**ANNAMALAI UNIVERSITY**

**211. B.Sc. Biotechnology**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted in Affiliated Colleges   
in the academic year 2022 -2023 ONLY)

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| **Course code** | **Part** | **Study Components & Course Title** | **Hours /Week** | **Credit** | **Maximum Marks** | | |
| **CIA** | **ESE** | **Total** |
| **SEMESTER - I** | | | | | | | |
| 22UTAML11 | I | Language Course – I : Tamil -I | 5 | 3 | 25 | 75 | 100 |
| 22UENGL12 | II | English Course – I : Communicative English - I | 5 | 3 | 25 | 75 | 100 |
| 22UBTHC13 | III | Core Course –I : Cell Biology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHC14 | Core Course – II : Genetics | 4 | 4 | 25 | 75 | 100 |
|  | Core Practical –I : Cell Biology, Genetics & Biochemistry | 3 | - | - | - | - |
| 22UBTHA01 | Allied – I : Paper – 1 : Biodiversity | 4 | 4 | 25 | 75 | 100 |
|  | Allied Practical – I : Biodiversity | 3 | - | - | - | - |
| 22UENVS18 | IV | Environmental Studies | 2 | 2 | 25 | 75 | 100 |
| **Total** | | | **30** | **20** |  |  | **600** |
| **SEMESTER - II** | | | | | | | |
| 22UTAML21 | I | Language Course – II : Tamil – II | 5 | 3 | 25 | 75 | 100 |
| 22UENGL22 | II | English Course – II : Communicative English - II | 5 | 3 | 25 | 75 | 100 |
| 22UBTHC23 | III | Core Course – III : Biochemistry | 4 | 4 | 25 | 75 | 100 |
| 22UBTHP24 | Core Practical –I : Cell Biology, Genetics & Biochemistry | 2 | 3 | 40 | 60 | 100 |
| 22UBTHA02 | Allied – II : Paper – 2 : Biophysics | 3 | 3 | 25 | 75 | 100 |
| 22UBTHP02 | Allied Practical – I : Biodiversity | 2 | 3 | 40 | 60 | 100 |
| 22UBTHE26 | Internal Elective – I : **(Select 1 out of 3)** | 3 | 3 | 25 | 75 | 100 |
| 1. Biomaterials |
| 1. Forensic Science |
| 1. Drug Designing |
| 22UVALE27 | IV | Value Education | 2 | 1 | 25 | 75 | 100 |
| 22USOFS28 | Soft Skill | 2 | 1 | 25 | 75 | 100 |
| 22UNMSD01 |  | Effective English | 2 | 2 | 25 | 75 | 100 |
| **Total** | | | **30** | **26** |  |  | **1000** |

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| **SEMESTER - III** | | | | | | | |
| 22UTAML31 | I | Language Course – III : Tamil – III | 5 | 3 | 25 | 75 | 100 |
| 22UENGL32 | II | English Course – III : English Through Literature-I | 5 | 3 | 25 | 75 | 100 |
| 22UBTHC33 | III | Core Course – IV : Microbiology | 4 | 4 | 25 | 75 | 100 |
|  | Core Practical – II : Microbiology & Molecular Biology | 3 | - | - | - | - |
| 22UBTHA03 | Allied – III : Paper – 3 : Biostatistics | 4 | 4 | 25 | 75 | 100 |
|  | Allied Practical – II : Biostatistics & Bioinformatics | 2 | - | - | - | - |
| 22UBTHE36 | Internal Elective – II : **(Select 1 out of 3)** | 3 | 3 | 25 | 75 | 100 |
| 1. Marine Biotechnology |
| 1. Stem cell Technology |
| 1. Molecular Diagnostics |
| 22UBTHN37 | IV | Non-Major Elective – I : | 2 | 2 | 25 | 75 | 100 |
| 22UBTHS38 | Skill Based Subject - I : Bioanalytics | 2 | 2 | 25 | 75 | 100 |
| **Total** | | | **30** | **21** |  |  | **700** |
| **SEMESTER - IV** | | | | | | | |
| 22UTAML41 | I | Language Course – III : Tamil – IV | 5 | 3 | 25 | 75 | 100 |
| 22UENGL42 | II | English Course – IV : English Through Literature-II | 5 | 3 | 25 | 75 | 100 |
| 22UBTHC43 | III | Core Course – V : Molecular Biology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHP44 | Core Practical – II : Microbiology & Molecular Biology | 3 | 3 | 40 | 60 | 100 |
| 22UBTHA04 | Allied – IV : Paper – 4 : Bioinformatics | 4 | 3 | 25 | 75 | 100 |
| 22UBTHP04 | Allied Practical – II : Biostatistics & Bioinformatics | 3 | 3 | 40 | 60 | 100 |
| 22UBTHN47 | IV | Non-Major elective – II : | 2 | 2 | 25 | 75 | 100 |
| 22UBTHS48 | Skill Based Subject - II : Clinical Trials | 2 | 2 | 25 | 75 | 100 |
| 22UNMSD02 |  | MS-Office Essentials | 2 | 2 | 25 | 75 | 100 |
| **Total** | | | **30** | **25** |  |  | **900** |
| **SEMESTER - V** | | | | | | | |
| 22UBTHC51 | III | Core Course – VI : Immunology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHC52 | Core Course – VII : Industrial Biotechnology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHC53 | Core Course – VIII : Recombinant DNA Technology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHC54 | Core Course – IX: Animal Biotechnology | 4 | 4 | 25 | 75 | 100 |
| 22UBTHP55 | Core Practical - III: Immunology & Industrial Biotechnology & Plant Biotechnology | 3 | - | - | - | - |
| 22UBTHP56 | Core Practical - IV: Recombinant DNA Technology, Animal Biotechnology & Environmental Biotechnology | 3 | - | - | - | - |
| 22UBTHE58 | Internal Elective – III : **(Select 1 out of 3)** | 4 | 3 | 25 | 75 | 100 |
| 1. Herbal Technology |
| 1. Food Technology |
| 1. Nano Biotechnology |
| 22UBTHS59 | IV | Skill Based Subject - III : Entrepreneurial Biotechnology | 2 | 2 | 25 | 75 | 100 |
| 22UGENS57 | Gender Studies | 2 | 1 | 25 | 75 | 100 |
| **Total** | | | **30** | **22** |  |  | **700** |

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| **SEMESTER - VI** | | | | | | | |
| 22UBTHC61 | III | Core Course – X : Plant Biotechnology | 5 | 5 | 25 | 75 | 100 |
| 22UBTHC62 | Core Course – XI : Pharmaceutical Biotechnology | 5 | 5 | 25 | 75 | 100 |
| 22UBTHC63 | Core Course – XII: Environmental Biotechnology | 5 | 4 | 25 | 75 | 100 |
| 22UBTHP64 | Core Practical - III: Immunology & Industrial Biotechnology & Plant Biotechnology | 5 | 3 | 40 | 60 | 100 |
| 22UBTHP65 | Core Practical - IV: Recombinant DNA Technology, Animal Biotechnology & Environmental Biotechnology | 4 | 3 | 40 | 60 | 100 |
| 22UBTHE66 | Internal Elective – IV : **(Select 1 out of 3)** | 4 | 3 | 25 | 75 | 100 |
| 1. Enzyme Technology |
| 1. Bio prospecting |
| 1. Biomarker Technology |
| 22UBTHS68 | IV | Skill Based Subject - IV : Bioethics and Biosafety | 2 | 2 | 25 | 75 | 100 |
| 22UEXTA67 | V | Extension Activities | - | 1 | 100 | - | 100 |
| **Total** | | | **30** | **26** |  |  | **800** |
| **Grand Total** | | | **180** | **140** |  |  | **4700** |

**Internal Elective Courses**

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| 22UBTHE27-1 | Internal Elective – I | Biomaterials |
| 22UBTHE27-2 | Forensic Science |
| 22UBTHE27-3 | Drug Designing |
| 22UBTHE36-1 | Internal Elective – II | Marine Biotechnology |
| 22UBTHE36-2 | Stem Cell Technology |
| 22UBTHE36-3 | Molecular Diagnosis |
| 22UBTHE58-1 | Internal Elective – III | Herbal Technology |
| 22UBTHE58-2 | Food Technology |
| 22UBTHE58-3 | Nano biotechnology |
| 22UBTHE66-1 | Internal Elective – IV | Enzyme Technology |
| 22UBTHE66-2 | Bio Prospecting |
| 22UBTHE66-3 | Biomarker Technology |

**Non – Major Elective Courses (NME)**

(Department of Biotechnology offers the following NME to other Departments)

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| 22UBTHN37 | Mushroom Technology |
| 22UBTHN47 | Environmental Management |

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| SEMESTER:I  PART:III  CORE – I | 22UBTHC 13: CELL BIOLOGY | CREDIT:4  HOURS:4/W |

COURSE OBJECTIVES

1. To impart the basic nature of the cellular origin.
2. To understand the basic components of a cell and their functions.
3. To understand the structural organization of chromosomes.
4. To understand the process of cell division and cell cycle.
5. To impart the knowledge on cell to cell signaling.

Unit I: Origin of Cell

Cell and membrane structure – History, Cell theory. Ultrastructure of Prokaryotic and Eukaryotic Cells. Structure and functions of Plasma membrane, Cytoskeleton. Structural organization of plant and animal cells.

Unit II: Components of a Cell

Structure and function of intracellular organelles (Nucleus, Nucleolus, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Vacuole, Cytosol, Microtubules, Microfilaments, and Intermediate filaments), Extracellular matrix.

Unit III: Cytogenetics

Chromosomes: Discovery, morphology, chemical composition, structural organization of chromosomes, Specialized Chromosomes (polytene, lampbrush chromosomes). Chromosomal aberrations.

Unit IV: Life of a Cell

Cell division and Cell cycle: Mitosis and Meiosis, interphase, comparison of mitosis and meiosis, Cell cycle regulation. Cell differentiation, Cancer – Characteristics, Metastasis, Types of Cancer, Oncogenes.

Unit V: Cell Signaling and Transport

Signaling molecules and their receptor; functions of cell surface receptors. Intracellular signal transduction pathway; Molecular Transport - Active, Passive, Nuclear – Cytoplasmic Transport.

COURSE OUTCOMES

1. Understand the theories on the origin of a living cell.
2. Identify the intracellular organelles.
3. Understand the chromosomal organization of cells.
4. Understand the process of cell division and its regulation.
5. Understand the transport and signaling mechanism between cells.

Text Books

1. Gupta, P.K. (2004). Cell and Molecular Biology. Third Edition. Rastogi Publications.
2. Verma, P.S and Agarwal, V.K. (1993). A Textbook of Cytology. S. Chand & Co, New Delhi.
3. E.D.P De Robertis, E.M.F De Robertis. (1987). Cell Biology. Eighth edition. Lea & Febiger.

Supplementary Readings

1. Aminul Islam. (2011). *A Text Book of Cell Biology.* 1st edition. Books and Allied (P) Ltd, Kolkata.
2. Powar. C.B.( 1983). *Cell Biology.* Himalaya Publishing House, New Delhi.
3. Gerald Karp. *Cell and Molecular biology, concepts and experiments*; 4th Edition.

OUTCOME MAPPING

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 2 | 2 | 2 | 3 |
| CO2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| SEMESTER: I  PART: III  CORE - II | 22UBTHC14: GENETICS | CREDIT: 4  HOURS: 4/W |

COURSE OBJECTIVES

1. Understand on Historical introduction to Genetics and genetic materials.
2. Understanding the concept of cell cycle and mendel’s principles.
3. Knowledge about the composition of eukaryotic chromosomes.
4. To understand the linkage and crossing over of chromosomes.
5. Its expression in host and to provide an idea about gene regulations and its control.

Unit I: Principles of Genetics

Mendel’s Experiments – principle of segregation – monohybrid crosses – dominance – recessiveness - lethal – principle of independent assortment – gene interaction – genetic versus environmental effects – multiple alleles.

Unit II: Sex Linkage

Mendel’s principles – mechanism of sex determination – environmental factors and sex determination – sex differentiation – sex-linked inheritance

Unit III: Eukaryotic chromosomes

Chemical composition of eukaryotic chromosomes – packing the giant DNA molecules into chromosomes – euchromatin and heterochromatin – repetitive DNA and sequence organization – Satellite DNAs – telomere structure – replication of eukaryotic chromosomes

Unit IV: Linkage and crossing over

Linkage and crossing over – chromosome mapping – two factor crosses – three factor crosses – somatic-cell hybridization – molecular mechanism of crossing-over – gene conversion - Discovery of transposable elements – transposable elements in bacteria – transposable elements in eukaryotes

Unit V: Structure of chromosome

Variations in chromosome structure – duplications – inversions –translocations – position effects – variations in chromosome number – trisomy in humans – chromosomal mosaics – euploidy – induced polyploidy - applications of polyploidy.

COURSE OUTCOMES

1. Comprehend the concept of replication of genetic materials
2. Understand about regulation of gene expression and mutation
3. Demonstrate the genetic exchange mechanism in microorganisms
4. Gain knowledge on Mutation
5. Grasp the Basic of genetics and their role

Text Books

1. Eldon, J.G., Simmons, M.J., & Snustad, D.P. (2005). *Principles of Genetics*. (8th ed.). Singapore: John Wiley & Sons.
2. Robert, T.B. (1999). *Genetics: Analysis and Principles*. (2nd ed.). Wisconsin: Addison’s Wesley publishers.
3. Primrose, S.B., & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics*. (7th ed.). Australia: Blackwell Publishing.

Suggested Readings

1. Brown, TA, 1999. *Genome*. Asia: John wiley and sons.
2. Varma, P.A., & Agarwal, V.K. (2009). *Genetics*. (9th ed.). New Delhi: Schand and Company Pvt Ltd.

OUTCOME MAPPING

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| --- | --- | --- | --- | --- | --- |
| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 3 | 3 | 2 | 2 |
| CO2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| SEMESTER: I  PART: III  CORE PRACTICAL -I | 22UBTHP15: CELL BIOLOGY, GENETICS & BIOCHEMISTRY | CREDIT:3  HOURS: |

Lab in Cell Biology &Genetics

1. Use of Micrometer and calibration, measurement of onion epidermal cells.
2. Cell division: Mitosis in onion root tips.
3. Cell division: Meiosis in flower buds of Allium cepa or grasshopper testis.
4. Blood smear preparation.
5. Identification of Barr body from buccal cavity.
6. Separation of cellular organelles by differential centrifuge.
7. Identification of cell organelles.
8. Identification and Karyotyping of Chromosomes.
9. Study of cyclosis in cells of suitable plant material.
10. Histochemical localization of starch, protein, lipid, and lignin.
11. Cell counting and viability.

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| SEMESTER: I  PART: III | Allied – I Paper – I 22UBTHA01: BIODIVERSITY | CREDIT: 4  HOURS: 4/W |

COURSE OBJECTIVES

1. To introduce the students to the essential basics of plants, and animals.
2. To explain about the plant and animal diversity
3. The student comes to know about the Biodiversity values and threats.
4. To knowledge the biodiversity hotspots and their conservation.
5. To distinguish plant distribution, vegetation pattern of world, continental, state level, forest biodiversity management.

Unit I: Introduction to Biodiversity Hours: 09

Introduction to Biodiversity, components of biodiversity. Biodiversity Hotspots - Criteria for selection of hotspots, Indian hotspots. Keystone species and their significance - scope and application of biodiversity.

Unit II: Plant Diversity Hours: 10

Kingdom - Plantae, Structure and reproduction (No developmental studies) Algae (Ectocarpus), Fungi (Puccinia), Bryophytes (Funaria), Pteridophytes (Selaginella), Gymnosperms (Cycas). Economic importance of Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms.

Unit III: Animal Diversity Hours: 10

Kingdom – Animalia Structure, organization and life history of Entamoeba histolytica, Taeniasolium, Ascaris, Penaeus indicus, Pila globosa, Star fish and Calotes.

Unit IV: Biodiversity values and threats Hours: 10

Direct use value (Food, Medicine, Biological control, Industrial materials, Recreational harvesting, Ecotourism). Threats to biodiversity – Direct exploitation - Habitat loss, fragmentation and degradation. Introduced species- Extinction cascade - Red data Book.

Unit V: Biodiversity Conservation Hours: 09

In situ conservation - objectives – National Parks- Wild life reserves and Sanctuaries - Biosphere reserves. Ex situ conservation principle - Botanical garden. Germplasm collection - Seed banks Cryopreservation.

COURSE OUTCOMES

1. The students will gain knowledge on the diversity of plant, animal and their importance.
2. The students can comprehend the structure and function of various ecosystems and hotspots.
3. The students can understand and differentiate the various plant ecological adaptations.
4. The students will be able biodiversity values and threats and its conservation strategies.
5. The students will gain knowledge on the importance of bioresources in human welfare

Text Books

1. Maiti, P.K., & Maiti, P. (2011). Biodiversity: Perception, peril and preservation (1st ed.). New Delhi: PHI Learning.
2. Longman, K.A., & Jenik, J. (1987). Tropical forest and its Environment:   
   (2nd ed.). London: ELBS.
3. Ekambaranatha Ayyar, M., & Ananthakrishnan, T.N. (2008). A manual of Zoology. Vol. I& II (Part 1 & 2). Chennai: Ananda Book Depot.

Supplementary Readings

1. Odum, E.P. (1983). Basic Ecology. New York: CBS College Publishing.
2. Barnes, R. D. (2001).Invertebrate Zoology. (5th ed.). Philadelphia: Saunders College Publishing.

OUTCOME MAPPING

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 1 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 |

1: Low; 2: Moderate; 3: High

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| SEMESTER: I  PART: IV | 22UENVS 18: ENVIRONMENTAL STUDIES | CREDIT: 2  HOURS: 2/W |

COURSE OBJECTIVES

1. To gain knowledge about the importance of environmental sciences and natural resources.
2. To learn the concept, structure and function of ecosystem and the importance of biodiversity.
3. To understand and gain knowledge about environmental pollution and management.
4. To impart knowledge about social issues and human population.
5. To acquire the skills for identifying and solving pollution problem.

UNIT - I: INTRODUCTION TO ENVIRONMENTAL SCIENCES: NATURAL RESOURCES:

Environmental Sciences – Relevance – Significance – Public awareness – Forest resources – Water resources – Mineral resources – Food resources – conflicts over resource sharing - Exploitation - Land use pattern - Environmental impact - fertilizer -PesticideProblems-casestudies.

UNIT - II:ECOSYSTEM, BIODIVERSITY AND ITS CONSERVATION:

Ecosystem – concept – structure and function producers, consumers and decomposers - Food chain - Food web - Ecological pyramids - Energy flow - Forest, Grassland, desert and aquaticeco system.

Biodiversity - Definition - genetic, species and ecosystem diversity - Values and uses ofbiodiversity - biodiversity at global, national (India) and local levels - Hotspots, threatstobiodiversity-conservationofbiodiversity-Insitu &Exsitu.

UNIT - III:ENVIRONMENTALPOLLUTIONANDMANAGEMENT

Environmental Pollution – Causes – Effects and control measures of Air, Water, Marine, soil, solidwaste, Thermal, Nuclear pollution and Disaster Management - Floods, Earth quake, Cyclone and Land slides.Role of individuals in prevention ofpollution-pollutioncasestudies.

UNIT - IV:SOCIALISSUES-HUMANPOPULATION

Urban issues - Energy - water conservation - Environmental Ethics - Global warming -Resettlement and Rehabilitation issues - Environmental legislations - Environmentalproduction Act. 1986 - Air, Water, Wildlife and forest conservation Act – Population growth and Explosion – Human rights and Value Education – Environmental Health- HIV/AIDS – Role of IT in Environment and Human Health – Women and child welfare – Public awareness – Case studies.

UNIT-V:FIELDWORK

Visittoalocalarea/localpollutedsite/localsimpleecosystem-Reportsubmission

COURSE OUTCOMES

After completion of this course, students will be able to gain knowledge in

1. The scope and importance of environmental science and natural resources.
2. The structure and functions of Ecosystem and biodiversity and its conservation.
3. The problem of environmental pollution and its management.
4. The social issues and human population.
5. They will identify and solve the pollution problem.

Text Books

1. Agarwal,K.C. (2008). *EnvironmentalBiology*, NidiPubl.Ltd.Bikaner.
2. Bharucha Erach, (2004). *Textbook for Environmental Studies,* UGC.
3. Odum, E.P., Odum, H.T. & Andrews, J. (1971). *Fundamentals of Ecology*. Philadelphia: Saunders.
4. Brusseau, M.L., Pepper, I.L., and Gerba, C. (2019). *Environmental and Pollution Science*. Academic Press, USA.
5. Primack R.B. (2014). *Essentials of Conservation Biology*, Oxford University Press, USA.
6. Raven, P.H, Hassenzahl, D.M., Hager M.C, Gift N.Y, and Berg L.R. (2015). *Environment*, (9th Ed.), Wiley Publishing, USA.
7. Rosencranz, A., Divan, S., and Noble M.L. 2002. Environmental Law and Policy in India: Cases, Material & Statutes. Oxford University Press.
8. Schmidtz, D., Shahar, D.C. 2018. Environmental Ethics: What Really Matters, What Really Works 3rd Edition, Oxford University Press, USA.
9. Sengupta,R.(Ed.) 2013. Ecological Limits and Economic Development. Oxford University Press, New Delhi, India.
10. Singh, J.S., Singh, S.P. and Gupta, S.R. 2017. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
11. Stuetz R.M., and Stephenson T. (Eds.) (2009). *Principles of Water and Wastewater Treatment Processes (Water and Wastewater Process Technologies).* IWA Publishing, London, UK.
12. Sodhi, N.S., Gibson, L. and Raven, P.H. (Eds). (2013). *Conservation Biology: Voices from the Tropic*s. John Wiley & Sons.
13. Thapar, V. (1998). *Land of the Tiger: A Natural History of the Indian Subcontinent*. University of California Press, USA.
14. Warren, C.E. (1971). *Biology and Water Pollution Control*. WB Saunders.
15. Wilson, E.O. (2006). *The Creation: An Appeal to Save Life on Earth*. W.W. Norton & Company, NewYork, USA.
16. World Commission on Environment and Development. (1987). *Our Common Future*. Oxford University Press, USA.

Supplementary Readings

1. Kumarasamy,K.,A. Alagappa Moses and M.Vasanthy, (2004). *Environmental Studies*, Bharathidsan University Pub,1, Trichy.
2. Rajamannar, (2004). *Environemntal Studies*, EVR College Pub, Trichy.
3. Kalavathy,S. (ED.) (2004). *Environmental Studies*, Bishop Heber College Pub., Trichy.

OUTCOME MAPPING

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| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 2 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 |

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| SEMESTER: II  PART: III  CORE – III | 22UBTHC23: BIOCHEMISTRY | CREDIT:4  HOURS:4/W |

COURSE OBJECTIVES

1. To understand the nature and significance of biomolecules.
2. To understand the structure of various carbohydrates and their functions.
3. To understand the amino acid structures, classifications, and proteins.
4. To describe the classification and structural organization of lipids.
5. To understand the structure and functions of nucleic acids and vitamins.

Unit I: Biophysical Chemistry

Acids and Bases, Buffers, Solutions, Colloidal State, Diffusion, Water and Life – Water turnover and electrolyte balance, Maintenance of blood pH, Osmosis, Isotopes-Applications of radioisotopes in biochemistry.

Unit II: Carbohydrates

Carbohydrates: Structure, Classification & Properties of carbohydrates, carbohydrate metabolism, Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenesis, Glycogenolysis, HMP Shunt, Biological Importance of Carbohydrates.

Unit III: Proteins and Amino acids

Structure and classification of amino acids, Essential and Non-Essential amino acids, Protein- Classification, Structure, Properties, and Urea cycle; Biologically important proteins (Insulin, Vasopressin, Glutathione).

Unit IV: Lipids

Lipids - Classification, and functions. Fatty acids-Essential fatty acids, Triacylglycerols, phospholipids, Glycolipids, lipoproteins, and steroids. Metabolism of Lipids: Fatty acid oxidation, Biological importance of lipids.

Unit V: Nucleic Acids and Vitamins

Nucleic Acids: Nucleotides. Structure of DNA- Watson and Crick model, Structure of RNA. Forms of DNA double helix. Vitamins: Definition, Classification, Sources, Structure, and physiological functions, antivitamins.

COURSE OUTCOMES

1. Understand the basic concepts of solutes, chemical bonding, and organic compounds.
2. Identify and interpret the structure, and classification, of carbohydrates.
3. Identify and interpret the structure, and classification, of proteins.
4. Identify and interpret the structure, and classification, of lipids.
5. Identify and interpret the structure, and classification, of nucleic acids and vitamins.

Text Books

1. U Satyanarayana. (2014). Biochemistry. Elsevier Health Sciences. 812 pages.
2. J.L. Jain. ( 2005). Fundamentals of Biochemistry. S. Chand Limited. 1230 pages.
3. G.Zubay. (1998). Biochemistry, Macmillan Publishing Co., New York.

Supplementary Readings

1. L.Stryer.(1994). Biochemistry. Freeman & Co., New York.
2. A.L.Lehninger, D.L.Nelson & M.M.Cox. (1993). Principles of Biochemistry. Worth Publishers, New York.
3. Voet & Voet. (2010). Fundamentals of Biochemistry, John Willey & Sons.

OUTCOME MAPPING

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| --- | --- | --- | --- | --- | --- |
| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 3 | 2 | 2 | 2 | 3 |
| CO2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 2 | 3 |

1: Low; 2: Moderate; 3: High

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| SEMESTER: II  PART: III  CORE PRACTICAL -I | 22UBTHP24: CELL BIOLOGY, GENETICS & BIOCHEMISTRY | CREDIT:3  HOURS:2/W |

Lab in Cell Biology &Genetics

1. Use of Micrometer and calibration, measurement of onion epidermal cells.
2. Cell division: Mitosis in onion root tips.
3. Cell division: Meiosis in flower buds of Allium cepa or grasshopper testis.
4. Blood smear preparation.
5. Identification of Barr body from buccal cavity.
6. Separation of cellular organelles by differential centrifuge.
7. Identification of cell organelles.
8. Identification and Karyotyping of Chromosomes.
9. Study of cyclosis in cells of suitable plant material.
10. Histochemical localization of starch, protein, lipid, and lignin.
11. Cell counting and viability.

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| SEMESTER: II  PART: III | Allied –II Paper – 2: 22UBTHA02: BIOPHYSICS | CREDIT: 3  HOURS: 3/W |

COURSE OBJECTIVES

1. To study the application of physics to biological systems
2. To learn the concepts and techniques of biophysics
3. To find the applications of biophysics in molecular studies and medicine

Unit I Introduction to Biophysics Hours: 09

Introduction - Molecular Biophysics; Thermodynamics of Biological system: First and second laws of thermodynamics, activation energy. Bioenergetics: Basic concept of energy coupling reactions in biological processors, Energy requirements in cell metabolism, high energy bonds, energy currency of cell.

Unit II Membrane Biophysics Hours: 10

Physical Properties of membrane: Elastic properties, Elastic constants, Chargeinduced microstructures and domain. Membrane melting. Membrane potentials: Cell surface charge, Resting membrane potential, Action potential, Membrane impedance and capacitance, Transmembrane potential, total electrochemical potential.

Unit III Biophysical Techniques and Methods Hours: 10

Introduction to Light: Reflection, Refraction, Diffraction, Interference phenomena, Refractometry: Refraction of light and Snell’s law, refractive index, principle, design, working and application of Abbe’s refractometer. Polarimetry, Viscomentry, Static Scattering Techniques, Dynamic Scattering Techniques, X-Ray Diffraction and Molecular Structure, Optical Tweezers, Patch Clamping, Molecular Dynamics, Potential Energy Contour Tracing.

Unit IV Neurobiophysics Hours: 10

Introduction: The Nervous System; Synapse, Physics of Membrane Potentials, Membrane potential due to diffusion, Voltage Clamp, Sensory Mechanisms –The Eye; The visual receptor, Electrical activity and visual generator potentials, Neural aspects of vision, Visual communications, Physical Aspects of Hearing - The Ear; Elementary acoustics, Theories of hearing.

Unit V Radiation & Medical Biophysics Hours: 09

Basics of Radiation Physics: Isotopes, Isobars, Isotones, Isomers, Radioactivity, General properties of alpha, beta and gamma radiations, Radiation units. Radiolysis of water, Production of free radicals & their interactions, Radiation chemical yield and G value, Target theory, Single hit & Multi hit theory, Effect of radiation on Nucleic acids, Proteins, Enzymes. Radioisotopes in biology, Medicine (Therapy & diagnosis), Agriculture, Biological applications of radioisotope, Radiolabeling & Tracer techniques, Radiation sterilization of medical product.

COURSE OUTCOMES

1. Learn basic of Molecular Biophysics
2. Understand the Membrane Biophysics, Physical Properties of membrane and Membrane potentials
3. Know the biophysical techniques applied in understating Biomolecules
4. Learn about Neurobiophysics; Nervous System, Visionary System and Hearing System
5. Know the Role of Radiation Physics in applied medical diagnosis & treatment

Text Books

1. VasanthaPattabhi , Gautham N, 2002, "Biophysics", 1st Edition, Kluwer Academic Publishers , United States
2. Rodney MJ, Cotterill, 2002, "Biophysics: An Introduction", 2nd edition, John Wiley & Sons Ltd, United States

Supplementary Readings

1. Tom AWaigh, 2007, "Applied Biophysics- A Molecular Approach for Physical Scientists" , 1st edition, John Wiley & Sons Ltd, United States
2. Jay L Nadeau, 2018, "Introduction to Experimental Biophysics Biological Methods for Physical Scientists", 2nd Edition, CRC Press, United States.
3. Glaser, Roland, 1999, "Biophysics", 1st edition, Springer-Verlag Berlin, Heidelberg.
4. Parke, William C, 2020, "Biophysics: A Student’s Guide to the Physics of the Life Sciences and Medicine", 1st edition, Springer International Publishing, United States

OUTCOME MAPPING

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| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 1 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| SEMESTER: II  PART: III | 22UBTHP01: LAB IN BIODIVERSITY  ALLIED PRACTICAL - I | CREDIT: 3  HOURS: 2/w |

LIST OF EXPERIMENTS

1. Study of the field collection, preservation and identification of plants
2. Study of the field collection, preservation and identification of animals
3. Diversity indices of given species (Shannon–Weaver Information Index or Simpson Dominance Index)
4. Identify biodiversity of pond ecosystem (using charts only)
5. Identify biodiversity of grassland ecosystem (using charts only)
6. Identify biodiversity of marine ecosystem (using charts only)
7. List out Plant diversity in the campus
8. List out Animal diversity in the campus
9. Preparation of Herbarium

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| SEMESTER: II  PART: III  INTERNAL ELECTIVE - I | 22UBTHE26-1: BIOMATERIALS | CREDIT: 3  HOURS: 3/W |

COURSE OBJECTIVES

1. The basic concepts of Biomaterials
2. The naturally occurring Biomaterials
3. About the different types of biomaterials and its application medical field.
4. Techniques involved in Biomaterial analysis.
5. Role of Proteomics in Biomaterials study.

Unit I Fundamentals of Biomaterials

Biomaterials- properties of biomaterials, Surface Properties and Surface Characterization of Biomaterials, Role of Water in Biomaterials. Applications of biomaterials in medical field.

Unit II Protein as Biomaterials

Collage and Gelatin-Alginate: Structure, Preparation and application. Fibroin (protein in silk): Production and its use

Unit III Carbohydrates as Biomaterials

Carbohydrates: Modified carbohydrates; Actin gas lubricants for biomedical applications; Bacterial Polydextrose; Carbohydrates modified from enzymes, Cellulose and Chitin-Chitosan: structure, preparation and application

Unit IV Biopolymers

Biopolymers: Synthesis from a simple biological monomer - hyaluronate polymer; Dextrans, Rubber produced by bacteria and fungi, PHB, PCL; Production of a copolymer of PHB and PHV.

Unit V Biocompatibility materials

Metallic Implant materials, Ceramic implant materials, Polymeric implant materials, Skin and Maxillofacial implant and blood interfacing implants.

COURSE OUTCOMES

1. Define Biomaterials and its applications
2. Biomaterials extracted from Protein.
3. Biomaterials extracted from Carbohydrates.
4. Biopolymers, synthesis and its uses
5. Biocompatibility materials used in medical field

Text Books

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, M.D, Jack E. Lemons, 2013, "Biomaterials Science An Introduction to Materials in Medicine", 3rd Edition, Elsevier Inc.
2. Ratledge, C. and Kristiansen, B., 2001, "Basic Biotechnology", 2nd Edition, Cambridge University Press.

Supplementary Readings

1. Yoshiharu D, 1990, "Microbial polyesters", 1st Edition, VCH Weinheim Publishers.
2. Joon Park and Lakes R. S, 2007, "Biomaterials: An Introduction", 3rd Edition, Springer Verlag Publishers.
3. David Byrom, 1991, "Novel materials from biological source", 1st Edition, Macmillan Publishers Limited.
4. Masoud Mozafari, 2020, "Handbook of Biomaterials and Biocompatibility", 1st Edition, Woodhead Publishing

OUTCOME MAPPING

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| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 2 | 2 | 3 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

1: Low; 2: Moderate; 3: High

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| SEMESTER: II  PART: III  INTERNAL ELECTIVE - I | 22UBTHE26-2: FORENSIC SCIENCE | CREDIT: 3  HOURS:3 /W |

COURSE OBJECTIVES

1. To make students on understanding the importance of forensic principles and technology
2. Its practical applicability in identifying the candidate who convicted the crime scenery.
3. The students also gain added skills in terms tracing the victim death by means of adapting the measurable molecular approaches.
4. Acquire knowledge about the fatality forensics and art illustration.
5. To understand the applications of DNA fingerprinting technology.

Unit I: Introduction to forensic science

Introduction, definition, Scope and branches of forensic science. Central F.S.L. and State F.S.L. Biological Evidence: Nature, collection, identification, evaluation of hair and fibres.

Unit II: Fingerprinting

Definition and Classification of fingerprints (Henry system). Taking fingerprints from living and dead persons. Automatic fingerprint identification system (AFIS).

Unit III: Forensic Art Illustration

Introduction, Finding and identifying human face image. Post mortem drawing, methods of super imposition.

Unit IV: Fatality Forensics

Introduction, cause, manner and characteristics of death, Road traffic fatality (RTF) investigation. General classification of RTFs.

Unit V: DNA fingerprinting technology

DNA Fingerprinting (DFP) technology: An overview, Applications of DFP in forensic investigations, paternity disputes. DNA Profiling practice in India with reference to criminal cases.

COURSE OUTCOMES

1. Gain knowledge on forensic science laboratories across India.
2. Acquires knowledge on fingerprint identification system.
3. To understand the finding and identifying face image by forensic art illustration
4. Know where abouts on the FAI and the concepts of fatality forensics.
5. Understand the concepts of DNA finger printing technology.

Text Books

1. Richard, S. (2001). *Criminalistic: An Introduction to Forensic Science*. (7th ed.). New Jersey: Prentice Hall.
2. Chowdhri, S. (2010). *Forensic Biology*. B.P.R. &D, Govt. of India.
3. Cammins, H., & Middle, C. (1961). *Fingerprints Palms and Soles*. New York: Dover Publications.

Supplementary Readings

1. Taylor, K.T. (2000). *Forensic Art and Illustration*. (1st ed.). U.S.A: CRC Press.
2. Kirby, T.L. (1993). *DNA Fingerprinting: An Introduction*. USA: OUP.

OUTCOME MAPPING

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| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 2 | 2 | 3 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| SEMESTER: II  PART: III  INTERNAL ELECTIVE - I | 22UBTHE26-3: DRUG DESIGNING | CREDIT: 3  HOURS: 3/W |

COURSE OBJECTIVES

1. The study of drug design and development.
2. To know about drug delivery systems.
3. To understand Cheminformatics and its Application in Drug Development.
4. To study Computer Aided Drug Design (CADD) and its role.
5. To study various receptors for Drug design.

Unit I Introduction to Drug Design

Introduction to Drug Design and Discovery, History and Evolution of the contemporary drug discovery process. Role of organic chemistry in Drug Discovery, Design and Development.

Unit II Drug Design

Types of Drug design and Drug development, difference between drug design and drug development. Classical Targets in Drug Discovery - Enzymes, Inhibition of Enzymes, G-Protein-Coupled Receptors (GPCRs), Ion Channels and Membrane Transport Proteins (Transporters).

Unit III Cheminformatics

Cheminformatics - Introduction to pharmacophore, concepts in CADD, methods in docking simulations, Applications in ADME-tox and Limitations.Role of Cheminformaticsand Molecular Diversity in Lead Discovery. Sources of Lead Compounds, Screening, Identification, Modification and Lead Optimization.

Unit IV Computer Aided Drug Design (CADD)

Introduction and classification ofCADD. Drug design based on bioinformatics tools, Molecular docking, De novo design, Structure Based Drug Design (SBDD) and Ligand Based Drug Design (LBDD). Challenges and emerging problems in CADD, Legal & ethical considerations in drug development.

Unit V Drug Delivery & Drug Delivery Systems

Introduction to drug delivery and targeting systems. Controlled drug release, parenteral and non parenteral routes of drug delivery and targeting - Oral,buccal, sublingual, GI tract, transdermal, nasal and pulmonary drug delivery. Gene delivery systems and Vaccine delivery. Challenges and obstacles to targeted drug delivery.

COURSE OUTCOMES

1. Insight on storage and retrieval of data
2. Understanding biological databases with applications
3. Discuss and distinguish the types of protein structures and its implications in function
4. Explain the sequences and its alignment which determines several roles of biomolecules
5. Comprehend the molecular modelling and visualization for drug designing

Text Books

1. Shanmughavel P, 2006, "Trends in Bioinformatics", Pointer Publishers, Jaipur, India.
2. Lesk AM, 2003, "Introduction to Bioinformatics", Oxford University Press, New Delhi.

Suggested Readings

1. Andrew R Leach, 2001, "Molecular Modeling: Principles and Application", Pearson Publishers, United Kingdom.
2. Hans X, 2008, "Basic principles and applications", Wiley publications, United States
3. Yvonne C Martin, 1998, "Designing bioactive molecules three-dimensional techniques and applications", American Chemical Society, United States
4. Leo, Albert, Hockma, Hansch, Corwin, 1995, "Exploring QSAR", 2nd edition, American Chemical Society, United States.

OUTCOME MAPPING

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| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 2 | 2 | 3 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: III**  **PART: III**  **CORE COURSE - IV** | **22UBTHC33: MICROBIOLOGY** | **CREDIT: 4**  **HOURS: 4**/W |

**Course Objectives**

1. To understand the classification of microorganisms.
2. To understand the structure of various microorganisms
3. To understand the growth of microorganisms
4. To understand the factors affecting the growth
5. to understand the disease caused by microorganism

**Unit I: History and recent Developments Hours: 09**

Contributions of Leevenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff, Edward Jenner, Alexnder fleming, Spontaneous generation, Biogenesis of Microbiology. Microscope-light, electron and laser optic system; micrometry. Staining techniques – Definition of auxo chrome, chromophores, dyes. Classification of stains-mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.

**Unit II: Bacteria, Viruses, Fungi and Aglae Hours: 10**

Bacteria - Ultra structure of bacteria–gram positive and gram negative bacteria, morphology. Viruses - General classification and properties of viruses. Fungi - general characteristics of fungi–structure and functions of yeast. Algae - General classification and properties of algae, Economic importance of algae.

**Unit III: Nutritional requirements Hours: 10**

Nutritional requirements and nutritional grouping of microorganisms, selective and differential media, enrichment media, microbial assay media. Growth curve; axenic culture, synchronous culture, continuous culture; Methods of enumeration of microorganisms and preservation of microbes.

**Unit IV: Factors controlling microbial growth Hours: 10**

Physical agents and processes - pH, light, temperatures, desiccations, osmotic pressure, radiation, filtration; Chemical agents-Disinfectants, antiseptics and chemical sterilants; Antimicrobial chemotherapy evaluation-tube dilution, agar plate technique, phenol coefficient techniques.

Sterilization technique – Definition, Physical methods – heat, radiation, ultrasonic action, filtration. Chemical methods-disinfection, sanitization, anti sepsis sterilants and fumigation.

**Unit V: Antibiotics Hours: 09**

History of Antibiotics – types of antibiotics – mode of action of antibiotics – antibiotics resistance – minimum inhibitory concentration assay – antibiotics sensitivity test

**Course Outcomes**

CO1 - The student will be able to know classification of microorganisms

CO2 - The student will be able to know the structure of various microorganisms

CO3 - The student will be able to know the growth of microorganisms

CO4 - The student will be able to know factors controlling microbial growth

CO5 - The student will be able to know various disease caused by microbes

**Text Books**

1. Pelzer, M.J., Chan, E.C.S., & Krieg, N.R. (1993). *Microbiology: concept and applications*. New York: McGraw Hill.
2. Atlas, R.M. (1987). *Microbiology: fundamentals and applications*. (2nd ed.). USA: Macmillan.
3. Stainer, R.Y., Ingraham, J.L., & Wheelis, M.L. (1986). *General Microbiology*. (5th ed.). London: The McMillan Press Ltd.

**Suggested Readings**

1. Willey, J., Sandman, K., & Wood, D. (2017). *Prescott's Microbiology*. (11th ed.). New York: McGraw Hill.
2. Atlas, R.M. (1997). *Principles of Microbiology*. (2nd ed.). New York: McGraw Hill.

**MAPPING WITH PROGRAMME OUTCOMES**

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| --- | --- | --- | --- | --- | --- |
| COs | PO1 | PO2 | PO3 | PO4 | PO5 |
| CO1 | 2 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: III**  **PART: III** | **MICROBIOLOGY & MOLECULAR BIOLOGY** | **CREDIT: -**  **HOURS: 3** |

**LIST OF EXPERIMENTS**

1. Sterilization techniques (Dry heat, moist heat, Filtration - membrane)
2. Preparation of nutrient media (Solid, semi - solid and liquid)
3. Isolation of pure culture (Streaking methods – simple, continuous, quadrant and T streaking).
4. Simple and negative staining
5. Differential staining (Gram‟s staining, Capsule staining, Spore staining)
6. Fungal staining (LCB)
7. Determination of bacterial motility (Hanging drop method)
8. Biochemical characterization of microorganisms (IMViC), Catalase test, fermentation test

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| **SEMESTER: III**  **PART: III**  **ALLIED - III** | **22UBTHA03: BIOSTATISTICS** | **CREDIT: 04**  **HOURS: 04/W** |

**Course Objectives**

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| 1. To understand the different methods of data collection and processing. 2. To impart knowledge on measures of central tendency and dispersion. 3. To understand the concepts of correlation and regression in statistical analysis. 4. To Develop their skills, the necessary for office automation industry oriented applications 5. To develop the basic skills required to write network ports. |

**Unit I: Sampling, Data Collection, and Processing Hours: 10**

Executing a statistical survey- Drafting an effective questionnaire, Concept of Sampling, and its types. Collection of data - Primary data, Secondary data. Formation of discrete and continuous frequency distribution. Parts of a table and general rules of tabulation.

**Unit II: Measures of Central Tendency and Dispersion Hours: 10**

Measures of Central Tendency – Arithmetic Mean, Median, Mode, Geometric Mean, and Harmonic Mean. Measures of Dispersion - Range, Mean Deviation, Standard Deviation, and Coefficient of variation.

**Unit III: Correlation and Regression Hours: 10**

Correlation - Types, Karl Pearson’s Coefficient of Correlation, and Spearman’s Rank Correlation. Regression lines and their properties, Regression equations.

**Unit IV: Histograms and graphs Hours: 09**

Histograms, plotting single and two graphs, matrix algebra addition, subtraction, multiplication, transpose, invert; string manipulation-string and string related functions, concatenation, subscripted string variables, alphabetical sorting.

**Unit V: File Management Hours: 09**

File types, handling sequential files, handling random files. Computer graphics - resolution and colour, points, lines, boxes, circles, ellipse, painting an area.

**Course Outcomes**

CO1 - The student will be able to collect through sampling and process biological data.

CO2 - The student will be able to calculate the average and analyze the dispersion of biological data.

CO3 - The student will be able to understand the correlation and regression patterns in statistics.

CO4 - To impart strong knowledge on spreadsheet application in biological data analytics

CO5 - Enable to know about basic presentation graphical representation of data.

**Text Books**

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| 1. Arumugam, N. (2015). *Basic Concepts of Biostatistics*. Nagercoil, Tamilnadu: Sara’s Publication. 2. Gupta, S.P. (1995). *Statistical Methods*. New Delhi: Sultan Chand & Sons. 3. Sundaralingam, R., Arumugam, N., Kumaresan, V., Gopi, A., & Meena, A. (2014). *Bio-Statistics, Computer Application and Bioinformatics*. Nagercoil, Tamilnadu: Saras Publication. |
| 1. Brassard, G., & Bartley, P. (1996). *Fundamentals of algorithms*. New Jersey: Prentice Hall. |

**Supplementary Readings**

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| 1. Banerjee, P.K. (2007). *Introduction to Biostatistics*. New Delhi: S. Chand Publication.   2. Prasad, S. (2018). *Elements of Biostatistics*. (3rd ed.). Meerut: Rastogi Publication.   1. Horowitz, E., Shahni,S., & Rajasekaran, S. (1998). *Fundamentals of Computer algorithms*. New York: Computer Science press. |
| 1. Balagurusamy, E. (1991). *Programming in BASIC*. (3rd ed.). New Delhi: Tata McGraw Hill. |

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: III**  **PART: III**  **INTERNAL ELECTIVE - II** | **22UBTHE36-1: MARINE BIOTECHNOLOGY** | **CREDIT: 03**  **HOURS: 03/W** |

**Course Objectives**

1. To make students on understanding the significance and importance of marine micro biota.
2. The rational applicability in the development of industrially important products.
3. To knowledge of the sources of pollutants on marine environment.
4. The students also gain knowledge on the environmentally hazardous management marine ecosystem.
5. Acquires knowledge of the Genetic modification of marine organisms and economical aspects.

**Unit I:** **Introduction to marine environment Hours: 07**

Characteristics and classification of Marine habitat, Marine Flora and fauna – scope of Marine biotechnology. Important terminologies Biodiversity of marine environment- Species, Ecosystem and genetic diversity.

**Unit II: Marine natural products Hours: 08**

Marine natural products – Isolation and Identification of bioactive compounds from marine organism, Anti cancer, Anti microbial, Bioadhesives, Biopesticides and enzymes from marine microbes. Microbes of Biotechnological Importance.

**Unit III: Sources of Marine pollution Hours: 07**

Oil spills – Impact of pollutants on marine environment –Biomonitoring and assessment of marine pollution – Bioindicators and biomarkers –Biofouling and its control.

**Unit IV: Control of Marine pollution Hours: 07**

Biodegradation – Biostimulation and Bioaugmentation –conservation of marine habitat and its biodiversity resources.

**Unit V: Genetic modifications Hours: 07**

Genetic modification of marine organisms, Transgenic Fish, Aquaculture, Economic aspects and ethical issues of marine biotechnology.

**Course outcomes**

CO1 - To understand basics of marine ecosystem and its pollution issues

CO2 - To understand basic biodegradation and bioremediation marine ecosystem pollutants

CO3 - To understand the principles of bio fouling

CO4 - To acquire knowledge of wastewater treatment in marine ecosystem.

CO5 - Acquiring knowledge of genetic modifications marine organisms.

**Text Books**

1. Fingermann, M. (2003). *Recent advances in Marine biotechnology*. (1st ed.). Boca Raton: CRC Press.
2. Bernard, G., & Pasternak, J.J. (1998). *Molecular Biotechnology*. Washington: ASM Press.
3. Devadasan, K., Mukundan, M. K., & Antony, P. D. (1994). *Nutrients and Bioactive substances and aquatic organisms*. Kerala: Society of fisheries technologists.

**Suggested Readings**

1. Balasubramanian, D., Bryce, C.R.F., Jayaraman. K., & Dharmalingam, K. (2004). *Concepts in Biotechnology*. Hyderabad: University Press, COSTED- IBN.
2. Kim, S.K. (2019). *Essentials of Marine Biotechnology*. (1st ed.). Switzerland: Springer Nature

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 3 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: III**  **PART: III**  **INTERNAL ELECTIVE – II** | **22 UBTHE 36-2: STEM CELL TECHNOLOGY** | **CREDIT:3**  **HOURS:3/W** |

**Course Objectives**

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| 1. To understand the basic characteristics of stem cells. 2. To understand the development of different types of stem cells. 3. To impart knowledge on stem cell disorders. 4. To understand the need for regenerative medicine. 5. To understand the regulations on stem cell research. |

**Unit I: Introduction to Stem cell biology Hours:07**

Stem cells - basics; unique properties – proliferation and differentiation; Potency definitions and types. Stem-cell plasticity. Stem Cell niches, organoids, and cancer stem cells.

**Unit II: Biology of Stem cells Hours:07**

Various types of stem cell development **-**Mesenchymal stem cells, Hematopoietic stem cells, Foetal Stem Cells, Epidermal adult stem cells, and endodermal stem cells. Hematopoiesis, cardiomyogenesis, vasculogenesis.

**Unit III: Stem cell Disorders Hours:07**

Overview of stem cell dysfunctions and disorders, stem cell aplasia (aplastic anemia), monoclonal (leukemia), and polyclonal hematopoietic stem cell proliferative syndrome (systemic and organ-specific autoimmune diseases).

**Unit IV: Regenerative medicine Hours:08**

Evolving concepts of Regeneration. Stem cells and aging. [Stem cells in tissue engineering](https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&sqi=2&ved=0ahUKEwiZ84zMs_bSAhVCvY8KHVD9AVcQFgg0MAM&url=http%3A%2F%2Fwww.nature.com%2Farticles%2F35102181&usg=AFQjCNHG2Yvl3nnPt-59z0dK7CLkW2kDJw&bvm=bv.150729734,d.c2I). Repair of damaged organs. Regeneration of Bone and Cartilage. 3D stem cell culture. Stem cell Bioprinting.

**Unit V: Stem cell cloning and Ethics Hours:07**

Cloning of Human embryos. Stem cell policy and ethics. Current Regulation and controversies of Human Embryonic Stem Cell Research. Postponement of stem cell research.

**Outcomes**

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| CO1 - Understand the basics of stem cells.  CO2 - Understand the differentiation of different types of stem cells.  CO3 - Learn about the disorders that occur due to defective stem cells.  CO4 - Learn regenerative medicine and its applications.  CO5 - Understand the policies and regulations on stem cell research. |
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**Text Books**

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| 1. Fagan, M. (2013). *Philosophy of stem cell biology.* 1st ed. New York: Palgrave Macmillan. 2. Schatten H. *Cell and Molecular Biology and Imaging of Stem Cells.* John Wiley & Sons. 3. Atala, A.(2011). *Principles of regenerative medicine.* 1st ed. Amsterdam: Elsevier/Academic Press. |
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**Supplementary Readings**

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| 1. Knoepfler, P. (2013). *Stem cells: an insider's guide.* World Scientific. 2. Meyers, R. A. (Ed.). (2013). *Stem cells: from biology to therapy.* John Wiley & Sons. 3. Lanza, R., Langer, R., & Vacanti, J. P. (Eds.). (2011). *Principles of tissue engineering*. Academic Press.   **OUTCOME MAPPING**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | | **CO1** | 3 | 3 | 3 | 2 | 3 | | **CO2** | 2 | 3 | 3 | 3 | 3 | | **CO3** | 2 | 3 | 3 | 3 | 3 | | **CO4** | 3 | 3 | 3 | 3 | 3 | | **CO5** | 2 | 3 | 3 | 3 | 2 |   **1:** Low; **2:** Moderate; **3:** High |
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| **SEMESTER: III**  **PART: III**  **INTERNAL ELECTIVE – II** | **22 UBTHE 36-3: MOLECULAR DIAGNOSTICS** | **CREDIT:3**  **HOURS:3/W** |

**Course Objectives**

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| 1. To learn the significance and history of molecular diagnostics. 2. To learn the traditional methods of disease diagnosis. 3. To evaluate the disease at the molecular level by using advanced techniques. 4. To learn the applications of PCR in disease diagnosis. 5. To learn different immunodiagnostic methods and their specific applications. |

**Unit I: Molecular Diagnostics – An Overview Hours:07**

Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases, philosophy, and general approach to clinical specimens.

**Unit II: Traditional disease diagnosis methods Hours:07**

Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa, and Helminthes. Detection and quantification of biochemical parameters.

**Unit III: Molecular Techniques for diagnosis**  **Hours:07**

Disease identification and Genetic tests of disorders; Population screening for genetic disorders; Treatment and management of genetic disorders.

**Unit IV: Applications of PCR-based microbial typing Hours:07**

PCR-based microbial typing; Culture-independent analysis of bacteria; Molecular diagnosis of fungal pathogens; RAPD for animals and plants.

**Unit V: Immunoassays Hours: 08**

Types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry – principle, and techniques. Different Levels of Biosafety, Containment.

**Course Outcomes**

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| CO1 - Understand the basic concepts of molecular diagnostics.  CO2 - Learn the traditional methods of disease diagnosis.  CO3 - Learn about the molecular methods of disease diagnosis.  CO4 - Learn about the applications of molecular diagnostic procedures.  CO5 - Diagnose and interpret different diseases using assays. |

**Text Books**

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| --- |
| 1. Bruce Alberts. Molecular *biology of the cell.,* 6th Edition.  2. Darnell J, Lodish H, and Baltimore D. *Molecular Cell Biology.*  3. De Robertis EDP and De Robertis EMF*. Cell and Molecular Biology.* |

**Supplementary Readings**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 1. Ralph Michael Aloisi, Lippincott Williams, and Wilkins. *Principles of Immunology and Immunodiagnostics.* 2. Valones et al., Braz. J. Microbiol., (2009). *Principles and applications of polymerase chain reaction in medical diagnostic fields: a review* 40, 1–11. 3. Daniel. C.L., “Introduction to Proteomics”, Humana Press. 2002.   **OUTCOME MAPPING**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | | **CO1** | 3 | 2 | 3 | 3 | 3 | | **CO2** | 2 | 3 | 3 | 3 | 3 | | **CO3** | 2 | 3 | 3 | 3 | 3 | | **CO4** | 3 | 3 | 3 | 3 | 3 | | **CO5** | 3 | 3 | 2 | 3 | 3 |   **1:** Low; **2:** Moderate; **3:** High |

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| **SEMESTER: III**  **PART: IV**  **NON MAJOR ELECTIVE - I** | **22UBTHN37: MUSHROOM TECHNOLOGY** | **CREDIT:2**  **HOURS:2/W** |

**Unit I Basic concepts of Mushroom Technology Hours:05**

Mushroom Technology - Introduction, History and Scope. Edible and Poisonous Mushrooms. Importance and nutritive value of edible mushrooms. Mushroom research centers in India

**Unit II Types of mushroom and its cultivation Hours:05**

Cultivation of button mushroom (Agaricus bisporus), milky mushroom (Calocybeindica), oyster mushroom (Pleurotus sajorcaju) and paddy straw mushroom (Volvariella volvcea)

**Unit III Production, Harvest and Storage methods Hours:05**

Isolation and culture of spores, culture media preparation. Production of mother spawn, multiplication of spawn - Inoculation Technique

**Unit IV Cultivation technology Hours:05**

Substrates, composting technology, bed, polythene bag preparation, spawning - Cropping and its importance

**Unit V Mushroom Production Hours:04**

Harvest -types and Storage methods and post marketing surveillance and types.

**Text Books**

1. Krishnamoorthy, A.S et al. 1991. Oyster Mushrooms. 2nd edition. TNAU Department of Plant Pathology. Tamil Nadu
2. Suman, B C, and Sharma V P. 2007. Mushroom Cultivation in India. 1st edition. Daya Publishing House. India

**References**

1. NIIR Board of Consultants and Engineers. 2011. Handbook on Mushroom Cultivation and Processing.1st edition. Asia Pacific Business Press Inc. India
2. Biswas S. 2012. Mushrooms: A Manual for Cultivation. 1st edition. PHI Learning Private Limited. New Delhi
3. Thapa, C.D et al. 2017. Mushroom Culture. 1st edition. Agrimoon.com.
4. Russel, S. 2018. Essential guide to Mushroom Cultivation. 2nd edition. Storey

Publishing, United States

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| **SEMESTER: III**  **PART: IV**  **SKILL BASED SUBJECT - I** | **22UBTHS38: BIOANALYTICS** | **CREDIT: 2**  **HOURS: 2/W** |

**Course Objectives**

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| 1. The student should have understood the analytical techniques in the field of Biotechnology. 2. Knowledge of the Spectroscopic techniques uses in biology. 3. To understand the separation of molecules by chromatographic techniques. 4. Acquire knowledge of the applications of Immunological techniques. 5. To make the students to understand the basic principles of Bioanalytical instruments. |
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**Unit I: Microscopy Hours: 05**

Principles and application of light microscopy, phase Contrast, Bright and Dark field Microscopy fluorescence Microscopy, Electron Microscopy- TEM and SEM.

**Unit II: Spectroscopic techniques Hours: 04**

Colorimeter, Ultraviolet and visible, Infra red and Mass Spectroscopy.

**Unit III: Molecular techniques Hours: 05**

Chromatographic techniques - Paper, Thin Layer, Column, HPLC and Gas Chromatography. Electrophoresis techniques - AGE, SDS -PAGE.

**Unit IV: Immunological techniques Hours: 05**

Principle, Instrumentation and application of ECG, EEG, Complement fixation Test, Radio Immuno Assay, ELISA.

**Unit V: Analytical techniques Hours: 05**

Spectrofluorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.

**Course Outcomes**

CO1 - To understand the concepts of the Microscopy techniques

CO2 - Acquiring knowledge with the basic concepts of spectroscopic techniques.

CO3 - Acquiring knowledge with the basic concepts of chromatographic techniques.

CO4 - Acquiring knowledge with the basic concepts of Immunological techniques.

CO5 - Exploring towards the use of radiation principles in the field of biomedical science.

**Text Books**

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| --- |
| 1. Shourie, A., & Shilpa S. C. (2015). *Bioanalytical Techniques*. New Delhi: TERI Press. |

**SEMESTER – IV**

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| **SEMESTER: IV**  **PART: III**  **CORE COURSE - V** | **22UBTHC43**  **MOLECULAR BIOLOGY** | **CREDIT:4**  **HOURS: 4/W** |

**Course Objectives**

1. To understand the scientific evidences on the genetic material and its organization.
2. Acquires knowledge of the Prokaryotic and Eukaryotic DNA replication.
3. To analyze the mechanisms of mutations and DNA repair.
4. To describe the events and processes involved in the mechanisms of gene regulation.
5. To correlate the development and causes of cancer to mutagenesis and gene expression.

**Unit I: Genetic materials Hours: 13**

Experiments on genetic material (Griffith, Hershey and Chase; Avery and McCarty experiments); Watson and Crick model; Chargaff’s rule. Genome Organization: Prokaryotic and Eukaryotic; Chromosome: structure and function, Chromatin (Hetero and Euchromatin); Chloroplast and Mitochondrial DNA; Gene families and Clusters.

**Unit II:** **Replication Hours: 13**

Prokaryotic and Eukaryotic DNA replication; Transcription: Mechanism (Prokaryotic and Eukaryotic); Post transcriptional modification (Polyadenylation and capping) and splicing mechanism; Translation: Genetic code; mechanism of translation; Post translational modifications (Phosphorylation and methylation).

**Unit III: DNA repair mechanisms Hours: 11**

Mutations: Mutagenesis, Types of Mutations, Biochemical basis of mutants, Mutational Hot Spots, Reversion; Transposable elements (Insertion Sequence and transposons, Integrons and Antibiotic Resistance Cassettes).

**Unit IV:** **Gene Regulation mechanisms Hours: 11**

General aspects of Regulation, The lactose system and the operon model, The Galactose operon, The Tryptophan operon, Concept of Feedback Inhibition.

**Unit V:** **Chromosomal Variations and Mapping Hours: 12**

Chromosomal aberrations (in Number & Structure) – Ploidy and structural aberrations; Position Effect; Chromosome Mapping. Oncogenesis: Development, causes and types of cancer; Oncogenes: proto and tumor suppressor gene.

**Course Outcomes**

CO1 - To under the basic concepts of DNA/RNA structure and experimental evidences as genetic material.

CO2 - To under the mechanisms of replication of DNA and it regulation.

CO3 - To know about the transcription process and its modifications into functional mRNA and translation into proteins.

CO4 - To under the concepts of gene regulation and know about the mechanisms of transposition.

CO5 - To acquiring knowledge of the Chromosomal Variations and Mapping.

**Text books**

1. Lodish, H. (2016). *Molecular Cell Biology*. (8th ed.). New York: W. H Freeman and company.
2. De Robertis, E.D.P., & De Robertis, E.M.F. (2001). *Cell and Molecular Biology*. (8th ed.). New York: Lippincott Williams and Wilkins.
3. Friefelder, D. (2009). *Molecular Biology*. (2nd ed.). New Delhi: Narosa Publishing House.

**Suggested Readings**

1. Lewin, B. (2008). *Genes IX*. Burlington: Jones and Bartlett.
2. Rastogi, S.C. (2004). Cell Biology. (2nd ed.). New Delhi: New Age International Publishers.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: IV**  **PART: III**  **CORE PRACTICAL: II** | **22UBTHP44: MOLECULAR BIOLOGY** | **CREDIT: 03**  **HOURS: 03** |

**LIST OF EXPERIMENTS**

1. Isolation of genomic DNA from bacterial culture
2. Isolation of genomic DNA from plant tissue.
3. Quantification of DNA using UV spectrophotometer.
4. Agarose gel electrophoresis of genomic DNA.
5. Isolation of Plasmid DNA.

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| **SEMESTER: IV**  **PART: III**  **ALLIED - IV** | **22UBTHA04: BIOINFORMATICS** | **CREDIT:4**  **HOURS: 3/W** |

**Course Objectives**

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| 1. To knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics. 2. Acquire knowledge of the biological databases. 3. To develop the basic skills required to sequences alignments using softwares. 4. To existing software effectively to extract information from large databases and to use this information in computer modelling. 5. Knowledge of the bioinformatics in drug discovery. |

**Unit I: Introduction to Bioinformatics**  **Hours: 09**

Bioinformatics - definition, history; Applications of Bioinformatics. Data generation - Generation of large scale molecular biology data.

**Unit II: Data Bases Hours: 10**

Nucleic acid sequence data bases (NCBI, EMBL, DDJB), Protein sequence data base - SWISS-PORT, data base searching - BLAST.

**Unit III: Sequences Alignments Hours: 10**

Introduction to Sequences – Alignments - local, global, pairwise & multiple sequences; phylogenetically analysis - CLUSTALW, PHYLIP & UPGMA. Gene finding and gene scan.

**Unit IV: Protein prediction Hours: 10**

Protein prediction - physical properties, secondary structure, alpha & beta structure, motifs, tertiary structures, specialized structure and function. Molecular visualization - protein conformation and visualization tool (RASMOL).

**Unit V: Drug discovery Hours: 09**

Drug discovery - role of bioinformatics in drug discovery, target discovery, lead discovery, microarray, docking and prediction of drug quality. Bioinformatics companies.

**Course Outcomes**

CO1 - Application of bioinformatics for solving different biological problems.

CO2 - Data handling process and data retrieval process from different biological databases

CO3 - Usage of different software for analyzing biological data.

CO4 - To the study of structural and functional relationships, and molecular evolution.

CO5 - To explain the role of bioinformatics in drug discovery.

**Text Books (In API Style)**

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| --- |
| 1. Attwood, T.K., & Parry smith, D.J. (2001). *Introduction to bioinformatics*. (1st ed.). Cambridge, UK: Benjamin Cummings. |
| 1. Gibas, C., & Jambeek P. (2001). *Developing bioinformatics in computer skill: An Introduction to Software Tools for Biological Applications*. (1st ed.). Sebastopol, CA: O'Reilly & Associates, Inc. |
| 1. Jin Xiong. (2006). *Essential Bioinformatics*. New York: Cambridge University Press. |

**Supplementary Readings**

|  |
| --- |
| 1. Coghlan, A. (2017). *A Little Book of R For Bioinformatics*. Wellcome Trust Sanger Institute, Cambridge, U.K. 2. Altman, R.B. (2004). *Building successful biological databases.* Brief. Bioinformatics. 5 (1):45.doi:10.1093/bib/5.1.4.PMID15153301(https://www.ncbi.nlm.nih.gov/pubmed/15153301). |

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: IV**  **PART: III**  **ALLIED PRACTICAL - II** | **22UBTHP04: BIO STATISTICS & BIOINFORMATICS** | **CREDIT: 3**  **HOURS: 3/W** |

**LIST OF EXPERIMENTS**

1. Pair wise alignment of DNA sequence using Bioedit
2. Submission of DNA sequence in Gen Bank, NCBI
3. Multiple alignment – CLUSTALW
4. Study of protein data banks - Swiss-PROT, UniPROT
5. Database & information retrievals

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| **SEMESTER: IV**  **PART: IV**  **NON MAJOR ELECTIVE – II** | **UBTHN47**  **ENVIRONMENTAL MANAGEMENT** | **CREDIT:2**  **HOURS: 2/W** |

**Unit I Ecology and Ecosystem Hours: 04**

Ecology - ecosystem and their types - definitions - environmental components and interrelationships - physical, chemical and biological characteristics of environment energy flow and materials cycling.

**Unit II Pollution Hours: 05**

Definition - source of pollution - types of pollution - air, water, soil, noise and radioactive pollution - environmental sanitation - environmental issues - global - national - regional and local

**Unit III Environmental Standards Hours: 05**

Prescribed environmental standards - WHO - Pollution Control Board – risk probability and hazards to humans - toxicology - chemical hazards – biological hazards: disease development and developing countries.

**Unit IV Pollution Control Methods Hours: 05**

Pollution control methods - physical, chemical and biological - waste water treatment - activated sludge process, oxidation ponds and trickling filter - anaerobic process.

**Unit V Environmental Management Hours: 04**

Tool for environment management - Environmental Impact Assessment – waste minimization techniques - environmental planning in urban development – natural resources and sustainable development - environmental ethics.

**Text Books**

1. Joseph, K. and Nagendra, R. 2004. Essentials of Environmental Studies. 2nd edition. Pearson Education. New Delhi
2. Tyler, M.J.R. 2004. Environmental Science. 2nd edition. Thomson Brooks/Cole Publishing. Singapore.

**References**

1. Dhamejam, S.K. 2005. Environmental Science and Engineering. 2nd edition. Kataria sons. Delhi
2. Dubey, R.C. 2006. Environmental Health Ecological Perspectives. 3rd edition. Jones and Bartlett Publishers. USA

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| **SEMESTER: IV**  **PART: IV**  **SKILL BASED SUBJECT - II** | **22UBTHS48**  **CLINICAL TRIALS** | **CREDIT: 2**  **HOURS: 2/W** |

**Course Objectives**

1. The regulations on clinical trials.
2. The different guidelines applicable.
3. The difference between different phases of clinical trials.

**Unit I Pharmaceutical Industry Hours: 05**

Introduction to Pharmaceutical Industry, Preclinical studies – Preclinical technology. Phase I, Phase II A and B, Phase III A and B, Phase IV and Types of Post marketing surveillances.

**Unit II DCGI and FDA Hours: 05**

DCGI – roles and responsibilities - Clinical research regulation of DCGI.FDA Regulations for Clinical Trials, FDA Guidelines and Information Sheets, FDA Compliance Program Guidance Manuals, FDA Bioresearch Monitoring Program (BIMO).

**Unit III Ethical Guidelines Hours: 05**

Ethical Guidelines for Biomedical Research in Human Subjects, Central Ethics committee on Human Research (CECHR), Ethics in Clinical Research for Communicable and Non Communicable Diseases. Ethics concerned with virology and serology studies.

**Unit IV Guidelines of Various Organizations Hours: 05**

History of GCP, ICH Guidelines for Good Clinical Practice, Central Drugs Standardization and Control Organization, Government of India, Schedule Y.

**Unit V Consent and Ethics Hours: 04**

CRF design, Informed Consent Documents - Subject Information Sheet and Informed Consent Form, Ethics Committee Approvals.

**Course Outcomes**

CO1 - Understand the phases of pre-clinical trials

CO2 - Gain knowledge on clinical guidelines and regulations of DCGI

CO3 - Comprehend the ethics of clinical trials

CO4 - Gather information on various guidelines of international organization..

CO5 - Learn about filling the consent forms and datainformation sheets.

**Text Books**

1. Katzung, B.G, 1995, "Basic and Clinical Pharmacology", 12th Edition, Prentice Hall of Intl.
2. Murugesh, N, 2014,"A Concise text book of Pharmacology", 7th Edition, Sathya Publications.

**References**

1. Hackshaw, A, 2009, "A Concise Guide to Clinical Trials", 1st Edition, Wiley Publishers.
2. Chin, R, and Bruce Y.L, 2008, "Principles and Practice of Clinical Trial Medicine", 1st Edition, Academic Press.
3. Weinberg, S, 2009, "Guide Book for Drug Regulatory Submissions", 1st Edition, John Wiley & sons.

# MAPPING WITH PROGRAMME OUTCOMES

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| COs | PO1 | **PO2** | **PO3** | **PO4** | **PO5** |
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| CO2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 |

**1-**Low**; 2-** Moderate**; 3-** High

**SEMESTER – V**

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| **SEMESTER: V**  **PART: III**  **CORE COURSE - VI** | **22UBTHC51**  **IMMUNOLOGY** | **CREDIT: 4**  **HOURS: 4/W** |

**Objectives**

1. To Understand the basics of immunology
2. To Widen their knowledge immune response and transplantation technology
3. To become familiar with different antigen antibody interactions and allergic reactions.
4. To understand the concept of antigen /antibody detection
5. To Enabling knowledge about types of vaccine

**Unit I: Fundamental Concepts and Anatomy of the Immune System Hours: 10**

Introduction to cells of immune system- Innate and Acquired immunity -Organs and cells of the immune system- Primary and Secondary lymphoid organs: lymphatic systems, lymphocyte circulation and lymphocyte homing. Principles of cell signaling

**Unit II: Types of immune response**  **Hours: 10**

Complement systems - structure and function of MHC class I and II molecules - antigen recognition and presentation - Humoral and Cell mediated immune responses - immune suppression and immune tolerance - Transplantation immunology- Graft rejection.

**Unit III: Hypersensitivity and Tumor immunology**  **Hours: 10**

Antigen - antibody reaction, Hypersensitivity - IgE mediated, antibody mediated, immune complex mediated and delayed type hypersensitivity. Tumor immunology- tumor associated antigens, Immune response to tumor. Auto immune disorders.

**Unit IV: Detection and quantification of an antigens/antibodies Hours: 9**

Anitgen – Antibody interactions: Antibody affinity, antibody avidity, precipitation reactions – radian immune diffusion, double immune diffusion, immune electrophoresis. Agglutination reactions – Hemagglutination, bacterial agglutination, passive agglutination.

**Unit V:**  **Vaccinology**   **Hours: 09**

Active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, Anti-idiotypic and conjugate vaccines – production & applications.

**Course Outcomes**

# CO1 - Know about the concept and anatomy of immune system

# CO2 - Acquire the knowledge about immune response.

# CO3 -Exemplify the adverse effect of immune system including Allergy, hypersensitivity and autoimmunity

# CO5 - Explain the detection and quantification of antigen /antibodies

# CO4 - Describe about different types vaccines

# Text Books

1. E. Riot. 2011. Essential Immunology 12th Edition. Wiley & Blackwell.
2. Janeway et al. 1999. Immunobiology. 4th Edition. J Current Biology publications.
3. D. M. Weir, John Stewart. 1997. Immunology. 8th Edition. Churchill. Livingstone.
4. P.J.Delves, I S.J.Artin, I D.R.Burton and I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition. Wiley & Blackwell.
5. Richard M. Hyde. 2012. Microbiology and Immunology. 3rd Edition. Springer Science & Business Media.

# Reference Books

1. Brostoff J, Seaddin JK, Male D, Roitt IM., 2002. Clinical Immunology. 6th Edition. Gower Medical Publishing.
2. Paul. 1999. Fundamental of Immunology. 4th Edition. Lippencott Raven.

# MAPPING WITH PROGRAMME OUTCOMES

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| COs | PO1 | **PO2** | **PO3** | **PO4** | **PO5** |
| CO1 | 3 | 2 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 |

**1-**Low**; 2-** Moderate**; 3-** High

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| **SEMESTER:V**  **PART: III**  **CORE COURSE -VII** | **22BTUHC52**  **INDUSTRIAL BIOTECHNOLOGY** | **CREDIT: 4**  **HOURS: 4/W** |

# Course Objectives

1. To understand the basics concept in fermentation technology.
2. To familiarize about the fermentation process.
3. To gain knowledge about the importance of fermentor and its types.
4. To widen their knowledge in downstream process of microbial biotechnology.
5. To know the applications of microbes as SCP.

**Unit I: Introduction to fermentation technology Hours: 09**

Introduction to fermentation technology: History, Principles of Fermentation technology, scope and applications. Isolation and screening of industrially important microbes. Strategies for Strain improvement . Preservation and maintenance of industrial microorganisms.

**Unit II: Microbial fermentation**  **Hours: 11**

Fermentation concept and design .Types of fermentation: Solid- state fermentation and submerged fermentation. Formulation and design of fermentation media .Substrates used as Carbon and Nitrogen sources for Inoculum development. Types of sterilization: Batch and continuous sterilization, Sterilization of air.

**Unit III: Design and construction of fermenters** **Hours: 09**

Bioreactors design parts and their functions. Types of reactors: Batch and continous reactor, air driven reactor, fluidized bed reactor, tower reactor, packed-bed reactor. Parameters for measurement and control of bioreactors.

**Unit IV: Downstream processing**  **Hours: 09**

Biomass separation by centrifugation; filtration; flocculation and other methods, Cell disintegration: physical chemical and enzymatic methods. Separation of solid and liquid phases. Drying of final products.

# Unit V: Microbial technology products and applications Hours: 10

Microbial production of Organic acids (Lactic acid, citric acid), Amino acids (Glutamic acid, Aspartic acid, Lysine).Fermentation by microbes for food additives: dairy products (Cheese, Yogurt), beverages (Beer, Wine) and antibiotics (Streptomycin, Erythromycin) Biofuel: Hydrogen, Alcohol, Methane.

**Course Outcomes**

CO1 - Become innovative in search of new microbes for microbial product production

CO2 - Increase their understanding that industrial biotechnology is based on using Bioreactor to control the growth of microorganisms

CO3 - Attain basic theoretical skills on operating fermentor under various parameters

CO4 - Analyze the potential products recovery techniques

CO5 - Illustrate the production of alcoholic beverages and organic acids.

**Text Books**

1. Satyanarayana. U, 2008. Biotechnology, , Books and Allied (p) Ltd
2. Kalaselvan P.T,Arul pandi,I Bioprocess Technology
3. A. H. Patel, 2005. Industrial Microbiology –MacMillan Publishers.

# References

1. Comprehensive Biotechnology – Vol. 1,2, 3 and 4 by Murray Moo Young (1985) Elsevier Science.
2. Principles of fermentation technology by Stephen J.Hall, Peter Stanbury and Allan Whittakker (1999) 2nd ed. Butterworth – Heinemann Publication.
3. Alexandar N. Glazer & Hiroshi Nikaido Microbial Biotechnology (Fundamental of Applied Microbiology)
4. El – Mans, E.M.T., and Bryce, C.F.A. 2002. Fermentation Microbiology and Biotechnology. Taylor & Francis group.
5. P. Ponmurugan, Nithya Ramasubramanian and Fredimoses. 2012.Experimental Procedures in Bioprocess technology and Downstream processing. Anjana Book House, Chennai.

# MAPPING WITH PROGRAMME OUTCOMES

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| COs/POs | PO1 | **PO2** | **PO3** | **PO4** | **PO5** |
| CO1 | 3 | 2 | 3 | 2 | 3 |
| CO2 | 2 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 2 | 2 | 3 |

**1-**Low; **2-** Moderate; **3-** High

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| **SEMESTER: V**  **PART: III**  **CORE COURSE - VIII** | **22BTUHC53**  **RECOMBINANT DNA TECHNOLOGY** | **CREDIT: 4**  **HOURS: 4/W** |

**Course Objectives**

1. To understand the basics techniques in rDNA technology.
2. To learn the concept of vectors and expression systems and methods of selection
3. To gain knowledge about the importance of gene manipulation and gene transfer technologies
4. To understand about the DNA analysis techniques
5. To understand and describe the Applications in rDNA Technology.

**Unit I: Tools of recombinant DNA technology & basic DNA cloning Hours: 09**

Milestones in genetic engineering and biotechnology. Enzymes used in genetic Engineering. Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications. Cloning strategies.

**Unit II: Vectors Hours: 10**

Vectors: Definition and properties. . Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, yeast vectors, YIp, YEp and YCp vectors. Baculo virus based vectors. Ti based vectors (Binary and Cointegrated vectors)

**Unit III: Molecular techniques Hours: 10**

Transformation of DNA by physical, chemical methods (vector and vector less method) Microinjection, biolistic method (gene gun), liposome, electroporation and viral-mediated delivery, Agrobacterium-mediated delivery. Genomic and cDNA libraries: Preparation and uses. Screening of recombinants. Probe construction and labelling.

**Unit IV: Analytical methods and DNA typing** **Hours: 10**

Sequencing -chemical degradation (Maxam Gilbert method) chain termination (Sanger’s dideoxy method) and pyrosequencing, Agarose gel electrophoresis, Southern and Northern and Western blotting techniques and dot blot, Chromosome walking and jumping. DNA finger printing by RFLP and RAPD.

**Unit V: Applications of rDNA technology Hours: 09**

Human genome sequencing project. Bt transgenics-rice, cotton, brinjal. Useful proteins through DNA Technology-insulin, hGH and Factor VIII. Human therapies–tPA, interferon, antisense molecules. Gene therapy.

**Course Outcomes**

CO1 - Correlate the role of restriction and modifying enzymes in recombinant DNA technology

CO2 - Comprehend with the tools and techniques in rDNA technology and types of Vectors

CO3 - Explore the techniques involved in construction of genomic DNA library and cDNA library

CO4 - Familiarize with molecular cloning strategies and techniques used to probe DNA for specific genes of interest

CO5 - Design the protocols for analyzing gene transfer methods and to explore knowledge on hybridization based markers

**Text books**

1. Brown TA. 2008. Genomes. 3rd Edition. New York: Garland Publishing Co.
2. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.
3. James. D. Watson (2001) Recombinant DNA technology, 2nd edition, WH Freeman and company, NewYork.

**Suggested Readings**

1. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rdedition.Cold Spring Harbor Laboratory Press.
2. Molecular Cloning: A Laboratory Manual (3Volumes) Joseph Sambrook, David W. Russell, Joe Sambrook, 2001, 3rd Edition, Cold Spring Harbor Laboratory.
3. Genes to clones. Ernst. L.Winnacker, (2003), 2nd edition, Panima publishing corporation, NewDelhi

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 3 | 3 | 2 | 2 | 3 |
| **CO2** | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: V**  **PART: III**  **CORE COURSE - IX** | **22UBTHC54**  **ANIMAL BIOTECHNOLOGY** | **CREDIT:4**  **HOURS: 4/W** |

**Course Objectives**

1. To Know the basic requirements of animal tissue culture
2. To learn the concept of cell culture techniques
3. To gain knowledge about animal farming
4. To understand about the transgnic animals
5. To gain Knowledge over Animal products and exploitation of them in Biotechnology.

**Unit I: Introduction to Animal cell culture Hours: 09**

History and Scope of Animal tissue culture. Design & layout of ATC laboratory. Requirements for Animal cell culture. Types of media, ingredients of media. Foetal Bovine Serum. Metabolic profiling of Animal cell culture.

**Unit II: Techniques in Animal Cell technology Hours: 10**

Basic Techniques of mammalian cell culture; Disaggregation of animal tissue. Primary culture & secondary culture. Evolution of cell line & continuous cell line, characterization of cell lines. Monolayer, suspension culture. Maintenance of cell culture. Stem cell cultures, embryonic stem cell and their application

**Unit III: Animal as bioreactor**  **Hours: 09**

Sericulture, Commercial production of silk, Baculo viruses as animal viral vector. Silkworm as a bioreactor. Biotechnology of aquaculture, apiculture.

**Unit IV: Animal breeding techniques**  **Hours: 10**

Embryo Technology and Animal Breeding: Invitro fertilization, Embryo transfer, ICSI, Embryo splitting, Fertility control & regulation, test tube babies. Cryopreservation of embryos Cell cloning methods. Trangenic animals.(sheep, goat ,pig and fish )

**Unit V: Applications of Animal biotechnology Hours: 10**

Applications of animal tissue culture for invitro testing of drugs. Production of transgenic animals & molecular pharming, animal cloning techniques. Cell culture based vaccines. Animal models for tackling human diseases (Gene knock out in mice models). Ethical values in animal biotechnology.

**Course Outcomes**

CO1- Understand scientific and technical skills on animal study

CO2 - Acquire knowledge on limitations and challenges in animal cell tissue culture

CO3 - Know about animal products

CO4 - Learn the preservative methods of cells

CO5 -Evaluate and discuss public and ethical concerns over the use of animal Biotechnology.

**Text Book(s)**

1. B Singh, SK Gautam and MS Chauhan. 2013. Textbook of Animal biotechnology. The Energy and Research Institute.
2. M.K. Sateesh. 2010. Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International.
3. R.C. Dubey., A Text Book of Biotechnology. S. Chand& Co Ltd, NewDelhi.

# References

1. Sudha Gangal, Animal Tissue culture. Second edition. University Press India)PvtLtd. Hyderabad.
2. Sverdrup H.V., Oceans & their Physics, Chemistry & Biology –Johns & R.H. Fleming, Prentice Hall Inc.
3. M. Ranga, 2006. Animal Bioteclmology, Studam publishers.
4. R.Sasidhara, 2006. Animal Biotechnology, MJP Publishers.
5. U.Satyanarayana, 2008. Biotechnology, Books and Allied

# MAPPING WITH PROGRAMME OUTCOMES

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| COs | PO1 | **PO2** | **PO3** | **PO4** | **PO5** |
| CO1 | 3 | 3 | 3 | 2 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 |

**1-**Low; **2-** Moderate**; 3-** High

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| **SEMESTER: V**  **PART: III**  **INTERNAL ELECTIVE - III** | **22UBTHE58-1: HERBAL TECHNOLOGY** | **CREDIT: 3**  **HOURS: 4/W** |

**Course Objectives**

1. To enable to students to know about the various technologies used in herbal preparations.
2. To knowledge about the concepts of crop cultivation methods.
3. Acquires knowledge of the essentials of medicinal palnts.
4. To understand the Traditional knowledge of medicinal plant’s chemical constitution.
5. To teach the fundamental of various systems of herbal medicines, screening and its standardization.

**Unit I: Herbal medicines Hours: 10**

History and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; Terminologies – Definitions – Classification of medicinal plants based on their effects – Ecological status with special reference to India.

**Unit II: Cultivation methods Hours: 09**

Cultivation methods – Crop protection – Harvesting – Storage and Protection – Marketing and utilization - Export of medicinally important (General aspects).

**Unit III: Importance of medicinal plants Hours: 10**

Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).

**Unit IV: Traditional knowledge of Medicinal plants Hours: 10**

Traditional knowledge and chemical constitution and medicinal uses of the following herbs in curing various ailments; – Solanum trilobatum,Cardiospermum halicacabum, Vitex negundo, Azadirachta indica, Aristolochia indica, Phyllanthus fraternus and Boerhaavia diffusa

**Unit V: Plants in day today Hours: 09**

Plants in day today life – Ocimum sanctum, Centella asiatica, Aloe vera. Nutritive and medicinal value of some fruits (Guava, Sapota, Mango, Banana, Lemon) and vegetables - Greens (Moringa) Cabbage.

**Course Outcomes**

CO1 - Understand the various Indian systems of medicine

CO2 - Understand the screening and characterization of herbal products.

CO3 - To acquiring knowledge of the importance of medicinal plants.

CO4 - Acquiring traditional knowledge of medicinal plants and its chemical constituents.

CO5 - Understanding about the plants in day today life.

**Text books**

1. Sinha, R.K., & Sinha, S. (2001). *Ethnobiology*. Jaipur: Surabhe Publications.
2. Pal, D.C., & Jain, S.K. (1998). *Tribal medicine*. Calcutta: Naya Prakash.
3. Jain, S.K. (1995). *Contribution to Indian ethnobotany*. (3rd ed.). Jodhpur: Scientific publishers.

**Suggested Readings**

1. Jain, S.K. (1995). *A Manual of Ethnobotany*. (2nd ed.). Jodhpur: Scientific publishers.
2. Sharma, A.K., Keservani, R.K., & Gautam, S.P. (2020). *Herbal Product Development: Formulation and Applications*. U.S: Auerbach Publications, CRC Press.

**MAPPING WITH PROGRAMME OUTCOMES**

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| --- | --- | --- | --- | --- | --- |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: V**  **PART: III**  **INTERNAL ELECTIVE- III:** | **22 UBTHE 58-2**  **FOOD TECHNOLOGY** | **CREDIT:3**  **HOURS:4/W** |

**Course Objectives**

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| 1. To understand the basics of nutrition and its role in the maintenance of health. |
| 2. To understand the properties of foods. |
| 1. To acquire knowledge about the relationship between food and microbes. 2. To impart knowledge on the importance of food processing. 3. To acquire skills to analyze different types of food. |
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**Unit I: Introduction to nutrition Hours:09**

Nutrition – introduction, importance, and scope of nutrition – balanced diet –food pyramid – food group – classification – recommended dietary allowances – malnutrition – relation of nutrition to health.

**Unit II: Properties of foods** **Hours:09**

Properties of foods – cereals, pulses, nuts, oilseeds, milk, and animal foods (egg, fish, and meat), Change during cooking. Gelatinization, denaturation, fermentation, nonenzymatic browning. Rancidity – types and prevention.

**Unit III: Microbiology of foods** **Hours:10**

Food as a substrate for micro-organisms- pH and Moisture requirements, the concept of water activity, oxidation-reduction potential, nutrient content, inhibitory substances, bacterial growth curve, and factors affecting the growth of microorganisms.

**Unit IV: Food spoilage** **Hours:10**

General principles of spoilage, fitness or unfitness of food for consumption, causes of spoilage, classification of spoiled foods, chemical changes caused by microorganisms in food, and important food spoilage bacteria in plant and animal-based foods.

**Unit V: Food Analysis Hours: 10**

Government regulations and international standards and policies on food sampling and sample preparation- selection of sampling procedures, preparation of samples. Rheological principles of food analysis, analysis of food emulsions.

**Course Outcomes**

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| 1. Understand the basic concepts of nutrition. 2. Classify food based on its properties. 3. Understand the microbiological changes that occur during the processing and preservation of food. 4. Differentiate between processed and spoiled food. 5. Become a food technologist or a food analyst. |
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**Text Books**

1. Mudambi, S.R., (2007). *Fundamentals of foods, nutrition, and diet therapy.* New Age International, New Delhi.

2.A.Y.Sathe.( 1999). *A first course in food Analysis*. New Age International Publishers.

3. William C Frazier & Dennis C Westhoff. (2013). *Food Microbiology*. Tata McGraw Hill Publications.

**Supplementary Readings**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 1. Raheena Begum. (2000). *A textbook of foods, Nutrition, and dietetics*. Sterling Publishers, New Delhi.  2. Ranganna, S. (2001) *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGrawHill Publishers.  3.VijayaKhader. (2001). *Textbook of Food Science and Technology*. ICAR, New Delhi.  **OUTCOME MAPPING**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | | **CO1** | 1 | 2 | 3 | 3 | 2 | | **CO2** | 2 | 3 | 3 | 3 | 2 | | **CO3** | 2 | 3 | 3 | 3 | 3 | | **CO4** | 3 | 3 | 3 | 3 | 3 | | **CO5** | 3 | 3 | 3 | 3 | 3 |   **1:** Low; **2:** Moderate; **3:** High |
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| **SEMESTER: V**  **PART: III**  **INTERNAL**  **ELECTIVE- III** | **22 UBTHE 58-3: NANO BIOTECHNOLOGY** | **CREDIT:3**  **HOURS:4/W** |

**Course Objectives**

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| 1. To understand the biology of nanoparticles. |
| 2. To characterize different types of nanoparticles. |
| 3. To impart knowledge on the use of nanoparticles in disease diagnosis.   1. To impart knowledge on the use of nanoparticles in environmental cleanup. 2. To understand the toxicological effects of nanomaterials. |
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**Unit I: Synthesis of Nanomaterials Hours:11**

Definition of a Nano system - dimensionality and size-dependent phenomena, Quantum dots, Nanowires and Nanotubes, 2D films. Biological synthesis of Nanoparticles. Nanofluidics. Properties of nanostructured materials.

**Unit II: Characterization of Nanomaterials Hours:09**

Microscopy in the characterization of Nanoparticles – TEM, SEM. Nuclear Quadrupole Resonance Spectroscopy, Electron Spin Resonance Spectroscopy.

**Unit III: Nanotechnology in Medicine Hours:10**

Nanotechnology and patient diagnostics – optical, electrical, and imaging diagnostic techniques –immunoassays - Nano diagnostic systems for HIV. Use of multifunctional nanoparticles in chemotherapy for Cancer. Nanobiology in cardiology and transplantation.

**Unit IV: Environmental and Nano remediation Technology Hours:09**

Thermal, Physical, Chemical, and Biological Methods. Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics, and Pathogens. Nanotechnology for Water Purification.

**Unit V: Nanotoxicology Hours: 09**

Toxicological effects of nanomaterials – physiological and biochemical effects – modes of exposure - effects on human health – effects of other novel nanoparticles - ethical issues related to nanoparticles.

**Course Outcomes**

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| CO1 - Understand the basics of nanomaterials.  CO2 - Characterize nanomaterials.  CO3 - Diagnose diseases using nanomaterials.  CO4 - Use nanomaterials for environmental cleanup.  CO5 - Understand the ethics and toxicological effects of nanomaterials. |

**Text Books**

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| --- |
| 1. Jain, K.K. (2006). *Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications*. Horizon Biosciences, India. 2. Parag Diwan and Ashish Bharadwaj. (2006). *Nano Medicines*. Pentagon Press. ISBN 81-8274-139-4. 3. Ratner, M. and Ratner, D. (2005). *Nanotechnology: A Gentle Introduction to the Next Big idea*. Pearson Education, Inc. NJ, USA. |
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**Supplementary Readings**

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| 1. Christef M. Niemeyer, C. A. Mirkin. (2004). *Nanobiotechnology: Concepts, Application, and Properties*. Wiley – VCH Publishers, New York. 2. Tuan Vo-Dinh. (2007). *Nanotechnology in Biology and Medicine: Methods, Devices, and Applications*. Taylor and Francis Inc., London. 3. Challa S.S.R, Kumar (Ed). (2006). *Biological pharmaceutical Nanomaterial,* Wiley-VCH Verlag Gmbh & Co, KgaA. Weinham, Germany.   **OUTCOME MAPPING**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | | **CO1** | 2 | 2 | 2 | 3 | 3 | | **CO2** | 2 | 3 | 3 | 2 | 2 | | **CO3** | 3 | 3 | 3 | 3 | 3 | | **CO4** | 3 | 3 | 2 | 2 | 3 | | **CO5** | 1 | 2 | 3 | 3 | 2 |   **1:** Low; **2:** Moderate; **3:** High |

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| **SEMESTER: V**  **PART: IV**  **SKILL BASED**  **SUBJECT – III** | **22UBTHS59: ENTREPRENEURIAL BIOTECHNOLOGY** | **CREDIT:2**  **HOURS: 2/W** |

**Course Objectives**

1. Entrepreneurial opportunities in Biotechnology
2. Good laboratory procedure and practices and standard operating
3. IPR and safety issue of the biological products

**Unit I Introduction Hours: 05**

Concept of Entrepreneurship, Definition, characteristics of entrepreneurship, Types of entrepreneurship. Startup process. Business identification, Project plan, Source of fund, production and marketing. Importance of ROC, Risk involved in entrepreneurship.

**Unit II Opportunities in PTC Hours: 05**

Business opportunities in Plant Tissue Culture – Banana, Bamboo, Sugarcane and Orchids like Carnation and Gerbera. Important PTC companies in India.

**Unit III Procedures and Certification in Organic farming Hours: 05**

Organic farming- Methods, Standards, Market potential and products impact. Tamilnadu Organic Certification Department (TNOCD) – process of organic certification, TNOCD certified products.

**Unit IV Commercialization Hours: 05**

Business scope for Biofertilizer, Biopesticide, Vermicompost, Mushroom, Single Cell Protein, Apiculture, Dairy products (Example with one commercially important product for all the above)

**Unit V Biopharmaceutical products, IPR and product safety Hours: 04**

Insulin, Vaccines, Therapeutic products, Monoclonal antibodies, Hormones, Interferon (Example with one commercially important product for all the above). Importance of IPR, Patents, Trade Marks, Trade secret, Copyright, Product safety and liability, Insurance and contracts.

**Course Outcomes**

CO1 - Understand the concept of Entrepreneurship strategy

CO2 - Know the business opportunities in plant tissue culture companies

CO3 - Understand the farming technique and certification procedures

CO4 - Learn about business scope in commercial important products like Biofertilizer, Biopesticide, Vermicompost etc

CO5 - Apply the Biopharmaceutical products, IPR and product safety management in industry

**Text Books**

1. Kumari Manimuthu Veeral, D, 2015, "Textbook of organic farming", Agrotech Publishing Academy.
2. Kanka, S. S., 1997, "Entrepreneurship Development", S. Chand and Co.

**References**

1. Kolehinsky P, 2004, "The Entrepreneur’s guide to Biotechnology startup", 4th Edition, www.elelexa.com
2. Casson M, Yeung B, Basu A and Wadespm N, 2006, "The Oxford Handbook of Entrepreneurship", Oxford University Press.
3. Shimasaki C, 2014, "Biotechnology Entrepreneurship", 1st Edition, Academia Press.
4. Eric Ries, 2011, "The Lean Startup", 1st Edition, Kindle Publication.

# MAPPING WITH PROGRAMME OUTCOMES

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| COs | PO1 | **PO2** | **PO3** | **PO4** | **PO5** |
| CO1 | 3 | 2 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 |

**1-**Low**; 2-** Moderate**; 3-** High

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| **SEMESTER: VI**  **PART: III**  **CORE COURSE - X** | **22UBTHC61**  **PLANT BIOTECHNOLOGY** | **CREDIT: 5**  **HOURS: 5/W** |

**Course Objectives**

1. To provide the knowledge of plant tissue culture.
2. To understand the concepts of transcriptional and translational modifications in plants.
3. In addition candidates are exposed to the use of vector based engineering of plant genome for the generation of genetically modified plants and food products.
4. Acquires knowledge of the transformation through Ti Plasmid based DNA delivery methods.
5. To understand the concepts of Plant genome mapping and its applications.

**Unit I: Introduction to plant tissue culture Hours: 09**

Definitions, scope, history, importance of plant tissue culture & biotechnology. Somatic embryogenesis and synthesis of artificial seeds. Protoplast culture - Plant protoplasmic isolation and fusion in hybrid production. Somaclonal variation.

**Unit II:** **Plant Molecular Biology Hours: 12**

Organization and expression of nuclear genome (Arabidopsis thaliana), and chloroplast genome. Transcription and post – transcriptional modifications in plants. Translation and posttranslational modifications in plants. Expression of nitrogen fixing genes in leguminous plants. Molecular interaction between Rhizobial genes and legumes.

**Unit III: Principles of cloning Hours: 10**

Restriction enzymes. Vectors: plant viruses (CaMV). Molecular biology of plant stress response (a biotic). Genetic modification - transgenic plants and its application, ecological impact of transgenic plants. Transgenic plants for disease resistance.

**Unit IV:** **Plant transformation Hours: 08**

Agrobacterium and Ti Plasmid based and physical DNA delivery methods. Gene silencing by antisense and RNAi technology in plants. Biopolymer Production through transgenic plants.

**Unit V:** **Plant genome mapping Hours: 09**

Molecular markers (RFLP, RAPD, SSR & SNP) and its applications. Transgenic plants for resistance to insect and Herbicide.

**Course Outcomes**

CO1 - To understand and recall the working principle of plant tissue culture and molecular techniques.

CO2 - To produce transgenic plants using genetic engineering.

CO3 - To differentiate the production methods of genetically modified plants from conventional hybrid plants.

CO4 - To justify plant tissue culture and plant molecular biology are the fundamental units of plant biotechnology.

CO5 - To summarize the importance of plant tissue culture and molecular techniques in crop improvement programme.

**Text Books**

1. Slater, A., Scott, N., & Fowler, M. (2008). *Plant Biotechnology: The genetic manipulation of plants.* (2nd ed.). U.K: Oxford University Press.
2. Srivasta, P.S. (1998). *Plant Tissue Culture and Molecular Biology*. New Delhi: Narosa Publishing House.
3. Mantel, S.H., Mathews, J.A., & Mickee, R.A. (1985*). An Introduction to Genetic Engineering in Plants*. London: Blackwell Scientific Publishers.
4. Primrose, S.B., & Twyman, R.M. (2006). *Principles of Gene Manipulation and Genomics*. (7th ed.). London: Blackwell Publishing.
5. Grierson, D., & Covey, S.N. (1988). *Plant Molecular Biology*. Glascow, Scotland: Blackie & Sons. Ltd.

**Suggested Readings**

1. Lycett, G.W., & Grierson, D. (1990). *Genetic Engineering of Crop Plants*. London: Heinemann.
2. Marks, J.L. (1989). *A Revolution on Biotechnology*. Cambridge: Cambridge University Press.
3. Dodds, J.H. (1985*). Plant Genetic Engineering*. Cambridge: Cambridge University Press.
4. Ignacimuthu, S., (2012). *Biotechnology: An Introduction*. New Delhi: Narosa Publishing House Pvt. Ltd.
5. De, K. K. (2008). *Plant Tissue Culture*. Calcutta: New Central Book Agency (P) Ltd.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: VI**  **PART: III**  **CORE COURSE - XI** | **22UBTHC62**  **PHARMACEUTICAL BIOTECHNOLOGY** | **CREDIT: 5**  **HOURS: 5/W** |

**Course Objectives**

1. Biotechnology has a long promise to revolutionize the biological sciences and technology.
2. Scientific application of biotechnology in the field of genetic engineering
3. Biotechnology is leading to new biological revolutions in diagnosis, prevention and cure of diseases, new and cheaper pharmaceutical drugs.
4. Pharmaceutical biotechnology is a relatively new and expanding subject in which biotechnology concepts are applied to the development of drugs.

**Unit I: Pharmaceutical industry & development of drugs Hours: 08**

Pharmaceutical industry & development of drugs; types of therapeutic agents and their uses; economics and regulatory aspects.

**Unit II:** **Mechanism of drug action Hours: 11**

Physico-chemical principles of drug metabolism; radioactivity; pharmacokinetics. Genetic recombination and drugs - Development of hybridoma for monoclonal antibodies. Types of reaction process and special requirements for bulk drug manufacture.

**Unit III:** **Enzyme immobilization Hours: 09**

Techniques of immobilization, factors affecting enzyme kinetics. Study of enzymes such as hyaluronidase, penicillinase, streptokinase and streptodornase, amylases and proteases.

**Unit IV: Principles of Drug Manufacture Hours: 11**

Compressed tablets; dry and wet granulation; slugging or direct compression; tablet presses; coating of tablets; capsule preparation; oval liquids – vegetable drugs – topical applications; preservation of drugs; analytical methods and other tests used in drug manufacture; packing techniques; quality management; GMP.

**Unit V: Biopharmaceuticals Hours: 09**

Biopharmaceuticals - Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.

**Course Outcomes**

CO1 - Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.

CO2 - Acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.

CO3 - Understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.

CO4 - Understand the legal steps involved in progressing a new drug to market.

CO5 - Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

**Text Books**

1. Richard, A.H., Pamela, C.C., Finkel, R., Cubeddu, L., Michelle, A.C. (2009). *Lippincott’s Illustrated Reviews Pharmacology*. (4th ed.). New York: Lippincott Williams & Wilkins.
2. Purohit, S.S., & Saluja, A.K. (2003). *Pharmaceutical Biotechnology*. Jodhpur: Agrobios
3. Satoskar, R.S., Bhandarkar, S.D., Nirmala, N.R., & Satoskar, R.R. (2017). *Pharmacology and Pharmacotherapeutics.* (20th ed.). India: Elsevier.

**Suggested Readings**

1. Torchilin, V.P. (2012). *Immobilized enzymes in medicine*. (Vol. 11). Berlin/Heidelberg, Germany: Springer Science & Business Media.
2. Katzung, B.G., Masters, S. B., & Trevor, A.J. (2012). *Basic and Clinical Pharmacology*. (12th ed.). New York: The McGraw-Hill Companies, Inc.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: VI**  **PART: III**  **CORE COURSE - XII** | **22UBTHC63**  **ENVIRONMENTAL BIO TECHNOLOGY** | **CREDIT:4**  **HOURS: 5/W** |

**Course Objectives**

1. Acquire knowledge of the ecosystem structure and functions and their environmental issues.
2. To provide the knowledge of biotechnological applications in waste treatment.
3. To study the biodegradation of various xenobiotics using microorganisms.
4. To introduce the students to the hazards of our environment.
5. The effects of pollution on living systems, solutions to protect the environment for sustainable development.

**Unit I: Ecosystem Hours: 09**

Ecosystem - structure, functions. Energy flow and mineral cycle-C, N, P. Environmental problems –Ozone depletion, Green House Effect, Air, Soil pollution, Land degradation.

**Unit II: Wastewater & Treatments Hours: 10**

Waste water – Physical, Chemical and biological characteristics. Introduction to water microbiology, Water borne diseases. Waste water treatment - Physical, Chemical and biological. Membrane filtration and Reverse Osmosis. Waste water treatment efficiency assessment.

**Unit III: Xenobiotics Hours: 10**

Xenobiotics – Xeno biotic compounds, Biodegradation of xenobiotics, Biological detoxification, Hazardous waste management. Mining and metal biotechnology–Copper and Iron, Microbial transformation, accumulation and concentration of metals, Metal leaching -extraction.

**Unit IV: Biofuels Hours: 09**

Introduction, Production of non-conventional fuels – Methane (Biogas), Hydrogen, and algal hydrocarbons. Use of micro organisms in augmentation of petroleum recovery.

**Unit V: Environmental Genetics Hours: 10**

Degradation plasmids (TOL), Release of genetically engineered microbes (GEM) in the environment, Impact of GEM in environment, Role of GEM in degradation of industrial pollutants. Biosensors and microprobes.

**Course Outcomes**

1. To understand the basic ecological concepts, various pollution, its measurements & remediation.
2. To understand the working of sewage treatment plant.
3. To explain about the Hazardous waste management.
4. Describe the various eco-friendly bio-products.
5. To acquire knowledge of the genetically modified organisms involved in the degradation of environmental pollution.

**Text Books**

1. George, T., Franklin, L. B., David, H., Metcalf, S., & Eddy. (2014). *Wastewater Engineering: Treatment and Reuse*. (5th ed.). New York: Tata McGraw Hill.
2. Chatterjee, A.K. (2011). *Introduction to Environmental Biotechnology*. (3rd ed.). New Delhi: PHI Learning Private Limited.
3. Wright, M. (1999). *An Introduction to Environmental Biotechnology*. (1st ed.). New York: Springer.

**Suggested Readings**

1. Agarwal, S.K. (2001). *Environment biotechnology*. New Delhi: APH Publishers.
2. Alexander, M. (1999). *Biodegradation & Bioremediation*. (2nd ed.). New York: Academic press.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Moderate; **3:** High

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| **SEMESTER: VI**  **PART: III**  **CORE PRACTICAL- III** | **22UBTHP64**  **IMMUNOLOGY AND INDUSTRIAL BIOTECHNOLOGY& PLANT BIOTECHNOLOGY** | **CREDIT: 3**  **HOURS: 5/W** |

# Lab in Immunology

1. Properties of antigen and antibody.
2. ABO blood grouping .
3. RH factor determination .
4. Widal test, Syphilis Fast Latex Agglutination Test .
5. Immune precipitation test: single radial immunodiffusion, Double immune diffusion.
6. Immuno electrophoresis.
7. Make a differential count and subset population in lymphocyte (B & T lymphocytes) .
8. Total RBC and WBC count .
9. ELISA test.

# Lab in Industrial Biotechnology

1. Maintenance of pure cultures of industrially important microbes .
2. Fermentor, Production media - Principles & applications.
3. Screening of Extracellular enzyme producing microbes (amylase & protease) & assay of enzyme.
4. Screening of antibiotic producing microbes from soil.
5. Alcohol fermentation by yeast, and quantification of ethanol.
6. Citric acid fermentation by *Aspergillus niger* and quantification.
7. Microbial fermentation of curd.

**PLANT BIOTECHNOLOGY**

1. Plant culture media preparation and sterilization.
2. Explants selection, sterilization and inoculation.
3. Callus culture
4. Endosperm culture.
5. Another culture.
6. Synthetic seed preparation
7. Protoplast isolation and culture.
8. Isolation of chlorophyll pigment.

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| **SEMESTER: V**  **PART: III**  **CORE PRACTICAL - IV** | **22UBTHP65**  **RECOMBINANT DNA TECHNOLOGY, ANIMAL BIOTECHNOLOGY**& **ENVIRONMENTAL BIOTECHNOLOGY** | **CREDIT: 3**  **HOURS: 4/W** |

**Lab in Recombinant DNA Technology**

1. Isolation of plasmid DNA from Bacteria
2. Analysis of plasmid DNA in Agarose Gel electrophoresis
3. Isolation of DNA from animal tissues.
4. Restriction fragment analysis of DNA
5. Preparation of Competent cells
6. Simple DNA ligation and transformation experiments.

# Lab in Animal Biotechnology

1. Basic laboratory practical in animal cell culture, introduction, sterilization and washing of glassware media preparation
2. Preparation of chick embryo 24 hrs, 48 hrs, 72 hrs and 96 hrs cell viability testing using trypan blue
3. Primary and sub culturing techniques.
4. Handling of lab animals (mice)
5. Preparation of antigens: erythrocytes, bacterial proteins
6. Immunization and bleeding techniques

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| **SEMESTER: VI**  **PART: III**  **INTERNAL ELECTIVE- IV** | **22UBTHE66-1**  **ENZYME TECHNOLOGY** | **CREDIT: 3**  **HOURS: 4/W** |

**Course Objectives**

1. This paper concisely presenting the fundamentals of enzymes.

2. Acquire knowledge to the mechanism of enzymes.

3. In addition knowledge of the classification of coenzymes.

4. To provide knowledge of the Factors affecting the enzyme activity.

5. To understand the concept of enzyme kinetics and industrial applications of enzymes

**Unit I: Introduction to enzymes Hours: 07**

Nomenclature and Classification of Enzymes, chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes.

**Unit II: Enzyme Mechanism Hours: 12**

Lock and key, Induced fit and Transition state Hypotheses. Enzyme specificity – active site – mechanisms at active site – covalent catalysis – acid base catalysis – proximity and orientation effects – zymogens – multienzyme complexes.

**Unit III: Coenzymes Hours: 12**

Coenzymes - prosthetic group, classification - vitamin and nonvitamin coenzymes, thiamine pyrophosphate - FMN and FAD - flavoprotein enzymes, NAD and NADP role in enzyme catalysis, biotin - carboxylation reaction, folate coenzymes, coenzyme role of vitamin Bl2 .

**Unit IV: Factors affecting the enzyme activity Hours: 08**

Factors affecting the enzyme activity: Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis - Menten Equation, Km, Vmax.

**Unit V: Industrial uses of enzymes Hours: 09**

Industrial uses of enzymes: food pharmaceutical industries, clinical Enzymology - serum enzymes in health and diseases, immobilized enzyme technology. Immobilization of enzymes and their applications.

**Course Outcomes**

CO1 - To familiarize the basics of enzyme classification, its unit measurement and extraction

CO2 - To explore to the usage of enzymes at molecular level such as active site, isoenzymes and their biochemical fundamentals.

CO3 - To explore the enzyme kinetics and its mechanism of inhibitions.

CO4 - To understand knowledge of the Factors affecting the enzyme activity.

CO5 - To explore the industrial and clinical applications of commercial enzymes

**Text Books**

1. Price, N.C., & Stevens, L. (2001). *Fundamentals of Enzymology*. (2nd ed.). New York: Oxford Science Publications.
2. Palmer, T., & Bonner, P.L. (2008). *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*. (2nd ed.). Cambridge: Woodhead Publishing.
3. Stephan, L. (2012). *Biocatalysts and enzyme technology*. (2nd ed.). New Jessery: John Wiley & Sons.

**Suggested Readings**

1. Dixon, M., & Webb, E.C. (1979). *Enzyme inhibition and activation - In: Enzymes*. (3rd ed.). New York: Academic Press.
2. Bhatt, S.M. (2011). *Enzymology and Enzyme Technology*. New Delhi. S Chand & Company.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 2 | 2 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Medium; **3:** Strong

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| **SEMESTER: VI**  **PART: III**  **INTERNAL ELECTIVE - IV** | **22UBTHE66-3**  **BIO PROSPECTING** | **CREDIT: 3**  **HOURS: 4/W** |

**Course Objectives**

1. The introduction about Bioprospecting and Biodiversity
2. The Bioprospecting potentials of available natural resources
3. The regulations related with biodiversity and bioprospecting

**Unit I Bioprospecting and Biodiversity** **Hours: 07**

Biodiversity in different agro ecological regions, endangered species, inventorisation and monitoring. Introduction, concepts and practices of bioprospecting; Traditional and modern bioprospecting; bioprospecting and biodiversity.

**Unit II Bioactive Compounds from Microbes** **Hours: 12**

Aerobic and anaerobic (extremophiles/archaea) organisms for bioprospecting. Bioactive compounds from microbes: bacteria, actinomycetes and fungi for antibiotics, antiviral compounds and anticancer agents. Plant growth promoting bacteria – Azospirillum lipoferum, Bacillus licheniformis, Pseudomonas chlororaphis, Rhizobia sp.

**Unit III Bioactive Compounds from Plants** **Hours: 12**

Bioprospecting of plants for novel medicines, random, ethnobotanical approaches and indigenous traditional knowledge for screening of medicinal plants. Isolation of crude and pure phytocompounds. Bioassays, structural elucidation, large scale production and market accessibility of phytocompounds.

**Unit IV Bioactive Compounds from Marine Sources** **Hours: 08**

Discovery of novel compounds from marine sources: coral - terpenoids, diterpenoids; sponges - spongothymidine and spongouridine; bryozoans - secondary metabolites and anti cancer drugs; molluscs, tunicates and seaweeds.

**Unit V Metagenomics and regulations for Bioprospecting**  **Hours: 09**

Metagenomics: microbes from soil, plants, animals and human beings. Bioprospecting of novel genes/biomolecules and enzymes for industrial and medicinal uses. Regulations-Convention on Biological Diversity- Intellectual property rights- Patenting of new genes and/or bioactive principles.

**Course Outcomes**

CO1 - Familiarize the students in major areas of bioprospecting and biodiversity

CO2 - Apprehend the bioprospecting aspects related to microorganisms

CO3 - Obtain a comprehensive knowledge about natural products from plants

CO4 - Gain the knowledge about bioprospecting knowledge about marine sources

CO5 - Familiar with regulatory legislation and convention in bioprospecting for commercialization

**Text Books**

1. Swaminathan, M.S. and Kocchar, S.L. (Es.) (1989). Plants and Society, MacMillan Publication Ltd.,
2. Sharma, O.P. (1996). Hills Economic Botany, Tata McGraw Hill Co., Ltd., New Delhi.

**References**

1. Krishnan. S and Bhat. D.J. 2009. Plant and Fungal Biodiversity and Bioprospecting, Broadway Book Center, India.
2. Bull A. T. (ed.) 2004. Microbial Diversity and Bioprospecting, ASM Press, Washington DC.
3. Igor, P (ed.). 2011. Research in Biodiversity - Models and Applications, InTech publishers,
4. Russell Paterson, Nelson Lima. 2017. Bioprospecting: Success, Potential and Constraints. Springer, Cham.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 2 | 2 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Medium; **3:** Strong

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| **SEMESTER: VI**  **PART: III**  **INTERNAL ELECTIVE - IV** | **22UBTHE66-3**  **BIOMARKER TECHNOLOGY** | **CREDIT: 3**  **HOURS: 4/W** |

**Course Objectives**

1. The application of markers in biology
2. The biosensing devices and their working
3. The technological advancement in biomarkers

**Unit I Basics about Biomarkers Hours: 07**

Introduction - history - milestones - biomarkers. Types of biomarkers in the biological sciences. Genomics - Proteomics - Transcriptomics – Metabolomics relating to biomarkers

**Unit II Types of Biomarkers Hours: 12**

Analysis of proteins - Analysis of transcripts - study of RNA profiling - identification of genomic DNA - comprehension of metabolites and intermediary products

**Unit III Biomarkers Databases Hours: 12**

Biomarker Databases - MarkerDB -clinical and therapeutic decision making - gobiomdbplus (comprehensive database) - Charles River database

**Unit IV Biomarkers in Drug Development Hours: 08**

Screening markers - toxicity markers - efficacy markers - drug development using biomarkers - disease management with examples

**Unit V Applications of biomarkers Hours: 09**

Prediction of diseases - diagnostics uses - prognostic applications - staging markers - safety biomarker - susceptibility biomarker - case studies relating to different types of biomarkers in diseases

**Course Outcomes**

CO1 - Understand the concepts on markers

CO2 - Value the importance of proteomics and genomics

CO3 - Comprehend the transcriptome and its role

CO4 - Diagnose the diseases and cures using biomarkers

CO5 - Understand the applications of biomarkers

**Text Books**

1. Veenstra, TD and Yates, JR. 2006. Proteomics for Biological Discovery. John Wiley & Sons, USA
2. Hubert,R. 2006. Protein Biochemistry and Proteomics (The Experimenter Series), Academic Press, USA

**References**

1. Dale, W. J and Schantz M. 2014. From Genes to Genomes. 3rd edition, Wiley, John & sons
2. Ridley, M. 2019. Genome: Autobiography of a species in 23 chapters. 1st edition, Harper Perinnial Publishing, USA
3. James Watson D, 2001, "Recombinant DNA technology". 2nd Edition, WH Freeman and company, United Kingdom
4. Campbell, A.M. and L. J. Heyer, 2007,"Discovering Genomics, Proteomics and Bioinformatics", 2nd Edition, Pearson Education

**MAPPING WITH PROGRAMME OUTCOMES**

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| --- | --- | --- | --- | --- | --- |
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 2 | 2 | 2 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 |

**1:** Low; **2:** Medium; **3:** Strong

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| **SEMESTER: VI**  **PART: IV**  **SKILL BASED SUBJECT - IV** | **22UBTHS68: BIOETHICS AND BIOSAFETY** | **CREDIT: 02**  **HOURS: 02** |

**Course Objectives**

1. To learn the Significance and Framework of Intellectual Property Rights.
2. To understand the protocols of patents law and patenting system.
3. To learn the importance of Biosafety protocols and handling.
4. To understand the Biological safety cabinets and guidelines.
5. To learn the available opportunities of bioethics in the field of applied Biotechnology.

**Unit I: Intellectual Property Rights Hours: 04**

Significance of IPR - Types of IP: Patents, Trademarks, Copyright, Industrial Designs and Geographical Indications – Treaties on IPR, TRIPS - Farmers rights.

**Unit II: Patents and Patenting System Hours: 04**

Patent law: Principles – Need for patent law in biotechnology–Role of a Country Patent office – Patent applications: Forms and guidelines. Patent databases: India, USPTO, and EPO – Patent infringement: Case studies on Turmeric and Neem.

**Unit III**: **Biosafety Hours: 05**

Definition – Causes: classification, identification of hazards – Issues. Handling – Types of accidents, first aid and precautionary measures – Clean room procedures: Classification specification – Basic methods for safe handling, transport, and storage of biological and chemical materials – Equipment related hazards.

**Unit IV**: **Levels of Biosafety Hours: 06**

Biological safety cabinets: Horizontal and Vertical Laminar Air Flow Cabinet, Fume hood – Primary and secondary containments – Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious Agents (Chemicals and carcinogens). Guidelines: Biosafety Guidelines and regulations (National and International including Cartegana Protocol) of Government of India – GMOs and LMOs – Roles of Institutional Biosafety Committee.

**Unit V:** **Bioethics Hours: 05**

Introduction to ethics and bioethics and its framework – Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research - Ethical implications of GM crops, GMOs, human genome project and cloning, designer babies, Eugenics –Animal right activities and Ethical limits.

**Course Outcomes**

CO1 - Understand the significance of IPR in biotechnology.

CO2 - Utilize IPR for research purposes.

CO3 - Understand the basics of biosafety protocols.

CO4 - Employ biosafety protocols in experimental research.

CO5 - Differentiate between ethical concerns.

**Text Books**

1. Erbisch, F.H., & Maredia, K.M. (2000). *Intellectual property rights in agricultural biotechnology.* New Delhi: Universities Press.
2. Deepa, G., & Shomini, P. (2013). *IPR, Biosafety and Bioethics*. New York: Pearson Education publisher.
3. Senthil, K.S., & Mohammed Jaabir M. S. (2008). *IPR, Biosafety and Biotechnology Management*. India: Jasen Publications.
4. Singh, K.K. (2015). *Intellectual Property Rights in Biotechnology*. India: Springer.

**Suggested Readings**

1. Sasson, A. (1988). *Biotechnologies and Development*. Netherlands: UNESCO Publications.
2. Rajmohan, J. (2006). *Biosafety and Bioethics*. New Delhi: Isha Books.

**MAPPING WITH PROGRAMME OUTCOMES**

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| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **CO1** | 3 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 2 |

**1:** Low; **2:** Moderate; **3:** High