1.http://www.nrm.se/download/18.33b738b8117bcb5a90c800011827/1367705565892/Diversity+of+Life.pdf
3. https://www.thebiomics.com/notes/diversity-life-forms

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTSS03 | Advanced Leaner Course – III Ecological Principles | | |
| I to IV | Credits: 2 | CIA: -- | ESE: 100 Marks |

**Course Objective:**

On successful completion of the subject the student should have understood ecology, compare their purposes with that of ecology

**Course Outcomes:**

On successful completion of the course the student will able to

| | |
|---|---|
| **CO1** | Understand the importance of environmental deterioration in different ecosystems; to define ecology and the related levels of biological organization. |
| **CO2** | Explain benefits of selective breeding and propagation |
| **CO3** | Describe both biotic and abiotic limiting factors of ecosystems |
| **CO4** | Apply their knowledge of general environmental science to improve the quality of life in individual context and as citizens in a global village. |
| **CO5** | Know about Geography |

**Offered by:** Biotechnology

**Course Content** **Instructional Hours / Week: --**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **The Environment**: Physical environment; biotic environment; biotic and abiotic interactions. **Habitat and Niche**: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. | 1 | 1-2 |
| | **Instructional Hours** | | -- |
| II | **Population Ecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. | 1 | 2-3 |
| | **Instructional Hours** | | -- |
| III | **Community Ecology**: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. Production of native and recombinant proteins in bacteria and yeast – vaccine production in | 1,2 | 3-5 |
| | **Instructional Hours** | | -- |

| | | | |
|---|---|---|---|
| **IV** | **Ecosystem Ecology**: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine) | 1,2 | 6-8 |
| | **Instructional Hours** | | |
| **V** | **Biogeography**: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. | 2 | 9,10 |
| | **Instructional Hours** | | -- |
| | **Total Hours** | | -- |

**Text Book (s):**

1. Peter J. Jarvis, **Ecological Principles and Environmental Issues**, Pearson education, Edition illustrated, Prentice Hall, 2000.
2. 2.N. S. Subrahmanyam, A. V. S. S. Sambamurty, **Ecology**, Alpha Science International, Edition 2, 2006.

Unit I : Text Book 1, Chapter 1-2: 5-20.
Unit II : Text Book 1, Chapter 2-3: 25-40; Text Book 2, Chapter 3-5: 24-97.
Unit III: Text Book 1,2 Chapter, 3-5: 61-72, 65-82.
Unit IV: Text Book 1, 2 Chapter 6-8: 90-122, 103-132.
Unit V : Text Book 2, Chapter 9-10: 143-172.

**Reference Book(s):**

1. Michael Begon, Colin R. Townsend, John L. Harper**, Ecology-From Individuals to Ecosystems**, Wiley-Blackwell 2009.
2. David B Lindenmayer, Gene E Likens, **Effective Ecological Monitoring**, CSIRO Publishing (2010).
3. Davide Geneletti, **Handbook on Biodiversity and Ecosystem Services in Impact Assessment**, Edward Elgar Publishing (2016).
4. https://www.barnesandnoble.com/w/treat-climate-change-save-the-earth-amanda-rothman/1123539104?ean=2940153101897.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTSS04 | Advanced Leaner Course - IV Applied Biology | | |
| I to IV | Credits: 2 | CIA: -- | ESE: 100 Marks |

**Course Objective:**
Applied Biology is a discipline that is currently at the forefront of scientific research and technological development and underpins a number of premier industries.

**Course Outcomes:**
At the end of the course a student should be able to

| | |
|---|---|
| **CO1** | Explain how biological knowledge is obtained by curiosity and creativity. |
| **CO2** | Understand biological concepts and experimental information in a professional manner. |
| **CO3** | Collect and analyse information that is relevant to understanding biological phenomena |
| **CO4** | Explore the design of simple field or laboratory based biological experiments. |
| **CO5** | Know about Biosensors. |

**Offered by:** Biotechnology
**Course Content** **Instructional Hours / Week: --**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| **I** | Microbial fermentation and production of small and macro molecules. | 1 | 1-5 |
| | **Instructional Hours** | | -- |
| **II** | Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals. | 2 | 1-6 |
| | **Instructional Hours** | | |
| **III** | Genomics and its application to health and agriculture, including gene therapy. | 2 | 7-9 |
| | **Instructional Hours** | | -- |
| **IV** | Breeding in plants and animals, including marker – assisted selection | 3 | 1-4 |
| | **Instructional Hours** | | -- |
| **V** | Bioremediation and phytoremediation. Biosensors | 1 | 9 |
| | **Instructional Hours** | | -- |

**Text Book(s):**

1. El-Mansi, E.M.T., Bryce, C.F.A., Dahhou, B., Sanchez, S., and A.R. Alman. **Fermentation microbiology and Biotechnology**, Taylor and Francis, 2012.
2. Seema J. Patel, **Plant and Animal tissue culture,** Laxmi Book Publication, 2016.
3. Louisiana, **Transgenic Animals and Plants Use Vectors to Improve Production and Disease Resistance,** LSU Ag Center, 2010.

Unit I : Text Book 1, Chapter 1-5: 5-50.
Unit II : Text Book 2, Chapter 1-6: 4-65.
Unit III: Text Book 2, Chapter 7-9: 66- 92.
Unit IV: Text Book 3, Chapter 1-4: 3-52.

Unit V : Text Book 1, Chapter 9: 73-92.

**Reference Book(s):**

1. John I Spicer, **Biodiversity**, The Rosen Publishing Group, 2009.
2. Vaidyanath, K., **Applied Biology and Biotechnology**, B.S Publication, 2004.

| Course Designed by | Verified by HoD | Checked by | Approved by |
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| Course Code | Title | | |
|---|---|---|---|
| 21PGBTSS05 | Advanced Leaner Course – V Histochemical and Immunological Techniques | | |
| I to IV | Credits: 2 | CIA: -- | ESE: 100 Marks |

**Course Objective:**

This course bequeath with an introduction to quality control with an emphasis on good laboratory practices

**Course Outcomes:**

At the end of the course a student should be able to

| | |
|---|---|
| CO1 | Know the methods of bruising over cell or tissue for characterization. |
| CO2 | Improve a scientific knowledge on tools used in histology. |
| CO3 | Classify and state biochemical analysis of blood. |
| CO4 | Learn the purpose of RIA in hormonal analysis. |
| CO5 | Know about applications of histochemical. |

**Offered by: Biotechnology**

**Course Content** **Instructional Hours / Week: --**

| Unit | Description | Text Book | Chapter |
|---|---|---|---|
| I | **Cell and Tissue Staining Techniques:** Elements of microtomy- pre-microtomy processes, microtomy process, post microtomy process. In situ and histological staining techniques- Whole mount (In situ) staining techniques, microbial staining techniques. Histochemistry- General histochemistry, enzyme histochemistry, Immunochemistry. | 1 | 5-10 |
| | **Instructional Hours** | | -- |
| II | **Microscopy &other methods:** Light microscopy, electron microscopy, three dimensional microscopy, camera lucida. centrifugation, spectroscopy, chromatography, electrophoresis. | 1<br>2 | 28-30<br>3-5 |
| | **Instructional Hours** | | -- |
| III | **Blood:** composition, hematological techniques: Detection of carbohydrates and lipids- chemistry and classification, qualitative and quantitative detection. Detection of enzymes- Chemistry and classification, qualitative and quantitative detection. | 1 | 11-13, 20 |
| | **Instructional Hours** | | -- |
| IV | **Nucleic acid biotechniques:** Salient features, laboratory biotechniques. Immunological techniques- Elements of immunology, immune reaction, immunological techniques. | 1 | 13, 21 |
| | **Instructional Hours** | | -- |
| V | **Radioimmunoassay of hormones:** Principle of radioimmunoassay, chemistry and classification of | 1 | 22 |

| | | |
|---|---|---|
| | hormones, radioimmunoassay (RIA) techniques for hormones. | |
| | **Instructional Hours** | -- |
| | **Total Hours** | -- |

**Text Book(s):**

1. Bancroft. J. D. and M. Gamble., **Theory and Practice of Histological Techniques,** Elsevier Publishers, 6th Edition, 2008.
2. Barbara J. Bain, Imelda Bates, Sir John Vivian Dacie., Dacie& Lewis, **Practical Haematology,** Elsevier Publishers, 11th Edition, 2011.

Unit I : Text Book 1, Chapter 5-10: 75-160.
Unit II : Text Book 1, Chapter 28-30: 575-640; Text Book 2, Chapter 3-5: 24-97.
Unit III: Text Book 1, Chapter 11-13, 20: 161-232, 405-432.
Unit IV: Text Book 1, Chapter 13, 21: 217-232, 433-472.
Unit V : Text Book 1, Chapter 22: 473-492.

**Reference Book(s):**

1. Bancroft, J. D. and Harry Charles Cook., **Manual of Histological Techniques and Their Diagnostic Application**, Churchill Livingstone Inc, New York, 1994.
2. http://shodhganga.inflibnet.ac.in/bitstream/10603/95455/13/13_chapter%206.pdf
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1942863/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424002/

| Course Designed by | Verified by HoD | Checked by | Approved by |
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