PONNAIYAH RAMAJAYAM INSTITUTE OF SCIENCE & TECHNOLOGY (PRIST)

Declared as DEEMED-TO-BE-UNIVERSITY
U/s 3 of UGC Act, 1956

# SCHOOL ARTS AND SCIENCE

# DEPARTMENT OF BIOTECHNOLOGY

# M.Sc. BIOTECHNOLOGY CURRICULUM

# REGULATION-2023

## M.Sc., Graduate Attributes

✓ Research, inquiry and analytical thinking abilities.
✓ Capability and motivation for intellectual development.
✓ Ethical, social and professional understanding.
✓ Communication in intra and inter disciplinary
✓ Teamwork, collaborative and management skills in scientific research
✓ Information literacy in respective discipline

## M.Sc., Program Educational Objectives-PEO

✓ PEO-1To gain and apply knowledge of Biotechnology concept to solve the problems.
✓ PEO-2 To identify, analyse and understand the problems related to biotechnology.
✓ PEO-3 Ability to design and develop solution to biotechnology.
✓ PEO-4Ability to design, perform experiments, analyse, and interpret data for investigating complex problems.
✓ PEO-5 To decide and apply appropriate tools and techniques in biotechnologicals manipulations

## M.Sc., Program Outcome-PO

- **PO1: Problem Solving Skill** - Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
- **PO2: Decision Making Skill** - Foster analytical and critical thinking abilities for data-based decision-making.
- **PO3: Ethical Value** - Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
- **PO4: Communication Skill** - Ability to develop communication, managerial and interpersonal skills.
- **PO5: Individual and Team Leadership Skill** - Capability to lead themselves and the team to achieve organizational goals.
- **PO6: Employability Skill** - Inculcate contemporary business practices to enhance employability skills in the competitive environment.
- **PO7: Entrepreneurial Skill** - Equip with skills and competencies to become an entrepreneur

**M. Sc Programme Specific Outcomes (Pos and PSos):**

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

# M. Sc- BIOTECHNOLOGY -SYLLABUS – REGULATION 2023

## COURSE STRUCTURE

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| | **SEMESTER I** | | | | |
| 23217AEC11 | Biochemistry | 5 | 1 | 0 | 4 |
| 23217AEC12 | Molecular Genetics | 5 | 1 | 0 | 4 |
| 23217AEC13 | Molecular Cell Biology | 5 | 1 | 0 | 4 |
| 23217SEC14L | Molecular Genetics Cell Biology Lab | 0 | 0 | 4 | 4 |
| 23217DSC15_ | Discipline specific elective courses-I | 5 | 1 | 0 | 3 |
| 23217RMC16 | Research methodology | 2 | - | - | 2 |
| | **Total** | **22** | **4** | **4** | **21** |
| | **SEMESTER II** | | | | |
| 23217AEC21 | Microbiology | 4 | 1 | 0 | 4 |
| 23217AEC22 | Plant and Animal Biotechnology | 4 | 1 | 0 | 4 |
| 23217AEC23 | Genetic Engineering | 4 | 1 | 0 | 4 |
| 23217SEC24L | Plant and Animal Biotechnology Lab | 0 | 0 | 4 | 4 |
| 23217DSC25_ | Discipline specific elective courses -II | 4 | 1 | 0 | 3 |
| 23217SEC26 | Environmental Biotechnology | 4 | 0 | 0 | 3 |
| 23217BRC27 | Participation in bounded Research | 2 | 0 | 0 | 2 |
| 23217SEC28 | Internship | - | - | - | 2 |
| | **Total** | **22** | **4** | **4** | **26** |

| | | | | | |
|---|---|---|---|---|---|
| | **SEMESTER III** | | | | |
| 23217AEC31 | Bioinformatics and Biostatistics | 5 | 1 | 0 | 4 |
| 23217AEC32 | Immunology | 4 | 1 | 0 | 4 |
| 23217AEC33 | Bioprocess Technology | 4 | 1 | 0 | 4 |
| 2317SEC34L | Immunology and Bioprocess Technology Lab | 0 | 0 | 4 | 4 |
| 23217DSC35_ | Discipline specific elective courses -III | 4 | 1 | 0 | 3 |
| 23217SEC36 | Molecular basis of Disease | 4 | 1 | 0 | 3 |
| 23217SEC37 | Internship in Industries to Biotechnology | - | - | - | 2 |
| | **Total** | **21** | **5** | **4** | **24** |

| | **SEMESTER IV** | | | | |
|---|---|---|---|---|---|
| 23217AEC41 | Proteomics | 4 | 1 | 0 | 4 |
| 23217AEC42 | Genomics | 4 | 1 | 0 | 4 |
| 23217PRW43 | Project and viva | 0 | 0 | 10 | 4 |
| 23217DSC44_ | Discipline specific elective courses -IV | 4 | 1 | 0 | 3 |
| 23217DSC45_ | Discipline specific elective courses -V | 4 | 1 | 0 | 3 |
| 23215SEC46 | Industrial Visit | - | - | - | 2 |
| | **Total** | **16** | **4** | **10** | **20** |
| | **Total Credits for the Programme** | | | | **91** |

**Discipline specific Electives**

| **Semester** | **Discipline specific Elective courses -I** |
|---|---|
| **I** | a) 23217DSC15A - Bioinstrumentation<br>b) 23217DSC15B - Enzymology<br>c) 23217DSC15C – Microbial Technology<br>d) 23217DSC15D – Cell and Cancer Biology<br>e) 23217DSC15E – Inheritance Biology<br>f) 23217DSC15F – Biosafety and Intellectual Property Rights |
| **II** | **Discipline specific Elective courses -II** |
| | a) 23217DSC25A - Regulatory affairs and Industrial standards<br>b) 23217DSC25B - Human physiology<br>c) 23217DSC25C - Instrumentation<br>d) 23217DSC25D - Medical Biotechnology<br>e) 23217DSC25F - Mushroom Technology |
| **III** | **Discipline specific Elective courses -III** |
| | a) 23217DSC35A - Nanobiotechnology<br>b) 23217DSC35B - Molecular developmental biology<br>c) 23217DSC35C – Vermitechnology<br>d) 23217DSC35D – Pharmaceutical Technology<br>e) 23217DSC35E – Biopesticides<br>f) 23217DSC35F – Food Fermentation techniques<br>g) 23217DSC35G – Microbial Diagnosis in Health clinics |
| **IV** | **Discipline specific Elective courses -IV** |
| | a) 23217DSC44A - Stem cell Biology<br>b) 23217DSC44B - Bioethics,human rights and social issues<br>c) 23217DSC44C – Biostatistics<br>d) 23217DSC44D – Microbiological Analysis of Air and Water |

| | |
|---|---|
| **IV** | **Discipline specific Elective courses – V** |
| | a) 23217DSC45A – Industrial Biotechnology<br>b) 23217DSC45B - Pharmaceutical Biotechnology<br>c) 23217DSC45C – Downstream processing<br>d) 23217DSC45D – Bioprocess technology |

**Credit Distribution**

| Semester | AEC | SEC | DSC | OEC | RSB Courses | Others | Total |
|---|---|---|---|---|---|---|---|
| **I** | 12 | 4 | 3 | - | 2 | - | 21 |
| **II** | 12 | 9 | 3 | - | 2 | - | 26 |
| **III** | 12 | 9 | 3 | - | - | - | 24 |
| **IV** | 8 | 5 | 3 | - | 4 | - | 20 |
| **TOTAL** | **44** | **27** | **12** | **-** | **08** | **-** | **91** |

**HOD** **DEAN**

## SEMESTER I

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC31 | BIOCHEMISTRY | 5 | 1 | 0 | 4 |

**AIM:**

This paper provides the knowledge about different types of microorganisms and their identification techniques in modern biology and there by the usefulness of the techniques in research and commercial purposes.

**LEARNING OBJECTIVES:**

The paper imparts a thorough knowledge on the basics of all the Biochemical concepts, Metabolic reactions and its regulation. The student will get to understand the core concepts of metabolism and physiological processes of the body in both healthy and disease state.

**COURSE OUTCOMES:**

**At the end of the Course, the Student will be able to:**

**CO-1** To understand the basics of pH and related principles and carbohydrate metabolism
**CO-2** To provide basic knowledge about lipid metabolism and related significance
**CO-3** To enlighten the students on Bio-energetics and Biological oxidation pathways
**CO-4** To update the knowledge on Amino acids and Protein
**CO-5** To assess and appraise the role of Nucleic acids

**Unit I**

pH, pK . acid, base .Buffers- Henderson- Haselbach equation, biological buffer system – Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Carbohydrates: Nomenclature, classification, structure,chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway

**Unit II**

Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.

**Unit III**

Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP ads universal unit of free energy in Biological systems. Biological oxidation: Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, cori.s cycle, glyoxalate pathway. Oxidation of fatty acids- mitochondrial and peroxisomal ß-oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms, Mineral metabolism

**Unit IV**

Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids.

Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids. Over all in born error metabolisms

**Unit V**

Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases

**Reference books:**


- Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011. Schaum.s Outline of Biochemistry, Third Edition (Schaum.s Outline Series), McGraw-Hill.
- Sathyanarayana.U and U.Chakrapani., 2011. Biochemistry. Books and Allied private limited, Kolkata.
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W. H. Freeman.
- Albert Lehninger, David L. NelsonVoet Donald, Judith G.Voet and Charlotte W.Pratt., 2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
- Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman
- Food Microbiology – W.C. Frazier and D.C. Westhoff, Tata Mcgra Hill Publication
- Microbial Biotechnology – Alexander N. Glazer, Hiroshni-Kaido, W.H. Freemanand Co. 1995.
- Chemical Microbiology – Antony H. Rose, Butterworths, 3rd Edition, PlenumPress, 1976.publishers.


**Useful web sites:**

·mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm
·www.biochemweb.org/
·http://golgi.harvard.edu/biopages.html
webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC12 | MOLECULAR GENETICS | 5 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of all the Genetics concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and genetics.

**Course outcomes:**

At the end of the Course, the Student will be able to:

**CO-1** To acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.

**CO-2** Identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.

**CO-3** Make the students understand different range of DNA damage and range of their tools for their detection an.

**CO-4** Learn the concepts of the transposons and their applications.

**CO-5** Detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution

**Unit I**

Gene as the unit of mutation and recombination. Identification of DNA as the geneticmaterial. Mutations: Molecular nature, mutagenesis by nitrous acid, hydroxylamine,alkylating agents, intercalators and UV, origin of spontaneous mutations and control,parasexual process in bacteria, transformation, transduction and conjugal gene transferthe phenomena, mechanisms and applications. Fine structure genetic analysis withexamples.

**Unit II**

Recombinations – Control, models and mechanisms. Gene as the unit of expression. Gene – cistron relationship in prokaryotes and eukaryotes. Colincarity of gene and polypeptide. Elucidation of the genetic code. Wobble base pairing. Suppression of nonsense, missense and frame shift mutations. Regulation of gene expression in prokaryotes and eukaryotes. The operon concept – positive and negative control, attention control. Control sequences, promoter, operator, terminator and attenuator, DNA methylation and epigenic regulation.

**Unit III**

DNA damage and repair DNA damage by UV, alkylating agents, cross linkers. Mechanisms of repair – photoactivation, excision repair, recombinational repair. The SOS and adoptive responses and their regulation, heat shock response.

**Unit IV**

Extrachromosomal heredity, Biology of plasmids – discovery, types and structure of RTF, col-factors and Ti. Replication and portioning. Incompatibility and copy numbercontrol. Natural and artificial plasmid transfer and their applications. Transposablegenetic elements: discovery, early experiments of McClintock in maize. Insertion sequences in prokaryotes. Omplex transposons – Tn 10, Tn 5, Tn 9 and Tn 3 as examples. Mechanisms control, consequences and applications of transposition by simple and complex elements. Retro elements.

**Unit V**

Genetics of Eukaryotes: Gene linkage and chromosome mappling, crossing over, three point cross, tetrad analysis. Complementation. Organization of chromosomes, specialized chromosomes. Chromosome abnormalities, quantitative inheritance, population genetics. Developmental genetics using Drosophilla as model system. Somatic cell genetics.

**Reference Books:**


- Microbial Genetics – S.R. Maloy, J.E. Cronan and D. Friefelde 1994. Jones andBarlett Publishers.
- Molecular Genetics of Bacteria – J.W. Dale 1994 John Willey and Sons.
- Concepts of Genetics – W.S. Klug and M.R. Cumm Prentice Hall, 1997.
- Introduction of Genetic Analysis of Griffths – Freeeman Co., 1996.
- Advanced Molecular Biology of the Gene – Watson J.D. Hopkins NH, Roberts,J.W.Steitz. J.A.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC13 | MOLECULAR CELL BIOLOGY | 5 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and cell biology.

**Course outcomes:**

CO-1 To understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.

CO-2 Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism

CO-3- Demonstrate knowledge and understanding of the principles and basic mechanisms of nuclear envelope and its functions.

CO-4 Understand the metabolic pathways and the process of transmission of extracellular signals

CO-5 Demonstrate the operation of various microscopes and microtomy in the laboratory

**Unit I**

Introduction to cell Biology- Basic properties of cells-Cellular dimension-Size of cells and their composition-Cell origin and Evolution (Endosymbiotic theory)–Microscopy- Light Microscopy, Electron Microscopy, Application of Electron Microscopy in cell biology, Phase Contrast Microscopy, Fluorescence Microscopy, Flow Cytometry and FRET .Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion- Cell junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)- components and role of ECM in growth.

**Unit II**

Carbohydrate – types, structure and functions of carbohydrates, biosynthesis, lipid biosynthesis, C2, C3, C4 cycles. Biosynthesis of fatty acids and triacyl glycerol.Secondary metabolites – occurrence, classification and functions of phenolics, terpenes, flavonoids, alkaloids, saponins, glycosides. Applications of secondary metabolites in food, dairy, agricultural, cosmetics and pharmaceutical Industries. peroxisome - protein glycosylation – mechanism and regulation of vesicular transport – golgi and post-golgi sorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids.

**Unit III**

Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome(Solenoid and Zigzag model)-Global structure of chromosome – (Lamp brush and polytene chromosomes).

**Unit IV**

Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways (GPCR-cAMP, IP3 , RTK, MAP Kinase, JAK-STAT, Wnt Pathway).

**Unit V**

Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p 53, Apoptosis and significance of apoptosis

**References**


- Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York.
- David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
- Prakash S. Lohar , 2009. Cell and Molecular Biology.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007.,Molecular Biology of the Cell, Fifth edition. Garland Science.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J. 2007. Molecular Cell Biology. Media Connected, sixth edition. W.H.Freeman and Company
- Geoffrey.M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates.
- Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic HistologyText and Atlas. McGraw-Hill Professional.
- Paul A, 2001, Text Book Of Cell And Molecular Biology 2edition Niyogi Books •
- T.Fleming. 2002. Cell interactions: A practical approach Second edition.
- Alberts B, Molecular Cell Biology. 8. Casimeris et al., Lewin’s cells. Jones and Bartlett.
- Plopper, Principles of cell Biology. Jones and Bartlett.
- Gartner, Cell Biology and Histology. LWW.
- Pollard et al., Cell Biology. Sounders.
- Copper, The Cell a Molecular approach. Sinauer

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217SEC14L | MOLECULAR GENETICS CELL BIOLOGY LAB | 0 | 0 | 4 | 4 |

**Course Objectives:**

The practical will establish basic study skills on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

**Course outcomes:**

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

CO 1 (K2) Illustrate basic biochemistry procedures
CO 2 (K3) study the methods of estimation of biomolecules
CO 3 (K4) isolate & Analyze DNA, RNA & protein
CO 4 (K5) critically analyze the isolated biomolecules
CO 5 (K5) evaluate the quality and purity of DNA, RNA & Protein

1. Culture media preparation liquid and solid media.
2. Selective differential media
3. Methods of sterilization and testing of sterility
4. Enumeration of bacteria, fungi and actinomycetes from soil
5. Pure culture techniques – Pour, spread and looping methods
6. Maintenance and preservation of cultures
7. Staining of Bacteria – gram, spore and AFB, Fungal wet mount – LPB
8. Motility test – hanging drop and soft agar inoculation
9. Water quality test – MPN
10. Effect of different parameters on bacterial growth kinetics (Substrate, pH, Temperature)
11. Single colony – isolation and checking for genetic markers, measurements ofgrowth rate one step growth curve using T7 phage.
12. Induced mutagenesis and isolation of antibiotic resistant and auxotrophic mutantsenrichment methods for auxotrophic and antibiotic resistant mutants.
13. Genetic mapping by p1 transduction, genetic mapping of conjugation andtransformation.
14. Transposan mutagenesis of chromosomal DNA, Transposan mutangenesis ofplasmid DNA
15. Experiments with gene fusion.

**Book references:**


- Sadasivam, S. and Manickam A. Biochemical Methods, 2nd Edition, New age
- International Private Ltd. Publishers.
- Laboratory Techniques in Biochemistry and Molecular Biology.
- A short Course in Bacterial Genetics – J.H. Miller 1992, Cold Spring Harbour
- Laboratory.
- Methods for Genetics and Molecular Bacteriology – RGF Murray, W.A. Wood &
- N.B. Krig 1994 American Society for Microbiology.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **23217DSC15A** | **DISCIPLINE SPECIFIC ELECTIVE I BIOINSTRUMENTATION** | 5 | 1 | 0 | 3 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology. The student will get to understand the core concepts of biological instruments and their principles.

**Course outcomes**:

At the end of the Course, the Student will be able to:

CO-1 Introduction and various types of Microscopic techniques

CO-2 Impart understanding on centrifugation instruments and techniques

CO-3- Separation of Biomolecules

CO-4 Analytical methods on Spectroscopic Analysis

CO-5 Understand the application and Detection on Bioinstrumentation

**Unit I**

Microscopic Techniques: Principles and Applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry.

**Unit II**

Centrifugation: pH meter, Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC & HPLC.

**Unit III**

Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, PAGE- NATIVE & SDS PAGE, Iso-electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (Immunofixation EP,), ELISA, RIA, Southern, Northern and Western Blotting. Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins)

**Unit IV**

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X- ray Spectroscopy, Laser Spectroscopy and Raman Spectroscopy

**Unit V**

Radio-isotopic Techniques: Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement , Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA, Radiation Dosimetry, Health effects of Radiations.

**Reference books**


- ·M.H. Fulekar and Bhawana Pandey Bioinstrumentation, Wiley
- Keith Wilson, John Walker, 2010. Principles and Techniques of Biochemistry and Molecular Biology (7th Edition), Cambridge University Press •
- David L. Nelson, Michael M. Cox. Menninger (2008). Principles of Biochemistry, Fifth edition W. H. Freeman, New York. •
- Experiments in Biochemistry: A Hands-On Approach by Shawn O. Farrell, Ryan T. Ranallo, Paperback: 324 pages, Publisher: Brooks Cole. 20 •
- Metzler D.E. 2001, the chemical reactions of living cells –Academic Press. 2nd edition.
- Stryer L,1999, Biochemistry-W.H. Freeman & Company, New York. 1. • 4th edition
- L.Veerakumari (2006) Bioinstrumentation MJP Publisher Kindle edition
- Jefrey. M., Backer el al., 1996. Biotechnology- A Laboratory Course. Academic Press, New York.
- Holcapek, M., Byrdwell, Wm. C. 2017. Handbook of Advanced Chromatography /Mass
- Spectrometry Techniques, Elsevier

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC15B | ENZYMOLOGY | 5 | 1 | 0 | 3 |

**Course Objectives:**

The subject imparts knowledge on the fundamentals of enzyme structure and its kinetics. The student will be provided with a basic knowledge and understanding about the functions of enzyme as well as the industrial application of enzymes.

**Course outcomes:**

CO-1 Explain the basics of enzyme nomenclature and properties
CO-2 Classify and Cognize the native and immobilized enzyme
CO-3 Examine the equations of steady state kinetics
CO-4 Assess extraction and downstream processing of enzymes
CO-5 Compile the uses of enzymes and design enzymes for Industrial and Clinical application

**Unit 1**

Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods

**Unit 2**

Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadie hoofstee equation ,Inhibition of enzyme activity

**UNIT 3**

Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis

**UNIT 4**

Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex

**UNIT 5**

Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of

enzymes, Immobilized enzymes and their industrial applications.Clinical and industrial applications of enzymes, Enzyme Engineering.

**Reference Books**


- Nicholas C.Price and Lewis Stevens., 2010. Fundamentals of Enzymology. Oxford University Press, New Delhi
- Lehninger, Nelson and Cox, 2005, Principles of Biochemistry - 4th edition, WH Freeman and Company, New York, USA
- Principles of Biochemistry with human focus - Garrett and Grisham, 2002, Harcourt College Publishers, Orlando, Florida, USA.
- Geoffrey L, Zubay, Biochemistry -, 1998, 4th edition. 23
- Donald Voet, Judith Voet and Pratt, 1995, Fundamentals of Biochemistry, 2nd edition.
- Harper.s Biochemistry - Murray et al, 2000, 25th edition, Appleton and Lange Publishers.
- Enzymes – Trevor Palmer 2002.


**Useful Websites**

- www.lsbu.ac.uk/biology/enztech/
- www. lsbu.ac.uk/biology/enzyme/
- http://www.aetlted.com/tech/applications.html

**Mapping with Programme Outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PO 13 | PO 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | | | | S | | | | S | | | |
| CO2 | | S | | | S | | S | | | | S | | | |
| CO3 | S | S | S | | S | | | | | S | S | | | |
| CO4 | | S | S | M | | | S | | | S | S | | | |
| CO5 | | | S | S | S | | S | | | S | S | | | |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC15C | MICROBIAL TECHNOLOGY | 5 | 1 | 0 | 3 |

**Course objective:** This course aims to introduce the basic and applied Microbiology. The contents of this course will help students to understand importance of microorganisms.

**Course outcome:** The students became trained manpower in microbial production of beverages, Antimicrobials, Organic acids and enzymes, Microbiology of wastewater and solid waste treatment, Plant Growth Promoting Rhizobacteria and Renewable bioenergy using microorganisms

**Unit-I**

Industrial Fermentation – role of microorganisms in food and dairy industry. Fermented beverages-beer, wine and other alcoholic beverages. Microbial preparation of Tempeh, sauerkraut, Miso, yogurt. Probiotics.

**Unit-II**

Industrial Process: Antimicrobials, Organic acids and enzymes- microbial production of pencillin, Lactic acid; Gluconic acid. Microbial production and commercial applications of Amylases, Proteases, Lipases. Biotransformation of steroids.

**Unit-III**

Microbiology of wastewater and solid waste treatment: - biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Treatment of industrial effluents by microorganisms. Microbiology of degradation of xenobiotics – BHC, DDT and pesticides. Bioremediation of insecticides, pesticides and heavy metals.

**Unit-IV**

Plant Growth Promoting Rhizobacteria (PGPR). Biofertilizers- Rhizobium, Azospirillum, Azotobacter, phosphobacteria - mycorrhizae - Blue Green Algae and Azolla. Biopesticides - Bacillus thuringiensis,. Mass production of biofertilizers and biopesticides

**Unit-V**

Green Energy: Renewable bioenergy using microorganisms – Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanolproduction by using microorganisms.

**Recommended Text Books:**

1. Prescott's Microbiology, Joanne M. Willey , Linda M. Sherwood , Christopher J. Woolverton 8th Edition McGraw-Hill Publishers.
2. Wulf Cruger and Anneliese Cruger., Biotechnoloogy, (A text book of industrial Microbiology), Panima Publishers, New Delhi, 2nd edition, 2003.

**Suggested Readings**

1. Prescott and Dunn, Industrial Microbiology, CBS Publishers, New Delhi, 4th Edition, 1987.
2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc.,Tata MacGraw Hill, New Delhi.
3. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A. D. Russell Sixth edition. Blackwell scientific Publications.
4. Bioremediation by Baker K.H. And Herson D.S. 1994.. Mac Graw Hill Inc. N.Y.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC15D | CELL AND CANCER BIOLOGY | 5 | 1 | 0 | 3 |

**Course objective:** To understand the role of different cell organelles in maintenance of life activities and to study about the knowledge in tumour, oncogenes, signals and diagnosis and treatment of Cancer.

**Course outcome:** Understand the basic unit of the living organisms and to differentiate the organisms by their cell structure. The student ill have a better understanding of mechanism behind cancer development and progression, cancer diagnosis and treatment, genetic and epigenetic basis of cancer development.

**Unit-I**

Cells, Prokaryotic and Eukaryotic cells, Plant and animal cells, Chemical components of biological membranes, Eukaryotic Cell organelles, Mitochondria, Chloroplast, ribosomes and nucleus, Endoplasmic Reticulum, Golgi apparatus, Lysosomes and Peroxisomes, Membrane Vacuolar system.

**Unit-II**

Cytoskeletons and Cell Membrane, Membrane Transport, Protein Trafficking, Ubiquitin Receptors and Protein Quality Control, Subcellular Fractionation; Nucleus: Structure and Function, Chromosomes and their structure Cell division.

**Unit-III**

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, different forms of cancers. Cancer screening and early detection, Detection using biochemical assays, tumour markers, molecular tools for early diagnosis of cancer.

**Unit-IV**

Signal targets and cancer, activation of kinases, Oncogenes, Identification of oncogenes, retroviruses and oncogenes, Oncogenes/proto oncogene activity. Growth factors related to transformation, telomerases.

**Unit-V**

Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, advances in cancer detection. Use of signal targets towards therapy of cancer, Gene therapy.

**REFERENCES:**

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, Keith; Walter, P., (eds) c2002: Molecular Biology of the Cell, Garland Science, New York and London. Copper, G.M., & Hausman, R.E., 2004: The Cell: A Molecular Approach, 3rd ed., Sinauer Associates, Inc, Sunderland, Massachusetts.
2. Lodish, H. Berk A, Zipursky SL, et al., 2000: Molecular Cell Biology, 4th edition., W.H. Freeman, New York.
3. Maly B.W.J, “Virology a Practical Approach”, IRLI Press, Oxford, 1987.
4. Dunmock N.J and Primrose S.B., “Introduction to Molecular Virology”, Blacwell Scientific Publications, oxford, 1988.
5. “An Introduction To Cellular and Molecular Biology of Cancer”, Oxford Medocal Publications, 1991.
6. Ruddon.R.W.,Cancer Biology, Oxford University Press, Oxford, 1995

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC15E | INHERITANCE BIOLOGY | 5 | 1 | 0 | 3 |

**Course objective:** To provide the background knowledge on the history of genetics and the importance of Mendelian principles. To acquaint the students, distinguish between polygenic, sex-linked, and multiple allelic modes of inheritance and extrachromosomal inheritance. To comprehend the Mendelian Genetic principles in humans, plants and animals

**Course outcome:** To acquire knowledge on interaction of genes, various types of inheritance patterns existing in animals with reference to non-Mendelian inheritance. To acquire knowledge on chromosomal inheritance. Ability to apply Mendelian inheritance principles to humans, plants and animals.

**Unit-I:** History of Genetics- Concepts of Phenotype, Genotype, Heredity, Variation, Pure lines and Inbreed Lines. Mendelian Principles on Monohybrid cross, back cross and Test cross. Mendelian Principles on Dihybrid cross.
**Unit-II**: Linkage - Definition, Types of linkage-complete linkage and incomplete linkage, Significance of linkage. Crossing over - definition; Mechanism of crossing over: Chiasma Interference and coincidence. Gene Interactions: Incomplete dominance, codominance, Pleiotropy. Gene Interactions: Lethal alleles, Epistasis, Non- Epistasis

**Unit-III:** Polygenes (General Characteristics & examples). Multiple Alleles (General Characteristics and Blood group inheritance). Rh inheritance erythroblastosis foetalis. Extra chromosomal inheritance- Kappa particles in Paramecium and Shell coiling in snails
**Unit-IV:** Penetrance and Expressivity (e.g. Polydactyly, Waardenburg Syndrome), Pleiotropism (e.g. Bardet Biedel Syndrome, Marfan syndrome), Phenocopy (e.g. Microcephaly)
**Unit-V:** Sex determination in Drosophila, Birds, Man and Bonellia; X-linked inheritanceHemophilia, Color blindness, Lyonization; Y-linked inheritance- Holandric genes; Sex limited and sex influenced characters; Inheritance patterns in Man-Pedigree analysis.

**REFERENCES**

1. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication.
2. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York.
3. The Science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication.
4. Principles of Genetics by R.H. Tamarin, International edtn McGrawhill
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
8. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC15F | BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS | 5 | 1 | 0 | 3 |

**Course Objectives:** To introduce basic concepts of ethics and safety that is essential for Life Science Labs. To understand the procedures involved in protection of Intellectual property. To give an insight into different treaties signed. To gain knowledge about patent filing.

**Course Outcomes:** Gain Knowledge of working principles in a laboratory taking all safety measures, handling of live cultures, disposal of infectious waste, care of the equipment requiring safety audit. Get an insight into Biosafety guidelines. Analyse and Manage the Risks involved with GMOs

**UNIT I**

Introduction, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs-Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture

**UNIT II**

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning and their Ethical Aspects.

**UNIT III**

Introduction to Intellectual Property and History. Patents, Trademarks, Copyright , Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Ethics, Pros and Cons of IP protection.

**UNIT IV**

Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

**UNIT V**

Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Patenting Living Organisms.

**Reference Books:**

1. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan K. Sell Cambridge University Press, 2000.
2. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition).
3. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006

**SEMESTER - II**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC21 | MICROBIOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:**

To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment

**Course outcomes:**

CO-1 To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.
CO-2 To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques
CO-3 To enlighten the students on host microbe interaction and Epidemiology of microbial disease
CO-4 To update the knowledge on epidemic and pandemic diseases.
CO-5 To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.

**UNIT-1**

History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs.

**UNIT-II**

Microbial culture, identification, and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria – Biochemical – IMViC, 16s rRNA sequencing. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods

**UNIT-III**

Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases

**UNIT-IV**

Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria, filariasis, Candidiasis, superficial mycosisg.

**UNIT-V**

Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremphiles- Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of extremophiles

**References**


- Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Prescott's
- Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594.
- Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
- Ananthanarayan and Paniker's (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251.
- Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill. 5
- Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018. 9. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11.
- Agriculture Microbiology, 2016. E-Course Developed By TNAU (ICAR)


**Web Sources**


- https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf ISBN 978-92-4-156553-0. https://doi.org/10.3389/fmicb.2020.631736
- https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC22 | PLANT AND ANIMALBIOTECHNOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

**Course outcomes:**

CO-1 To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.
CO-2 Importance of secondary metabolites and production in plants.
CO-3 To develop concepts, principles and processes in animal biotechnology.
CO-4 Concept and different types in Animal Cell Culture and animal cell lines.
CO-5 Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.

**UNIT-I**

Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants - Phytochemicals- Glycosides and Flavonoids; Anthocyanins and Coumarins - Lignans, Terpenes, Volatile oils and Saponins; Carotenoids and Alkaloids: biogenesis, therapeutic applications

**UNIT-II**

Plant Transformation Direct transformation by electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps, Linkage analysis, RAPD markers, STS Mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular marker assisted selection

**UNIT-III**

Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture

**UNIT-IV**

Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell

cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays

**UNIT-V**

Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidised bed reactors. Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically important compounds. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells-Properties, Types, Therapy, Prospects and Ethics in stem cell research.

**Reference Books**


- J.D.Watson, Gillman, J.Witknowski and M.Zoller, 2006. Recombinant DNA. 3rd ed.
- W.H.Freeman. 26 K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
- H.Kreuzer & A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
- M.Sudhir. 2000. Applied Biotechnology & Plant Genetics. Dominant publishers & Distributors.
- Genetic Engineering of Animals by (Ed) A.Puhler, VCH Publishers, Weinheim, FRG, 1993.
- Animal Cell culture Practical approach. Ed. John R.W.Masters, Oxford.2004.
- Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC23 | GENETIC ENGINEERING | 4 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

**Course outcomes:**

CO-1 Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
CO-2 Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.
CO-3 Acquiring theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.
CO-4 Describes the genome mapping and sequencing and methods for gene therapy.
CO-5 Elucidate different techniques involved in genetic engineering

**Unit I**

Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries

**Unit II**

E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (*Bacillus subtilis*)

**Unit III**

Cloning in yeast *Saccharomyces cerevisae*. Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro; Vectors for cloning promoters and terminators; vectors with adjustable copy number

**Unit IV**

Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing).Second generation sequencing methods

**Unit V**

Site directed mutagenesis; DNA microarray; chromosome walking and jumping.Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavr savr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis.

**Reference Books:**


- T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
- Sandy B.Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
- Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
- Raymond Rodriguez and David T.Denhart 2003.Vectors, A survey of molecular cloning vectors and their uses
- Errst-L. Winnacker 1987.From genes to clones. Introduction to Gene Technology,
- Ed. David V. Geoddel 2002.Gene Expression technologies. Methods in enzymology (Vol.185)
- William Wu, Michael J.Welsh, Peter B.Kaufrmar, Helen H.Zhang 2001. Methods in
- Gene Biotechnology

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217SEC24L | PLANT AND ANIMAL BIOTECHNOLOGY LAB | 0 | 0 | 4 | 4 |

**Course Objectives:** The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands on experience on the above core subjects.

**Course outcomes:**

CO-1 To know about the media preparation and sterilization techniques
CO-2 To understand the callus formation
CO-3 (K4) Examine Plant and Animal cells and their functions
CO-4 (K5) Assess extracted DNA, RNA and protein for rDNA technology
CO-5 (K6) to study cloning tools

**Experiments**

**Demonstration**

16srRNA sequencing

**Plant and Animal Biotechnology - Practical:**

1. Plant tissue culture media preparation
2. Plant tissue culture sterilization techniques.
3. Generation of Callus from leaf
4. Generation of Callus from root
5. Generation of Callus from bud
6. Generation of Callus from shoot apex
7. Maintenance of callus culture.
8. Cell suspension culture
9. Anther culture
10. Pollen culture
11. Embryo culture.
12. Isolation of plant protoplast
13. Culture of plant protoplast.
14. Protoplast viability test.
15. Localization of nucleus using nuclear stain.
16. Agrobacterium culture maintenance and isolation of plasmid DNA.
17. Mass culture of Chlorella /Spirulina
18. Introduction to Animal Cell culture: Procedure for handling cells and medium.
19. Cleaning and sterilization of glassware and plastic tissue culture flasks
20. Preparation of tissue culture media
21. Preparation of sera for animal cell culture
22. Preparation of single cell suspension from chicken liver (Primary cell culture).
23. Trypsinization of established cell culture.
24. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining.
25. MTT Assay

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC25A | REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS | 4 | 1 | 0 | 3 |

**Course Objectives:** The subject imparts knowledge on the fundamentals of regulatory requirement in industries. The student will be provided with a basic knowledge and understanding about the regulatory affairs based on biotechnological industry requirements.

**Course outcomes:**

CO-1 Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body's requirements
CO-2 Describe the Scientific, technical knowledge about various food preservation techniques
CO-3 Describe the basic concepts of packing of food materials, various parameters observed during packaging
CO-4 Describe the testing of food materials and identifying of microbial food contaminant
CO-5 Explain the basic of food safety management system, good manufacturing practice and good hygienic practices

**UNIT-I: Planning, Organisation and setting of Food testing laboratory and laboratory safety**

Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017, documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety: Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety equipment, storage of chemicals, acids, flammables etc, handling and biological spills and waste disposal

**UNIT-II :Principles of Food Preservation technology**

Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology.Temperature reduction: Chilling, Freezing,Radiation: Ionizing Radiation, Microwave,Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives,New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields, hurdle technology, ultrasonic and ohmic heating etc.

**UNIT-III: Principles of Food Packaging technology**

Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical properties: Glass, metals, paper, plastics .Biodegradable and edible films and coatings aseptic

packaging and combinations, Selection of packaging material and design for various food commodities including fresh produce (Fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods, Evaluation of quality and safety of packaging materials- different testing procedures, Function of packaging: Protective packaging and active packaging smart and intelligent packaging, Newer packaging technologies-CAP/MAP packaging aseptic processing and packaging, irradiated packaging, retort pouch and microwaveable packaging.

**UNIT-IV: Food Microbiology and testing**

Introduction of Food microbiology: Classification and nomenclature of microorganisms. Morphology and structure of microorganisms in foods (yeast and Molds, Bacterial cells viruses), Important genera of mold, yeast, bacteria (Gram positive and Gram negative, facultative aerobic and anaerobic, endospore forming bacteria and non-sporulating bacteria), Bacterial groups (lactic acid, acetic acid, butyric acid etc.,), thermophilic, proteolytic, saccharomyticetc, coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics: Reproduction and growth (fission, generation time optimum growth, growth curve etc). Microbial growth in foods: intrinsic (pH, Moisture content, oxidation-reduction potential, nutrient content, antimicrobial constituents and extrinsic parameters (temperature of storage, relative humidity of environment, presence and concentration of gases in the environment, Thermal destruction of microorganisms: Thermal death time, D Value, Z- Value, F-Value, thermal death time curve, 12 D Concept, Microbial food spoilage and food borne diseases, food pathogens, bacillus cereus and other bacillus species, campylobacter, clostridium species, Enterobacteriaceae, E. coli, listeria monocytogens, salmonella, shigella, staphylococcus aureus, vibrio species, yersinia enterocolitica, fungi, virus etc., Methods for the Microbiological examination of foods: Sampling activity and sampling plan, pure culture isolation: streaking, serial dilution and plating, cultivation, maintenance and preservation/stocking of pure culture, Observation of Indicator organisms: Direct examination, enumeration methods, plate count, MPN, biochemical test, Rapid methods detection of specific organisms.

**UNIT-V: HACCP and Food safety management systems:**

ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products. Prerequisite programs, HACCP principles, some limitation of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, food safety management risk analysis. Traceability food products recall and sanitation.

**REFERENCE:**


- ISO 9001, Quality management systems – Requirements
- ISO 17034 General requirements for the competence of reference material producers
- ISO/IEC 17043 Conformity assessment – General requirements for proficiency testing.
- Food safety standards authority regulation 2011.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC25B | HUMAN PHYSIOLOGY | 4 | 1 | 0 | 3 |

**Course objectives:**

• This course provides an overview on physiology, an insight into the processes responsible for sustaining life • It serves as a bridge between medicine and chemistry by explaining the chemistry behind physiological processes like digestion, muscle contraction, nerve conduction, heart pumping, etc. • The course also describesthe alterationsin normal physiology, which occur during disease, thus, providing a molecular perspective of several disease states

**UNIT I: THE DIGESTIVE SYSTEM** (8 hrs)

The anatomy of the human alimentary canal. Accessory glands of the digestive system. The biochemistry of digestion of carbohydrates, protein and fats in various regions of the alimentary canal in humans. Absorption, and fates of ingested carbohydrates, protein and dietary lipids. Storage and detoxification.

**UNIT II: THE CARDIOVASCULAR AND CIRCULATORY SYSTEM**

Structure and functions of heart, conductive system of heart, origin and conduction of the heartbeat. Cardiac cycle, and electrocardiogram (ECG). Structure of the endothelium. Anatomy of the human vascular and lymphatic systems. Composition of blood and its functions. Common diseases of the blood, blood vessels and heart.

**UNIT III: THE RESPIRATORY AND MUSCULAR SYSTEMS**

Structure and functions of lung. Mechanism of pulmonary ventilation: exchange of gases between lung and blood, and transport of gases between blood and tissues. Disorders associated with the lungs: occupational and habitual diseases. Ultra-structure and chemical composition of skeletal muscle, sliding filament theory, physico-chemical changes during muscle contraction and muscular dystrophy.

**UNIT IV: THE NERVOUS SYSTEM**

Concept of nerve and nerve cells. Transmission of nerve impulse. Action potential, neurotransmitters. Synaptic conduction: neuromuscular synapse, adrenergic and cholinergic neurotransmission. The anatomy of the human brain. Functions of different parts of the human brain. The blood–brain barrier. Structure and functions of the spinal cord. Parts of the nervous system: central, peripheral and autonomic. Reflex action: importance of reflexes, sympathetic and parasympathetic nervous systems. CSF and its composition. Neurodegenerative diseases.

**UNIT V: THE EXCRETORY SYSTEM**

Structure and functions of kidney and nephron. Composition and formation of urine. Principle of ultrafiltration. Fluid and electrolyte balance, acid–base dynamics. Role of the lungs in excretion. Metabolic and respiratory acidosis and alkalosis.

**REFERENCE BOOKS:**

1. Hall JE, Guyton and Hall textbook of medical physiology (13th ed.), Philadelphia: Saunders, 2015. 2. Waugh A and Grant A, Ross and Wilson anatomy and physiology in health and illness (13th ed.), New York: Churchill Livingstone, 2018.
3. Bell GH, Emslie-Smith D and Paterson CR, Textbook of physiology and biochemistry (9th ed.), London: Churchill Livingstone, 1976. S

**SUGGESTED READING:**

1. Barrett KE, Barman SM, Brooks HL and Yuan JXJ, Ganong's review of medical physiology (26th ed.), New York: McGraw-Hill Education, 2019. Course outcome:

**Course Outcomes**

Upon successful completion of this course, students are able to:

- Understand the chemical reactions involved in digestion, absorption and assimilation, as well as the electrochemical and ionic changes that power the heart, neurons and muscle functions
- Comprehend the applications of gas laws and buffer systems in the transport of gases by the circulatory system, and the alterations in disease states
- Independently perform complete blood count, and be competent in hematology

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC25C | INSTRUMENTATION | 4 | 1 | 0 | 4 |

**Course Objectives:** The primary objective of the Instrumentation course is to provide students with a fundamental understanding of measurement systems, including their components, functions, and classifications. Students will gain knowledge of various transducers and sensors used to measure physical quantities like temperature, pressure, displacement, and flow, along with the principles behind their operation and application.

**Course Outcome**: Upon completion of the Instrumentation course, students will have developed the ability to understand and apply the fundamental concepts of instrumentation and measurement systems, demonstrating a clear grasp of the different types of instruments, their characteristics, and error correction techniques.

**UNIT 1**

Definition of instrumentation and its applications.Types of instruments: Analog, Digital, and Smart Instruments.Measuring systems: components, functions, and classification Static and dynamic characteristics of instruments (accuracy, precision, sensitivity, response time, etc.).

**UNIT 2**

**Introduction to Transducers:** Types of transducers: Active and Passive.Characteristics of transducers: Sensitivity, Range, Linearity, Hysteresis.**Types of Sensors-** Temperature sensors: Thermocouples, RTDs, Thermistors.Pressure sensors: Strain gauges, Piezoelectric sensors.Displacement sensors: LVDT, RVDT, capacitive, and inductive sensors.Humidity and other environmental sensors.

**UNIT 3**

**Electrical Measurements-** Measurement of voltage, current, power, and resistance using different instruments (Multimeter, Oscilloscope, etc.).Measurement of frequency, phase, and impedance. **Non-Electrical Quantities** -Measurement of mechanical quantities: Force, displacement, torque, etc.Flow measurement: Orifice plate, rotameter, electromagnetic flowmeters.Level measurement: Float type, capacitive, ultrasonic level sensors.

**UNIT 4**

**Data Acquisition Systems-** Components of a data acquisition system (DAQ).Analog and digital data acquisition.Interface with microcontrollers and computers.

**UNIT 5**

**Modern Instrumentation Techniques**Optical and Laser-based instruments.Fiber-optic sensors.Wireless sensors and IoT in instrumentation.**Industrial Applications**Instrumentation in manufacturing, process industries, and quality control.Case studies of instrumentation applications in industries like oil and gas, automotive, and power generation.

**REFERENCE:**

1. Principles of Instrumental Analysis" by Douglas A. Skoog.
2. Introduction to Instrumentation and Measurements" by Robert B. Northrop.
3. Measurement Systems: Application and Design" by E.O. Doebelin.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC25D | MEDICAL BIOTECHNOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:** The aim of this course is to • provide comprehensive information on synthesis and characterization of heterocyclic compounds • provide comprehensive information on tests for impurities and pharmaceutical aids • provide comprehensive information on coordinate compounds and their applications in medicine.

**Course Outcome**: At the end of the course the students will be able to, CO1 understand the importance of micromeritics in dosage form design CO2 understand the surface, interfacial phenomena and the rheology of liquids CO3formulate and evaluate liquid dispersions CO4 carry out dissolution and diffusion studies CO5 determine half -life and shelf life of pharmaceutical products.

**UNIT 1: Overview of Biotechnology-**Definition and scope of biotechnology,History and evolution of medical biotechnology,Applications in medicine, agriculture, and industry.**Principles of Medical Biotechnology-**Molecular biology basics (DNA, RNA, proteins),Genetic engineering and recombinant DNA technology,Cloning and gene expression.

**UNIT 2: Genetic Manipulation Techniques-**PCR (Polymerase Chain Reaction),Gel electrophoresis, DNA sequencing,Gene cloning and expression vectors.**Gene Therapy-**Gene delivery methods (viral and non-viral vectors)-Application in treating genetic disorders (e.g., cystic fibrosis, muscular dystrophy)-Ethical and safety concerns.

**UNIT 3: Diagnostic Techniques-**Polymerase Chain Reaction (PCR) and its variants (Real-time PCR, Nested PCR)-DNA fingerprinting and profiling-ELISA and Western blotting-Fluorescence in situ hybridization (FISH).**Biomarkers and Disease Diagnosis-**Cancer biomarkers-Genetic testing for inherited diseases-Diagnostic applications in infectious diseases.

**UNIT 4: Biopharmaceuticals-**Biologics vs. traditional pharmaceuticals-Monoclonal antibodies and their therapeutic use-Recombinant proteins and vaccines,**Techniques in Drug Development-**Drug discovery and testing.High-throughput screening (HTS).Clinical trials and regulatory approval.

**UNIT 5: Ethical Considerations-**Ethical issues in gene therapy and genetic testing-Stem cell research and cloning-Access to biotechnology-based therapies.**Legal Framework-**Intellectual property (patents, copyrights) in biotechnology-Regulatory bodies (FDA, EMA)-Biotechnology laws and guidelines in different countries.**Social Implications-**Public perception of genetic technologies-Privacy concerns related to genetic information-Impact of biotechnology on society and health policy

**REFERENCE:**


- Medical Biotechnology: Principles and Applications" by Shivesh Kumar, Om Parkash, and Pradeep Kumar
- "Biotechnology for Beginners" by Reinhard Renneberg
- "Introduction to Biotechnology" by William J. Thieman and Michael A. Palladino

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC25D | MUSHROOM TECHNOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:** The Mushroom Technology course aims to provide students with a comprehensive understanding of the biology, cultivation techniques, and commercial potential of mushrooms.

**Course Outcome**: Furthermore, the course promotes sustainable farming practices and encourages students to consider careers in mushroom cultivation, biotechnology, and research. By the end of the course, students will be well-prepared to apply mushroom technology in both small-scale and commercial production settings.

**UNIT 1: Overview of Mushroom Science-**Definition and importance of mushrooms in food and medicine-Historical development of mushroom cultivation-Importance of mushroom technology in agriculture and industry.Classificationof Mushrooms-Edible mushrooms (e.g., *Agaricus bisporus, Pleurotus ostreatus, Lentinula edodes*)-Medicinal mushrooms (e.g., Ganoderma, Cordyceps)-Toxic and non-edible mushrooms

**UNIT 2: Substrate Preparation-**Selection of substrates (e.g., straw, sawdust, compost)-Methods of substrate sterilization and pasteurization-Factors affecting substrate quality.**Inoculation and Spawn Production-**Preparation of spawn (types of spawn: grain spawn, sawdust spawn)-Methods of inoculation and spawn run-Factors influencing spawn quality and performance.**Fruiting and Harvesting-**Conditions for fruiting body development (temperature, humidity, light),Pinning, cropping, and harvesting techniques,Yield enhancement methods.

**UNIT 3: Common Edible Mushrooms-**Cultivation and uses of *Agaricus bisporus, Pleurotus spp., Lentinula edodes*, and other edible varieties-Nutritional and culinary significance of mushrooms.**Medicinal Mushrooms-**Importance of mushrooms in traditional and modern medicine-Medicinal species like Ganoderma, Cordyceps, and their therapeutic properties-Mushrooms in immune modulation, anti-cancer, and anti-inflammatory therapies.

**UNIT 4: Common Mushroom Diseases-**Fungal diseases: e.g., Trichoderma, Verticillium, and their management-Bacterial diseases and their prevention-Viral infections in mushrooms.

**Unit 5:Pests and Their Control-**Common pests in mushroom cultivation (e.g., sciarid flies, mites)-Biological and chemical pest control methods-Integrated pest management (IPM) strategies.

**REFERENCE:**


- "Mushroom Biotechnology: Recent Developments" by D. K. Arora
- "Mushroom Cultivation: A Comprehensive Guide to Growing Mushrooms at Home" by Peter Oei
- "Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact" by K.L. P. R. R.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217SEC26 | ENVIRONMENTALBIOTECHNOLOGY | 3 | 0 | 0 | 2 |

**Course Objectives:**

The subject imparts knowledge on the fundamentals of ecology and pollution. The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.

**Course outcomes:**

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

CO-1 Explain various waste management methods
CO-2 Classify potential methods of biodegrading organic pollutants.
CO-3 Examine the techniques involved in remediation of polluted environments
CO-4 Assess types of pollution & its control
CO-5 Compile biotechnological approaches to degrade xenobiotic compounds

**Unit I –Research**

Selection of problem-stages in the execution of research: choosing a topic to publication-preparation of manuscript-report writing- format of journals – proof reading – sources of information: Journals, reviews, books, monographs, etc, Bibilograpy. Journal ; standard of research journals – Impact factor.

**Unit II: Statistical method**

Measures of dispersion: Universe and population – delimiting population – sampling method – random sampling, stratified random sampling – types of variables: qualitative and quantitative variables – continuous and discontinuous variables – scaling method S- mean – standard deviation – standard error – coefficient of variation.

**Unit III**

Coparision of means, chisquard test, student test (ANOVA ‘’portioning of variation). F test – model sums on one way ANOVA with interpretation of data – introduction to MANIVA – Statistical and their use – significance test and fixing levels of significance – use of statisticalsoftware like COSTAT and STATISTICA. Breif introduction to pie and histograms. Use of LCD.

**UNIT IV:**

Chromatography – priniciple, operative technique and applications of paper, TLC, adsorption chromatography, GLC and HPLC. Ion-Exchange, molecular sieve, Electrophoretic techniques – principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focusing, plused field gel electrophoresis and capillary electrophoresis. Spectrometry – Centrifugation techniques.

**UNIT V:**

X-Rays – X-Ray diffraction, crystals and detectors, quantitative analysis and applications. Radio chemical methods – Basic concepts, counting methods and applications. Autoradiography, detection and measurement of radioactivity, applications of radioisotopes in biology.

**References:-**


- An introduction to practical biochemistry by David T. Plummer.
- Laboratory Manual in Biochemistry by Pattabiraman and Acharya
- Practical Biochemistry by J. Jayaraman.
- Analytical Biochemistry, D. J. Homie and Hazel Peck, Longman group, 3rd edition, 1998.
- Physical Biochemistry – Application of Biochemistry and Molecular Biology, David Friefelder, W.H Freeman and Co, 2nd Edition 1999.
- Experimental Biochemistry, Robert Switzer and Liamgarrity, W.H. Freeman and Co, 3rd 1999.
- Davis, G.B and C.A Parker, 1997. Writing the doctoral dissertation, Barrons Education series, 2nd edition, Pp 160, ISBN: 081208005
- Duneary, P. 2003. Authoring a Ph. D thesis: how to plan, draft, write and finish a doctoral dissertation. Plagrave Macmillan, Pp256. ISBN 1403905843

**SEMESTER - III**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC31 | BIOINFORMATICS AND BIOSTATISTICS | 5 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge of the basics of bioinformatics tools and all the statistical concepts, in biology. The student will get to understand the core concepts of computation principles for the data analysis and In-Silico biological research.

**Course outcomes:**

CO-1 To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
CO-2 Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.
CO-3 Explain about the methods to characterize and manage the different types of Biological data.
CO-4 To update the knowledge on Tests of significance for large and small samples.
CO-5 To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.

**Unit I**

Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA. Artificial Intelligence: Introduction to biological neural network, motivation for artificial neural network (ANN), Big data analysis - DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI) data, pathway data and gene ontology (GO) data

**Unit II**

Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, pairwise alignment. Global and local alignment algorithms,multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching. PSI- Blast, PAM and Blosum matrices

**Unit III**

Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP, CATH, DALI and HSSP ;Visualization of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction

**Unit IV**

Correlation and regression – correlation table – coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions – Binomial (Gaussian distribution) and negative binomial, compound and multinomial distributions – Poisson distribution

**Unit V**

Normal distribution – graphic representation.– frequency curve and its characteristics – measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors

**Reference Books:**


- DassanayakeS.Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, SimminderKaurThukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P, 2004. Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Veer bala Rastogi. 2011. Fundamentals of Biostatistics. Ane books Pvt Ltd, Chennai.
- Rosner,B (2005), “Fundamentals of Biostatistics”, Duxbury Press.
- Warren,J; Gregory,E; Grant,R (2004), “Statistical Methods in Bioinformatics”,1st edition, Springer
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC32 | IMMUNOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of immunology. The student will get to understand the core concepts of immune systems and their non-specific and specific mechanisms, vaccine, etc.

**Course outcomes:**

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

CO-1 Illustrate various mechanisms that regulate immune responses and maintain tolerance
CO-2 Describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses
CO-3 Learn the concepts of cellular and molecular processes that represents the human immune system.
CO-4 Elucidate the role of immunological regulation and tolerance at a cellular and molecular level
CO-5 Compile concepts on immunological principles and diagnosis

**Unit I**

History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system .Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes

**Unit II**

Lymphocyte-sub-populations of mouse and man. APC cells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents. Immunoglobulins- structure, distribution and function. Immunoglobulin super family Isotypic,Allotypic and Idiotypic variants, generation of antibody diversity

**Unit III**

Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology- immunological basis of graft rejection, cinical transplantation

and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours

**Unit IV**

Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins

**Unit IV**

Immunotechniques- Principle and Applications: Immuno diffusion,Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test.Purification ofantibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.

**Reference Books:**


- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,2011.
- Roitt.s Essential Immunology, 12 edition, Wiley-Blackwell. USA.
- Kannan. I., 2010. Immunology. MJP Publishers, Chennai.
- Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and MolecularImmunology. 6th Edition. Saunders Elsevier Publications, Philadelphia.
- SeemiGarhat Bashir, 2009. Text Book of Immunology, PHI LearningPvt. Ltd. New Delhi.
- Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, 2006.Kuby Immunology, 6th edition, W. H. Freeman & Company.
- Nandini Shetty, 1996, Immunology: introductory textbook - I. NewAge International, New Delhi.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC33 | BIOPROCESS TECHNOLOGY | 4 | 1 | 0 | 4 |

**Course Objectives:**

The paper imparts a thorough knowledge on the basics of bioprocess and industrial fermentation. The student will get to understand the core concepts of fermentation and its commercial application.

**Course outcomes:**

The student will learn about the:

CO-1 (K2) Outline the basis of Bioprocess Engineering
CO-2 (K3) Relate reactors in fermentation
CO-3 (K4) Differentiate fermentation processes
CO-4 (K5) Assess Scale up and Scale down
CO-5 (K6) Compile the output of fermentation processes

**Unit I**

Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes. Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO.

**Unit II**

Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters, body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms, Media for Industrial fermentation and Sterilization.

**Unit III**

Introduction to bioproducts and bioseparation. Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration: Principles, Conventional, Crossflow filtration. Sedimentation: Principles, Sedimentation coefficients. Extraction Principles, Liquid liquid extraction, aqueous two phase extraction, supercritical fluid extraction.

**Unit IV**

Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.

**Unit V**

Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.

**Reference Books:**


- Min-tzeLiong, 2011. Bioprocess Sciences and Technology. NovaScience Pub Inc.
- Michael L.Shuler, FikretKargi. 2003. Bioprocess Engineering. PHIpublishers.
- P.A.Belter, E.L.Cursler, and W.S.Hu. 1988.Bioseparation: Downstream processing for Biotechnology. John Wiley and sons.
- R.G. Harrison, P.Todd, SR.Rudge and D.P. Petrides. 2003.Bioseparation science and engineering. Oxford Press.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 2317SEC34L | IMMUNOLOGY AND BIOPROCESS TECHNOLOGY | 0 | 0 | 4 | 4 |

**Course Objectives:**

The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

**Course outcomes:**

CO-1 (K2) to learn the Bioinformatics tools for sequence retrieval and alignment

CO-2 (K3) to apply the learned tools for various applications

CO-3 (K4) to isolate, identify & enumerate immune cells

CO-4 (K5) to learn the technique of immunodiagnostics

CO-5 (K6) to study upstream & downstream techniques

**Unit I: Immunology Practical**

1. Identification of various immune cells from human peripheral blood.
2. Lymphocyte separation and identification
3. Determination of lymphocyte viability by trypan blue method
4. WBC counting
5. Preparation of serum and plasma
6. Electrophoretic profile of human serum in native PAGE
7. Preparation of cellular antigen – human RBC
8. Preparation of antigen-adjuvent mixture for production of polyclonal antibody
9. Isolation of IgG molecule from serum
10. Immunodiagnostics: CRP
11. Immunodiagnostics: ASO
12. Immunodiagnostics: Widal
13. Immunodiagnostics: RA
14. Immunodiagnostics: Blood grouping and typing
15. Immunodiagnostics: hCG
16. ELISA
17. Radial Immunodiffusion
18. Ouchterlony Immunodiffusion
19. Immunoelectrophoresis
20. Rocket electrophoresis
21. Counter current immunoelectrophoresis.
22. Bioassays for cytokines
23. Radioimmunoassays (Demonstration)

**Unit II:Bioprocess Technology - Practical**

1. Parts and design of fermenter

2. Solid state fermentation
3. Submerged fermentation
4. Foaming and antifoaming agents
5. Media preparation and sterilization
6. Isolation of industrially important microorganisms for microbial processes.
7. Conservation of Bacteria by Lyophilization.
8. Production and estimation of protease
9. Production and estimation of amylase.
10. Production of wine using grapes
11. Production of penicillin
12. Determination of penicillin activity
13. Citric acid production
14. Use of alginate for cell immobilization.
15. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism.
16. Cell disruption (Sonication)
17. Aqueous Two Phase Extraction of enzymes

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35A | NANOBIOTECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:**

The subject imparts knowledge on the fundamentals of nanoparticles. The student will be provided with a basic knowledge and understanding about the role of nanoparticles in biotechnology.

**Course outcomes**:

| | |
|---|---|
| CO-1 | Understand the bases for Introduction to Nanotechnology |
| CO-2 | To impart understanding on Nanoparticle based Drug Delivery. |
| CO-3 | Fabrication of nanomaterials for bone tissue grafting |
| CO-4 | Methods of Nanofabrication |
| CO-5 | Understand the application of Nanotechnology |

**Unit I**

Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of nanobiomaterials -Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size deoendent variation in the properties of Nanomaterials, Nature's Nanophenomena.

**Unit II**

Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials- Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.

**Unit III**

Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti-microbial coating – medical implants and paints, Application of Nanotechnology in textile industry.

**Unit IV**

Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia.

**Unit V**

Nanotoxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles, Nanoparticles in Mammalian systems and Health threats, Biological response and cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.

**Reference Books:**


- Nanotechnology, S.Shanmugam, Mjp publication. 2011.
- Advanced nanomaterials, kurt E. geckeler, Hiroyuki Nishide , Wiley VHC.2010.

- Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012.
- Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish.
- World scientific publishing co. pte. ltd. 2011.
- Oded Shoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
- Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
- Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.
- K.K.K.Jain 2006. Nanobiotechnology in Molecualr Diagnostics: Current Techniques and Applications Horizon Bioscience
- Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
- Andrze w. Miziolek, Shashi P.Karna, J malthew Mauro and Richard A.Vaia. 2005 Defense Applications of Nanomaterials :
- Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag (2004)
- The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag (2004)
- Nanomaterials for medical diagnosis and therapy, Challa Kumar, Wiley-VCH, 2007.
- Nanotechnology for cancer therapy, Mansoor M. Amiji, CRC Press, 2007.
- K.K.Jain, Nano Biotechnology, Horizions Biosciences, 2006
- Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, Wiley VCH, 2008
- Cato T. Laurencin and Lakshmi S. Nair, Nanotechnology and Tissue Engineering The
- Scaffold, CRC Press taylor& Francis Group.
- Introduction to Nanoscience and Nanotechnology, Gabor .L et al, Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009.
- Assessing Nanoparticle Risks to Human Health, Gurumurthy Ramachandran, Elesvier, 2011.
- Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.
- Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press, 2013

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35B | MOLECULAR DEVELOPMENTAL BIOLOGY | 4 | 1 | 0 | 3 |

**Course Objective:**To understand the mechanisms of cell development, and mechanisms that ensure consistency and reliability of development.

Course Outcome:

- The students will be able to understand the basic concepts of development and the role of genes in sex determination
- Understand the concept of abnormal differentiation
- Apply the knowledge of developmental biology in Assisted Reproductive Technologies (ART)

**Unit I:** Phases of development Developmental patterns among Metazoans – Gametogenesis: Structure of Mammalian gametes. Fertilization: Biochemical events, Cleavage (patterns & types), Gastrulation: Germ layer formation. Organogenesis. Growth and differentiation.

**Unit II:** Embryonic induction and organiser Embryonic induction. Organizers - Spemann and Mangold experiments. Molecular biology of the Nieuwkoop center - Functions of organizer – Induction Regional specification types – Nuclear transplantation - Imprinting- Cell aggregation and differentiation in Dictyostelium.

**Unit III:** Metamorphosis and regeneration Influence of hormones on growth and metamorphosis of Insects and Amphibians – Formation of limb bud inAmphibia – Specification of limb fields – Induction of early limb bud – Eye lens induction-Cell death and the formation of digits and joints.

**Unit IV:** Differentiation and aging Teratogenesis: Teratogenic agents. Embryonic induction and differentiation. Embryonic induction in vertebrates: Types – exogenous and endogenous. Theories of organizer or inductor. Morphology – Chemical basis of neural induction.

**Unit V:**Advanced Techniques In Developmental Biology Assisted Reproductive Technology (ART) , Super ovulation, ICSI, GIFT- Artificial insemination, In vitro fertilization.

**REFERENCES;**

1. Balinsky, Boris I, and B.C Fabian. An Introduction to Embryology. Philadelphia: Saunders College Publishing, 1981.
2. Berrill, N.J. Developmental Biology. New Delhi: Tata McGraw-Hill, 1979.
3. Browder, Leon W. Developmental Biology. Philadelphia: Saunders College, 1980.
4. Di, Castri F, and T Younes. Biodiversity, Science and Development: Towards a New Partnership. Wallingford, Oxon, UK: CAB International in association with the International Union of Biological Sciences, 1996.
5. Gilbert, Scott F, and Michael J. F. Barresi. Developmental Biology. , 2020.
6. Kaur, H. Environmental Chemistry. Meerut: Pragati Prakashan, 2010.
7. Oppenheimer, Steven B, and George Lefevre. Introduction to Embryonic Development. Englewood, Cliffs, NJ: Prentice Hall, 1989.
8. Strickberger, Monroe W, Monroe W. Strickberger, Benedikt Hallgri msson, and Brian K. Hall. Strickberger's Evolution: The Integration of Genes, Organisms and Populations. Sudbury, Mass. [etc.: Jones and Bartlett Publishers, 2008.
9. Tacconi, Luca. Biodiversity and Ecological Economics: Participatory Approaches to Resources Management. Sterling, Va: Earthscan Publications, 2000.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35D | VERMITECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:** The objective of this course is to equip students with knowledge and practical skills in vermiculture, focusing on earthworm biology, farming techniques, and the production of organic fertilizers like vermicompost. Students will learn to manage small and large-scale earthworm farming, understand its environmental benefits, and explore its role in sustainable agriculture.

**Course Outcome:** The outcome of this course will be students' ability to apply vermiculture practices to enhance soil health, reduce waste, and promote organic farming, while also understanding the commercial aspects and co-operative structures that support agricultural development.

**UNIT 1**

Introduction to vermiculture. definition, meaning, history, economic important, their value in maintenance of soil structure, role as fourr's of recycling reduce, reuse, recycle, restore. 2. His role in bio transformation of the residues generated by human activity and production of organic fertilizers. How does nature works. 3. The matter and humus cycle (product, qualities). Ground population, transformation process in organic matter. 4. Choosing the right worm. Useful species of earthworms. Local species of earthworms.

**UNIT 2**

1. Key to identify the species of earthworms. 2. Biology of Eisenia fetida. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of Eisenia fetida: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Complementary activities of auto evaluation. 3. Biology of Eudriluseugeniae. a) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. b) Vital cycle of Eudriluseugeniae: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Complementary activities of auto evaluation.

**UNIT 3**

1. Small Scale Earthworm farming for home gardens - Earthworm compost for home gardens 2. Conventional commercial composting - Earthworm composting larger scale 3. Earthworm Farming (Vermiculture), Extraction (harvest), vermicomposting harvest and processing. 4. Nutritional Composition of Vermicompost for plants, comparison with other fertilizers 5. Vermiwash collection, composition &use 6. Enemies of Earthworms, Sickness and worm's enemies. Frequent problems. How to prevent and fix them. Complementary activities of auto evaluation.

**UNIT 4**

1. Effect of vermicompost application on soil and plant growth, 2. Vermicompost as a organic manure a good substitute of fertilizers. 3. Influence of pests and microbes on vermiculture, measures to control them. 4. Marketing of vermicomposting products and financial support by governments and NGOs for vermiculture.

**UNIT 5**

Co-operative Credit Societies- Functions, Structure Importance and Problems, District Central Co-operative Banks - Functions, Structure , Importance and Problems, State Cooperative Banks- Role and urban, Urban Co-operative Banks, Nationalized Banks, Regional Rural Bank, Need and Importance, Structure, development and present position of Co-operative Marketing, Problems and Remedies of co-operative marketing, Role of NAFED, E-Marketing, Role of Co-operative Processing Societies in Development, Sugar Co-operatives – Present Position and Problems, Dairy Co-operatives- Present Position and Problems, Poultry Farming, Cotton Industry, Horticultural, Floricultural and Medical Plants Process Industry, Fisheries, Meaning & definition of Agriculture Transport, Role of Transportation in agriculture, Types of Transportation, Importance of Transportation in Agriculture.

**REFERENCE:**

1. Bhatt J. V. & S. R. Khambata (1959) “Role of Earthworms in Agriculture” Indian Council of Agricultural Research, New Delhi.

2. Dash, M.C., B.K.Senapati, P.C. Mishra (1980) “ Verms and Vermicomposting” Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa.

3. Edwards, C.A. and J.R. Lofty (1977) “Biology of Earthworms” Chapman and Hall Ltd., London.

4. Lee, K.E. (1985) “Earthworms: Their ecology and Relationship with Soils and Land Use” Academic Press, Sydney.

5. Kevin, A and K. E .Lee (1989) “ Earthworm for Gardeners and Fisherman” (CSIRO, Australia, Division of Soils)

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35E | PHARMACEUTICAL TECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:** The aim of this course is to • provide comprehensive information on synthesis and characterization of heterocyclic compounds • provide comprehensive information on tests for impurities and pharmaceutical aids • provide comprehensive information on coordinate compounds and their applications in medicine.

**Course Outcome:** At the end of the course the students will be able to, CO1 understand the importance of micromeritics in dosage form design CO2 understand the surface, interfacial phenomena and the rheology of liquids CO3formulate and evaluate liquid dispersions CO4 carry out dissolution and diffusion studies CO5 determine half -life and shelf life of pharmaceutical products.

**UNIT 1**

Classification of heterocyclic compounds, nature and nomenclature, preparation and important reactions of pyrrole, furan, thiophene, pyrazole, imidazole, oxazole, isoxazole, thiazole, pyridine, pyrimidine, indole, quinoline, isoquinoline, acridine, phenothiazine, azepines, diazepines, quinolones and quinazolines and structural examples of medicinal compounds and examples prototype pharmaceutical compounds.

**UNIT 2**

Definition, principles and properties of various agents such as – Sodium bisulphate, Sodium metabisulphite, Sulphur dioxide, Bentonite, Magnesium stearate, Zinc stearate, Aluminium sulphate, Sodium carboxymethyl cellulose, Sodium methyl paraben. Theory of coordination compounds with special reference to application in Pharmacy such as – EDTA, Dimercaprol, Penicillamine, 1, 10-Phenanthroline.

**UNIT 3**

Liquid interface, surface and interfacial tension, surface free energy, measurement of surface and interfacial tensions, free energy, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interface, solid gas and solid-liquid interface, complex films, electrical properties of the interface. Newtonian system, Law of flow, kinematic viscosity, effect of temperature on viscosity, non-Newtonian systems, plastic, pseudoplastic, dilatant, thixotropy, thixotropy in formulation, determination of viscosity: capillary, falling ball, rotational viscometers.

**UNIT 4**

Definitions, Steady state diffusion, Procedures and apparatus for diffusion, dissolution and drug release, factors affecting dissolution, Complexation and protein binding; Metal complexes, organic molecular complexes, inclusion compounds, methods of analysis of complexes, crystalline structures of complexes and thermodynamic basis of stability constants. Protein binding and drug action, protein binding studies.

**UNIT 5**

General considerations and concepts of drug reaction kinetics; zero order, first order and pseudo first order, half-life determination, Influence of temperature, light, catalytic species, solvent and other factors, Stabilization of drugs, Accelerated stability study – shelf-life

**REFERENCE:**

1. Eugene L. Parrott, WitoldSaski, Experimental Pharmaceutics, IVth Ed, Burgess Pub. Co., 1977.
2. Liberman H.A., RiEgor M.M, & Banker GS. Pharmaceutical dosage forms – Disperse systems, Vol 1, 2 and 3, IInd Edition, Marcel Dekker Inc, New York, 1996.
3. Morrison R.T., Boyd R.N., "Organic Chemistry", Prentice- Hall of India, VI edition, 1992.
4. A.I. Vogel, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell, Vogels "Textbook of Practical Organic Chemistry", V Edition., ELBS longman, 1994.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35F | BIOPESTICIDES | 4 | 1 | 0 | 3 |

**Course Objectives:** The objective of this course is to provide students with an in-depth understanding of biofertilizers, their types, and the key microbes involved, such as Rhizobium, Azospirillum, Azotobacter, and Mycorrhiza. The course will cover the cultivation, maintenance, and application of these microorganisms, along with their role in organic farming and soil fertility. Students will also learn about biopesticides, including Bacillus thuringiensis, insect viruses, and entomopathogenic fungi, and their use in pest control.

**Course Outcome:** The outcome of this course will be students' ability to effectively use biofertilizers and biopesticides in agricultural practices, enhancing plant growth and sustainable farming methods.

**UNIT 1**

Biofertilizers – Definition, kinds, microbes as biofertilizers, Symbiotic associates – Rhizobium taxonomy, Physiology, Host cell – Rhizobium interactions, mass cultivation, inoculants and serology.

**UNIT 2**

Frankia woodland and Actinornizal nitrogen fixing plants and its host plants, characteristics, identification, cultural method and maintenance of Azospirillum, Azotobacter, Azolla and anabaena.

**UNIT 3**

Mycorrhiza - VAM association, types, occurrence, Collection, isolation and inoculum production.

**UNIT 4**

Large scale production of biofertilizer, Organic farming Carrier materials, general outline of microbes as fertilizers, Rhizosphere effect microbial products influencing plant growth.

**UNIT 5**

Biopesticides – Definition, kinds and commerce of biopesticide, Bacillus thuringiensis, insect viruses and entomopathogenic fungi – its characteristics, physiology, mechanism of action and application.

**REFERENCE:**

1. Subba Rao, N.S. 2000 Soil Microbiology. Oxford and IBH Publishing Co. Ltd.

2. Verma A and Hock B. 1995. Mycorrhiza. ISBN

3. Yaacovokan, 1994 - Axospirillum, CBC press.

4. Wicklow, D.T. and B.E. Soderstrom. 1997, Environmental and microbial relationships.. Springer ISBN.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35H | FOOD FERMENTATION TECHNIQUES | 4 | 1 | 0 | 3 |

**Course Objectives:** Students will become knowledgeable in the following topics: Identity, characteristics, and sources of microorganisms in food fermentations. Metabolic activities of microorganisms and their influence on product attributes. Interactions between microorganisms. Processing of fermented foods. Growth, maintenance, and preservation of microbial starter cultures. Problems that may arise during fermentations and solutions.

**Course Outcome:** The Food Fermentation Techniques course equips students with a deep understanding of the science, microbiology, and practical applications of food fermentation. Students will learn various fermentation methods, the role of microorganisms, and the health benefits of fermented foods.

**UNIT 1** Basic terms used in study of food and nutrition, Body Mass Index (BMI) and Nutritional Status, Understanding Relationship between food, nutrition and health. Definition of calorie & Joule, Measurement of basic nutrients. Functions of food-physiological, psychological and social, Concept of Balanced Diet, Malnutrition – over and under. Basic Food Groups, Food Pyramid.

**UNIT 2** Classification, digestion, functions, dietary sources, requirement, Clinical manifestations of deficiency and excess and factors affecting absorption of carbohydrates. Classification, digestion, functions, dietary sources, requirement, evaluation of protein quality, Clinical manifestations of deficiency and excess and factors affecting absorption of proteins .Classification, digestion, functions, dietary sources, requirement, essential fatty acids, PUFA, Cholesterol, Clinical manifestations of deficiency and excess and factors affecting absorption of Lipids.

**UNIT 3** Classification, digestion, functions, dietary sources, requirement, effects of deficiency (Vitamin A, D, K).Classification, digestion, functions, dietary sources, requirement, effects of deficiency (Iodine, Sodium and Potassium). Chlorophyll, Flavanoids, Anthocyanins, Anthoxanthins, Colloidal chemistry, Properties of solutions, Sols & Suspensions, Food colloids.

**UNIT 4** Classification of enzymes, Source of enzymes in food, Use of enzymes in food, Enzymatic and non-enzymatic reactions during storage. Dry, moist, frying and microwave cooking, Advantages, disadvantages and the effect of various methods of cooking on foods, Changes in food during cooking using dry heat, moist heat, heated oil and microwave.Importance, global trends, codex guidelines, nutritional labeling in India, FSSAI guidelines.

**REFERENCE:**

1. Bamji MS, Krishnaswamy K, Brahmam GNV. Textbook of Human Nutrition, 3 rdEdition. Oxford and IBH Publishing Co. Pvt. Ltd. 2009.
2. Srilakshmi. Food Science, 4 thEdition. New Age International Ltd, 2007.
3. Srilakshmi. Dietetics, Revised 5 thedition. New Age International Ltd. 2005.
4. Wardlaw MG, Paul M Insel Mosby. Perspectives in Nutrition, 3 rdEdition, 1996.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC35I | MICROBIAL DIAGNOSIS IN HEALTH CLINICS | 4 | 1 | 0 | 3 |

**Course Objectives:** The objective of the Microbial Diagnosis in Health Clinics course is to equip students with the knowledge and skills necessary to identify and diagnose microbial pathogens using various diagnostic techniques.

**Course Outcome:** The outcome of this course will be students' ability to apply diagnostic techniques for the identification of bacterial, viral, fungal, and parasitic infections, ensuring effective patient management and treatment in health clinics.

**UNIT 1** Definition and Importance of Microbial Diagnosis, Overview of Microbial Pathogens: Bacteria, viruses, fungi, and parasites. Principles of Diagnostic Microbiology: Techniques and tools used in diagnosis. Role of Microbial Diagnosis in Health Clinics: Patient management and infection control. Types of Samples for Microbial Diagnosis: Blood, urine, sputum, swabs, etc.

**UNIT 2** Basic Laboratory Techniques: Staining (Gram, acid-fast, etc.), culture media, and incubation methods. Microscopic Examination: Direct microscopy, wet mounts, and special staining techniques. Biochemical and Immunological Methods: Catalase test, oxidase test, ELISA, and PCR. Molecular Diagnostic Techniques: PCR, DNA sequencing, and microarray. Serological Testing: Detection of antibodies and antigens.

**UNIT 3** Diagnostic Techniques for Bacterial Infections: Culture, biochemical testing, and susceptibility testing. Common Bacterial Pathogens in Health Clinics: Staphylococcus aureus, Escherichia coli, Mycobacterium tuberculosis, etc. Identification and Antibiotic Resistance: Antimicrobial susceptibility testing and resistance mechanisms. Case Studies: Diagnosing bacterial infections and treatment options.

**UNIT 4** Diagnostic Approaches for Viral Infections: Viral culture, PCR, antigen detection, and serology. Common Viral Infections in Health Clinics: Influenza, HIV, Hepatitis, Herpes simplex, etc. Fungal Infections and Diagnosis: Culture, microscopy, and serological methods. Identification of Fungal Pathogens: Candida, Aspergillus, Cryptococcus, etc. Case Studies: Diagnosing viral and fungal infections and their clinical relevance.

**UNIT 5** Diagnostic Methods for Parasitic Infections: Stool examination, blood smears, serology, and PCR. Common Parasitic Infections in Health Clinics: Malaria, Giardia, Toxoplasmosis, etc. Emerging Infectious Diseases and Diagnostic Challenges: Zoonotic diseases, antibiotic-resistant pathogens, and global health threats. Role of Microbial Diagnosis in Disease Surveillance: Public health implications and outbreak detection.

**REFERENCE:**

1. Mackie & McCartney's Practical Medical Microbiology
2. Medical Microbiology(Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller)
3. Diagnostic Microbiology and Infectious Disease (James Versalovic)

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **23217SEC36** | MOLECULAR BASIS OF DISEASE | 4 | 1 | 0 | 3 |

**Course Objectives:**

The course aims to integrate molecular aspects of chronic human disease into the context of histopathology and macroscopic specimens for each above disease topics outlined in the timetable and in Moodle. Furthermore, course aims mesh well with other disciplines including Anatomy, Biochemistry, Molecular Biology, Immunology, Microbiology, Pharmacology and Physiology.

**Course outcomes:**

CO-1 Account for the basic terms, principles and mechanisms within general pathology
CO-2 Explain about molecular and cellular pathophysiological mechanisms for common disorders
CO-3 To know about molecular basis of human diseases
CO-4 To identify the molecular basis of ischaemic diseases
CO-5 Give an account of the molecular connections in organ system-related diseases

**Unit I**

Intro to Infectious Disease Diseases - Clinical Epidemiology - Pathology of Human Disease, genes, cell cycles, and chromosomes, Human disease pedigree and hemophilia

**Unit II**

Molecular basis of infectious diseases a Tuberculosis, Amoebiasis, Malaria. Genetic Neuropathies - Parkinson's Disease - Mitochondrial Disorders - lysosomal disorders, storage disorders

**Unit III**

Signaling pathways and their disruption in cellular adaptation mechanisms including hypertrophy, hyperplasia, atrophy and metaplasia, leading to manifestation of signs and symptoms in diseases such as cardiac failure, obesity, diabetes, cancer, etc

**Unit IV**

Molecular basis of ischaemic diseases a Myocardial ischaemia and infarction including new diagnostic parameters, Cerebral ischaemia and infarction , ischaemic limb disorders , renal failure a acute and chronic, ischaemic placental disorder and foetal mal developments , obesity , Rheumatoid Arthritis.

**Unit V**

Molecular basis of metabolic diseases. Organ Transplantation - Heart Failure

**Reference Books:**

- Principles of Gene Manipulation ,Sandy B. Primrose, Richard Twyman, Bob Old,Wiley, 08- Feb-2002

- From Genes to Genomes: Concepts and Applications of DNA Technology. Jeremy W Dale and Malcom von Schantz Copyright 2002 John Wiley & Sons, Ltd.
- Synthetic Biology: Tools and Applications. Edited by Huimin Zhao.Academic Press. Amsterdam (The Netherlands) and Boston (Massachusetts): Elsevier. ISBN: 978-0-12- 394430-6. 2013.


**URL**

- Metabolic and Molecular Bases of Inherited Disease (MMBID) – 8th Edition – http://ommbid.mhmedical.com, on Pitt campus or through Pulse Secure VPN
- Online Mendelian Inheritance in Man, OMIM: https://www.omim.org/
- Genetics Home Reference: https://ghr.nlm.nih.gov/
- Gene Reviews: https://www.ncbi.nlm.nih.gov/books/NBK1116/
- Molecular Biology of the Cell (Alberts) 4th edition available from NCBI Bookshelf, https://www.ncbi.nlm.nih.gov/books/NBK21054/

## SEMESTER IV

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC41 | PROTEOMICS | 4 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

To understand the proteins enclosed by the genes with respect to structure, function, protein – protein interactions, techniques for separation and analysis, database and applications.

**COURSE OUTCOME:**

- Gain knowledge on phylogenetic profiles
- Describe the features of Yeast two-hybrid system.

**UNIT I INTRODUCTION:** Proteomics introduction – Protein sequencing – Protein Digestion Techniques – Mass Spectrometers for Protein and Peptide Analysis – Protein Identification by Peptide Mass Fingerprinting – Software Tools for Peptide Mass Fingerprinting: Finding the Matches – Peptide Sequence Analysis and Protein Identification with Tandem Mass Spectrometry

**UNIT II PROTEOME DATABASES:** Proteome databases – Comparative proteomics methods – 2D gel databases – Protein interaction data bases – Metabolic pathway databases – resources for interaction prediction – network and pathway visualization tools – Protein network analysis

**UNIT III PROTEOMICS TOOLS:** 2D gel electrophoresis and Mass spectra – Protein identification from 2D gel, mass spectra and sequence data – Protein property prediction – bulk, active sites, modification sites, interactive sites, location, localization, stability, shape, domains properties, secondary and tertiary structures – Protein identification programs – Muscot – Peptldent – Protein prospector – GFS

**UNIT IV FUNCTIONAL PROTEOMICS:** Functional proteomics – protein phenotypes – Protein-Protein Interaction Mapping: Experimental – Yeast two-hybrid system – phage display – protein fragment complementation assays – Computational approach

**UNIT V APPLICATION OF PROTEOMICS:** Applications of Proteomics – Protein Expression Profiling – Identifying Protein – Protein Interactions and Protein Complexes – Mapping Protein Modifications – Protein Arrays and Protein Chips – Application of proteomics to medicine, toxicology and pharmaceuticals

**REFERENCES**


- Baxevanis D and Ouellette BFF, Bioinformatics: A practical guide to the analysis of genes and proteins (3rd Edn.), John Wiley & Sons, Inc. 2005.
- . Baxevanis D and Ouellette BFF, Bioinformatics: A practical guide to the analysis of genes and proteins (2nd Edn.), John Wiley & Sons, Inc. 2002.
- Brown TA, Genomes (2nd Edn.), BIOS Scientific Publishers, Oxford, UK, 2002.
- Sensen CW, Essentials of Genomics and Bioinformatics, Wiley–VCH. 2002.
- Sensen CW, Hand book of Genome Research, Wiley–VCH Verlag GmBh & Co

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217AEC42 | GENOMICS | 4 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

To study prokaryotic and eukaryotic genomes, general methods of genome sequencing techniques, genome analysis and annotations, genome mapping techniques and applications of genomics.

**COURSE OUTCOME:**

- Acquire the aspects of Gene Contig and Shotgun method.
- Know the features of the Genome Mapping databases.

**UNIT -I INTRODUCTION:** Genome structure and anatomy of prokaryotic and eukaryotic genome – Nuclear genomes – Organelle genomes – Repetitive DNA sequence – Transposable elements– Pseudo genes – Genome databases – organisms-specific databases.

**UNIT -II GENOME SEQUENCING DNA:** sequencing techniques: Maxam Gilbert method – Sanger‟s method – Pyrosequencing – Whole genome sequencing – Gene Contig and Shotgun method – Human genome project.

**UNIT -III GENOME ANALYSIS AND ANNOTATION:** Searching and locating Genes – Programs and databases – Determining function of genes – Gene Prediction – Methods of gene prediction – Softwares and tools.

**UNIT -IV GENOME MAPPING:** Mapping databases – Types of mapping – Genetic mapping: DNA markers – RFLP, SSLP, RH maps, SNP – Linkage analysis – Physical mapping: Restriction mapping – FISH – STS mapping

**UNIT -V APPLICATIONS OF GENOMICS DNA:** microarray and its applications – Medical applications: Development of Antibiotics – Vaccines – Drug discovery – Human genetics diseases: Identification – Gene Diagnosis and Gene therapy– Genomics in Plant Biology.

**REFERENCES:**


- Brown T.A., Genomes 3 (3rd Edn.), Garland Science Publishing, New York, 2007.
- Brown T.A., Gene Cloning and DNA Analysis – An Introduction (6th Edn.), A John Wiley & Sons, Ltd., Publications, UK, 2010.
- Jeremy W. Dale and Malcolm von Schantz, From Genes to Genomes – Concepts and Applications of DNA Technology, John Wiley & Sons, Ltd., Publications, UK, 2002.
- Richard J. Reece, Analysis of Genes and Genomes, John Wiley & Sons, Ltd., Publications, UK, 2004.

## DISSERTATION

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217PRW43 | PROJECT VIVA | 0 | 0 | 10 | 4 |

**COURSE OBJECTIVES:**

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of pursuing research.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **23217DSC44A** | **DISCIPLINE SPECIFIC ELECTIVE COURSE-IV STEM CELL BIOLOGY** | 4 | 1 | 0 | 3 |

**Course Objectives:**

The subject imparts knowledge on the fundamentals of stem cells. The student will be provided with a basic knowledge and understanding about the application of stem cell biology.

**Course Outcomes**:

At the end of the Course, the Student will be able to:

CO1 To understand the major discoveries of stem cell biology
CO2 To provide basic knowledge about stem cell niche and functions
CO3 To enlighten the students on Stem cell isolation and culture techniques
CO4 To update the knowledge on Stem cell cycle
CO5 To assess and appraise Applications of Embryonic stem cells.

**Unit- I**

Stem cells - Definition, Characterization, Pluripotency, Self-renewal and differentiation. Types of stem cells- Embryonic stem cells, Adult stem cells and mesenchymal stem Cells, Adipose stem cells

**Unit-II**

Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells

**Unit-III**

Stem cell isolation and culture techniques. Characterization of stem cells

**Unit-IV**

Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control

**Unit-V**

Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research

**Reference Books:**


- Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
- Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
- Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer, STEM CELL TECHNOLOGY Syllabus - Semester First References:
- Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.
- Progress in gene therapy, Volume 2,Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers
- Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,
- Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **23217DSC44B** | **DISCIPLINE SPECIFIC ELECTIVE COURSE- IV**<br><br>**BIOETHICS, HUMAN RIGHTS AND SOCIAL ISSUES** | 4 | 1 | 0 | 3 |

**COURSE OBJECTIVES:**

This course provides the guidelines and regulations governing research; evaluate ethical conduct and social responsibilities; to adhere to safe working practices; to appreciate the need for protection of human subjects; to recognize the potential harms in research and show sensitivity to cultural and ethical issues; to create a general awareness about IPR.

**Course outcomes:**

| | |
|---|---|
| CO-1 | Understand the basics of biosafety and bioethics and its impact on biological sciences and the importance of human life. |
| CO-2 | Apply the knowledge to recognize the importance of biosafety guidelines and good clinical practices. |
| CO-3 | Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health. |
| CO-4 | Evaluate the benefits of GM technology and importance of IPR |
| CO-5 | Analyse the importance of protection of new knowledge and innovations and its role in business and entrepreneurship |

**Unit I**

Introduction to Bioethics Need for bioethics in social and cultural issues. Bioethics & GMO's Issues and concerns pertaining to Genetically modified foods & food crops, Organisms and their possible health implications and mixing up with the gene-pool. Bioethics in Medicine Protocols of ethical concerns related to prenatal diagnosis, gene therapy, Organ transplantation, Xenotransplantation, Containment facilities for genetic engineering experiments, regulations on field experiments and release of GMO`s labeling of GM foods.

**Unit II**

Clinical trials –Regulations. Bioethics & Cloning Permissions and Procedures in Animal Cloning, Human cloning, Risks and hopes. Bioethics in Research Stem cell research, Human Genome Project, Use of animals in research, human volunteers for Clinical research, Studies on Ethnic races. Ethics in patient care, Informed consent.

**Unit III**

Biosafety – Biological risk assessment. Biological agents and Hazard groups. Criteria in biological risk assessment. Guidelines for categorization of genetically modified plants for

field test. Regulation, national and international guidelines of Biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP. Biosafety levels. Safety equipments and Biological Safety cabinets.

**Unit IV**

SAFETY, RESPONSIBILITIES AND RIGHTS: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk – the three mile island and case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights.

**Unit V**

Multinational corporations - Environmental ethics - computer ethics - weapons development and bioterrorisms - engineers as managers-consulting engineers-engineers as expert witnesses and advisors - moral leadership-sample code of Ethics.

**Reference Books:**


- "Bioethics & Biosafety" by Sateesh MK, IK International publications, 2008
- USPTO Web Patent Databases at: www.uspto.gov/patft
- Government of India's Patents Website: patinfo.nic.in
- Intellectual property India: www.ipindia.nic.in
- "Indian Patent Law : Legal and Business Implications" by Ajit Parulekar, Sarita D'Souza Macmillan India publication, 2006
- "Agriculture and Intellectual Property Rights", edited by: Santaniello,V., Evenson, R.E., Zilberman, D. and Carlson, G.A. University Press publication, 2003
- Research papers and Reports provided from time to time
- Ganguli P, (2001), Intellectual Property Rights, Tata Mcgraw Hill.
- Ramesh Chandra, (2004), Issues Of Intellectual Property Rights, Isha Books.
- Erbisch F.h., Maredia K.M, (2000), Intellectual Property Rights In Agricultural Biotechnology, Universities Press.
- Shiv Sahai Singh, (2004), Law Of Intellectual Property Rights, Deep & Deep Publications (p) Ltd.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC44C | **DISCIPLINE SPECIFIC ELECTIVE COURSE- IV**<br>BIOSTATISTICS | 4 | 1 | 0 | 3 |

**Course Objectives:**

This course aims to provide students with knowledge of random variables and their distributions, particularly in univariate cases and order statistics. Students will earn various sampling techniques for survey design, including finite population methods and the estimation of population parameters. It will also cover unequal probability sampling methods and non-probability sampling techniques, with a focus on biostatistical applications. Additionally, students will understand disease frequency measures and epidemiological analysis and develop skills for analyzing bioassay data using statistical methods like ratio estimators and Filler's theorem.

**Course Outcome**: By the end of the course, students will gain a deep understanding of random variables and their distributions, including the exponential family, location and scale families and symmetric distributions. They will be able to apply sampling techniques, including SRSWR and SRSWOR, estimate population parameters, and handle sampling errors.

**UNIT 1**

Functions of random variables, their distributions in case of univariate random variables and its applications. Exponential family of distributions. Location and scale families, non-regular families. Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples.

**UNIT 2**

Concepts of population and sample, need for sampling, census and sample surveys, designing of a questionnaire, sampling and non-sampling errors, sample size determination, finite population sampling techniques-SRSWR, SRSWOR, estimation of mean and total in each case and their variances.

**UNIT 3**

Unequal probability sampling: PPSWR Methods: cumulative total method, Lahiri's method, related estimation problems, PPSWOR method and related estimation of a finite population mean, Horvitz- Thompson estimator of a finite population total/mean and expressions for variance and its unbiased estimator. Non-probability sampling: Incidental sampling, quota sampling, purposive sampling, snowball sampling, convenience sampling, consecutive sampling. Examples based on biostatistical experiments.

**UNIT 4**

Disease registries, International classification of diseases. Measures of disease frequency: Prevalence, Incidence, Risk, Odds of disease, Incidence time, Relationship between prevalence, rate and risk, measures of disease occurrence, direct and indirect method of standardization, cumulativerate, cumulative risk, proportional incidence. Confidence intervals and significance tests for measures of occurrence and effect.

**UNIT 5:**

Introduction, component of bioassay, role of statistics in bioassay, Type of biological assays: direct assays, indirect assays, parallel line assays, ratio estimators, asymptotic distributions, Filler's theorem.

**REFERENCE:**

1. Kempthorne O. (2007): Design and Analysis of Experiments, 2nd Edition, Vol I-II, Wiley.
2. Montgomery D.C. (2008): Design and Analysis of Experiment, 7th Edition, John Wiley & sons.
3. Dass M.N. and Giri N.C. (1986): Design and Analysis of Experiments, 2nd Edition, Wiley.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **23217DSC44C** | **DISCIPLINE SPECIFIC ELECTIVE COURSE- IV**<br>MICROBIOLOGICALANALYSISOFAIRANDWATER | 4 | 1 | 0 | 3 |

**Course Objectives**: This course aims to equip students with foundational knowledge about bioaerosols, including airborne microorganisms and their environmental impact, particularly in human health and industries like food, pharmaceuticals, and healthcare. It will provide a detailed overview of bioaerosol sampling techniques, including the use of air samplers and identification methods for bacteria and fungi.

**Course Outcome**: Upon completing the course, students will have a comprehensive understanding of bioaerosols, the role in human health, and their significance in various industries such as food, pharmaceuticals, and healthcare. They will gain expertise in the methods used for bioaerosol sampling, analysis, and identification of airborne microorganisms, including bacteria, viruses, and fungi.

**UNIT 1:**

Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their and environment, impact on human health significance in food and pharma industries UNIT and operation theatres, allergens.

**UNIT 2:**

Bioaerosol sampling, air samplers, methods of bacteria and analysis, CFU, culture media for fungi, ldentification characteristics.

**UNIT3:**

Fate of bioaerosols, inactivation mechanisms UV light, HEPA filters, desiccation, Incineration.

**UNIT 4:** Sample Collection, Treatment and safety of drinking (potable) water, methods to potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (¢) Presence/absence tests.

**UNIT 5:**

Precipitation, chemical disinfection, filtration, high temperature, UV light.

**REFERENCE:**

1. NS.SubbhaRao,SoilMicrobiology,SciencePublisher.1SBN:9781$78080700
2. Dubey R.C. Advanced Biotechnology.
3. P.D. Sharma, S. Chand & Co. P Ltd, New Delhi, p. I161; ISBN: 81:2194290-X. Microbiology, Rastogi Publication ISBN: 978-8171339358.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC45A | **DISCIPLINE SPECIFIC ELECTIVE COURSE- V**<br>INDUSTRIAL BIOTECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:** To study the application of studied biotechnology fundamentals in an industrial set up with an added emphasis of industrial bioproduction in India.

**Course Outcomes:**

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

**CO 1** Identify industrially relevant microorganisms and their isolation and screening techniques along with the substrates used for industrial fermentations.

**CO 2** Explain the basic fermentations processes and the design of various industrially used bioreactors.

**CO 3** Understand the methods and processes for industrial bio production of commonly used

**CO 4** primary and secondary microbial metabolites. Relate the production of bio products in India with the case studies of ethanol and the corona virus vaccine by studying the process, problems and compare them to production in the global market.

**UNIT I**

Industrial Fermentation: An overview, isolation, screening and selection of industrially important microorganisms, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes used in the industry - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations with examples.

**UNIT II**

Industrial Bioreactors: Design and components of basic fermentor, specialized fermentors for specific purposes – continuous, anaerobic, for gaseous nutrients, for treatment of wastes, trickle flow reactors, cyclone reactors, submerged types, tube reactors, bubble reactors, packed bed reactors, lab scale to pilot to industrial – Scale up process, online monitoring.

**UNIT III**

Primary products of microbial production: Single cell protein, amino acids (lysine and glutamic acid), production of citric acid by Koji process and submerged process production, nucleic acids. Acetone - butanol fermentation, glycerol from yeasts and bacteria

**UNIT IV**

Secondary products of microbial metabolism, Antibiotics (penicillin, tetracycline), alkaloids, taxol, Microbial polysaccharides (xanthan, dextran, alginate, gellan, cellulose, curdlan, pullulan, scleroglucan) and polyesters - bioplastics (polyhydroxyalkanoates)

**UNIT V**

Industrial case studies: Case Study of Covid 19 Vaccine Production in India- Types of Covid 19 Vaccines/ Scope and production methods and manufacturing companies. Industrial Economics of Covid 19 Vaccine Production in India for Global Markets. Advantages of India as a global vaccine manufacturing hub.

**Reference Books**

1. Stanbury, P.F and Whittacker; "Principles of Fermentation technology", Pergamon. Press Oxford
2. Michael L Shuler and Fikret Kargi., "Bioprocess Engg.: Basic concepts", Prentice Hall, New Delhi.
3. M.Yoong (Ed-in-Chief)., "Comprehensive Biotechnology", Vol 3 , Pergamon, Oxford.
4. B.D.Singh., "Biotechnology- Expanding Horizons", Kalyani Publishers ,NewDelhi.
5. H.K.Das., "Text book of Biotechnology", Wiley Publications , New Delhi.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC45B | DISCIPLINE SPECIFIC ELECTIVE COURSE- V<br>PHARMACEUTICAL BIOTECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:**

Upon completion of the subject student shall be able to

1. Understanding the importance of Immobilized enzymes in Pharmaceutical Industries
2. Genetic engineering applications in relation to production of pharmaceuticals
3. Importance of Monoclonal antibodies in Industries
4. Appreciate the use of microorganisms in fermentation technology

**Unit I**

Brief introduction to Biotechnology with reference to Pharmaceutical Sciences - Enzyme Biotechnology- Methods of enzyme immobilization and applications - Biosensors- Working and applications of biosensors in Pharmaceutical Industries.

**Unit II**

Brief introduction to Protein Engineering - Use of microbes in industry. Production of Enzymes- General consideration Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase - Basic principles of genetic engineering.

**Unit III**

Cells and cellular processes: Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes; Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; Cell-ECM and cell-cell interactions; cell receptors and trans-membrane signaling; cell motility and migration; cell death: different modes of cell death and their regulation

**Unit IV**

Basic principles of biochemical engineering: Isolation, screening and maintenance of industrially important microbes; strain improvement for increased yield and other desirable characteristics.

**Unit V**

Enzyme fermentation using immobilized enzymes: Different techniques of immobilization of enzymes and whole cells; Advantages and disadvantages of immobilization, Application and future of immobilized enzyme technology.

Course outcomes

1. Know the significance and application of biotechnology in healthcare sector
2. Appreciate relevance of microorganisms from industrial context
3. Explain and apply design and operations of various fermenters; the fundamental principles for basic methods in production technique for bio-based products
4. Explain and apply of important microbial/enzymatic industrial processes

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC45C | **DISCIPLINE SPECIFIC ELECTIVE COURSE- IV** DOWNSTREAMPROCESSING | 4 | 1 | 0 | 3 |

**Course Objectives:** The primary goal of this course is to provide students with an in-depth understanding of the downstream processing of bioproducts. The course will cover the principles behind bio-molecule characteristics and bioprocesses, along with techniques for cell disruption, bio-product stabilization, and pre-treatment. It will introduce students to various physical methods of separation, such as filtration and centrifugation, and methods for isolating products, including adsorption, liquid-liquid extraction, and membrane separation techniques.

**Course Outcome:** Upon successful completion of the course, students will be equipped with a solid understanding of downstream processing techniques in biotechnology, including the principles, characteristics of bio- molecules, and bioprocesses. They will gain practical knowledge in various methods for cell disruption, bio-product stabilization, and pre-treatment processes.

**UNIT 1:** Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre-treatment and stabilisation of bio-products.

**UNIT 2:** Physical Methods of Separation – Unit operations for solid-liquid separation– filtration and centrifugation.

**UNIT 3:** Isolation of Products- Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

**UNIT 4:** Product Purification- Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.

**UNIT 5:** Final Product Formulation and Finishing Operations- Crystallization, drying and lyophilization in final product formulation

**REFERENCE:**


- Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006.
- Michael R. Ladisch Bioseparations Engineering: Principles, practice and Economics, Wiley Interscience, 1st Edition, 2001.
- Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| 23217DSC45D | **DISCIPLINE SPECIFIC ELECTIVE COURSE- IV** BIOPROCESSTECHNOLOGY | 4 | 1 | 0 | 3 |

**Course Objectives:** The objective of this course is to provide students with foundational knowledge in fermentation and bioprocess technology. It will cover the types of bioprocesses and the essential aspects of designing media for industrial bioprocesses, including nutrient requirements and sterilization techniques. Students will learn about bioreactor design and operation, as well as the challenges associated with scaling up bioprocesses.

**Course Outcome:** Upon completion of this course, students will gain a thorough understanding of the principles and techniques used in bioprocess technology and fermentation. They will be able to design and formulate media for industrial bioprocesses, select appropriate carbon and nitrogen sources, and understand the sterilization processes for media.

**UNIT 1**: The fundamental concept of Fermentation and bioprocess technology, Types of bioprocesses, Design and formulation of Media for industrial bioprocess, Criteria for medium design, carbon/nitrogen sources, nutrients, Sterilization of media

**UNIT 2**: Bioreactors, bioreactor design, criteria, operation and types of bioreactors. Agitation and aeration in the bioreactor, impeller and sparger design. Concept of scale up, scale up challenges. Influence of various bioprocess parameters viz. pH, temperature, medium components on product synthesis. Bioprocess monitoring and control, automated control vs manual control of bioprocesses.

**UNIT 3:** Downstream processing: definition, cost involved in downstream processing, Typical steps involved in Downstream processing. Criteria for downstream processing, Target application of product vs cost, separation of cells and broth.

**UNIT 4:** Typical unit operation for downstream processing filtration, centrifugation, chromatography, solvent extraction, HPLC. Methods for cell breakage for harvesting intercellular products.

**UNIT 5:** Commercial production of various bioprocess based products (Bioethanol, butanol, citric acid, acetic acid), Antibiotics-penicillin, streptomycin, tetracycline. Single cell protein; amino acids: glutamic acid, lysine, Types and nature of wastes generated from bioprocesses

**REFERENCE:**

1. "Bioprocess Engineering: Basic Concepts "by Michael L. Shuler and Fikret Kargi
2. "Principles of Fermentation Technology "by Peter F. Stanbury, Allan Whitaker and Stephen J. Hall
3. "Bioprocess Engineering Principles " by Pauline M. Doran
4. "Downstream Processing for Biotechnology" by L.M. Keith and David L. Irwin