|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **I semester** | **Course Title** | **Int. Marks** | **Ext.****marks** | **L** | **P** | **C** |
|  | Core Course I | Cell Biology | 25 | 75 | 4 | - | 4 |
|  | Core Course II | Bacteriology | 25 | 75 | 4 | - | 4 |
|  | Core Course III | Biochemistry | 25 | 75 | 4 | - | 4 |
|  | Core Elective I | 1. Molecular Biology
2. Animal Cell Science Technology
 | 25 | 75 | 4 | - | 4 |
|  | Open Elective I | 1. Basic Mathematics and Biostatistics
2. Bioethics, Biosafety and IPR
 | 25 | 75 | 4 | - | 4 |
|  | Laboratory I | Cell Biology and Bacteriology Lab | 25 | 75 | - | 8 | 4 |
|  | Laboratory II | Biochemistry and Molecular Biology Lab | 25 | 75 | - | 8 | 4 |
|  | **Total** | **175** | **525** | **20** | **16** | **28** |

**Centre for Biotechnology (CBT)**

**M.SC MICROBIOLOGY**

**Course Structure**

**(W.e.f-2015-16 Batch)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **II semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | Core Course IV | Bioanalytical Techniques | 25 | 75 | 4 | - | 4 |
| 2. | Core Course V | Immunology | 25 | 75 | 4 | - | 4 |
| 3. | Core Course VI | Virology | 25 | 75 | 4 | - | 4 |
| 4. | Core Elective II | (i) Industrial Microbiology(ii) Plant Biotechnology  | 25 | 75 | 4 | - | 4 |
| 5. | Open Elective II | (i) Environmental Microbiology (ii) Computers Programming and Data Structures | 25 | 75 | 4 | - | 4 |
| 6. | Laboratory III | Bioanalytical techniques and Virology Lab  | 25 | 75 | - | 8 | 4 |
| 7. | Laboratory IV | Immunology and Industrial Microbiology/ Plant Biotechnology Lab | 25 | 75 | - | 8 | 4 |
|  | **Total** | **175** | **525** | **20** | **16** | **28** |

**I YEAR**

**II YEAR**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **III semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | Core Course VII | r-DNA Technology | 25 | 75 | 4 | - | 4 |
| 2. | Core Course VII | Enzymology and Bioenergetics  | 25 | 75 | 4 | - | 4 |
| 3. | Core Course IX | Soil, Food and Diary Microbiology | 25 | 75 | 4 | - | 4 |
| 4. | Core Elective III | (i) Medical Microbiology(ii) Nano-Biotechnology | 25 | 75 | 4 | - | 4 |
| 5. | Open Elective III | (i) Bioinformatics(ii) Bio Business Management | 25 | 75 | 4 | - | 4 |
| 6. | Laboratory V | r-DNA Technology and Medical Microbiology/Nano Biotechnology Lab | 25 | 50 | - | 6 | 3 |
| 7. | Laboratory VI | Enzymology and Bioenergetics and Soil, Food and Diary Microbiology Lab | 25 | 50 | - | 6 | 3 |
|  | Seminar  |  | 50 | - | - | 4 | 2 |
|  | **Total** | **225** | **475** | **20** | **16** | **28** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **IV Semester** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. |  Project Work Review | 50 | - | - | 8 | 4 |
| 2. |  Project Evaluation (VivaVove) | - | 150 | - | 16 | 12 |
|  | **Total**  | 50 | 150 |  | 24 | 16 |

M.Sc. MICROBIOLOGY - FIRST SEMESTER– W.E.F.2015

CORE COURSE I

**CELL BIOLOGY**

**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 Exo cytosis. 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 & Checkpoints. Disruption 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.

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**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**

**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; Homoacetogenic acid bacteria; Budding and Appendaged bacteria; Spirilla; Spirochaetes; Gliding and sheathed bacteria; Pseudomonads – Lactic and Propionic acid bacteria; Endospore forming rods and cocci; Mycobacteria; Rickettsia’s; Chlamydia’s ; Mycoplasma’s; Cyanobacteria; Prochlorons and Cyanelles.

**UNIT-III Cultivation of Bacteria:**Nutritional types; Culture media types; Growth curve; Generation time; Growth kinetics; Synchronous and Asynchronous cultures; Batch and Continous 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; Chemolithotrophy; Photosynthesis; Calvin cycle.

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

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**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.

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CORE COURSE III

 **BIOCHEMISTRY**

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

**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, E.T.C.

**UNIT –III LIPIDS:** Classification, physical and chemical properties of Lipids, Metabolisim 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; Metabolisim of Protiens: Biosynthesis of non-essential aminoacids; catabolism of aminoacids.

**NUCLEIC ACIDS**: Nucleotides, DNA & RNA, Metabolism of nucleic acids: Purine synthesis and catabolism; Pyramidine synthesis and catabolism.

**UNIT-V Photosynthesis:** Bacterial & Plant photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll

as trapper of solar energy, photosynthetc reaction centres, Hill reaction, PS I & PS II,

Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO2 fixation

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**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

**1.MOLECULAR BIOLOGY**

**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.

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**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

 **2.ANIMAL CELL SCIENCE AND TECHNOLOGY**

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

**UNIT-II CELL CULTURE MEDIUM, COMPONENTS, TYPES & THEIR PHYSIOLOGICAL 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).

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**TEXTBOOKS:**

1. Culture of Animal Cells, (3rd Edition), Fl. Ian Freshney. 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

**1.BASIC MATHEMATICS & BIOSTATISTICS**

UNIT-I DIFFERENTIAL CALCULUS: Functions, limit continuity and differentiation. Differentiation of sum, product and quotient of function. Differentiation of implicit, trigonometrically universe trignomentrical functions; Differentiation of impllict, trigonometrical universe trigonometrical functions, Partial differentiation; Eulers theorem on homogenous function; Maxima and minima, Errors and approximation.

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

UNIT-III MATRICES: Basics, Determinants addition and subs traction of and multiplication of Matrices. Adjoint, Universe of a matrix, Rank of matrix; solution of linear system of equations, elementary operations, Gauss-Jordan method – Matrix inversion

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 central moments-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-parsons 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 test for goodness of fit and chi square test of means and f-test for equality of variances-arithmetic, Geometric and harmonic mean.

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**TEXTBOOKS:**

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

**REFERENCES:**

1. Differential Calculus - Shanthi Narayan

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OPEN ELECTIVE I

**2. BIO ETHICS, BIOSAFETY & INTELLECTUAL PROPERTY RIGHTS**

**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

**UNIT III: INTRODUCTION TO IPR & PATENTS:** Discovery, Creativity, Innovation, Invention, Need for IPR, Types of IPR, Genesis & development of IPR in India, Definition, Scope, Protection, Patentability Criteria, Types of Patents (Process, Product & Utility Models), Software Patenting. Types of searching, public & private searching Databases. Drafting & Filing of Patent applications, Patent Cooperation Treaty (PCT), Patent infringement.

**UNIT IV: OTHER TYPES OF IPR:** Copyrights – Definition, granting, infringement, searching & filing, distinction between copy rights and related rights; Trade Marks - role in commerce, importance, protection, registration, domain names; Trade Secrets, Unfair competition; Industrial Designs – Scope, protection, filing, infringement; Semiconductors, Integrated Circuits & Layout design; Geographical Indications & Appellations of Origin; Case Studies.

**UNIT V: IPRS AND BIOTECHNOLOGY:** Plant variety Protection, Farmers & Breeders Rights, Indian Biodiversity Act, Protection of Traditional Knowledge, Biopiracy & Bioprospecting, ITPGRFA, Budapest Treaty & IDA, Biotechnology Patenting issues, Gene Patenting, Case studies (Diamond vs Chakravarthy, Dimminaco AG vs. Controller of Patents, Basmati Rice, Turmeric, Neem, Harvard Oncomouse, Transgenic Plant Patents)

**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 I

**CELL BIOLOGY & BACTERIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (CELL BIOLOGY)**

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

### PART-B (BACTERIOLOGY)

1. Isolation, Purification & Quantification of bacteria
2. Factors affecting bacterial growth
3. Determination of thermal death point
4. Determination of antimicrobial activity (Disc diffusion, cup plate method)
5. Determination of minimum inhibitory concentrations
6. Transformations: Bacteria
7. Quantification of Viruses: Plaques

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 LABORATORY II

**BIOCHEMISTRY & MOLECULAR BIOLOGY / ANIMAL CELL SCIENCE AND TECHNOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (BIOCHEMISTRY)**

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.

**PART-B (MOLECULAR BIOLOGY)**

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)

**BT-308 ANIMAL SCIENCE & TECHNOLOGY LABORATORY**

**PRACTICALS:**

1. Preparation of tissue culture medium and membrane filtration
2. Trypsinization of monolayer and sub culturing
3. Cell counting and cell viability Cryopreservation and thawing

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CORE COURSE IV

**BIOANALYTICAL TECHNIQUES**

**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.

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**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, MeGraw Hill, New York.
8. Biophysical Chemistry, Cantoz, WH Freeman.
9. Protein Structure, by Max Perutz.

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CORE COURSE V

 **IMMUNOLOGY**

**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, applications of adjuvants.

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

Cells of the immune system: Hematopoiesis and differentiation, Inflammation (IL6), Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells (IL2).

**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 Melletus, Diphtheria (bacteria), Hepatitis, Transplantation, Vaccination for disease control.

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**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

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CORE COURSE VI

**VIROLOGY**

**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). Single stranded & ds RNA viruses

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)

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**TEXT BOOKS:**

1. Intoduction 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

**1. 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.

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**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.

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

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**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

**2.PLANT BIOTECHNOLOGY**

**UNIT-I PLANT TISSUE CULTURE & TOTIPOTENCY:** Totipotency,Different areas and applications of plant tissue culture, Nutritional components of tissue culture media, Establishment of aseptic cultures, Initiation of callus and suspension cultures.

**UNIT-II TISSUE CULTURE TECHNIQUES-I:** Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis. Anther Pollen culture, Production of haploids and their application, Storage of plant genetic resources (Cryopreservation), Somoclonal variation.

**UNIT-III TISSUE CULTURE TECHNIQUES-II:** Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization, Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites, Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells. Biotransformations using plant cell cultures.

**UNIT-IV TRANSGENIC TECHNOLOGY-I:** Genetic Transformation methods for production of transgenic plants (Direct, Indirect), Direct Gene Transfer (DGT) methods, Agrobacterium mediated genetic transformation (Indirect), Chloroplast transformation and production of transplantomics.

**UNIT-V TRANSGENIC TECHNOLOGY-II:** Production of genetically modified plants/crops for agronomic traits, transgenic plants for biotic and abiotic stress tolerance, transgenic plants for quality traits, Industrial enzymes, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines).

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**TEXTBOOKS:**

1. Bhojwani SS and Rajdan MK Plant Tissue Culture: Theory and Practice, A revised Edition. 2002

2. Hammond, R McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000

3. Glick BR and Pasternak JJ. Molecular Biotechnology principles and applications of

 Recombinant DNA. 2006

**REFERENCES:**

1. H.S. Chawla: Biotechnology in Crop Improvement. International Book Distributing Company,

 1998.

2. Giri CC and Archana Giri: Plant Biotechnology Practical Manual. I K International 2007

3. R.J. Henry: Practical Application of Plant Molecular Biology. Chapman and Hall. 1997

4. P.K. Gupta., Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

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OPEN ELECTIVE II

 **1.ENVIRONMENTAL MICROBIOLOGY**

**UNIT-I INTRODUCTION:** 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:

**UNIT-II WASTE WATER TREATMENT:**

**Water:** Water Pollution and treatment technologies (clean technology). Waste water types, major contaminants in waste water. Physical, chemical and biological methods of waste water treatment.

**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 biological treatment process.

**UNIT-III MANAGEMENT OF WASTE:** Management of Contaminated land**,** lake sediments and Solid Waste, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting.

**UNIT-IV** **BIOREMEDIATION:**  Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons & Lignocellulosic Compounds.

**UNIT-V** **BIOENERGY & BIOMINING:**

**Bio Energy:** Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass. **Biomining:** Bioleaching, Types and Applications, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells and their applications.

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**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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OPEN ELECTIVE II

**2. COMPUTER PROGRAMMING 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.

**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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LABORATORY III

 **BIOANALYTICAL TECHNIQUES & VIROLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (BIOANALYTICAL TECHNIQUES)**

1. Verification of lambert – Beer’s law by UV-VIS Spectrophotometer.
2. Estimation of different macro molecules by visible spectrophotometer
3. Estimation of turbidity using by UV-VIS spectrophotometer
4. Separation of different macro molecules by paper, thin layer, column
5. Electrophoresis of proteins- Native and under denaturing conditions(coomsive staining)

**PART-B (VIROLOGY)**

* + 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.

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LABORATORY IV

**IMMUNOLOGY AND ENIRONMENTAL MICROBIOLOGY / PLANT BIOTECHNOLOGY**

**LIST OF EXPERIMENTS:**

**IMMUNOLOGY**

1. Radial immuno diffusion,
2. Ouchterolony double immuno diffusion
3. Dot blot,
4. Immuno electrophoresis,
5. ELISA
6. Purification of antibodies,
7. Lateral flow diagnostics – HCG, malaria, Tuberculosis (Kits)
8. Blood grouping – Agglutination,

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

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

**PART- B (PLANT BIOTECHNOLOGY LABORATORY)**

1. Preparation of medium.
2. Surface sterilization.
3. Organ culture.
4. Cell suspension cultures.
5. Growth and production kinetics for secondary metabolite production and quantification.
6. Genetic transformation studies using ***Agrobacterium***.

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CORE COURSE VII

**r-DNA TECHNOLOGY**

**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.

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**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**

**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, Lineweaver burk’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 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.

**UNIT-V 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.

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**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

 **SOIL, FOOD AND DAIRY MICROBIOLOGY**

**UNIT-I Soil Microbiology:** Occurance and activities of soil microorganisms and their influence on soil productivity and plant growth. Rhizoshere, role of rhizobacter and their importance in recycling the elements (Carbon, Nitrogen, Sulfur, Phosphorous cycles). Microbial dynamic equilibrium in soil neutralism, symbiosis, competition, commenalisms and antagonism.

**UNIT-II Food & Dairy Microbiology:** Brief history of microorganism in food stuff, source types and role of microorganisms in foods, intrinsic and extrinsic parameters in foods which effect microbial growth, methods for studying microbes and their products in food stuff spoilage of fruits and vegetables, fresh and processed meats and poultry, and miscellaneous foods such as eggs, bakery products, diary products, beer and wine fermented foods, canned foods, food preservation Techniques (acidophilus milk, cheese, yoghurt), meat and fishery products (dry sausages an sauces), plant products (cocoa beans, coffee beans, olives, pickles, saur-kraut, sTempeh, idli ), breads, beverages, ( cider, sake, vinegar, palm wines), food born diseases and food poisoning.

**UNIT-III Important Microorganisms of Food:** Molds, yeast and their characterizations, classification and importance. Principles of food Asepsis removal of microorganism (anaerobic conditions, high temperatures, drying).Chemical preservatives and Food additives. Canning, process treatment D, Z, and F values and working out treatment parameters.

**UNIT-IV Microbes of Dairy and Food Borne Diseases:** Contamination and spoilage, cereals, sugar products vegetables, Meat, fish and other sea products, Milk products, poultry spoilage, spoilage of canned food and characterization. Food borne infections and intoxications, nonbacterial with example of infective and toxic types Bruce clostridium, Escherichia, Salmonella, Staphylococcus, Vibrio, Yersinia, nematode, algae, fungi and viruses. Food borne outbreaks laboratory testing procedure measures Food sanitation in manufacture and retail trade,

**UNIT-V Fermented Foods:** Bread, cheese, vinegar, fermented vegetables, fermented oriental Fermented foods, their quality standard and control, experimental methods, microbial cells as food (Single cell proteins) and mushroom cultivation .Genetically modified foods-Bt Brinjal, Golden rice, sweet corn. Microbial quality control of food products, ISI standards .FAO/WHO regulations, FDA regulations and APHA/IDF regulations. Basic GMP in the industries

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**TEXT BOOKS:**

1. Food Microbiology. 2nd Edition By Adams
2. Basic Food Microbiology by Banwart George J.
3. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology, Volume 2 by Joshi.
4. Food Microbiology by Frazier, Tata McGraw-Hill Publishing Company Limited.
5. Soil Microbiology by Alexanders. Martins

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CORE ELECTIVE III

**1. MEDICAL MICROBIOLOGY**

**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 *E.coli* 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 genes.Host 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

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**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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CORE ELECTIVE -III

**2. NANO BIOTECHNOLOGY**

**UNIT-I INTRODUCTION TO NANO-BIOTECHNOLOGY:** Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

**UNIT-II: BASIC CHARACTERIZATION TECHNIQUES**; Electron microscopy; Atomic force: microscopy; Photon correlation Spectroscopy.

**UNIT-III NANO STRUCTURES:** Thin films; Colloidal nanostructures; Nanovesicles; Nanospheres; Nanocapsules.

**UNIT-IV NANOSTRUCTURES FOR DRUG DELIVERY:** Concepts, targeting, routes of delivery and advantages.

**UNIT-V APPLICATIONS OF NANO STRUCTURES:** Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nanodevices for sensor development.

**TEXT / REFERENCE BOOKS:**

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH

 Verlag GmbH & Co. KGaA ISBN: 3527304401

2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss

 ISBN: 047141719X

3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press

 ISBN: 0-8247-2579-4.

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OPEN ELECTIVE III

**1. BIOINFORMATICS**

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).

**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)

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**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 & Applicatrions by Zhumur Ghosh, Oxford University Press

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OPEN ELECTIVE- III

**2. BIOBUSINESS MANAGEMENT**

**UNIT I: INTRODUCTION TO BIOBUSINESS:** Principles of business management and concept of Biobusiness, SWOT analysis of Indian Biobusiness. **Project formulation** Project formulation and selection based on size, technological assessment, technical report, feasibility and commercial viability of project.

**UNIT II: PROJECT COST AND MARKET POTENTIAL:** Total product cost, capital investment and profitability, manufacturing costestimation, capital investment estimation, Risk capital and working capital,manufacturing cost estimation for an intracellular protein, using cost analysis for R& D decision making.

**UNIT III: LEGAL PROTECTION IN BIOTECHNOLOGY:** Regulatory and IPR issues in Biotechnology, Intellectual Property Protection (IPP), Trade secret protection, licensing of bio-product, procedure for obtaining US patent, characteristics of the disclosure for a biotechnology invention, marketing a biotechnology invention, trade regulations.

**UNIT IV: BIO-SAFETY:** General guidelines (GLP, GMP), containment facilities, types of containment, guidelines for recombinant DNA research, release of genetically modified

organisms (GMOs), ISO Series, GATT.

**UNIT V: INDUSTRIAL SICKNESS:** Symptoms, Control and rehabilitation and sick units. **Ethics in Biotechnology:** Statutory requirements of social responsibility and entrepreneurial discipline.

**BOOKS:**

1. Patent Law - P. Narayan
2. Economic reforms and Indian markets - S. L Rao
3. Manual of Industrial Microbiology and Biotechnology - A. L. Demain and N.A.

Solomon

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LABORATORY V

 **r-DNA TECHNOLOGY & MEDICAL MICROBIOLOGY/ NANO BIOTECHNOLOGY**

**LIST OF EXPERIMENTS:**

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

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

**PART- B MEDICAL MICROBIOLOGY LABORATORY**

* 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

**NANO BIOTECHNOLOGY**

1. Antibacterial activity of nano particles.
2. Antifungal activity of nano particles.
3. Antiactinomycetes of nano particles.
4. Assay of antimicrobial activity of nano particles.

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LABORATORY VI

**ENZYMOLOGY AND BIOENERGETICS & SOIL, FOOD & DAIRY MICROBIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

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

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.

**PART-B (SOIL, FOOD & DAIRY MICROBIOLOGY)**

1. Estimation of Streptomycin
2. Fermentation Process during Curdling
3. Estimation of Lactose by DNS method
4. Estimation of Proteins
5. Estimation of Lactic Acid
6. Bacterial count determination
7. Estimation of Citric Acid
8. Isolation of Yeast cells
9. Isolation of *Azospirillum* specis from soil
10. Estimation and enumeration of bacteria, fungi and actinomycetes by serial dilution and agar plating technique.

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| **IV Semester** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. |  Project Work Review | 50 | - | - | 8 | 4 |
| 2. |  Project Evaluation (VivaVove) | - | 150 | - | 16 | 12 |
|  | **Total**  | 50 | 150 |  | 24 | 16 |