**CENTRE FOR BIOTECHNOLOGY**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**Kukatpally, Hyderabad-500 085, Telangana State, India**

**Master of Science**

**in**

**MICROBIOLOGY**

 **(FTPG)**

**COURSE STRUCTURE**

**&**

**DETAILED SYLLABUS**

**W.E.F.2017**



# EACH SEMESTER IS APPROXIMATELY 20-21 WEEKS DURATION INCLUDING EXAMINATIONS. EACH PERIOD IS ABOUT 50 MINITUES DURATION. THERE WILL BE NORMALLY FOUR SESSIONS PER DAY EACH OF ABOUT 100 MINITUES DURATION. TWO SESSIONS OF LABORATORY IS EQUIVALENT TO ONE SESSION OF THEORY

**Centre for Biotechnology (CBT)**

**M.SC MICROBIOLOGY**

**Course Structure**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **II semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | MB-201 | Core Course IV | Bioanalytical Techniques | 25 | 75 | 4 | - | 4 |
| 2. | MB-202 | Core Course V | Immunology | 25 | 75 | 4 | - | 4 |
| 3. | MB-203 | Core Course VI | Virology | 25 | 75 | 4 | - | 4 |
| 4. | MB-204 | Core Elective II | (i) Industrial Microbiology(ii) Process Engineering  Principles  | 25 | 75 | 4 | - | 4 |
| 5. | MB-205 | Open Elective II | (i) Computers Programming  & Data Structures (ii) Bioethics, Biosafety and  Regulatory affairs | 25 | 75 | 4 | - | 4 |
| 6. | MB-206 | Laboratory III | Bioanalytical Techniques and Virology Lab  | 25 | 75 | - | 8 | 4 |
| 7. | MB-207 | Laboratory IV | Immunology and Industrial Microbiology Lab | 25 | 75 | - | 8 | 4 |
|  |  | **Total** | **175** | **525** | **20** | **16** | **28** |

 **(W.e.f-2017 Batch)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **I semester** | **Course Title** | **Int. Marks** | **Ext.****marks** | **L** | **P** | **C** |
|  | MB-101 | Core Course I | Cell Biology | 25 | 75 | 4 | - | 4 |
|  | MB-102 | Core Course II | Bacteriology | 25 | 75 | 4 | - | 4 |
|  | MB-103 | Core Course III | Biochemistry | 25 | 75 | 4 | - | 4 |
|  | MB-104 | Core Elective I | 1. Molecular Biology
2. Animal Cell Science and Technology
 | 25 | 75 | 4 | - | 4 |
|  | MB-105 | Open Elective I | 1. Basic Mathematics and Biostatistics
2. Bioentrepreneurship
 | 25 | 75 | 4 | - | 4 |
|  | MB-106 | Laboratory I | Cell Biology and Bacteriology Lab | 25 | 75 | - | 8 | 4 |
|  | MB-107 | Laboratory II | Biochemistry and Molecular Biology Lab | 25 | 75 | - | 8 | 4 |
|  | **Total** | **175** | **525** | **20** | **16** | **28** |

 **I YEAR**

**II YEAR**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **III semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | MB-301 | Core Course VII | r-DNA Technology | 25 | 75 | 4 | - | 4 |
| 2. | MB-302 | Core Course VIII | Enzymology and Bioenergetics  | 25 | 75 | 4 | - | 4 |
| 3. | MB-303 | Core Course IX | Biopharmaceutical Technology | 25 | 75 | 4 | - | 4 |
| 4. | MB-304 | Core Elective III | (i) Research methodology  & communication skills(ii) Medical Microbiology | 25 | 75 | 4 | - | 4 |
| 5. | MB-305 | Open Elective III | (i) Environmental  Microbiology (ii) Bioinformatics | 25 | 75 | 4 | - | 4 |
| 6. | MB-306 | Laboratory V | r-DNA Technology and Medical Microbiology Lab | 25 | 50 | - | 6 | 3 |
| 7. | MB-307 | Laboratory VI | Enzymology and Bioenergetics and Biopharmaceutical Technology Lab | 25 | 50 | - | 6 | 3 |
| 8. | MB-308 | Seminar  |  | 50 | - | - | 4 | 2 |
|  |  | **Total** | **225** | **475** | **20** | **16** | **28** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Subject code** | **IV Semester** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | MB-401 |  Project Work Review | 50 | - | - | 8 | 4 |
| 2. | MB-402 |  Project Evaluation (Viva Voce) | - | 100 | - | 16 | 12 |
|  |  | **Total**  | 50 | 100 |  | 24 | 16 |

M.Sc. MICROBIOLOGY – FIRST SEMESTER –W.E.F.2017

CORE COURSE I

**CELL BIOLOGY**

**Course Objective:** The cell biology course provides a basic understanding of the structure and function of cellular organelles and components, and the functional interaction of the cell with its microenvironment

**UNIT-I: CELL STRUCTURE AND FUNCTION:** Diversity of cell size and shape; Cell theory; Structure of Prokaryotic and Eukaryotic cells; Plasma membrane structure and function, Cytoskeleton; Microtubules, Intermediate filaments, Microfilaments Cellular organelles and their organization, Sub-cellular fractionation and criteria of functional integrity

**UNIT-II: INTRA CELLULAR TRANSPORT SYSTEMS:** Active and passive transport of ions, Na+/K+ pump, ATPase pumps, Co-transport, Symport, Antiport, Endo cytosis and Exocytosis Intracellular Protein traffic and Targeting

**UNIT-III: CELL CYCLE AND CHECK POINTS:** Cell cycle- Various phases of cell cycle, Interphase, Mitosis, Meiosis and Cytokinesis Cell cycle Control & CheckpointsDisruption in cell cycle; Biology of cancer- Types and causes, Classification of tumor

**UNIT-IV: CELL SIGNALING:** Overview, Cytosolic, Nuclear & membrane bound receptors, Concept of Secondary messengers, cAMP, cGMP, Protein kinases, G proteins Signal transduction mechanisms

**UNIT-V: CELL DIFFERENTIATION:** General characteristics of cell differentiation, Cytoplasmic determinants, Nucleoplasmic interactions; Stem cell differentiation and its Biological importance

**COURSE OUTCOMES:**

1. At the end of the course, student understands the basic information about classification of organisms, basic differences between prokaryotic and eukaryotic cells, structural and functional integrity of a cell.
2. At the end of the course, student gets the overall idea about the transport across plasma membrane transport across the organelles.
3. At the end of the course, student gets the information about the molecular mechanism behind cell cycle, causes of deregulation of cell cycle and effects
4. At the end of the course, student understands the underlying molecular mechanism of cell signaling, different types of receptors, different signal transduction pathways with examples.
5. At the end of the course, student gets the knowledge about cellular differentiation, stem cells and therapeutic importance.

**TEXTBOOKS:**

1. Molecular Biology of cell, Alberts. B et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and inheritance, EB Wilson, MacMilan, New York.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall

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CORE COURSE II

 **BACTERIOLOGY**

**Course Objective:** The main objective of this course is to provide knowledge of the classification & diversity of microorganisms, their nutrition, growth & metabolic activities, culture & control methods, and genetics.

**UNIT-I: Classification & Morphology:** Classification of microorganisms - Haeckels three kingdom concept, Whittaker’s five kingdom concept, Three domain concept of Carl Woese; Basis of microbial classification according to the Bergey’s manual of determinative bacteriology Morphological types; Cell walls of Archae bacteria, Eubacteria – gram –ve & gram +ve; Capsule – types, composition, function; Cell membrane – structure and its properties; Structure and functions of Flagella,Cilia & pili; Nucleoid; Cell division; Spores; Reserve food materials - Polyhydroxybutyrate, Polyphosphate granules, Oil droplets, Phycobilisomes, Cyanophycin granules, Sulphur inclusions; Cell inclusions -Carboxysomes, Magnetosomes, Gas vescicles

**UNIT-II: Prokaryotic Diversity**: Purple and Green bacteria; acetic acid bacteria; Pseudomonads – Lactic and Propionic acid bacteria; Endospore forming bacteria; Mycobacteria; Rickettsia’s; Chlamydia’s ; Mycoplasma’s; Cyanobacteria;

**UNIT-III: Identification of Bacteria & their Cultivation:** 16S&18S rRNA, lipid profiles, universal primers, peptide mapping,Nutritional types; Culture media types; Growth curve; Generation time; Growth kinetics; Synchronous and Asynchronous cultures; Batch and Continuous cultures; Measurement of growth and factors affecting growth; Control of Bacteria – physical and chemical agents; Preservation methods

Pure culture techniques; Preservation and maintenance of cultures and Culture collection centres; Principles of microbial nutrition, Construction of culture media; Enrichment culture techniques

**UNIT-IV: Bacterial Metabolisms:** Redox reactions and electron carriers; An overview of metabolism; Glycolysis; Pentose-phosphate pathway; Entner-Doudoroff pathway; Glyoxalate pathway; The citric acid cycle; Fermentation; Aerobic and anaerobic respiration, Bacterial Photosynthesis

**UNIT-V: Bacterial Genetics:** Methods for Exchange of genetic material - Transformation, Transduction, Conjugation; Plasmids, episomes.

**COURSE OUTCOMES:**

1. By the end of this course, student will have a thorough knowledge of the classification of microorganism and ultra structure of bacteria
2. At the end of this course, student will be well equipped with the knowledge of diverse groups of bacteria
3. By the end of this course, student will have detailed knowledge of microbial nutrition, growth & metabolism, culture, preservation & control methods
4. At the end of this course, the student will be well equipped with the knowledge of Microbial metabolism
5. By the end of this course, the student will have a thorough knowledge of microbial genetics

**TEXT BOOKS:**

1. A.J.Salle, Fundamental Principles of Bacteriology.
2. Brock T.D. Madigan M.T. Biology of Microorganisms. Preentice Hall Int. Inc.
3. Pelczar M. J., Chanm E.C.S, Kreig N.R. Microbiology, Mc Graw Hill.

**REFERENCE BOOKS:**

1. Bergey’s Manual of Systematic Bacteriology – P.H.A. Sneath, N.S. Mair, M.Elizabeth
2. The Prokaryotes – A.Balows, A.G.Thuper, M.Dworkin, W.Harder, K.Schleifer Springer – Verlag 1991.
3. Principles of Biochemistry – Zubey GL, Parson WW and Vance DE, WM.C.Brown Publishers, Oxford, England.
4. Biochemistry – Stryer L, W.H. Freeman Company, New York.
5. Modern Microbiology – Brige EA, WM.C.Brown Publishers, Oxford, England.
6. General Microbiology – Stainer RY, Ingraham JL, Wheelis ML, Painter PR, Macmillan Ltd, London.
7. The Bacteria – Gunsales IC, Stainer RY, Vol. I, II, III, Academic Press.

 M.Sc. MICROBIOLOGY - FIRST SEMESTER– W.E.F.2017

CORE COURSE III

 **BIOCHEMISTRY**

**Course Objective:** The main objective of the course is to study the various biomolecules, their structures, biological functions and metabolism.

**UNIT-I: FUNDAMENTALS OF BIOCHEMISTRY:** Water, pH, pK, buffers, covalent bond, non-covalent interactions and colligative properties

**Bioenergetics:** free energy, enthalpy, entropy, laws of thermodynamics, high energy compounds

**UNIT-II: CARBOHYDRATES:** Classification, physical and chemical properties of carbohydrates Metabolosim of Carbohydrates: Synthesis of carbohydrates, HMP shunt; aerobic and anaerobic fate of carbohydrates, ETC

**UNIT –III: LIPIDS:** Classification, physical and chemical properties of Lipids, Metabolism of lipids: Biosynthesis of lipids; oxidation of fatty acids – saturated and unsaturated, fatty acids with odd no of carbon atoms

**UNIT –IV: PROTEINS:** Classification, physical and chemical properties of amino acids and proteins; structural hierarchy, ramachandran plot; Protein folding: Anfinsen’s Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons Metabolisim of Proteins: Biosynthesis of non-essential amino acids; catabolism of amino acids

**NUCLEIC ACIDS**: DNA, Types of DNA (A-form, B-form & Z-form) ,RNA,Types of RNA ( mRNA, r RNA & tRNA) Metabolism of nucleic acids: Purine synthesis and catabolism; Pyramidine synthesis and catabolism

**UNIT-V: Photosynthesis:** Bacterial & Plant photosynthesis; oxygenic and an oxygenic photosynthesis; chlorophyll as trapper of solar energy, photosynthetic reaction centers, Hill reaction, PS I & PS II, Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO2 fixation

**COURSE OUTCOMES:**

1. At the end of the course students will have good knowledge of basics of biochemistry related to physical and chemical properties.
2. At the end of the course students will have thorough h knowledge of carbohydrates and their metabolic reactions.
3. By the end of the course students will have good knowledge of Lipids and their metabolism.
4. At the end of the course students will have thorough knowledge of proteins and nucleic acids their metabolism.
5. By the end of the course students will have thorough knowledge of photosynthesis, followed by light and Dark recycles.

**TEXTBOOKS:**

1. Biochemical Calculations, lrwin H. Segel, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauling, W.H. Freeman & Company.
3. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry. D Voet and JG Voet, J Wiley and Sons.
5. Physical Biochemistry, D Freifilder, W.H. Freeman & Company.
6. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work.
7. Understanding Chemistry, CNR Rao, Universities Press. Hyderabad 1999.
8. A Biologist’s Guide to Principles and Techniques of Practical Biochemistry, K Wilson & KH Goulding, ELBS Edition, 1986.
9. Tools of Biochemistry by T.G. Cooper.

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CORE ELECTIVE I

**MOLECULAR BIOLOGY**

**Course Objective:** The objective of this course is to demonstrate knowledge and understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.

**UNIT-I: Information Carrier Molecules – DNA & RNA:** Structure and Types of DNA, Conformational variants of double helix (A, B, Z types), Super coiled DNA features, Organelles DNA (Chloroplast/ Mitochondria), DNA denaturation & renaturation kinetics, Different classes of RNAs (mRNA, tRNA, rRNA, snRNA/ miRNA etc)

**UNIT-II: DNA Replication:** Modes of Replication in Prokaryotes and Eukaryotes, Enzymology of DNA replication, Telomeric replication; Inhibitors of DNA replication

DNA damage and Repair:Various types of DNA damage and repair mechanisms, Relationship between DNA damage & Cell cycle regulation

**UNIT-III: Gene Expression – Transcription:** Transcription (Prokaryotic & Eukaryotic) –Transcription inhibitors, Processing of tRNA and rRNA, Post transcriptional modifications in eukaryotes, RNA editing, transport mechanisms (exportins & importins)

# UNIT-IV: Gene Regulation – Transcriptional Level: Prokaryotic gene regulation: Operon concept, Positive & Negative gene regulation, Lac operon - Catabolite repression, Arabinose Operon, Tryptophan Operon – Attenuation

# Eukaryotic Gene Regulation: Transcriptional level (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure/Transacting elements); Regulation at Post-transcriptional level

### UNIT-V: Gene Expression – Translation: Genetic code, Wobble Hypothesis, Translation in prokaryotes and eukaryotes, Inhibitors of protein synthesis, translational controls, Post translation modifications, protein targeting.

**COURSE OUTCOMES:**

1. Students will acquire an understanding of the structure and functions of DNA
2. Students will acquire knowledge about the replication of DNA in both prokaryotes and eukaryotes.
3. This course aims in making the students understand gene expression in both prokaryotes and eukaryotes.
4. This course gives thorough knowledge of gene regulation in both prokaryotes and eukaryotes.
5. This course aims at providing a detailed knowledge of the process of translation and its regulation

**TEXTBOOKS:**

1. Molecular Cloning:A Laboratory Manual, J. Sambrook, E.F. Fritsch and T Maniatis, ColdSpring Harbor laboratory Press, New York, 2000
2. Introduction to Practical Molecular Biology, PD Dabre, John Wiley & Sons Ltd, New York, 88
3. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
4. Molecular Biology of the Gene (4th Edition), J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A.Steitz and A.M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientific American Books, Inc., USA, 1994
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis,M. Raff, K.
7. Roberts and J. D. Watson. Garland publishing, Inc., New York, 1994
8. Gene VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998, VCH Publishers, Inc., New York, 1995
9. Genomes, T.S. Brown.

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CORE ELECTIVE I

**ANIMAL CELL SCIENCE & TECHNOLOGY**

**Course Objectives:** This course aims to impart in students an understanding of the primary cell culture and methods that convert them to long term established cultures They will be exposed to all the factors which could impact cell culture and equipment requirements for propagation Awareness is generated about recent advances in the area of stem cell technology, organ culture, tissue engineering etc,

**UNIT-I: BASICS OF ANIMAL CELL AND ITS CULTURING:** Structure and organization of an animal cell, Types of animal cell culture – cell culture, organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology

**UNIT-II: ANIMAL CELL CULTURE MEDIUM AND ITS COMPONENTS AND THEIR SIGNIFICANCE:** Introduction to the balanced salt solutions and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon-di-oxide and role of serum and its supplements in maintaining cells in culture medium, Serum and protein free defined media and their application

**UNIT-III: BASIC TECHNIQUES OF MAMMALIAN CELL CULTURE *in vitro*:** Primary and established cell lines, Biology and characterization of the cultured cells, measuring parameters of growth Maintenance of cell culture, Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity, Apoptosis – characteristic features and molecular mechanisms, Measurement of cell death

**UNIT-IV: ENGINEERING ANIMAL CELLS:** Somatic cell genetics, Cell culture based vaccines, Genetic engineering of mammalian cells in culture, Scaling up of animal cell culture, Stem cell cultures – embryonic and adult stem cells and their applications

**UNIT-V: APPLICATIONS OF ANIMAL CELL CULTURE:** Three dimensional culture and tissue engineering, Applications of animal cell culture technology (heterologous, Primary culture/CEF culturing, Protein Expression).

**COURSE OUTCOMES:**

1. At the end of the course, student gets information about the basics of structure and organization of animal cells and their culture
2. At the end of the course, student understands the information about the various types of media, role and significance of medium constituents and formulation and design of media and related ethical issues
3. At the end of the course, student gets the knowledge on characterization, maintenance, preservation, revival, subculturing separation and viability analysis of cells and apoptsis
4. At the end of the course, student gets the knowledge on cell cloning techniques and its applications, second generation vaccines, large scale production of therapeutic proteins, stem cells and their applications in human medicine.
5. At the end of the course, student gets the information about the advanced techniques in cell culture; 3D culture design, types of scaffolds and parameters maintained in tissue engineering and over all applications of animal cell culture in research.

**TEXT BOOKS:**

1. Culture of Animal Cells, (3rd Edition), Fl. !an Froshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
3. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

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OPEN ELECTIVE I

 **BIOENTREPRENEURSHIP**

**Course Objectives:** The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

**UNIT-I:** Basics of Bioentrepreneurship Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; opportunities for bioentrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); patent landscape, IP protection & commercialization strategies

**UNIT-II:** Accounting and Finance Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; business plan proposal for „virtual startup company‟; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet, profit and loss statement, double entry 36 bookkeeping; collaborations & partnerships; information technology for business administration and expansion

**UNIT-III**: Business Strategy Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions

**UNIT-IV**: Marketing Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for „virtual startup company‟

**UNIT-V:** Knowledge Centre and R&D Knowledge centres eg, in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)

**COURSE OUTCOMES:**

1. At the end of the course, the student will have an overall understanding of the advantages and identify the scope ofentrepreneurship in biosciences.
2. At the end of the course, the student will have an overall understanding of the ways and means of raising funds
3. At the end of the course, the student will have an overall understanding of thevarious issues related to entry, exit, pricing strategies and managerial skills
4. At the end of the course, the student will have an overall understanding of the marketing strategies involved in entrepreneurship
5. At the end of the course, the student will have an overall understanding of the ways and means of developing research for business growth and expansion

**TEXTBOOKS & REFERENCES:**

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press. 5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

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 OPEN ELECTIVE I

 **BASIC MATHEMATICS & BIOSTATISTICS**

**Course Objective:** The course intends to provide the knowledge of differential and integral calculus, matrices, statistics and concept of random variables

**UNIT-I: DIFFERENTIAL CALCULUS:** Functions, limits, continuity and differentiation Differentiation of sum, product and quotient of function Differentiation of implicit, trigonometric, inverse trigonometric functions; Partial differentiation; Euler’s theorem on homogenous function; Maxima and minima (Basics)

**UNIT-II: INTEGRAL CALCULUS:** Basics, Methods of substitution integration by parts Integration of national, irrational, trigonometric functions, Definite integrals (Basics); Trapezoidal rule Simpsons 1/3 rule; Ordinary differential equations of First order Formation and method of variable separable, simple applications

**UNIT-III: MATRICES:** Basics, addition, subtraction, multiplication and Determinants (Basic concept) of Matrices Adjoint, inverse of a matrix, Rank of matrix (Basics); solution of linear system of equations: elementary operations, Gauss-Jordan method – Matrix inversion method

**UNIT-IV: INTRODUCTION TO STATISTICS:** population-sample –primary data and secondary data - graphical and diagrammatic representation of data Measure of central tendency:- Mean, median and mode Measure of dispersion:-range-standard deviation-raw and skewness and kurtosis(definition only)-Concept of probability –classical and relative frequency definition of probability-addition and multiplication laws of probability ( without proofs) and examples

**UNIT-V: CONCEPT OF RANDOM VARIABLES:** Probability mass function-probability density function-probability distribution function (definitions only) - Binomial, Poisson and Normal distribution (definitions and statements of properties and examples) Principles of least square-fitting of straight line –Pearson’s coefficient of correlation and concept of linear regression

Tests of Significance: Concept of testing of hypothesis critical region-two type errors-level of significance of large sample tests for single mean and difference of means Single proposition and difference proportion, chi square (c2) test for goodness of fit and chi square test of means and f-test for equality of variances

**COURSE OUTCOMES:**

1. At the end of the course students will have a good knowledge of the Functions, limits, continuity and differentiation
2. At the end of the course students will have a good knowledge of integral calculus
3. At the end of the course students will have a good knowledge of matrices
4. At the end of the course students will have a good understanding of the various concepts of statistics
5. At the end of the course students will have a good understanding of the various concepts of random variables and biostatistics

**TEXTBOOKS:**

1. Statistical methods S.P.Gupta. S Chand Pubplications
2. Business Statistics by S.P Gupta & M.P.Gupta
3. Engineering Mathematics - N.P. Bali and others.
4. Engineering mathematics - B.V. Ramana

**REFERENCES:**

1. Differential Calculus - Shanthi Narayan

 2. Integral Calculus - Shanthi Narayan

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 LABORATORY I

**CELL BIOLOGY & BACTERIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (CELL BIOLOGY)**

**Course Objective:** To provide hands on training in cell biology techniques

1. Microscopy: Compound Microscope
2. Motility of bacteria
3. Protoplast isolation
4. Cell cycle analysis
5. Isolation of Chloroplast
6. Feedback inhibition

**Course outcome:** At the end of the course, students will have a thorough knowledge of the techniques involved in studying the motility of bacteria, isolation of cell organelles and cell cycle

### PART-B (BACTERIOLOGY) LAB

**Course Objective:** To provide hands on training in microbiological techniques

1. Isolation and preservation of bacteria
2. Morphological and Biochemical characterization of bacteria (Staining IMViC, Amylase test, H2O2 test, Nitrate reduction test)
3. Study of the factors affecting bacterial growth (pH, Temperature and salinity)
4. Determination of antimicrobial activity (Disc diffusion/ cup plate method)
5. Determination of minimum inhibitory concentrations

**Course outcome:** At the end of the course, students will have a thorough knowledge of the techniques involved in microbial isolation, identification, characterization, growth and control

M.Sc. MICROBIOLOGY - FIRST SEMESTER– W.E.F.2017

LABORATORY II

**BIOCHEMISTRY & MOLECULAR BIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (BIOCHEMISTRY)**

**Course objective:** The main objective of the course is to study the different methods used to estimate the various bimolecules

1. Titration of amino acids.
2. Determination of pK
3. Reactions ofamino acids, sugars and lipids- quantitative reactions
4. Analysis of oils-iodine number, saponification value, acid number.
5. UV, Visible, Absorption spectra.
6. Centrifugation, TLC & SDS-PAGE –Silver staining
7. Estimation of inorganic phosphorus by Fiske Subbarao Method
8. Isolation and estimation of protein using various colorimetric and spectrophotometric methods

**Course outcomes**: At the end of the course students will have through knowledge of biomolecules estimations and analysis etc.

**PART-B (MOLECULAR BIOLOGY)**

**Course objective:** The main objective of the course is to provide practical knowledge of the isolation and quantification of DNA

1. Isolation of Nucleic Acids: Genomic DNA, Plasmid, RNA

2. Quality check for Isolated Nucleic Acids: Spectrophotometric (UV Method)

3. Visualization: Electrophoresis (Detection and separation of NA)

**Course outcomes**: At the end of the course students will have through knowledge of the techniques involved in isolation and quantification of DNA

M.Sc MICROBIOLOGY- SECOND SEMESTER– W.E.F.2017

CORE COURSE IV

**BIOANALYTICAL TECHNIQUES**

**Course Objectives:** The objective of the course is to create general understanding of Microscopy, Spectroscopy, Electrophoresis, Sequencing methods and different chromatographic methods.

**UNIT-I: MICROSCOPY:** Microscopy (Theory: Simple and Compound, Types: Light Field, Dark Field, Phase Contrast, SEM, TEM, Fluorescent)

**UNIT-II: SPECTROSCOPY:** Spectroscopy techniques: (Theory of Light) UV, IR, NMR, LASER Raman Spectroscopy, Fluorescence Spectroscopy

**UNIT-III: RADIATION AND FLOURESCENCE BASED METHODS**: Radioactivity, measurement of radioactivity, photographic emulsion, ionisation chamber, autoradiography, RIA, Fluorescent and Chemiluminiscent methods, Fluorescent Probes, FISH

**UNIT-IV: SEQUENCING OF PROTEINS AND NUCLEIC ACIDS**: N-terminal sequencing for determination of protein sequence (Edman degradation); MALDI-TOF analysis Nucleic acid sequencing automated methods (Sangers Dideoxy and Maxim Gilbert methods) and determination technologies

**UNIT-V: SEPARATION TECHNIQUES:** Centrifugation: Preparative and analytical; Electrophoresis: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immuno precipitates (Immuno electrophoresis), Peptide mapping, IEF; Chromatography: Adsorption, affinity, Ion exchange, gel permeation, TLC, GLC, RPC, HPLC etc

**COURSE OUTCOMES:**

1. At the end of this course student will have comprehensive understanding on microscopic techniques.
2. At the end of this course student will get knowledge on spectroscopy and principles of Beer- Lamberts Law.
3. At the end of this course student will get knowledge on radioactivity, measurement of radioactivity and different radiolabelled and flouresence labelled based techniques involved in Biotechnology.
4. At the end of this course student will get knowledge on different techniques involved in sequencing of proteins and nucleic acids.
5. At the end of this course student will understand on different biomolecules separation techniques like chromatography, electrophoresis sedimentation and centrifugation.

**TEXTBOOKS:**

1. Essentials of Molecular Biology, David Friefilder, Jones and Barllett Publications.
2. Proteins-Structure and Molecular Properties. TE Creighton, WH Freeman and company.
3. Genes VII, B. Lewin, Oxford University Press.
4. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
5. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
6. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons.
7. Introduction to BiophysicalChemistry, RB Martin, McGraw Hill, New York.
8. Biophysical Chemistry, Cantoz, WH Freeman.
9. Protein Structure, by Max Perutz.

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CORE COURSE V

**IMMUNOLOGY**

**Course Objective:** This course intends to provide the knowledge of innate and acquired immunity, cells and organs of immune system, humoral immunity, cell mediated immunity and the role of immunity in infectious diseases

**UNIT-I: INTRODUCTION** - Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response, Humoral and Cell mediated immunity, Nature and Biology of antigens haptens, immunogens and super antigens, compliment system

**UNIT-II: ORGANIZATION AND STRUCTURE OF LYMPHOID ORGANS:** Lymphoid follicle, Thymus Lymph node, Spleen, MALT, CALT, SALT

Cells of the immune system: Hematopoiesis and differentiation, Inflammation, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Basophils, Neutrophils and Mast-Cells

**UNIT-III: HUMORAL IMMUNITY:** BCR and generation of Immunoglobulin diversity, Activation of B-Lymphocytes, Antibody structure and function, Hybridoma Technology and Monoclonal antibodies, Antigen- antibody interactions

**UNIT-IV: CELL MEDIATED IMMUNITY:** Major histocompatibility complex, MHC restriction, Antigen processing and presentation, TCR, generation of diversity, generation of cell mediated immune responses, Mechanism of T cell cytotoxicity, Antibody dependent cell mediated cytotoxicity

**UNIT-V: AUTOIMMUNE DISORDERS, INFECTIONS AND TRANSPLANTATIONS:** Rheumatoid arthritis, Insulin dependent Diabetes Mellitus, Diphtheria (bacteria), Hepatitis, Transplantation, Vaccination for disease control.

**COURSE OUTCOMES:**

1. By the end of the course, student will have the knowledge of innate immunity and nature and biology of antigens
2. At the end of this course student will have a thorough knowledge of the different organs and cells of immune system
3. By the end of this course the student will be well equipped with the knowledge of antigen – antibody interactions, humoral immunity and hybridoma technology
4. At the end of this course students will have a thorough understanding of cell mediated immunity
5. By the end of this course students will have a thorough knowledge of the autoimmune disorders and the role of immune system in infectious diseases and transplantation

**TEXT BOOKS:**

1. Kuby Immunology (Kindt, Kuby Immunology) -Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, publisher: W. H. Freeman,2006
2. Immunology- David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby, 2006

**REFERENCE BOOKS:**

1. Fundamental Immunology- William E Paul, publisher: Lippincott Williams & Wilkins, 2008
2. Immunology, Infection, and Immunity - Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler, Publisher: ASM Press, 2004
3. Lecture Notes: Immunology, 5th Edition- Ian Todd, Gavin Spickett, publisher: Wiley- Blackwell, 2005
4. Immunology: A Short Course- Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell, 2009
5. Cellular and Molecular Immunology-Abul K. Abbas MBBS, Andrew H. Lichtman MD PhD, Shiv Pillai MD, publisher: Saunders, 2007
6. Roitt's Essential Immunology (Essentials) -Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, publisher: Wiley-Blackwell, 2006
7. Schaum's Outline of Immunology- George Pinchuk, publisher: McGraw-Hill, 2001.

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CORE COURSE VI

 **VIROLOGY**

 **Course Objective:** This course intends to provide insights into the historical developments in Virology, Structures, Classification, virological diagnostics methods and viral replications etc.

**UNIT-I: Microorganisms lacking cell structures:** Introduction tovirology, nature of viruses, nomenclature and classification of viruses, General characteristics of viruses: Physical, Biological, Biochemical properties, Methods of cultivation, Purification and assay of viruses Biology of sub-viral agents

**UNIT-II: Virological Methods:**

**Diagnostic Methods:** Immunodiagnostic, Haemagglutination and Haemagglutination-inhibition tests, complement fixation, neutralization, RIA, flow cytometry and immuno histochemistry

**Nucleic Acid Based Diagnosis**: Hybridization, Blotting techniques, polymerase chain reaction, Microarray and nucleotide sequencing

**UNIT-III: Virus Cell Interaction:**

**Cellular Receptors and Virus Entry:** Polio, Herpes, VSV, HIV Mechanism of Entry into cells,

**Virus Morphogenesis:** Replication (Uncoating, Nucleic Acid Replication, Protein Synthesis & Assembly)

**Mechanisms of Host Cell Damage**: Host cell ‘Shut off’, Apoptosis, Necrosis, Stress response, Alteration of signaling pathways, Cellular basis of transformation, Types of cytopathic effects

**UNIT-IV: Virus Replication:**

**RNA Viruses:** General strategies, Replication of Plus stranded RNA virus (Polio), Negative Strand RNA viruses (VSV and influenza) Replication of double Stranded RNA viruses (rota), and retro viruses (HIV and HTLV)

**DNA Viruses:** Replication of doubles Stranded DNA Viruses (SV 40 and Pox), ss DNA Viruses (AAV), DNA tumor viruses: Hepatitis B Virus; Replication of Plant viruses: RNA & DNA viruses

**UNIT-V: Application of viruses in biomedicine**

**Viral vectors:** Development of viral vectors, gene transfer, gene therapy, vaccine development

Protein expression, Viral subunits (Virus like particles VLP), Oncolytic Virus (Virotherapy for cancer)

**COURSE OUTCOMES:**

1. At the end of this course students will have through knowledge of the viruses, structures and their properties.
2. At the end of the course students will have through knowledge of the viral diagnostic methods and their analysis.
3. At the end of this course students will have through knowledge of the virus cell interactions and host cell damage mechanisms.
4. By the end of the course students will have through knowledge of the viral replication of DNA and RNA viruses.
5. By the end of the course students will have through knowledge of the applications of the viruses in biomedicine.

**TEXT BOOKS:**

1. Introduction to Modern Virology - Dimmock NJ, Primrose SB, Blackwell Scientific Publications, Oxford.
2. Text Book on Principles of Bacteriology, Virology and Immunology – Topley and Wilson’s, Edward Arnold, London.

**REFERENCE BOOKS:**

1. Medical Virology – Morag C and Timbury M.C, Churchill Livingstone, London.
2. Virology – III – Conrat HF, Kimball PC and Levy JA, Prentice Hall, Englewood Cliff, New Jersey.
3. Diagnostic procedures for Viral and Rickettsial diseases – Lennetter EH, American Public Health Association, NY.
4. The Genetics of Bacteria and their Viruses – William Hayes, Blackwell Scientific Publishers, London.

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CORE ELECTIVE II

**INDUSTRIAL MICROBIOLOGY**

 **Course Objective:** The major objective of this course is to familiarize students to microbes & microbial processes, including fermentation and optimization covering all areas of industrial microbiology.

**UNIT-I: INTRODUCTION AND METHODS OF MICROBIOLOGY:** History and development of fermentation industry, Isolation, and screening methods for industrially important micro organisms, Primary screening and secondary screening

**UNIT-II: STRAIN IMPROVEMENT:** Strain selection and Strain improvement Mutation and recombinant DNA techniques for strain development

**UNIT-III: FERMENTATION & ITS BASICS:** sterilization methodologies adopted in fermentation industry Media formulation, Fermentation equipment and its uses, types of fermentors and different fermentation modes, Shake flask, batch, and continuous operations Solid state fermentation Solid suspension fermentation

**UNIT-IV: FERMENTATION PRODUCTS:** Primary and secondary metabolites Productions: Antibiotics - Penicillin, semi synthetic Penicillin, cephalosporin, Streptomycin; Organic acids – Citric acid , Lactic acid; Industrial enzymes – Amylases, Proteases, Cellulases; Alcoholic beverages – Ethanol, Beer, Wine; production of amino acids-L-Glutamic acid, L- Lysine Production of Vitamins-Riboflavin, Vitamin B12

**UNIT-V: PROCESS VARIABLES AND PRODUCTION OF r-DNA BASED PRODUCTS:** Special procedures for production of r-DNA based products – Monoclonal antibodies (mAb’s) and Bio- therapeutics eg: Insulin, vaccines, Applications of Bioconversions in r-DNA products.

**COURSE OUTCOMES:**

1. At the end of this course student can able to understand about basics of microbiology, and difference between primary and secondary screening
2. At the end of this course student can able to understand about strain selection and improvement techniques.
3. At the end of this course student can able to understand fermentation basics and different modes of operation of fermentation
4. At the end of this course student can able to understand production of various products industrially.
5. At the end of this course student can able to understand production of r-DNA based products.

**TEXT BOOKS:**

1. “General Microbiology” 5th Edition Stanier et al.

 2. “Enzymes in food processing” by Gerald Reed, Academic press.

3. “Comprehensive Biotechnology” Vols III & IV, Editor M.Moo young.

4. “Industrial Microbiology” by Prescott

5. "Principles of fermentation technology" by P F Stanbury and

 A Whitaker, Pergamon press (1984)

6. “Industrial Microbiology” by Casida

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CORE ELECTIVE II

**PROCESS ENGINEERING PRINCIPLES**

**Course objective:**This course enables students to understand the concept of fluids, flow properties, heat, heat flow mechanism, mass, mass flow mechanism and their equipment design.

**UNIT-I: Process Calculations & Thermodynamics:**Overview of Chemical Engineering, Concepts of Unit operations & Unit processes with examples, Units & Dimensions, Stoichiometric principles, Law of conservation of mass

**Thermodynamics:**Scope of Thermodynamics, Force, Temperature, Volume, Pressure, Work, Energy, Heat, Heat capacities, Enthalpy, Law of thermodynamics

**UNIT-II: Unit Operation & Fluid Mechanics:**Introduction, Characterization of solid particles, Screen analysis, Size reduction – law of crushing, various types of size reduction equipment

**Fluid Mechanics:**Fluid Flow, Newton’s law of viscosity, Classification of Fluids, Hydrostatic Pressure, Manometers, Continuity equation, Bernoulli’s equation & Its applications, Metering & Transportation of fluids using orifice meter, venture meter & Rota meter

**UNIT-III: Heat Transfer:** Modes of heat transfer with examples, Conduction – Fourier’s law, one dimensional conduction through plane wall, composite wall, cylinder and spherical system

**Convection:**Introduction, natural and forced convection, Concept of heat transfer coefficient, relationship between Individual and overall heat transfer coefficient

**UNIT-IV: Radiation & Heat Transfer Equipment:**

**Radiation:**Introduction, Black body, Laws of black body radiation; Kirchoff’s law, Stefan-Boltzmann law, Wein’s displacement law

**Heat Transfer Equipment:**Overview of heat exchangers-types and temperature area graphs, Concept of LMTD Concepts of Boiling & evaporation-types of boiling & its mechanism, types of evaporators

**UNIT-V:  Mass Transfer:**Introduction, Molecular diffusion, Fick’s law of diffusion, diffusivities of gases and liquids, Theories of mass transfer, Concept of mass transfer coefficients, Principles of Absorption, Adsorption, extraction, Distillation and Drying.

**COURSE OUTCOMES:**

* 1. At the end of this course student can able to understand the process calculations & thermodynamics.
	2. At the end of this course student can able to understand course operation & fluid mechanics.
	3. At the end of this course student can able to understand about heat transfer by conduction and convection.
	4. At the end of this course student can able to understand about heat transfer by radiation and equipments used for heat transfer.
	5. At the end of this course student can able to understand about mass transfer operations.

**TEXT BOOKS:**

1. Unit operations of Chemical Engineering, (1993), by McCabe, Smith and Harriott, McGraw Hill publishers.
2. Introduction to Biochemical Engineering, Second edition, By D G Rao, Tata McGraw Hill Publications.
3. Bioprocess Engineering principles By Pauline M Doran, Academic Press.

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OPEN ELECTIVE II

**COMPUTER PROGRAMMING AND DATA STRUCTURES**

 **Course objectives:** To impart the knowledge of computer systems, computer languages (C-language) and data structures

**UNIT – I:**

Introduction to Computers – Computer Systems, Computing Environments, Computer Languages, Creating and running programmes, Software Development Method, Algorithms, Pseudo code, flow charts, applying the software development method

**UNIT – II:**

Introduction to C Language – Background, Simple C Programme, Identifiers, Basic data types, Variables, Constants, Input / Output, Operators Expressions, Precedence and Associativity, Expression Evaluation, Type conversions, Bit wise operators, Statements, Simple C Programming examples

Selection Statements – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, goto, Simple C Programming examples

**UNIT – III:**

Designing Structured Programmes, Functions, basics, user defined functions, inter function communication, Standard functions, Scope, Storage classes-auto, register, static, extern, scope rules, type qualifiers, recursion- recursive functions, Preprocessor commands, example C programmes Arrays – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays, C programme examples

Strings – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion, C programme examples

**UNIT – IV:**

Input and Output – Concept of a file, streams, standard input / output functions, formatted input / output functions, text files and binary files, file input / output operations, file status functions (error handling), C programme examples

 **UNIT – V:**

Data Structures – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack application-infix to postfix conversion, postfix expression evaluation, recursion implementation, Queues-operations, array and linked representations.

**COURSE OUTCOMES:**

1. By the end of this course, student will have good understanding of computer systems, languages and creation and running of software
2. By the end of this course, student will have good understanding of C language.
3. By the end of this course, student will have thorough understanding of designing structured programmes
4. By the end of this course, student will have good knowledge of Input and Output operations and file status functions
5. By the end of this course, student will have thorough understanding of data Structures

 **TEXT BOOKS :**

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition,

 Pearson education.

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OPEN ELECTIVE II

**2. BIO ETHICS, BIOSAFETY & REGULATORY AFFAIRS**

 **Course Objective:** To introduce basic concepts of ethics and safety that are essential for different disciplines of science and about regulatory affairs and documentation

**UNIT I:** **BIOETHICS: PRINCIPLES OF BIOETHICS, ETHICS IN CLINICAL RESEARCH:** History structure regulation impact of Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF), shared responsibilities for decisions and the understanding of the risk

**UNIT II: BIOSAFETY CONCEPTS & REGULATIONS:** Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol, Use of genetically modified organisms and their release in to the environment Special procedures for r-DNA based products International dimensions in Biosafety Biotechnology and food safety Case study – Bt Cotton, Bt Brinjal, DBT Biosafety Guidelines

**UNIT III: REGULATORY AFFAIRS** : Indian context – requirements and guidelines of GMP, understanding of Drugs and Cosmetics Act 1940 and Rules 1945 with reference to Schedule N, U & Y 4

**UNIT IV: RELATED QUALITY SYSTEMS**: Objectives and guidelines of USFDA, WHO and ICH Introduction to ISO series

**UNIT V: DOCUMENTATION** Types related to pharmaceutical industry, protocols, harmonizing formulations, development for global filings, ANDA, NDA, CTD, dealing with post – approval changes – SUPAC, handling and maintenance including electronic documentation 3 Related Quality Systems: Objectives and guidelines of USFDA, WHO and ICH Introduction to ISO series.

**COURSE OUTCOMES:**

1. By the end of this course student will have good knowledge of ethical issues related to the industry and research of biosciences
2. By the end of this course student will have thorough understanding of biosafety measures that need to be followed in bioscience related industries and research
3. At the end of this course student will have a good understanding of the guidelines of GMP and drug and Cosmetics Act 1940 and rules of 1945
4. By the end of this course student will have a thorough understanding of guidelines laid by different quality systems
5. This course covers the different aspects of documentation in regulatory affairs

**TEXT BOOKS:**

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007.
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights,
4. Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

**REFERENCES:**

1. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
2. Anitha Rao R & Bhanoji Rao “Intellectual Property Rights – A Primer”, Eastern Book Company, 2008.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. M. M. S. Karki , Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009
5. Neeraj Pandey & Khushdeep Dharni, Intellectual Property Rights, Phi Learning Pvt. Ltd
6. Ajit Parulekar and Sarita D’ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
7. B. L. Wadehra. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
8. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

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LABORATORY III

**BIOANALYTICAL TECHNIQUES AND VIROLOGY LAB**

**LIST OF EXPERIMENTS:**

**PART-A (BIOANALYTICAL TECHNIQUES)**

**Course objective: The main objective of this course is to gain knowledge on different analytical techniques involved in microbiology.**

1.     Microscopy

2.     Electrophoresis of Proteins - native and under denaturing conditions –silver staining,

 coomassie staining.

3.     Determination of Tm of nucleic acid.

4.     Séparation techniques (HPLC, GPC, FPLC, Ion-Exchange).

5.     IEF Demonstration

**Out comes**: at the end of this course student gain practical training on different analytical techniques like microscopy Electrophoresis and Different chromatographic techniques

**PART- VIROLOGY LAB**

**Course objective:** This course intends to provide insights to different isolation methods of viruses**.**

* + 1. Mechanical Transmission of Tobacco Mosaic Virus.
		2. Symptomatic Observation of Plant Viral Infections.
		3. Effect of Nuclear Poly hedrosis Virus on Insects.
		4. Quantification or Titration of Bacteriophages.
		5. Isolation of Bacteriophages from Soil or Sewage.

**Course Outcomes:** By the end of the course students will have through knowledge of various method of for cultivation and enumeration of viruses**.**

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LABORATORY IV

**IMMUNOLOGY AND INDUSTRIAL MICROBIOLOGY LAB**

**LIST OF EXPERIMENTS:**

**PART-A (IMMUNOLOGY)**

**Course Objective:** This course intends to provide the practical knowledge of different immunological techniques

1. Radial immuno diffusion,
2. Ouchterolony double immuno diffusion
3. Latex agglutination test
4. ELISA
5. Purification of antibodies,
6. Blood grouping – Agglutination

**Course Outcome:**

By the end of this course student will acquire skill to perform different immunodiffusion techniques, ELISA and purify antibodies

**PART- B (INDUSTRIAL MICROBIOLOGY LABORATORY)**

**Course Objective:** This course intends to provide the practical knowledge of different industrial microbiology related techniques

1. Screening of soil samples for antibiotic producing bacteria
2. Isolation of actinomycetes from given soil samples
3. Production of Citric acid
4. Production of wine from Grapes
5. Production of ethanol
6. Cellulase production by microorganisms
7. Protease production by microorganisms
8. Estimation of ethanol

**Course Outcome:**

By the end of this course student will be well versed with isolation of microorganisms and production of different industrially important products

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CORE COURSE VII

**r-DNA TECHNOLOGY**

**Course Objectives:** To familiarize the student with emerging field of biotechnology i.e. recombinant DNA technology as well as create understanding and expertise in wet lab techniques in genetic engineering

**UNIT-I: SCOPE OF GENETIC ENGINEERING:**  Milestones in Genetic Engineering, Biosafety issues – Genetic engineering guidelines; Patenting of life forms

Molecular Tools in Genetic Engineering – Restriction enzymes and DNA Modifying enzymes (Polmerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc)

Nucleic Acid isolation and purification yield analysis, Gel electrophoresis, DNA and RNA markers Restriction mapping of DNA fragments and Map construction, Nucleic acid Amplification (PCR analysis) and its applications

**UNIT-II: GENE CLONING STRATEGIES:** Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids, Artificial chromosomes), Gene Cloning strategies, Transformation and selection of recombinants; Construction of DNA libraries (Genomic library and cDNA library preparations –mRNA enrichment, reverse transcription, use of linkers and adaptors); and their screening; Alternative strategies of Gene cloning; Cloning of differentially expressed genes

**UNIT-III: GENE EXPRESSION:** Study of introduced Gene expression – hybridization techniques, Northern blot analysis, Primer extension, S1 mapping, Rnase protection assays, Reporter assays), Nucleic acid microarrays

Gene expression in bacteria and Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants – characterization of recombinant proteins, stabilization of proteins; Phage display, Yeast Two- and three Hybrid system

**UNIT-IV: TRANSGENIC TECHNOLOGY:** Gene tagging (T-DNA tagging and Transposon tagging) in gene analysis (identification and isolation of gene), Transgenic and Gene Knockouts Technologies - Targeted gene replacement, Chromosome engineering, Gene Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing and silencing

**UNIT-V: APPLICATIONS OF GENETIC ENGINEERING**; Genome sequencing projects, site directed mutagenesis and protein engineering RNAi, antisense technology ribozymes, CRISPAR/Cas 9

**COURSE OUTCOMES:**

1. At the end of this course student will understand the scientists contribution and the enzymes involved in recombinant DNA technology and also know the PCR and its application
2. At the end of this course student will get knowledge on different types of vectors, cloning, transformation and selection and also Genomic and C-DNA library constriction and its application
3. At the end of this course student will understand the different expression systems, protein interaction studies, and hybridization techniques.
4. At the end of this course student will get concept on different transgenic techniques (Gene Knockouts Technologies and Gene therapy) and also understand about gene tagging.
5. At the end of this course student will understand the applications of genetic engineering principles.

**REFERENCES:**

1. Principles of gene manipulation, 1994. Old & Primrose, Blackwell Scientific Publications.
2. Molecular coling. 3 volumes. Sambrose and Russell. 200. CSH press.
3. Genome analysis. Four volumes. 2000. CSH press.

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CORE COURSE VIII

**ENZYMOLOGY & BIOENERGETICS**

**Course objective:** To provide deeper insights into how enymes work and various applications of enzymes

**UNIT-I: Introduction to Enzymes:** Classification, Nomenclature and their chemical nature Factors affecting enzyme catalyzed reactions – pH, temperature, concentration of enzyme and concentration of substrate Assay of enzymes

**UNIT-II: Enzyme Isolation & Purification:** Methods of isolation and purification, recovery and yield, purity and characterization of enzyme preparations Mechanism of action of – Chymotrypsin, Carboxy-peptidase, Ribonuclease, Lysozyme

**UNIT-III: Enzyme Kinetics:** Derivation of Michaelis and Menten equation for uni-substrate reactions Determination of Km,Vmax, Kcat and their significance, Lineweaverburk’s plot and its limitation

**Inhibition Kinetics:** Reversible and irreversible inhibition – competitive, non-competitive, uncompetitive inhibitions, determination of Km and Vmax in presence and absence of inhibitors Allosteric enzymes

**Immobilized Enzyme kinetics:** Methods of immobilization, comparison of kinetics of immobilized and free enzymes, applications of immobilized enzymes

**UNIT-IV: Application of Enzymes:**

Industrial applications of Enzymes, Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose- fructose syrup from sucrose; use of proteases in food, detergent and leather industry; medical application of enzymes; use of glucose oxidase in enzyme electrodes, Ribozymes, Xeno nucleic acids

**UNIT-V: Bioenergetics:** Electron Flow as source of ATP Energy, Site of Oxidative Phosphorylation, ATP synthetase, Electron- Transferring Reactions, Standard Oxidation, Electron Carrier, electron transport complexes, incomplete reduction of Oxygen, Mechanism of Oxidative Phosphorylation, Oxidation of Extra mitochondrial NADH, ATP yield and P: O Ratio, Role of Electron Transport Energy.

**COURSE OUTCOMES:**

1. At the end of the course the student will be able to understand the basics of enzymes
2. By the end of the course student will obtain knowledge of isolation & purification of enzymes and their mechanisms of action
3. By the end of this course student will acquire thorough knowledge of Enzyme kinetics
4. At the end of the course the student will be able to understand the generation of high energy compounds
5. By the end of this course student will acquire good knowledge of various applications of enzymes

**TEXT BOOKS:**

1. Biochemical Calculations, lrwin H. Segel, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauling, W.H. Freeman & Company.
3. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry. D Voet and JG Voet, J Wiley and Sons.
5. Physical Biochemistry, D Freifilder, W.H. Freeman & Company.

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CORE COURSE IX

**BIOPHARMACEUTICAL TECHNOLOGY**

 **Course Objective:** To introduce the students about biogenerics and biosimilars and their characterization using analytical methods and presumptions of therapeutic equivalence along with case studies. And main objective students acquire knowledge about aspects of traditional and modern biotechnology viz. Fermentation technology and Recombinant DNA technology. To enhance knowledge in Pharmacokinetic and to correlate theoretical principles with Industrial applications.

**UNIT I: PROKARYOTIC AND EUKARYOTIC CELLS IN BIOTECH PRODUCTION**: Actinomycetes in BiotechProduction, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in BiotechProduction, Transgenic Plants as Functional Foods or Neutraceuticals Transgenic Plants andPlant Cell Culture as Bioreactors of Secondary Metabolites, Transgenic Plants as Bioreactors ofRecombinant Protein

**UNIT II: BIOTHERAPEUTICS:** Pharmacodynamics of protein therapeutics; Chemical modificationof proteins/ therapeutics; Immuno suppressor in antibody therapy; PharmacoGenomics**,** Molecular modification of lead compounds; Assay systems and models (eg, KnockoutMice) Antisense technology as cell based therapeutics, small peptides, Therapeutic enzymes

**UNIT III: PHARMACEUTICALS PRODUCTION IN PLANTS:** Drugs derived from plants, Antitumor agent -Etoposide, Colchicine, Taxol, Vinblastine, Vincristine Cardiotonic – Convallatoxin,Acetyldigoxin, Adoniside, Anti-inflammatory – Aescin, Bromelain, Choleretic – Curcumin,Biopharmaceuticals Expressed in Plants Alternative Expression Systems, Three PromisingExamples: Tobacco (Rhizosecretion, Transfection) and Moss (Glycosylation)

**UNIT IV: PROTEIN AND DNA VACCINES:** DNA Vaccine Construction and Immunology DNAVaccine Expression Plasmids Delivery of DNA Vaccines Peptide vaccine, Gene Pharming,Cytokines as biopharmaceuticals, therapeutic enzymes, Cell and tissue engineering: Stem cell therapy,T-cell therapy

**UNIT V: BIOGENERIC DRUGS RECOMBINANT THERAPEUTIC PROTEINS:** Erythropoietin (EPO), ColonystimulatingFactors (CSFs), Human Growth Hormone (hGH), Insulins, Factor VIII (FVIII), Interferons (IFN)Therapeutic hormone- insulin production throughrecombinant DNA technology, therapeutic monoclonal antibodies

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**COURSE OUTCOMES:**

1. By the end of this course students will understand the basic concepts of Neutraceuticals, microbes and Biotech production strategies at industrial level.
2. By the end of this course students will gain knowledge of physiochemical properties and radioactivity of biopharmaceuticals
3. By the end of this course students will understand the production of plant drugs like antitumor, anti inflammatory etc.
4. By the end of this course students will get knowledge of Protein & DNA vaccines and tissue engineering concepts.
5. By the end of this course students will get knowledge of biogenerics, and biopharmaceuticals to make their career in pharmaceutical industries.

 **TEXT BOOKS:**

1. Pharmaceutical Biotechnology; Oliver Kayser, Rainer H. Müller, Wiley Publishers, 2005.
2. Drug Discovery and Clinical Applications; Heinrich Klefenz, 2002.
3. Industrial Pharmaceutical Biotechnology, WILEY-VCH Publication, Germany. Daan Crommelin, Robert D Sindelar, 2002.
4. Pharmaceutical Biotechnology; Tailor and Francis Publications, Newyork. Jay P Rho, Stan G Louie, 2003, Hand.

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CORE ELECTIVE III

**RESEARCH METHODOLOGY & COMMUNICATION SKILLS**

**Course Objectives**: - - To use the framework of these methodologies for understanding effective lab practices and scientific communication - To use the framework of these methodologies to understand and appreciate scientific ethics.

**Unit I:** History of Science and Science Methodologies Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist vs holistic biology

**Unit II:** Preparation for Research Choosing a mentor, lab and research question; maintaining a lab notebook with date-wise entry

 **Unit III**: Process of Communication Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding repetitions & breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non-verbal communication Interpreting non-verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

**Unit IV** Presentation skills - Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point slides with clearly legible fonts without crowding the content; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions Computing Skills for Scientific Research Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

**Unit V:** Scientific Communication Technical Writing Skills - Types of reports; Layout of a formal report; Scientific writing skills - Importance of communicating science; Problems while writing a scientific document; Plagiarism; Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts; Publishing scientific papers - the peer review process and problems, recent developments such as open access and non-blind review; Plagiarism; Characteristics of effective technical communication; Scientific presentations; Ethical issues; Scientific misconduct.

**COURSE OUTCOMES:**

1. By the end of this course student will develop an awareness of methodologies used to do research
2. By the end of this course student will develop good understanding of methodology for proper initiation and execution of research
3. By the end of this course student will acquire knowledge of effective communication methods
4. By the end of this course student will acquire knowledge of proper presentation skills
5. By the end of this course student will get good knowledge of scientific communication and technical writing

**TEXTBOOKS & REFERENCES:**

1. Valiela, I. (2001). Doing science: Design, analysis, and communication of scientific research. Oxford: Oxford University Press.
2. On being a scientist: A guide to responsible conduct in research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English effectively. Delhi: Macmillan India. 5. Movie: Naturally Obsessed, The Making of a Scientist.

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CORE ELECTIVE III

**MEDICAL MICROBIOLOGY**

**Course objectives:** To provide the knowledge of various methods used to detect the pathogens and their diagnosis.

**UNIT-I: INTRODUCTION:** Introduction to pathogenesis, components of microbial pathogenicity Population genetics of Microbial pathogenesis, methods to detect genetic diversity and structure in natural population, epidemiology, cryptic diseases

**UNIT-II: HOST DEFENCES & MODULATION OF IMMUNE RESPONSE:** Host defense against pathogens, clinical importance of understanding host defense, components of the host surface defence systems like skin, mucosa, eye, mouth, respiratory tract Components of the systemic defense like the tissues and blood Modulation of immune response by vaccines, properties of vaccines, other immuno modulators

**UNIT-III: BACTERIAL INFECTIONS & PARADIGMS OF PATHOGENESIS:** Diphtheria disease by colonisation; Disease without colonisation, *Clostridium botulinum* and *Staphylococcus aureus;* Intestinal infections, *Shigella* and *Ecoli* infections; *Vibrio cholera, Salmonella* infections

**UNIT-IV: VIRULENCE AND HOST PARASITE INTERACTIONS:** Virulence and virulence factors, Colonizing virulence factors, Virulence factors damaging host tissues, Measurement of virulence factors,virulence genes & regulation of virulence genesHost parasite interactions related to bacterial and viral infections

**UNIT-V: FUTURE CHALLENGES:** Gastric and duodenal ulcers - are they due to infections? Lyme disease and Syphilis - unsolved mystery Legionnaire’s disease-aftermath of comforts Tuberculosis and other mycobacterial infections reemerging with vengeance Rheumatic fever and glomerulo nephritis - still a question to be solved.

**COURSE OUTCOMES:**

1. By the end of the course students will have through knowledge of introduction to microbial pathogenesis.
2. By the end of the course students will have through knowledge of host defense system against pathogens.
3. At the end of the course students will have through knowledge of bacterial infections and their pathogenesis.
4. At the end of the semester students will have through knowledge of virulence and host parasite interactions with related to bacterial infections.
5. By the end of the course students will have through knowledge of Future challenges of infections and their treatments.

**TEXT BOOKS:**

1. Iglewski B.H. and Clark V.L. Molecular basis of Bacterial pathogenesis, Academic press, 1990.
2. Janeway C.A. Jr, and Travers P. T. Immunobiology. Blackwell J Scientific Publishers, 1994.

**REFERENCES:**

1. Talaro K. and Talaro A. Foundations in Microbiology, W.C. Brown Publishers, 1993. Roitt I. Essentials of Immunology, 8th edition, Blackwell Scientific Publishers, 1994.
2. Austyn J.M. and Wood K.J. Principles Cellular and Molecular Immunology, OxfordUniversityPress,1993.

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OPEN ELECTIVE III

 **ENVIRONMENTAL MICROBIOLOGY**

**Course Objective:** The main objective of this course is to impart students an understanding of pollution of environment by air, water and soil responsible for degradation of natural resources and degradation of biodiversity. It also familiarizes them with various remediation techniques, non polluting technologies viz. bioenergy and biomining..

**UNIT-I: ENVIRONMENTAL POLLUTION AND CONTROL:** Introduction to Environmental pollution, Air, water and soil pollution-common effects and control measures

**Air Pollution Treatment:** Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste

**Pathogenic microorganisms in the environment**: Air and water-borne diseases; sources of environmental pathogens, mode of transmission and disinfection

**UNIT-II: WASTE WATER TREATMENT: Microbial aspects of water pollution**; Microbial toxins in the environment; disposal/treatment of organic solid wastes, sewage and industrial effluents

**Aerobic:** Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactor

**Anaerobic:** Anaerobic digestion, Anaerobic digesters, Contact Digesters, Packed Column Reactors, UASB for biological treatment process

**UNIT-III: MANAGEMENT OF WASTE: Microorganisms in the Natural Environments:** Microbes in terrestrial, aquatic, atmospheric and biological environments, environmental selecting factors (physical, chemical and biological); microbes in the extreme environments and their adaptations; dispersal of microorganism, and methods for the determiantion of microbial numbers, biomass and activities Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermi composting

**UNIT-IV: ROLE OF MICROORGANISMS IN** **BIOREMEDIATION:**  Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediationMicrobial degradation of pesticides and other recalcitrant chemicals, microbial degradation of petroleum and hydrocarbons; biodeterioration and control

**UNIT-V:** **BIOENERGY & BIOMINING:**  **Bio Energy:** Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass **Biomining:** Bioleaching, Types and Applications, monitoring of point and nonpoint sources of pollutants, microbially enhanced oil recovery, microbial fuel cells and their applications

**COURSE OUTCOMES:**

1. At the end of this course Students will have through knowledge of various types of pollution, common effects and control measures.
2. At the end of this course Students will have through knowledge of the types of waste water, their contaminants and treatment technologies.
3. By the end of this course students will have through knowledge of Microbial ecology and their adaptations followed by phytoremediation techniques.
4. By the end of this course students will have through knowledge of Bioremediation techniques and their applications followed by Biodeterioration and their control.
5. At the end of this course students will have through knowledge of Bioleaching, Biomining and microbial fuel cells and their applications.

**REFERENCE BOOKS:**

1. Wastewater Engineering-Treatment, Disposal, and Resuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Industrial Pollution control Engineering- AVN Swamy., Galgotia Publication, (2006).
3. Environmental Biotechnology- Allan Stagg.

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CORE COURSE VIII

**BIOINFORMATICS**

Course Objectives: This course is formulated to provide students an in depth knowledge of biological data analysis using compilation methods. It is also useful for investigating molecular biology Problems from computational perspective. To enhance knowledge about protein structural predictions, molecular docking and evolutionary relationships between organisms.

UNIT-I: Introduction to Bioinformatics & Sequencing alignment CONCEPTS:

Need of Computers in Biotechnology Research; File Transfer Protocol (FTP), TELNET,HTTP; Bioinformatics- Introduction, Scope, Applications; Strings, Edit distance, Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment

UNIT-II: biological Databases and datamining:

Biological Information on the web- Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (RASMOL)

UNIT-III: Phylogenetic analysis and prediction: Understanding Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods, Tools & Problems (Clustal W)

UNIT-IV: genOME MAPPINg and prediction:

Genome sequencing; Genome Mapping; Comparative Sequence Analysis; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP), Promoter analysis

**RNA Sequence and structure Analysis** - si-RNA design and development, micro RNA identification strategies, RNA secondary structure, RNA structure Prediction Methods

**UNIT-V: PROTEIN STRUCTURE PREDICTION METHODS:**

Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods), Molecular docking.

**COURSE OUTCOMES:**

1. At the end of this course students will understand the specific features of the subject as seen in relation to application across the two disciplines of computational and bioscience and they can learn the computational fundamentals which are useful for bioinformatics programming.
2. At the end of this course students will get good knowledge of different Databases, data retrieval process, data mining and important Visualization tools in Proteomics.
3. At the end of this course students will understand the evolutionary relationships between species and the sequence alignment tools and process for sequence comparisons to know the relationship between the species
4. At the end of this course students will obtain thorough knowledge of sequencing and mapping of genomes and RNA design and development
5. At the end of this course students will obtain knowledge Protein modeling and structure prediction of unknown proteins.

**TEXT BOOKS:**

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
2. Bioinformatics Basics, Applications in Biological Science and Medicine- Hooman
3. Bioinformatics: Genome and sequence analysis by David W Mount.
4. Bioinformatics: A practical guide to analysis of genes and proteins by Baxevanis, Andreas D Wiley – Interscience publishers.

**REFERENCE BOOKS:**

1. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, Jhon Wiley & Sons
2. Essential Bioinformatics by Jin Xiong, Cambridge University Press
3. Bioinformatics Principles & Applications by Zhumur Ghosh, Oxford University Press.

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LABORATORY V

**r-DNA TECHNOLOGY & MEDICAL MICROBIOLOGY**

**LIST OF EXPERIMENTS:**

**PART-A (r-DNA TECHNOLOGY)**

**Course Objective:** This course intends to provide practical knowledge of different techniques involved in r-DNA technology.

1. Isolation of DNA
2. PCR-Amplification of DNA
3. Restriction digestion
4. Ligation
5. Screening for recombinants

**Course Outcome:**

By the end of this course student will acquire skill to perform techniques involved in isolation restriction digestion & ligation of DNA and screening of recombinants

**PART- B MEDICAL MICROBIOLOGY LABORATORY**

**Course Objective:** This course intends to provide the practical knowledge of different techniques used in medical microbiology lab.

* 1. Preparation of medically important media
	2. Urea estimation
	3. Glucose estimation
	4. Acid-Fast staining
	5. Bacteriological examination of blood, urine & pus
	6. Determination of Hemoglobin
	7. Erythrocyte Sedimentation Rate
	8. Collection and culture of Nosocomial micro-organisms
	9. Permanent slide preparation

**Course Outcome:**

1. By the end of this course student will acquire skill to perform different methods used in medical field.

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LABORATORY VI

**ENZYMOLOGY AND BIOENERGETICS & BIOPHARMACEUTICAL TECHNOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (ENZYMOLOGY AND BIOENERGETICS)**

**Course Objective:** This course intends to provide the practical knowledge required to study different aspects of microbial enzymes

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.(b) Compute specific growth rate (m), growth yield (Yx/s,) from the above
4. Comparative studies of Ethanol production using different substrates.
5. Production of Citric acid using *Aspergillus Niger.*
6. Production and estimation of Alkaline Protease.
7. Use of alginate for cell immobilization.

**Course Outcome:**

1. By the end of this course student will acquire skill for production and estimation of microbial enzymes.

**PART- B BIOPHARMACETUICAL TECHNOLOGY LAB**

**Course Objective:** This course intends to provide the practical knowledge of Biopharmaceutical technology

* + 1. Isolation of Pharmaceutically important phytochemicals from crude drugs.
		2. TLC characterization of medicinal plant extracts and isolation of phytochemicals.
		3. CC Characterization of medicinal plant extracts and isolation of phytochemicals.
		4. Secondary metabolite extraction from plant cell suspensions.
		5. Chemical tests for alkaloids, glycosides, steroids, flavonoids, tannins and resins.
		6. Estimation of plant phytoconstituents using HPLC.

**Course Outcome:**

1. By the end of this course student will acquire skill for isolation, separation and estimation of pharmaceutically important phytochemicals.

**CENTRE FOR BIOTECHNOLOGY**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**Kukatpally, Hyderabad-500 085, Telangana State, India**



**Master of Science**

**in**

**MICROBIOLOGY**

 **(FTPG)**

**STUDENTS ATTENDANCE LIST**