Department of Life Science

Syllabus

1. Btech Biotech
2. M.Tech Integrated Biotech
3. M.Tech Biotech
4. Msc. Biotech
5. Msc. Botany
6. M.Sc. Zoology
7. M.Sc. Microbiology
8. M.Phil Biotech
9. M.Phil Microbiology
10. M.Phil Zoology
11. M.Phil Botany

B.Tech. in Biotechnology

Course Structure

Semester – I

S. No.	Code	Name of Subject	L	P	U
1	BTBT111	General Biology			
2	BTBT121	Fundamental of Computer			
3	BTBT131	Mathematics			
4	BTBT141	Biophysics			
5	BTBT151	Basics of Chemistry			
6	BTBT161	General English			

Semester – II

S. No.	Code	Name of Subject	L	P	U
1	BTBT112	Concept of Microbiology			
2	BTBT122	Principle of Management			
3	BTBT132	Scope & Objective of Biotechnology			
4	BTBT142	Elementary Chemistry			
5	BTBT152	C-Language			
6	BTBT162	Additional Subject-English Language & Personality Development			

Semester – III

S. No.	Code	Name of Subject	L	P	U
1	BTBT211	Molecular Biology			
2	BTBT221	Biochemical Engineering			
3	BTBT231	Biostatics & Probability			
4	BTBT241	Biomolecules			
5	BTBT251	Biochemistry			

Semester – IV

S. No.	Code	Name of Subject	L	P	U
1	BTBT212	Genetics			
2	BTBT222	Genetic Engineering			
3	BTBT232	Food Technology			
4	BTBT242	Analytic Techniques in Biotechnology			
5	BTBT252	Down Stream Processing in Biotechnology			

Semester – V

S. No.	Code	Name of Subject	L	P	U
1	BTBT311	Immunology & Immunos Technology			
2	BTBT321	Plant & Animal Virology			
3	BTBT331	Enzyme Technology			
4	BTBT341	Introduction of Bioinformatics			
5	BTBT351	Computational Methods for Biological Sequence Analysis			

Semester – VI

S. No.	Code	Name of Subject	L	P	U
1	BTBT312	Bioethics, Bio Safety and Intellectual Property Rights			
2	BTBT322	Molecular Mechanism of gene Expression			
3	BTBT332	Environmental Biotechnology			
4	BTBT342	Industrial Biotechnology			
5	BTBT352	Emerging Areas in Bioinformatics			

Semester – VII

S. No.	Code	Name of Subject	L	P	U
1	BTBT411	Animal Biotechnology			
2	BTBT421	Plant Biotechnology			

3	BTBT431	Protein Engineering			
4	BTBT441	Cell & Tissue culture Technology			
5	BTBT451	Molecular modeling & drug designing			

Semester – VIII

Project (Industrial & Training Project)

Semester - I

GENERAL BIOLOGY AND ENVIRONMENTAL SCIENCE

UNIT I

Origin of Life: Theories of Origin of Life, Classification and Evolution of Organism.

UNIT II

Cell & Cell Division: Prokaryotic and Eukaryotic cells, Plant and Animal Cell, Cell wall, Cell membrane, Cell organelles (Structure and function), Transport system in cell.

Cell cycle: Mitosis and Meiosis.

UNIT III

Continuity of life: Mendalism, monohybrid and dihybrid crosses, Double hellicle structure of DNA.

Biological Compounds: Introduction, Classijicaion, Properties, Function of following Biomolecules – Carbohydrates, Amino Acids, Proteins, Lipids and Nucleic acids.

UNIT IV

Organisms and Environment: What is Environment? Green house effect, Acid Rain, Environmental Pollution.

TEXT BOOKS:

1. P.S. Dashmi

2. H.N. Srivastiva

FUNDAMENTAL OF COMPUTER

UNIT I

Introduction: Classification of computer and generation, Basic architecture of computer and its building blocks, Input Devices, Computer memories.

Number System: Binary, Octal, Decimal, and Hexadecimal representation of characters: ASCII and EBDIC codes, Binary arithmetic and logic circuit.

UNIT II

Classification of Computer language: Machine, Assembly and High level language, Brief idea of operating system, Assembler, Compiler and interpreter.

Fundamentals of Computer Programming: Problem solving through computer algorithms and flow chart level of programming.

UNIT III

Operating System: Introduction to O.S., Types of operating system, Multiprogramming, Timesharing, Batch, Real time and UNIX.

UNIT IV

Internet: Introduction to internet, Components, Services and working on internet.

Introduction to protocols, tools

MATHEMATICS

UNIT – I

Differential equations of first order and first degree – exact, linear and Bernoulli. Non-homogeneous linear differential equations of second and higher order with constant coefficients with RHS term of the type e^{ax}, Sin ax, cos ax, polynomials in x, e^{ax} V(x), xV(x), method of variation of parameters.

UNIT – II

Rolle's Theorem – Lagrange's Mean Value Theorem – Cauchy's mean value Theorem – Generalized Mean Value theorem (all theorems without proof) Functions of several variables – Functional dependence- Jacobian- Maxima and Minima of functions of two variables with constraints and without constraints

Radius, Centre and Circle of Curvature – Evolutes and Envelopes Curve tracing – Cartesian, polar and parametric curves.

UNIT –III

Applications of integration to lengths, volumes and surface areas in Cartesian and polar coordinates multiple integrals - double and triple integrals – change of variables – change of order of integration.

Sequences – series – Convergences and divergence – Ratio test – Comparison test – Integral test – Cauchy's root test – Raabe's test – Absolute and conditional convergence

UNIT – IV

Vector Calculus: Gradient- Divergence- Curl and their related properties of sums- products- Laplacian and second order operators. Vector Integration - Line integral – work done – Potential function – area- surface and volume integrals Vector integral theorems: Green's theorem-Stoke's and Gauss's Divergence Theorem (With out proof). Verification of Green's - Stoke's and Gauss's Theorems.

Text Books:

1. A text Book of Engineering Mathematics, Vol-1 T. K. V. Iyengar, B. Krishna Gandhi and Others, S. Chand & Company.
2. A text Book of Engineering Mathematics, C. Sankaraiah, V. G. S. Book Links.
3. A text Book of Engineering Mathematics, Shahnaz Bathul, Right Publishers.
4. A text Book of Engineering Mathematics, P. Nageshwara Rao, Y. Narasimhulu & N. Prabhakar Rao, Deepthi Publications.

BIOPHYSICS / INSTRUMENTATION

UNIT – I

Microscopy: Introduction, Principle, Theory, Types, application, Parts of Compound Microscope, Light Microscopy, Optics of Microscopy, Optical Systems, Refractive Index, Numerical Aperture, Resolution, Magnification Range, Polarized Light Microscopy, Phase contrast, Dark field Microscopy, Fluorescence, Confocal Microscopy, 2, Imaging Modes of Confocal Microscopy, Differential Interference Contrast, Types Stereomicroscopy, Fluorescence Microscopy, Atomic Force Microscopy, Electron Microscopy, Scanning Electron Microscope (SEM), SEM guide, How it works, Transmission Electron microscope (TEM)

UNIT – II

Centrifugation: Principle, types, application, Theory, Density gradients, Ultracentrifugation (velocity and buoyant)

Radiation dosimetry: Radioactive isotopes and half life, Autoradiography, Effect of radiation on biological system, X-Ray Crystallography: Vectors and Symmetry (application, point group, lattice, elementary ideas of space group); Diffraction and Fourier Transformation; Application (steps in solving crystal structures,

UNIT –III

Spectroscopy: Principle, types, application, Overview, UV-VIS Spectroscopy, Theory of electronic spectra (atomic and band spectra, L-B law, application and exception); Instrumentation; Chromophore, auxochrome;

IR Spectroscopy: Vibrational Spectroscopy, Vibration (different modes, di- and poly atomic); Frequency, wavenumber; Hook?s law; Instrumentation; Vibration-rotation spectrum of CO2; Factors influencing vibrational frequency (vibronic coupling, H-bond, electronic factors, bond angles etc).

Fluorescence: Spectroscopy Approaches To Teaching Fluorescence Spectroscopy, Fluorescence Correlation Spectroscopy, Principle; Characteristic of Fluorescence (Stokes?s shift, life-time, mirror image rule etc) and molecules shown fluorescence; Application to simple and biomolecules.

UNIT – IV

Nuclear Magnetic Resonance (NMR): Fundamentals of NMR, Diagrams for Multidimensional NMR, Principle; Chemical shift (different unit) and factors influencing chemical shift;

Correlation data; Solvent effect; Spin-spin coupling and splitting and factors involve; Application to small and biomolecules.

NMR of Paramagnetic Proteins, Fluorine NMR, Teaching High-Resolution NMR, Electron Paramagnetic Resonance (EPR), Optical Single-Molecule Methods,

BASICS OF CHEMISTRY

UNIT-1

WATER: Common Impurities, Hardness, Determination of hardness by Clark's test and complexometric (EDTA) method, Degree of hardness, Methods of water treatment.

UNIT-2

PHASE RULE: Statements, definition and meaning of terms involved; Study of one component and two component system.

UNIT- 3

CEMENT & GLASS: Manufacturing of Portland cement, Vertical shaft kiln technology, Chemistry of setting and hardening; Glass: Preparation, varieties and uses.

UNIT – 4

COORDINATION CHEMISTRY: Introduction, Types of ligands, IUPAC Rules, nomenclature of coordination compounds, Isomerism in coordination compounds, Theories of coordination, Crystal field theory, CFSE.

UNIT – 5

CHEMICAL BONDING: Introduction, Types of bonds, Ionic bond, Lattice energy, Born-Haber cycle, Covalent bond, Fajan's Rule, Hybridization, VSEPR theory.

UNIT – 6

POLYMER: Introduction, Polymers and their classification, Polymerization, Mechanism of polymerization, commercially important thermoplastics and thermosets, Biodegradable polymers.

GENERAL ENGLISH

UNIT – I

Listening Skills:

1. To enable students to develop their listening skill so that they may appreciate its role in the LSRW Skills approach to language and improve their pronunciation.

2. To equip students with necessary training in listening so that can comprehend the speech of people of different backgrounds and regions.

Students should be given practice in listening to the sounds of the language to be able to recognise them, to distinguish between them to mark stress and recognise and use the right intonation in sentences.

• Listening for general content, Listening to fill up information, Intensive listening, Listening for specific information

UNIT – II

Speaking Skills:

1. To make students aware of the role of speaking in English and its contribution to their success.

2. To enable students to express themselves fluently and appropriately in social and professional contexts.

• Oral practice, Describing objects/situations/people

• Role play – Individual/Group activities (Using exercises from all the nine units of the prescribed text: *Learning English : A Communicative Approach*.)

• Just A Minute(JAM) Sessions.

UNIT –III

Reading Skills:

1. To develop an awareness in the students about the significance of silent reading and comprehension.
2. To develop the ability of students to guess the meanings of words from context and grasp the overall message of the text, draw inferences etc.

Skimming the text, Understanding the gist of an argument, identifying the topic sentence, Inferring lexical and contextual meaning, Understanding discourse features, recognizing coherence/sequencing of sentences

UNIT – IV

Writing Skills:

1. To develop an awareness in the students about writing as an exact and formal skill
2. To equip them with the components of different forms of writing, beginning with the lower order ones.

Writing sentences, Use of appropriate vocabulary, Paragraph writing, Coherence and cohesiveness, Narration / description, Note Making, Formal and informal letter writing, editing a passage

Textbooks Prescribed:

1. **LEARNING ENGLISH:** ***A Communicative Approach***, Hyderabad: Orient Longman, 2006. (Six Selected Lessons)
2. **WINGS OF FIRE:** ***An Autobiography – APJ Abdul Kalam***, Abridged version with Exercises, Universities Press (India) Pvt. Ltd., 2004.

Semester – II

CONCEPT OF MICROBIOLOGY

UNIT – I

Introduction of Microbiology:

History and Scope of Microbiology, Bacterial taxonomy (Classification, Identification and nomenclature) Microscopic examinations.

UNIT – II

Cell Structure:

Prokaryotic cell structure and function, cell wall, cell membrane, slime layer, capsule, flagella and nucleus. Microbial Growth Curve.

UNIT –III

Microbial Control:

Control by Physical Agent: sun light drying, dry heat (flaming, incineration, hot air)

Moist heat (Pasteurization, Boiling and Steam under pressure) filtration, radiation, ultra sonic and sonic vibrations.

Control by Chemical agent: Alcohols, aldehydes, dyes, halogens, phenols, surface active agents, ethylene oxide, formaldehyde and betapropiolactone.

UNIT – IV

Clinical Microbiology:

Morphology, cultural characteristics, biochemical reaction, resistance, pathogencity and lab diagnosis of:

Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Clostridium

PRINCIPLE OF MANAGEMENT

UNIT – I

Nature and Importance of Management:

Meaning, Definition, Importance, Characteristics and functions of Management,

UNIT – II

Principal of Management, Management as a science and an art.

UNIT –III

Planning, Organizing, Staffing

UNIT – IV

Directing Supervision, Controlling, Delegation of authority.

Ref. Books:

Tulsian P.C. Business Organization and Management,

SCOPE & OBJECTIVE OF BIOTECHNOLOGY

UNIT – I

Introduction of Biotechnology: History, Definition, Biotechnology in India, Different areas of Biotechnology, Career in Biotechnology.

UNIT – II

Gene and Genetic Engineering: Introduction, Basic Principle of Genetic Engineering, Plasmids, Vectors for E.coli, Selection and Screening of recombinant cells.

UNIT –III

Bioprocess and Fermentation Technology: Introduction, Different Fermentation Process, Basic requirement of fermentation, Fermentor, Use of Fermentation Technology.

Enzyme Technology: Introduction of Enzyme, Classification, Rate equation of Enzyme, Industrial production of Enzyme, Application of Enzyme.

UNIT – IV

Role of Biotechnology in Medicine, Agriculture and Forestry,

Safety in Protocols, GLP/ GMP.

ELEMENTARY CHEMISTRY

UNIT – 1

CORROSION: Introduction; causes and effects of corrosion, Types and mechanism of corrosion, Factors influencing corrosion, Protective measures against corrosion.

UNIT – 2

NUCLEAR CHEMISTRY: Natural and artificial radioactivity, nuclear reactions, artificial transmutation of elements, nuclear fission and fusion, radioactive isotopes and their uses, half-life period, radioactive dating.

UNIT – 3

CHEMICAL KINETICS: Introduction, Factors influencing rate of reaction, Order and molecularity of reaction, Determination of order of reaction, Activation energy.

UNIT – 4

THERMODYNAMICS: Introduction, Zero law of thermodynamics, Ist law of thermodynamics, Enthalpy, Hess's law, Heat capacity, Relationship between Cp & Cv, Entropy, Free energy, 2^{nd} law of thermodynamics and 3^{rd} law of thermodynamics.

UNIT – 5

SOLID STATE: Introduction, Crystal structure, Packing fraction, Lattice energy, Born-Haber cycle, Crystal imperfections, Types of semiconductors.

C PROGRAMMING AND DATA STRUCTURES

UNIT - I

Algorithm / pseudo code, flowchart, program development steps, structure of C program, A Simple C program, identifiers, basic data types and sizes, Constants, variables, arithmetic, relational and logical operators, increment and decrement operators, conditional operator, bit-wise operators, assignment operators, expressions, type conversions, conditional expressions, precedence and order of evaluation.

Input-output statements, statements and blocks, if and switch statements, loops- while, do-while and for statements, break, continue, go to and labels, programming examples.

UNIT - II

Designing structured programs, Functions, basics, parameter passing, storage classes- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, example c programs.

UNIT - III

Arrays- concepts, declaration, definition, accessing elements, storing elements, arrays and functions, two-dimensional and multi-dimensional arrays, applications of arrays. pointers- concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, c program examples.

UNIT - IV

Derived types- structures- declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self referential structures, unions, typedef, bitfields, C program examples.

Introduction to data structures, singly linked lists, doubly linked lists, circular list, representing stacks and queues in C using arrays and linked lists, infix to post fix conversion, postfix expression evaluation.

TEXT BOOKS : 1. Computer science, A structured programming approach using C, B.A. Forouzan and R.F. Gilberg, Third edition, Thomson.

2. DataStructures Using C – A.S.Tanenbaum, Y. Langsam, and M.J. Augenstein, PHI/Pearson education.

Semester – III MOLECULAR BIOLOGY

UNIT-I

STRUCTURE OF DNA: Detailed structure of DNA, variation from Watson & Crick model, Z - DNA, A & B DNA, Denaturation & melting curves.

DNA REPLICATION: Models of DNA replication: semi conservative Mechanism of DNA replication in *E.coli* (bi- directional). Mitochondrial (D-loop), Viral DNA (Rolling circle), Single stranded- DNA phages (M13, Ø174), Eukaryotic telomeres and its replication Inhibitors of DNA Replication. Enzymes involved in replication, step by step process.

UNIT-II

RNA STRUCTURE AND BIOSYNTHESIS: m-RNA, r-RNA, t-RNA structures, Transcription apparatus, RNA polymerases and proteins involved in transcription (initiation, elongation and termination steps)

POST TRANSCRIPTIONAL PROCESSING: Post transcriptional processing of RNA‘s t-RNA, r-RNA, m- RNA splicing. Inhibitors of transcription.

UNIT – III

PROTEIN BIOSYNTHESIS: The genetic code and Wobble Hypothesis, Codon usage, Protein synthesis In Prokaryotes.

Eukaryotic Protein synthesis, differences between prokaryotic and eukaryotic protein synthesis, Post translational modifications. Inhibitors of protein synthesis.

UNIT – IV

MUTAGENESIS: Mutations, spontaneous, induced, lethal, mutagens their types and actions, classification of mutations and their applications. Site - directed mutagenesis and reverse genetics. DNA damage and repair mechanisms. Mutagenicity testing using microbial systems, Ames TEST.

TEXT BOOKS:

1. Molecular Biology, David Friefelder, Jones and Bartllett Publishing Home, 1987.

2.ShortProtocolsinMolecularBiology,2nd editionT..M.Ausubel,Brent,R.E.Kingston,D.D.Moire, Green Publication Associates and John Wiley and sons 1991

BIOCHEMICAL ENGINEERING

UNIT-I

Introduction to Bioprocesses: An overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and down stream) unit operations involved in bioprocesses, generalized process flow sheets.

UNIT-II

Media Design: Medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations

Sterilization Process: Heat sterilization, other sterilization Process.

UNIT-III

Metabolic Stoichiometry: Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients.

UNIT-IV

Kinetics of Microbial Growth and Product Formation: Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non - growth associated (secondary) product formation Kinetics. Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Introduction to Structured Models for growth and product formation.

Immobilization process, types of immobilization process, and their application.

Mineral beneficiation and oil recovery.

TEXT BOOKS

1. M.L.Shuler and F. kargi Bioprocess engineering, Prentice Hall of India.
2. P.M. Doran, Biochemical process principles, Academic Press, 1995.
3. Harvey W. Blanch, Douglas S. Clark Biochemical Engineering, Marcecel, Dekker.

BIOSTATIC AND PROBABILITY

UNIT-I

Introduction and definition of Biostatistics, Concept of variables in biological systems, Collection, Classification, Tabulation, Graphical and diagrammatic representation of numerical data.

Measures of Central Tendency: Mean, Median and mode and their relationship, measures of dispersion, range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.

UNIT-II

Probability: Random experiment, events, sample space, mutually exclusive events, independents and dependent events, Various definitions of probability addition and multiplication theorems of probability random variables (Discrete and Continuous), Probability density functions and its properties.

Some probability distributions such as binomial, Poisson and normal (Basic idea about these distributions) and their applications.

UNIT-III

Concepts of populations and sample, Simple random sampling without replacement, definition of simple random sample, chi-square, student's t- and f-distributions, their properties and uses, concepts of standard error.

UNIT-IV

Correlation and regression, Linear and quadratic regression analysis of variance: one-way and two-way classification with single observation per cell.

Ref. Books:

1. S.P. Gupta
2. S.C. Gupta

BIOMOLECULES

UNIT-I

Chemical foundations of biology- pH, pK, acids, bases, buffers, weak bonds and covalent bonds, Principles of thermodynamics, Classes of organic compounds and functional groups- atomic and molecular dimensions, space filling and ball and stick models.

UNIT-II

Carbohydrate – Classification, Structures, Chemical & Physical Properties.

Lipids- Classification, structure and functions.

UNIT-III

Amino acids and peptides- Classification, Chemical reactions and physical properties.

Proteins- Classification, Structure, Chemical & Physical Properties.

UNIT-IV

Heterocyclic compounds and secondary metabolites in living systems- nucleotides, pigments and isoprenoides.

Separation techniques for different biomolecules.

Ref. Books:

1. Irwinn H. Segel, John wiley

2. W.H. Freeman

3. T.G. Cooper

UNIT-I

Metabolism of carbohydrates: Glycolysis, oxidative phsophorylation, TCA cycle, Gluconeaogenesis, HMP shunt, Glycogen metabolism, Oxidative phosphorylation.

Synthesis of cellulose and starch.

UNIT-II

Metabolism of lipids: by lipid hydrolysis, lipases, biosynthesis of triacyglyceros and phospholipids.

UNIT-III

Metabolism of amino acids and proteins/ hydrolysis of proteins, proteases.

Metabolism of purines and pyrimidines: Biosynthesis of bases, nucleosides and nucleotides.

UNIT-IV

Carbon dioxide assimilation in microbes and higher plants; photosynthesis and energy transduction; photosynthetic pigments; photo system I and II, electron flow through cyclic, noncyclic photophosphorylations. Calvin Benson Cycle and Stack Cycle.

Ref. Book:

Biochemistry by lubert stryre

Semester – IV **GENETICS**

UNIT-I

Physical Basis of Heredity: Basic laws of inheritance mono-hybrid, n and tri-hybrid ratios, Modification of Mendel's ratios due to gene interaction. Multiple factors of inheritance. Genes and environment, identification of the genetic materials - classical experiments. Hershey Chase, Avery McLeod etc,

Organization of Genetic Material: Packing of DNA, organization of genetic material in prokaryotes, Eukaryotes. Euchromatin and Heterochromatin organization of Nucleosomes.

UNIT-II

Linkage & Recombination: Chromosomal inheritance, the concept of linkage, cytological basis of crossing over. Mechanism of recombination, Transduction phenomena, Methods of transduction, Generalized, Specialized & Abortive transduction, Bacteriophages - lytic & lysogenic life cycle Discovery, Detection, Molecular mechanisms of transformation, transformation methods. Bacterial conjugation.

Mapping: Two point and three point testcrosses and gene mapping. Mapping of genes by tetrad analysis by mitotic crossing over.

UNIT-III

Sex Determination in Prokaryotes and Eukaryotes: Mechanism of sex determination in insect (Fruit fly) and plants (Melandrium), Sex factors in bacteria, F and HFr transfer, mechanism of transfer.

Sex Determination in Humans: Sex differentiation and developments in humans, Dosage compensation, Maryleons hypothesis, Sex linked disorders in human beings – Haemophilia, Fragile-x syndrome, Down's syndrome

UNIT-IV

Chromosome Structure, Organization & Aberrations: Chromosome morphology, classification, karyotying. Special chromosome, chromosome aberrations, origins, types and cytogenetic effects.

Extra Chromosomal Inheritance: Introduction to extra chromosomal inheritance, examples of extra chromosomal inheritance. Petite phenotypes in yeast. Uniparental inheritance in algae.

TEXT BOOKS

1. E.J. Gardner, M.J.Simmons & DP Shustad. Principles of Genetics, 1991.

GENETIC ENGINEERING

Unit I

Gene Regulation and Expression in Prokaryotes: Lactose, Arabinose and Tryptophan operons, Repressors and activator, Sigma switch in *Bacillus subtilis.*

Gene Regulation in Eukaryotic system: Gene regulation in Eukaryotic system, Repetitive DNA, Gene rearrangement, Promoters, enhancer elements, gene amplification.

Plasmids, Transposons / Vectors for Gene Transfers: Plasmids: Definition, types, Identification, classification and purifications and transfer of Plasmids. Host restriction in transfer. Transposable elements: Definition, detection of transposition in bacteria, types of bacterial transposons, mechanisms of transposition and excision, applications of transposons. Retrotransposons

Unit II

Molecular markers: Molecular markers: RFLP, RAPD, AFLP, 16s r-RNA typing, gene chip and micro array; applications in disease profile

DNA Technology : Purification of genomic DNA from living cells, Manipulation of purified DNA; construction of prototype vector (pBR 322), different types of cloning vectors (plasmid – pUC 19, ? phage, cosmid, M13). Enzymes involved in genetic engineering; cloning strategies, Introduction of DNA into living cells. Methods of Gene transfer, Restriction mapping.

Unit III

Expression and Detection of clones: Detection of clones and its expression: Expression of cloned genes in yeast & *E.* coli*.* Blot analysis - Southern, Northern & Western blot; dot and slot blot. Immunological techniques. DNA methylation, DNA hybridization. Genomic and cDNA library construction and application. DNA sequencing.

Unit IV

PCR and its application: Principles, designing of primers, PCR methodology, RT - PCR, multiplex PCR, identification of PCR product, application of PCR technology.

Applications of r-DNA Technology: Gene cloning in medicine (Insulin, Blood clotting factor VIII) High level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells) Limitation and advantages and novel technologies- for generation of transgenic animals. Introduction to Gene therapy (Ex vivo & In vivo), case study of ADA as an example. Advantages and limitations of Gene therapy.

FOOD TECHNOLOGY

Unit I

Introduction to Food Science & Technology: Fundamentals and Aims of food science and technology. Interdisciplinary approach, Nutritive value of foods, Food as a source of energy, Food Health and disease.

Unit II

Food Microbiology: Microbial growth pattern, Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products. Contaminants of foods-stuffs, Fisheries, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, standards for different foods. Food borne intoxicants and mycotoxins.

Food Biotechnology: Biotechnology in relation to food industry, Enzymes in foods and food industry, Nature and type of starters, Role of starters in Fermented foods, Fermentation of Milk products-Fermented soy and peanut milk, Fruit and cereal based beverages, Non beverage plant products. Mycoprotein production.

Unit III

Food Preservation: Principles of food preservation: Physical, Chemical, and biological methods of preservations. Bioprocessing of meat, Fisheries, vegetables, diary products. Irradiated foods.

Food Processing: Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging

Unit IV

Food Additives and Analysis: Sampling techniques and theory and practice of chemical and physical methods of food analysis for determination of food composition; Pigments in food, food flavors, food additives and toxicants. Natural sweeteners and artificial sweeteners and their role in controlling diseases and deficiencies, Nutraceuticals, and Functional Foods

1 Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.

2 Food processing and Preservation PHI private ltd,New Delhi

3 Food Microbiology fourth edition William C.Frazier, Tata Mc Graw Hill

4 Food Microbiology 2nd Edition, Michael P.Doyle ,ASM press

5 Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, New York.

6 Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.

ANALYTIC TECHNIQUE IN BIOTECHNOLOGY

Unit I

Microscopy: Introduction, Types of Microscope, Principle, Parts of Microscope, Uses of Microscope, Refractive Index, Resolution Power, SEM, Phase contrast and Dark field Microscopy, Process of Microscope Technique.

Unit II

Methods of Biochemical Analysis: Carbohydrate-Isolation and Estimation Technique

Protein- Isolation and Estimation Technique; Amino Acid- Isolation and Estimation Technique; Lipid-Isolation and Estimation Technique.

Unit III

Separation Technique: Chromatographic Technique, Electophoretic Technique, Analysis Technique- Gel documentation,

Unit IV

Nucleotide and Nucleic Acid Analysis: Isolation and purification DNA & RNA from cells and organisms.

Text Books:

1. Willson & Walker: Principle of Biochemistry.
2. Strayer

DOWN STREAM PROCESSING IN BIOTECHNOLOGY

UNIT I

ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY: Role and importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification. Economics of downstream processing in Biotechnology, cost-cutting strategies, characteristics of

biological mixtures, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high Value products)

UNIT-II

Physico-chemical basis of bio-separation processes. Recent development in productIsolation (for ex. one step purification, reverse Micro cellular extraction on line membrane separation).

UNIT-III

PRIMARY SEPARATION AND RECOVER PROCESS: Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods.

MEMBRANE SEPARATIONS: Membrane-based separations (micro and ultrafiltration), theory, design and configuration of membrane separation equipment applications,

UNIT-IV

ENRICHMENT OPERATIONS: Precipitation methods (with salts, organic solvents, and polymers, extractive separations, aqueous two-phase extraction, supercritical extraction), in situ product removal, integrated bioprocessing.

UNIT-V

NEW AND EMERGING TECHNOLOGIES: Dialysis, Crystallization Pervaporation, super liquid extraction foam based separation case study with examples for processing of Two Industrial Products (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

Semester – V

IMMUNOLOGY

UNIT I

The Immune System: Introduction, Phylogeny of the Immune system, Innate and acquired immunity.

Cells of the IS: Haematopoiesis, lymphocyte leafficking, T, B, Macrophases, Dendritic cells, Natural killer cells, Eosinophils, Neutrophils, Mast cells and Phasocylosis. Primary and Secondary organs of I.S. (Thymus, Spleen, Lymphnode, lymphoid fo kicle, MALT, CALT, SALT

UNIT II

Immunochemistry: Immunogens, antigens, their chemical nature, Properties influencing immunogenicity, Haptens, adjuvants.

Hypersensititvity: Types of hypersensitivity, Principle, mechanisms their relevance & significance. Role of immune system in transplantation, autoimmunity, tumors.

UNIT III

Humoral Immunity: B-lymphocytes, their lineage, Immunoglobulins, their structure function, classes, sub classes, genetic control of ab production. (Maturation of B cell) Isotype, allotypes, Idiotypes. Antigen-Antibody intereactions, hypersensitivity. Activation of B cells, their differentiation and effector

functions. Hybridoma Technology Monoclonal antibodies their application. Immunotoxing chimeric antibodies and abzymes

UNIT IV

Cell Mediated Immunity: T-cells subclasses their lineage, maturation TCR diversity, MHC, Ag processing and presentation, T-cell artivation, effector functions.

Role of immune system in transplantation, autoimmunity, tumors: Transplantation- Graft rejection evidence and mechanisms of graft rejection ,prevention of graft rejection, immuno suppressive drugs, Autoimmunity – experimental models of autoimmune disease treatment of autoimmune disorders and Tumor immunology.

TEXT BOOKS:

1.E. Roitt Essential Immunology, Vaccines Blackwell Scientific publications, Oxford.

2. Kuby Immunology, 5th Edition . Richard A Goldsby, Thomas J Kindt Barbara A

PLANT & ANIMAL VIROLOGY

UNIT I

Inroduction: Definition of Virus, structure of virus particle, physiochemical properties of virus particles; properties of viral nucleic acids, viral proteins, serological relationships. Virus of Algae, Fungi, Ferns, Gymnosperms; Disease symptoms; macroscopic, systemic; Agents inducing virus-like symptoms.

UNIT II

Purification and composition of plant viruses: Isolation, components, architecture and assembly of virus particles; chemical and biochemical studies, architecture of rod shaped viruses, isometric, icosahedra enveloped viruses.

Histological changes: necrosis, hypoplasia, and hyperplasia.

Cytological Effects: Methods, effects on cell structure, virus-induced structure in cytoplasm, cytological structure reassembly those induced by viruses.

UNIT III

Genome Organization: General properties of double stranded DNA viruses, single stranded DNA viruses, double stranded RNA viruses and single stranded RNA viruses.

Expression of viral genomes: virus entry and uncoating, viral genome expression, synthesis of m-RNA, plant viral genome strategies.

Bacteriophage structure organization; Replication, one step growth curve, eclipse phase, phage production, burst size, lysogenic cycle.

Viral replication: mutation, recombination.

UNIT IV

Paramyxo virus: measles virus, parainfluenzae virus, and mumps virus.

Phabdovirus: Rabies virus.

Taga virus: Arbovirus, Rubella virus.

Poxviruses: small pox and hepatitis virus.

Yellow leaf curl of tomato, tobacco mosaic virus, sugar cane mosaic.

ENZYME TECHNOLOGY

UNIT I

Enzyme: Classification, active sites and specificity kinetics, Ramchandran plot: Factors affecting the rate of enzyme catalysis, interrelationships between initial velocity and substrate concentration, Michaelis-Menten equation, significance of Km, reaction order, methods of plotting kinetics data.

UNIT II

Rapid reaction kinetics, relaxation kinetics, enzyme inhibition, (reversible, competitive, non competitive, mixied type and irreversible inhibitions)

Kinetics of bisubstrate reactions (random, ordered, ping pong and bibi mechanism).

UNIT III

Active site determination, regulation of enzymes; activation, covalent modification, feedback inhibition, allosteric control.

Immobilization of Enzyme, Enzyme Engineering, Biosensor.

UNIT IV

Enzyme Preparations and Use: Sources of Enzyme, Screening novel Enzymes, Media and Bioreactor for Enzyme Production, Preparation of Enzyme, Preparation of Enzyme for sale, Use of different enzyme.

Suggested Readings:

1. Webb.
2. Production & Application, W. Gerhartz.

BIOINFORMATICS

UNIT I

Introduction to Bioinformatics: Scope of Bioinformatics, Elementary commands and protocols, ftp, telnet, http. Primer on information theory.

Introduction to Homology: Introduction to Homology (with special mention to Charles Darwin, Sir Richard Owen, Willie Henning, Alfred Russel Wallace).

UNIT II

Special Topics in Bioinformatics: DNA mapping and sequencing, Map alignment, Large scale sequencing methods Shotgun and Sanger method.

Sequencing Alignment and Dynamic Programming: Heuristic Alignment algorithms. Global sequence alignments-Neddleman-Wunsch Algorithm Smith-Waterman Algorithm-Local sequence alignments (Amino acid substitution Matrices (PAM, BLOSUM).

UNIT III

Primary Database and Their Use: Introduction to Biological databases, Organization and management of databases. Searching and retrieval of information from the World Wide Web. Structure databases - PDB (Protein Data Bank), Molecular Modeling Databases (MMDB). Primary Databases NCBL, EMBL, DDBJ.

Secondary Databases: Introduction to Secondary Databases Organization and management of databases Swissprot, PIR, KEGG

UNIT IV

Biochemical Data Bases: Introduction to BioChemical databases-organization and Management of databases. KEGG, EXGESCY, BRENDA, WIT.

Evolutionary Trees and Phylogeny: Multiple sequence alignment and phylogenetic analysis

TEXT BOOKS:

1. Bioinformatics Basics. Applications in Biological Science and Medicine by Hooman H. Rashidi and Lukas K.Buehler CAC Press 2000.

2. Algorithms on Strings Trees and Sequences Dan Gusfiled. Cambridge University Press 1997.

COMPUTATIONAL METHOD FOR BIOLOGICAL SEQUENCE ANALYSIS

UNIT I

Elements of Molecular Biology.

Nucleic Acid, protein, central dogma, Transcription and Translation

Comparison of Biological Sequence

Biological sequence, Alignment, Types of Alignment.

UNIT II

Computational Methods and online Approaches

Tools including BLAST and FASTA database, database formats, sequence alignment, scoring matrices including PAM, BLOUSM, DNA scoring matrices, MSA, pair wise and global alignment, phylogenetics analysis, Dynamic programming method.

UNIT III

Genomic Sequencing and Sequence assembly.

Genomic Mapping Sequencing, BAC, EST's Sequence Assembly, Clone contigs, sequence Assembly.

UNIT IV

Analysis and Modeling of Metabolic pathway.

Introduction, a model for approximating complicated metabolic activities, model generation for fining targets for Experimentation.

Text Books: Bioinformatics-A Practical Guide to the Analysis of Genes and Protein;
Baxevanis A. B, Quellette B.F.F (EDS); 2001

Semester – VI

BIOETHICS, BIO SAFETY AND INTELLECTUAL PROPERTY RIGHTS

UNIT I

BIOETHICS: Introduction to Bioethics. Social and ethical issues in Biotechnology

UNIT II

BIOSAFETY: Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products

UNIT III

REGULATORY AFFAIRS: Regulatory requirements for drugs and Biologics. GLP. GMP, WTO guidelines

UNIT IV

INTELLECTUAL PROPERTY RIGHTS:

Intellectual property rights, and Intellectual Property protection, patents and methods of application of patents, Trade Secrets copyrights, Trade Marks, legal implications, farmers rights, plant breeder's rights. International and National conventions on biotechnology and related areas.

TEXT BOOKS:

1. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.

2. Sasson A. Biotechnologies in developing countries present and future,

UNESCO publishers, 1993.

MOLECULAR MECHANISM AND GENE EXPRESSION

UNIT I

Prokaryotic & Eukaryotic Genomes and their topology, DNA-Protein Interactions.

UNIT II

RNA transcription & transcriptional control, DNA Replication, Transcription in Yeast, RNA Processing, Translation.

UNIT III

Gene Pool, Allele frequency, genotype frequency, Hardy-Weinberg equilibrium & its complications, Non-random breeding, Genetic drift, Genetic Load Gene Flow, Selection, Intensity of Selection pressure.

UNIT IV

Mechanism of Gene Expression in Prokaryotic & Eukaryotics.

Inbreeding & artificial selection, natural selection & polymorphism, neutral theory & evolution specialization.

TEXT BOOKS:

1. Edward J. Kormondy
2. M.C. Dash
3. Robert H. Tomarin
4. R.W.Old &S.B. Primrose

ENVIRONMENTAL BIOTECHNOLOGY

UNIT I

Environmental Biotechnology: Definition & Scope, Concepts and dynamics or ecosystem, components, food chain and energy flow productivity Biogeochemical cycles; types of ecosystem, population ecology and biological control community structure and org. Environmental pollution; sustainable development economic importance of microbes, plants and animals

UNIT II

Environment Pollution: types of pollution, Methods for measurement of pollution, Air pollution, Water pollution,Soil & Agriculture pollution, Noise & Radiation pollution

Microbiology & Biochemistry of Waste Water, **Waste Water Treatment**: Aerobic Process, Aerobic Waste Water Treatment,Activated sludge, Oxygen ditches, trickling filter,Towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes, anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors.Treatment scheme of waste water of dairy, distillery, tannery, sugar and antibiotic industry

UNIT III

Solid Wastes: Sources, Solid Waste Management, Anaerobic Digestion of Waste Biogas Production, Methanogenesis, Vermicomposting Xenobiotic Compounds, Hazardous Wastes, Biodegradation of Xenobiotics, decay behavior & degradative plasmids, oil pollution, surfactants, pesticides, Bioremediation of contaminated soils and waste land. Bioremediation, Biotechnology Applications to Hazardous Waste Management & Examples

UNIT IV

Integrated Pest Management (IPM)

Global Environmental Problems

Ozone layer: Ozone Depletion & UV-B, Ozone in the Atmosphere, Ozone Chemistry, Ozone Reaction Mechanisms, High Level Ozone, Low Level Ozone, How does ozone absorb UV light?, Stratospheric Ozone Depletion, Ozone Depletion Process, Ozone Links, Ozone Depletion Glossary

Green House Effect: Global Warming Acid Rain

INDUSTRIAL BIOTECHNOLOGY

UNIT I

Basis and Development of Industrial fermentation Processes.

Screening, Detection and assay of Fermentation products, Stock Cultures, Fermentation Media, Inoculum Preparation.

UNIT II

Typical Fermentation Process:

Antibiotic Fermentation: Penicillin, Streptomycin

Anaerobic Fermentation: Acetone, Butanol Fermentation, Brewing, Industrial Alcohol Lactic Acid.

UNIT III

Environmental Control of Metabolic Pathways: Glycerol from Yeast, Glycerol from *Bacillus subtilis.*

Genetic Control of Metabolic Pathways: Indirect or Dual Fermentation, Direct Fermentation.

UNIT IV

Microbial Oxidative Transformation of substrate:

Vitamins & Growth Stimulates - Riboflavin, Vitamin A, Vitamin B_{12}, Gibberellins.

Enzymes as Fermentation Products: Amylases, Proteolytic enzymes, Pectinases, Invertases.

Organic Acid: Citric Acid, Fumaric Acid, Itaconic Acid, Kojie Acid & Bacterial gluconic & α-ketoglutanic Acid Fermentation.

Text Books:

1. Prescott & Dunn's
2. L.C. Casida

EMERGING AREAS IN BIOINFORMATICS

UNIT I

Introduction to Computational Molecular Biology: Introduction to active areas of research in Computational Molecular Biology, Functional Genomics, Comparative Genomics, Dynamic Programming, Graphical representation of biochemical systems, S-systems equations, steady state analysis, Model refinements,

UNIT II

Genomics: DNA Sequence assembly and gene identification. Homology based gene prediction. SNPs and applications. Methods of studying gene expression, EST approach,
Dendograms and its interpretation

UNIT-III

Proteomics: Introduction to proteins. Protein identification, structure and function determination. Structure comparison methods. Prediction of secondary structure from sequence. Protein homology modeling, Protein threading. Protein ab initio structure prediction. Protein design emphasis on structural Bioinformatics.

UNIT IV

Micro Arrays: Basics of Micro array

Drug Design: Drug discovery cycle, Role of Bioinformatics in Drug discovery

Taxonomy and Phylogeny: Basic concepts in systematics, Molecular evolution, Definition and description of Phylogenetic trees and types of trees

TEXT BOOKS:

1. David W Mount. Bioinformatics- Sequence and genome analysis. CSHL.
2. Jonathan Pevsner . Bioinformatics and Functional Genomics. A Jhon Wiely & Sons, Inc., Publication

Semester – VII ANIMAL BIOTECHNOLOGY

Unit I

Structure and Organization of animal cell; Equipments and materials for animal cell culture technology; Primary and established cell line cultures; Introduction to the balanced salt solutions and simple growth medium,

Unit II

Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements; Serum & protein free defined media and their application.

Unit III

Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth;

Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.

Unit IV

Cell synchronization; Cell cloning and micromanipulation; Cell transformation; Application of animal cell culture; Scaling-up of animal cell culture.

Stem cell cultures, embryonic stem cells and their applications; Cell culture based vaccines, Somatic cell genetics, Organ and histotypic cultures; Measurement of cell death; Apoptosis;

TEXT BOOKS:

1. Culture of Animal Cells, (3rd Edition), F1. Ian Froshney. Wiley-Liss.

2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, OXFORD.

PLANT CELL & TISSUE CULTURE

UNIT I

Introduction to tissue culture: Cleaning, sterilization, sterile handling of tissue culture labs. Synthetic medium for plant tissue culture, nutritional requirement of cells in vitro, totipotency, concepts of differentiation, redifferentiation, and growth controls.

UNIT II

Somatic embryogenesis, Synthetic seeds; anther, pollen and ovary culture, Significance and advantages of haploid plants.

Use of plant tissue culture techniques for micropropagation and cloning; application agriculture, horticulture and forestry; in sexual imcompatibility.

UNIT-III

In vitro production of commercially important secondary metabolites and natural products; hairy root cultures, elicitors, factors affecting yield application of immobilization and bioreactors in Secondary metabolite production from plant cell culture.

UNIT IV

Cryopiology of plant cell cultures and establishment of gene banks.

Protoplast isolation and fusion, somatic hybridization, cybrids.

Production of virus free plants by meristem tip and other tissue culture techniques.

Text Books:

1. R. Ian Freshney, Wiley-Liss.
2. Matin Clyness, Springer.
3. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. 2004

PLANT BIOTECHNOLOGY

UNIT I

Plant Transformation Technology: Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment.

UNIT II

Plant Genetic Engineering for Productivity and Performance I (Biotic Stress)

Herbicide resistance, Insect resistance, Fungus resistance, Bacteria resistance, virus resistance,.

Plant Genetic Engineering for Productivity and Performance II (Abiotic Stress)

Abiotic stress tolerance; Drought, temperature, salt

UNIT III

Molecular Farming & Industrial Products: Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic Proteins, Antigens (edible vaccine).

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UNIT IV

Metabolic Engineering: Metabolic engineering for plant primary metabolites and secondary metabolites.

Pest Management: male sterile technology; orle of juvenile hormones, pheromones and its anqalogues for pest management, development of genetically engineered microbial bio-control agents.

PROTEIN ENGINEERING

UNIT I

Protein Structure: Introduction, Overview of protein structure, Higher level structure,

Protein post-translational modification, Protein stability and folding.

Protein Sources: Introduction, Microorganisms as sources of proteins, Proteins from plants, Animal tissue as a protein source, Direct chemical synthesis, Conclusion.

Protein modification through different methods.

UNIT II

Protein Purification and Characterization: Introduction, Initial recovery of proteins,

Removal of whole cells and cell debrisConcentration and primary purification, Column

chromatography, Protein inactivation and stabilization, Protein characterization.

Large-Scale Protein Purification: Some general principles, Therapeutic protein production: some special issues, Range and medical significance of impurities potentially present in protein-based therapeutic products, Labelling and packing of finished products.

UNIT III

Therapeutic Proteins: Introduction, Blood products, Haemophilia A and B, Anticoagulants, Thrombolytic agents, Additional blood-related products, Vaccine technology, Vaccines for AIDS.

Therapeutic Antibodies and Enzymes: Introduction, Antibodies for in vivo application,

Therapeutic enzymes.

UNIT IV

Hormones and Growth Factors used Therapeutically: Introduction, Insulin,Glucagon,

Gonadotrophins, Growth hormone, Erythropoietin, Other growth factors, Thyrotrophin,

Corticotrophin, Prolactin, Peptide Regulatory Factors.

Interferons, Interleukins and Additional Regulatory Factors: Regulatory factors;

cytokines versus hormones, Interferons, Interleukins, Tumour necrosis factors, Colonystimulating factors, Cytokine toxicity.

UNIT V

Proteins Used for Analytical Purposes: Introduction, Enzymes as diagnostic/analytical

reagents, Biosensors, Antibodies as analytical reagents.

Non-catalytic Industrial Proteins: Introduction, Functional properties of proteins, Milk and milk proteins, Animal and microbial proteins, Sweet and taste modifying proteins.

MOLECULAR MODELING AND DRUG DESIGN

UNIT I

Introduction to Molecular Modelling: Introduction to Molecular Modelling. What are models used for? Areas of application – Single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co-ordinate systems two – matrix, potential energy surface.

UNIT II

Molecular Dynamics: Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching, Systematic search. Applications to protein folding

Comparative Protein Modeling: Modelling by Homology-the alignment, construction of frame work, selecting variable regions, side chain placement and refinement, validation of protein models – Ramchandran plot, threading and ab initio modeling.

UNIT III

Analog Based Drug Design: Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modelling in drug discovery.

UNIT IV

Structure Based Drug Design: 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies.

Further Applications on the Design of New Molecules: 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility

TEXTBOOKS:

1. Principles and applications of modelling by Leach

2. Molecular Modelling by Hans Pieter,Heltje & Gerd Folkens, VCH.

Singhania University

Pacheri Bari, Distt. Jhunjhunu (Raj.)

Phone No.-01593 271299, 300, Fax No. – 01593 271003

B.Tech-cum-M.Tech. in Biotechnology(Integrated)zz

Course Structure

Semester – I

S. No.	Code	Name of Subject	
1	M.Tech.BT 111	General Biology	
2	M.Tech.BT 112	Fundamental of Computer	
3	M.Tech.BT 113	Mathematics	
4	M.Tech.BT 114	Biophysics	
5	M.Tech.BT 115	Basics of Chemistry	
6	M.Tech.BT 116	General English	
7		Practical	

Semester – II

S. No.	Code	Name of Subject	
1	M.Tech.BT 121	Concept of Microbiology	
2	M.Tech.BT 122	Principle of Management	
3	M.Tech.BT 123	Scope & Objective of Biotechnology	
4	M.Tech.BT 124	Elementary Chemistry	
5	M.Tech.BT 125	C-Language	
6		Practical	

Semester – III

S. No.	Code	Name of Subject	
1	M.Tech.BT 231	Molecular Biology	
2	M.Tech.BT 232	Biochemical Engineering	
3	M.Tech.BT 233	Biostatics & Probability	
4	M.Tech.BT 234	Biomolecules	
5	M.Tech.BT 235	Biochemistry	
6	M.Tech.BT 236	Nano-Biotechnology	
7		Practical	

Semester – IV

S. No.	Code	Name of Subject	
1	M.Tech.BT 241	Genetics	
2	M.Tech.BT 242	Genetic Engineering	
3	M.Tech.BT 243	Food Technology	
4	M.Tech.BT 244	Analytic Techniques in Biotechnology	
5	M.Tech.BT 245	Down Stream Processing in Biotechnology	
6	M.Tech.BT 246	Computational Biology	
7		Practical	

Semester – V

S. No.	Code	Name of Subject	
1	M.Tech.BT 351	Immunology & Immuno Technology	
2	M.Tech.BT 352	Plant & Animal Virology	
3	M.Tech.BT 353	Enzyme Technology	
4	M.Tech.BT 354	Introduction of Bioinformatics	
5	M.Tech.BT 355	Computational Methods for Biological Sequence Analysis	
6	M.Tech.BT 356	Pharmaceutical Biotechnology	
7		Practical	

Semester – VI

S. No.	Code	Name of Subject	
1	M.Tech.BT 361	Bioethics, Bio Safety and Intellectual Property Rights	
2	M.Tech.BT 362	Molecular Mechanism of gene Expression	
3	M.Tech.BT 363	Environmental Biotechnology	
4	M.Tech.BT 364	Industrial Biotechnology	
5	M.Tech.BT 365	Emerging Areas in Bioinformatics	
6	M.Tech.BT 366	Operational Research	
7		Practical	

Semester – VII

S. No.	Code	Name of Subject	

1	M.Tech.BT 471	Animal Biotechnology	
2	M.Tech.BT 472	Plant Biotechnology	
3	M.Tech.BT 473	Protein Engineering	
4	M.Tech.BT 474	Cell & Tissue culture Technology	
5	M.Tech.BT 475	Molecular modeling & drug designing	
6	M.Tech.BT 476	Artificial Neural Networks	
7		Practical	

Semester – VIII

S. No.	Code	Name of Subject	
1	M.Tech.BT 481	Bioenergy Engineering	
2	M.Tech.BT 482	Biosensors	
3	M.Tech.BT 483	Bioprocess Plant Design	
4	M.Tech.BT 484	Transgenic Technology	
5	M.Tech.BT 485	Nanotechnology	
6		Practical	

Semester – IX

S. No.	Code	Name of Subject	
1	M.Tech.BT 591	Genomics & Proteomics	
2	M.Tech.BT 592	Pollution Protection Fundamentals	
3	M.Tech.BT 593	Biotechnology & Management	
4	M.Tech.BT 594	Minor Project	

Semester – X

Project (Industrial & Training Project)

Semester - I

GENERAL BIOLOGY AND ENVIRONMENTAL SCIENCE

UNIT I

Diversity of Life: Biological classification, Advantage, Binomial nomenclature, taxonomy. Viruses, Fungi, Lichen, Micorrhiza and Algae.

UNIT II

Cell & Cell Division: Prokaryotic and Eukaryotic cells, Plant and Animal Cell, Cell wall, Cell membrane, Cell organelles (Structure and function), Transport system in cell.

Cell cycle: Mitosis and Meiosis.

Continuity of life: Mendalism, monohybrid and dihybrid crosses, Double hellicle structure of DNA.

UNIT III

Biodiversity. Wild Life of India. Endangered flora & fauna of India. Conventional and non-conventional energy resources. Environmental challenges in India.

Water quality parameters and standards.

UNIT IV

Organisms and Environment: What is Environment; Biological principle of an ecosystem, Green house effect.

TEXT BOOKS:

1. P.S. Dashmi

2. H.N. Srivastiva

FUNDAMENTAL OF COMPUTER

UNIT I

Introduction: Classification of computer and generation, Basic architecture of computer and its building blocks, Input Devices, Computer memories.

Number System: Binary, Octal, Decimal, and Hexadecimal representation of characters: ASCII and EBDIC codes, Binary arithmetic and logic circuit.

UNIT II

Classification of Computer language: Machine, Assembly and High level language, Brief idea of operating system, Assembler, Compiler and interpreter.

Fundamentals of Computer Programming: Problem solving through computer algorithms and flow chart level of programming.

UNIT III

Operating System: Introduction to O.S., Types of operating system, Multiprogramming, Timesharing, Batch, Real time and UNIX.

UNIT IV

Internet: Introduction to internet, Components, Services and working on internet.

Introduction to protocols, tools

MATHEMATICS

UNIT – I

Differential equations of first order and first degree – exact, linear and Bernoulli. Non-homogeneous linear differential equations of second and higher order with constant coefficients with RHS term of the type e^{ax}, Sin ax, cos ax, polynomials in x, e^{ax} V(x), xV(x), method of variation of parameters.

UNIT – II

Rolle's Theorem – Lagrange's Mean Value Theorem – Cauchy's mean value Theorem – Generalized Mean Value theorem (all theorems without proof) Functions of several variables – Functional dependence- Jacobian- Maxima and Minima of functions of two variables with constraints and without constraints

Radius, Centre and Circle of Curvature – Evolutes and Envelopes Curve tracing – Cartesian, polar and parametric curves.

UNIT –III

Applications of integration to lengths, volumes and surface areas in Cartesian and polar coordinates multiple integrals - double and triple integrals – change of variables – change of order of integration.

Sequences – series – Convergences and divergence – Ratio test – Comparison test – Integral test – Cauchy's root test – Raabe's test – Absolute and conditional convergence

UNIT – IV

Vector Calculus: Gradient- Divergence- Curl and their related properties of sums- products- Laplacian and second order operators. Vector Integration - Line integral – work done – Potential function – area- surface and volume integrals Vector integral theorems: Green's theorem-Stoke's and Gauss's Divergence Theorem (With out proof). Verification of Green's - Stoke's and Gauss's Theorems.

Text Books:

5. A text Book of Engineering Mathematics, Vol-1 T. K. V. Iyengar, B. Krishna Gandhi and Others, S. Chand & Company.
6. A text Book of Engineering Mathematics, C. Sankaraiah, V. G. S. Book Links.
7. A text Book of Engineering Mathematics, Shahnaz Bathul, Right Publishers.

BIOPHYSICS / INSTRUMENTATION

UNIT – I

Microscopy: Introduction, Principle, Theory, Types, application, Parts of Compound Microscope, Light Microscopy, Optics of Microscopy, Optical Systems, Refractive Index, Numerical Aperture, Resolution, Magnification Range, Polarized Light Microscopy, Phase contrast, Dark field Microscopy, Fluorescence, Confocal Microscopy, 2, Imaging Modes of Confocal Microscopy, Differential Interference Contrast, Types Stereomicroscopy, Fluorescence Microscopy, Atomic Force Microscopy, Electron Microscopy, Scanning Electron Microscope (SEM), SEM guide, How it works, Transmission Electron microscope (TEM)

UNIT – II

Centrifugation: Principle, types, application, Theory, Density gradients, Ultracentrifugation (velocity and buoyant)

Radiation dosimetry: Radioactive isotopes and half life, Autoradiography, Effect of radiation on biological system,

X-Ray Crystallography: Vectors and Symmetry (application, point group, lattice, elementary ideas of space group); Diffraction and Fourier Transformation; Application (steps in solving crystal structures,

UNIT –III

Spectroscopy: Principle, types, application, Overview, UV-VIS Spectroscopy, Theory of electronic spectra (atomic and band spectra, L-B law, application and exception); Instrumentation; Chromophore, auxochrome;

IR Spectroscopy: Vibrational Spectroscopy, Vibration (different modes, di- and poly atomic); Frequency, wavenumber; Hook?s law; Instrumentation; Vibration-rotation spectrum of CO2; Factors influencing vibrational frequency (vibronic coupling, H-bond, electronic factors, bond angles etc).

Fluorescence: Spectroscopy Approaches To Teaching Fluorescence Spectroscopy, Fluorescence Correlation Spectroscopy, Principle; Characteristic of Fluorescence (Stokes?s shift, life-time, mirror image rule etc) and molecules shown fluorescence; Application to simple and biomolecules.

UNIT – IV

Nuclear Magnetic Resonance (NMR): Fundamentals of NMR, Diagrams for Multidimensional NMR, Principle; Chemical shift (different unit) and factors influencing chemical shift; Correlation data; Solvent effect; Spin-spin coupling and splitting and factors involve; Application to small and biomolecules.

NMR of Paramagnetic Proteins, Fluorine NMR, Teaching High-Resolution NMR, Electron Paramagnetic Resonance (EPR), Optical Single-Molecule Methods,

BASICS OF CHEMISTRY

UNIT-1

WATER: Common Impurities, Hardness, Determination of hardness by Clark's test and complexometric (EDTA) method, Degree of hardness, Methods of water treatment.

UNIT-2

PHASE RULE: Statements, definition and meaning of terms involved; Study of one component and two component system.

UNIT- 3

CEMENT & GLASS: Manufacturing of Portland cement, Vertical shaft kiln technology, Chemistry of setting and hardening; Glass: Preparation, varieties and uses.

UNIT – 4

COORDINATION CHEMISTRY: Introduction, Types of ligands, IUPAC Rules, nomenclature of coordination compounds, Isomerism in coordination compounds, Theories of coordination, Crystal field theory, CFSE.

UNIT – 5

CHEMICAL BONDING: Introduction, Types of bonds, Ionic bond, Lattice energy, Born-Haber cycle, Covalent bond, Fajan's Rule, Hybridization, VSEPR theory.

UNIT – 6

POLYMER: Introduction, Polymers and their classification, Polymerization, Mechanism of polymerization, commercially important thermoplastics and thermosets, Biodegradable polymers.

GENERAL ENGLISH

UNIT – I

Listening Skills:

3. To enable students to develop their listening skill so that they may appreciate its role in the LSRW Skills approach to language and improve their pronunciation.

4. To equip students with necessary training in listening so that can comprehend the speech of people of different backgrounds and regions.

Students should be given practice in listening to the sounds of the language to be able to recognise them, to distinguish between them to mark stress and recognise and use the right intonation in sentences.

• Listening for general content, Listening to fill up information, Intensive listening, Listening for specific information

UNIT – II

Speaking Skills:

1. To make students aware of the role of speaking in English and its contribution to their success.

3. To enable students to express themselves fluently and appropriately in social and professional contexts.

• Oral practice, Describing objects/situations/people

• Role play – Individual/Group activities (Using exercises from all the nine units of the prescribed text: *Learning English : A Communicative Approach*.)

• Just A Minute(JAM) Sessions.

UNIT –III

Reading Skills:

3. To develop an awareness in the students about the significance of silent reading and comprehension.
4. To develop the ability of students to guess the meanings of words from context and grasp the overall message of the text, draw inferences etc.

Skimming the text, Understanding the gist of an argument, identifying the topic sentence, Inferring lexical and contextual meaning, Understanding discourse features, recognizing coherence/sequencing of sentences

UNIT – IV

Writing Skills:

3. To develop an awareness in the students about writing as an exact and formal skill
4. To equip them with the components of different forms of writing, beginning with the lower order ones.

Writing sentences, Use of appropriate vocabulary, Paragraph writing, Coherence and cohesiveness, Narration / description, Note Making, Formal and informal letter writing, editing a passage

Textbooks Prescribed:

4. **LEARNING ENGLISH:** ***A Communicative Approach***, Hyderabad: Orient Longman, 2006. (Six Selected Lessons)
5. **WINGS OF FIRE:** ***An Autobiography – APJ Abdul Kalam***, Abridged version with Exercises, Universities Press (India) Pvt. Ltd., 2004.

Semester – II

CONCEPT OF MICROBIOLOGY

UNIT – I

Introduction of Microbiology:

History and Scope, Classification and identification, Microscopic examination.

UNIT – II

Cell Structure:

Prokaryotic cell structure and function, Microbial Growth.

UNIT –III

Microbial Control:

Control by Physical Agent, Control by Chemical agent.

UNIT – IV

Clinical Microbiology:

Specimens, Identification, Susceptibility Testing.

PRINCIPLE OF MANAGEMENT

UNIT – I

Nature and Importance of Management:

Meaning, Definition, Importance, Characteristics and functions of Management,

UNIT – II

Principal of Management, Management as a science and an art.

UNIT –III

Planning, Organizing, Staffing

UNIT – IV

Directing Supervision, Controlling, Delegation of authority.

Ref. Books:

Tulsian P.C. Business Organization and Management,

SCOPE & OBJECTIVE OF BIOTECHNOLOGY

UNIT – I

Introduction of Biotechnology: History, Definition, Biotechnology in India, Different areas of Biotechnology, Career in Biotechnology.

UNIT – II

Gene and Genetic Engineering: Introduction, Basic Principle of Genetic Engineering, Plasmids, Vectors for E.coli, Selection and Screening of recombinant cells.

UNIT –III

Bioprocess and Fermentation Technology: Introduction, Different Fermentation Process, Basic requirement of fermentation, Fermentor, Use of Fermentation Technology.

Enzyme Technology: Introduction of Enzyme, Classification, Rate equation of Enzyme, Industrial production of Enzyme, Application of Enzyme.

UNIT – IV

Role of Biotechnology in Medicine, Agriculture and Forestry,

Safety in Protocols, GLP/ GMP.

ELEMENTARY CHEMISTRY

UNIT – 1

CORROSION: Introduction; causes and effects of corrosion, Types and mechanism of corrosion, Factors influencing corrosion, Protective measures against corrosion.

UNIT – 2

NUCLEAR CHEMISTRY: Natural and artificial radioactivity, nuclear reactions, artificial transmutation of elements, nuclear fission and fusion, radioactive isotopes and their uses, half-life period, radioactive dating.

UNIT – 3

CHEMICAL KINETICS: Introduction, Factors influencing rate of reaction, Order and molecularity of reaction, Determination of order of reaction, Activation energy.

UNIT – 4

THERMODYNAMICS: Introduction, Zero law of thermodynamics, Ist law of thermodynamics, Enthalpy, Hess's law, Heat capacity, Relationship between Cp & Cv, Entropy, Free energy, 2^{nd} law of thermodynamics and 3^{rd} law of thermodynamics.

UNIT – 5

SOLID STATE: Introduction, Crystal structure, Packing fraction, Lattice energy, Born-Haber cycle, Crystal imperfections, Types of semiconductors.

C PROGRAMMING AND DATA STRUCTURES

UNIT - I

Algorithm / pseudo code, flowchart, program development steps, structure of C program, A Simple C program, identifiers, basic data types and sizes, Constants, variables, arithmetic, relational and logical operators, increment and decrement operators, conditional operator, bit-wise operators, assignment operators, expressions, type conversions, conditional expressions, precedence and order of evaluation.

Input-output statements, statements and blocks, if and switch statements, loops- while, do-while and for statements, break, continue, go to and labels, programming examples.

UNIT - II

Designing structured programs, Functions, basics, parameter passing, storage classes- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, example c programs.

UNIT - III

Arrays- concepts, declaration, definition, accessing elements, storing elements, arrays and functions, two-dimensional and multi-dimensional arrays, applications of arrays. pointers- concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, c program examples.

UNIT - IV

Derived types- structures- declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self referential structures, unions, typedef, bitfields, C program examples.

Introduction to data structures, singly linked lists, doubly linked lists, circular list, representing stacks and queues in C using arrays and linked lists, infix to post fix conversion, postfix expression evaluation.

TEXT BOOKS : 1. Computer science, A structured programming approach using C, B.A. Forouzan and R.F.

Gilberg, Third edition, Thomson.

2. DataStructures Using C – A.S.Tanenbaum, Y. Langsam, and M.J. Augenstein,

PHI/Pearson education.

Semester – III

MOLECULAR BIOLOGY

UNIT-I

STRUCTURE OF DNA: Detailed structure of DNA, variation from Watson & Crick model, Z - DNA, A & B DNA, Denaturation & melting curves.

DNA REPLICATION: Models of DNA replication: semi conservative Mechanism of DNA replication in *E.coli* (bi- directional). Mitochondrial (D-loop), Viral DNA (Rolling circle), Single stranded- DNA phages (M13, Ø174), Eukaryotic telomeres and its replication Inhibitors of DNA Replication. Enzymes involved in replication, step by step process.

UNIT-II

RNA STRUCTURE AND BIOSYNTHESIS: m-RNA, r-RNA, t-RNA structures, Transcription apparatus, RNA polymerases and proteins involved in transcription (initiation, elongation and termination steps)

POST TRANSCRIPTIONAL PROCESSING: Post transcriptional processing of RNA's t-RNA, r-RNA, m- RNA splicing. Inhibitors of transcription.

UNIT – III

PROTEIN BIOSYNTHESIS: The genetic code and Wobble Hypothesis, Codon usage, Protein synthesis In Prokaryotes.

Eukaryotic Protein synthesis, differences between prokaryotic and eukaryotic protein synthesis, Post translational modifications. Inhibitors of protein synthesis.

UNIT – IV

MUTAGENESIS: Mutations, spontaneous, induced, lethal, mutagens their types and actions, classification of mutations and their applications. Site - directed mutagenesis and reverse genetics. DNA damage and repair mechanisms. Mutagenicity testing using microbial systems, Ames TEST.

TEXT BOOKS:

1. Molecular Biology, David Friefelder, Jones and Bartllett Publishing Home, 1987.

2.ShortProtocolsinMolecularBiology,2nd editionT..M.Ausubel,Brent,R.E.Kingston,D.D.Moire, Green Publication Associates and John Wiley and sons 1991

BIOCHEMICAL ENGINEERING

UNIT-I

Introduction to Bioprocesses: An overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and down stream) unit operations involved in bioprocesses, generalized process flow sheets.

UNIT-II

Media Design: Medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations

Sterilization Process: Heat sterilization, other sterilization Process.

UNIT-III

Metabolic Stoichiometry: Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients.

UNIT-IV

Kinetics of Microbial Growth and Product Formation: Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms. Growth associated (primary) and non - growth associated (secondary) product formation Kinetics. Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Introduction to Structured Models for growth and product formation.

Immobilization process, types of immobilization process, and their application.

TEXT BOOKS

1. M.L.Shuler and F. kargi Bioprocess engineering, Prentice Hall of India.

2. P.M. Doran, Biochemical process principles, Academic Press, 1995.

6. Harvey W. Blanch, Douglas S. Clark Biochemical Engineering, Marcecel, Dekker.

BIOSTATIC AND PROBABILITY

UNIT-I

Introduction and definition of Biostatistics, Concept of variables in biological systems, Collection, Classification, Tabulation, Graphical and diagrammatic representation of numerical data.

Measures of Central Tendency: Mean, Median and mode and their relationship, measures of dispersion, range, quartile deviation, mean deviation, standard deviation, coefficient of variation, skewness and kurtosis.

UNIT-II

Probability: Random experiment, events, sample space, mutually exclusive events, independents and dependent events, Various definitions of probability addition and multiplication theorems of probability random variables (Discrete and Continuous), Probability density functions and its properties.

Some probability distributions such as binomial, Poisson and normal (Basic idea about these distributions) and their applications.

UNIT-III

Concepts of populations and sample, Simple random sampling without replacement, definition of simple random sample, chi-square, student's t- and f-distributions, their properties and uses, concepts of standard error.

UNIT-IV

Correlation and regression, Linear and quadratic regression analysis of variance: one-way and two-way classification with single observation per cell.

Ref. Books:

3. S.P. Gupta
4. S.C. Gupta

BIOMOLECULES

UNIT-I

Chemical foundations of biology- pH, pK, acids, bases, buffers, weak bonds and covalent bonds, Principles of thermodynamics, Classes of organic compounds and functional groups- atomic and molecular dimensions, space filling and ball and stick models.

UNIT-II

Carbohydrate – Classification, Structures, Chemical & Physical Properties.

Lipids- Classification, structure and functions.

UNIT-III

Amino acids and peptides- Classification, Chemical reactions and physical properties.

Proteins- Classification, Structure, Chemical & Physical Properties.

UNIT-IV

Heterocyclic compounds and secondary metabolites in living systems- nucleotides, pigments and isoprenoides.

Separation techniques for different biomolecules.

Ref. Books:

1. Irwinn H. Segel, John wiley

2. W.H. Freeman

3. T.G. Cooper

BIOCHEMISTRY

UNIT-I

Metabolism of carbohydrates: Glycolysis, oxidative phsophorylation, TCA cycle, Gluconeaogenesis, HMP shunt, Glycogen metabolism, Oxidative phosphorylation.

Synthesis of cellulose and starch.

UNIT-II

Metabolism of lipids: by lipid hydrolysis, lipases, biosynthesis of triacyglyceros and phospholipids.

UNIT-III

Metabolism of amino acids and proteins/ hydrolysis of proteins, proteases.

Metabolism of purines and pyrimidines: Biosynthesis of bases, nucleosides and nucleotides.

UNIT-IV

Carbon dioxide assimilation in microbes and higher plants; photosynthesis and energy transduction; photosynthetic pigments; photo system I and II, electron flow through cyclic, noncyclic photophosphorylations.

Ref. Book:

Biochemistry by lubert stryre

CELL AND MOLECULAR BIOLOGY

UNIT I

Introduction to cell and organelles, Protein targeting - Chemical and physical properties of cell membranes and their major components, significance of these properties to membrane structure, integral and peripheral membrane proteins, biosynthesis of membrane and secreted proteins; targeting of proteins to membranes.

UNIT II

Membrane transport/Cell Cycle - Mechanisms for transport of small molecules across the membrane, including simple diffusion, facilitative diffusion, active transport by Ca2+ ATPase, Na+, K+, ATPase, ABC transporters, secondary active transport, action of ionophores. Cell cycle and the events associated with each stage, control of the cell cycle and the proteins involved; know the role of the cyclins and cyclin-dependent kinases, cell cycle checkpoints, methods for synchronizing the cell cycle in cell populations.

UNIT III

Intracellular Signaling I -define growth, growth factor, growth factor receptor, mitogen, receptor, effector,second messenger, action of hormones and other biologically active agents that act via receptors in the nucleus and/or cytoplasm, role of cyclic AMP as a second messenger, activation of its synthesis and breakdown, and its activation of protein kinase A.

UNIT IV

Intracellular Signaling II - Hormonal activation of phospholipase C, the role of 7-helix receptors coupled to G proteins, the action of Ca2+ and diacylglycerol as second messengers, activation of protein kinase C, role of calmodulin in signaling processes, hormone receptors that exhibit hormone-regulated tyrosine kinase activity, the intracellular signaling cascades triggered by hormone binding to these receptors and how the signal is switched off at each stage, similarities and differences in the actions of insulin, epidermal growth factor and growth hormone, action of “small G proteins”.

UNIT V

Oncogenes/Apoptosis - Define oncogene, proto-oncogene, and tumor suppressor, examples of cellular or viral oncogenes that alter cellular signaling pathways, Describe apoptosis, the apoptosome, caspases, the role of cytochrome c, Bcl2 and IAP proteins

Semester – IV

GENETICS & PROTEOMICS

UNIT-I

Physical Basis of Heredity: Basic laws of inheritance mono-hybrid, n and tri-hybrid ratios, Modification of Mendel's ratios due to gene interaction. Multiple factors of inheritance. Genes and environment, identification of the genetic materials - classical experiments. Hershey Chase, Avery McLeod etc,

Organization of Genetic Material: Packing of DNA, organization of genetic material in prokaryotes, Eukaryotes. Euchromatin and Heterochromatin organization of Nucleosomes.

UNIT-II

Linkage & Recombination: Chromosomal inheritance, the concept of linkage, cytological basis of crossing over. Mechanism of recombination, Transduction phenomena, Methods of transduction, Generalized, Specialized & Abortive transduction, Bacteriophages - lytic & lysogenic life cycle Discovery, Detection, Molecular mechanisms of transformation, transformation methods. Bacterial conjugation.

Mapping: Two point and three point testcrosses and gene mapping. Mapping of genes by tetrad analysis by mitotic crossing over.

UNIT-III

Sex Determination in Prokaryotes and Eukaryotes: Mechanism of sex determination in insect (Fruit fly) and plants (Melandrium), Sex factors in bacteria, F and HFr transfer, mechanism of transfer.

Sex Determination in Humans: Sex differentiation and developments in humans, Dosage compensation, Maryleons hypothesis, Sex linked disorders in human beings – Haemophilia, Fragile-x syndrome, Down's syndrome

UNIT-IV

Chromosome Structure, Organization & Aberrations: Chromosome morphology, classification, karyotying. Special chromosome, chromosome aberrations, origins, types and cytogenetic effects.

Extra Chromosomal Inheritance: Introduction to extra chromosomal inheritance, examples of extra chromosomal inheritance. Petite phenotypes in yeast. Uniparental inheritance in algae.

TEXT BOOKS

1. E.J. Gardner, M.J.Simmons & DP Shustad. Principles of Genetics, 1991.

GENETIC ENGINEERING

Unit I

Gene Regulation and Expression in Prokaryotes: Lactose, Arabinose and Tryptophan operons, Repressors and activator, Sigma switch in *Bacillus subtilis.*

Gene Regulation in Eukaryotic system: Gene regulation in Eukaryotic system, Repetitive DNA, Gene rearrangement, Promoters, enhancer elements, gene amplification.

Plasmids, Transposons / Vectors for Gene Transfers: Plasmids: Definition, types, Identification, classification and purifications and transfer of Plasmids. Host restriction in transfer. Transposable elements: Definition, detection of transposition in bacteria, types of bacterial transposons, mechanisms of transposition and excision, applications of transposons. Retrotransposons

Unit II

Molecular markers: Molecular markers: RFLP, RAPD, AFLP, 16s r-RNA typing, gene chip and micro array; applications in disease profile

DNA Technology : Purification of genomic DNA from living cells, Manipulation of purified DNA; construction of prototype vector (pBR 322), different types of cloning vectors (plasmid – pUC 19, ? phage, cosmid, M13). Enzymes involved in genetic engineering; cloning strategies, Introduction of DNA into living cells. Methods of Gene transfer, Restriction mapping.

Unit III

Expression and Detection of clones: Detection of clones and its expression: Expression of cloned genes in yeast & *E.* coli. Blot analysis - Southern, Northern & Western blot; dot and slot blot. Immunological techniques. DNA methylation, DNA hybridization. Genomic and cDNA library construction and application. DNA sequencing.

Unit IV

PCR and its application: Principles, designing of primers, PCR methodology, RT - PCR, multiplex PCR, identification of PCR product, application of PCR technology.

Applications of r-DNA Technology: Gene cloning in medicine (Insulin, Blood clotting factor VIII) High level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells) Limitation and advantages and novel technologies- for generation of transgenic animals. Introduction to Gene therapy (Ex vivo & In vivo), case study of ADA as an example. Advantages and limitations of Gene therapy.

FOOD TECHNOLOGY

Unit I

Introduction to Food Science & Technology: Fundamentals and Aims of food science and technology. Interdisciplinary approach, Nutritive value of foods, Food as a source of energy, Food Health and disease.

Unit II

Food Microbiology: Microbial growth pattern, Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products. Contaminants of foods-stuffs, Fisheries, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, standards for different foods. Food borne intoxicants and mycotoxins.

Food Biotechnology: Biotechnology in relation to food industry, Enzymes in foods and food industry, Nature and type of starters, Role of starters in Fermented foods, Fermentation of Milk products- Fermented soy and peanut milk, Fruit and cereal based beverages, Non beverage plant products. Mycoprotein production.

Unit III

Food Preservation: Principles of food preservation: Physical, Chemical, and biological methods of preservations. Bioprocessing of meat, Fisheries, vegetables, diary products. Irradiated foods.

Food Processing: Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging

Unit IV

Food Additives and Analysis: Sampling techniques and theory and practice of chemical and physical methods of food analysis for determination of food composition; Pigments in food, food flavors, food additives and toxicants. Natural sweeteners and artificial sweeteners and their role in controlling diseases and deficiencies, Nutraceuticals, and Functional Foods

Suggested Books:-

1 Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.

2 Food processing and Preservation PHI private ltd,New Delhi

3 Food Microbiology fourth edition William C.Frazier, Tata Mc Graw Hill

4 Food Microbiology 2nd Edition, Michael P.Doyle ,ASM press

ANALYTIC TECHNIQUE IN BIOTECHNOLOGY

Unit I

Microscopy: Introduction, Types of Microscope, Principle, Parts of Microscope, Uses of Microscope, Refractive Index, Resolution Power, SEM, Phase contrast and Dark field Microscopy, Process of Microscope Technique.

Unit II

Methods of Biochemical Analysis: Carbohydrate-Isolation and Estimation Technique

Protein- Isolation and Estimation Technique; Amino Acid- Isolation and Estimation Technique; Lipid- Isolation and Estimation Technique.

Unit III

Separation Technique: Chromatographic Technique, Electophoretic Technique, Analysis Technique- Gel documentation,

Unit IV

Nucleotide and Nucleic Acid Analysis: Isolation and purification DNA & RNA from cells and organisms.

Text Books:

3. Willson & Walker: Principle of Biochemistry.
4. Strayer

DOWN STREAM PROCESSING IN BIOTECHNOLOGY

UNIT I

ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY: Role and importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification. Economics of downstream processing in Biotechnology, cost-cutting strategies, characteristics of biological mixtures, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high Value products)

UNIT-II

Physico-chemical basis of bio-separation processes. Recent development in productIsolation (for ex. one step purification, reverse Micro cellular extraction on line membrane separation).

UNIT-III

PRIMARY SEPARATION AND RECOVER PROCESS: Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods.

MEMBRANE SEPARATIONS: Membrane-based separations (micro and ultrafiltration), theory, design and configuration of membrane separation equipment applications,

UNIT-IV

ENRICHMENT OPERATIONS: Precipitation methods (with salts, organic solvents, and polymers, extractive separations, aqueous two-phase extraction, supercritical extraction), in situ product removal, integrated bioprocessing.

UNIT-V

NEW AND EMERGING TECHNOLOGIES: Dialysis, Crystallization Pervaporation, super liquid extraction foam based separation case study with examples for processing of Two Industrial Products (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

COMPUTATIONAL BIOLOGY

Unit – I

Software and hardware for interactive computer graphics; Implementation of device drivers; Line and circle drawing algorithms; 3-D transformation, windowing, clipping, perspective and input routines;

Unit – II

Data structure, hidden surface removal, hidden surface removal, color shading techniques; scaling, translation, rotation, reflection; viewing

Unit – III

Transformations; Programming practices with standard graphics libraries like open GL; Graphical display of molecules, background objects, dihedral;

Unit – IV

Retrieving and displaying biological structures; Comparing structure, homology modeling or protein structure; Digital images and image processing.

Semester – V

IMMUNOLOGY

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phaagocytic barriers, Inflammation, Adaptic immunity.

Cells and Organs of Immune System: Lymphoid cells; stem cells, B and T Lymphocytes, Natural killer cells, Mononuclear phagocytes, Granulocytic cells.

Organs: Thymus, Bone Marrow, Lymphatic system, Lymph nodes, Spleen.

Antigens and Antibodies:-Antigens: Structure, properites, types, Epitopes, Haptens. Antibodies: Structure and function, Antibody mediated functions, Antibody classes and biological activies, Monoclonal Antibodies.

Antigen-Antibody Interaction:-Precipitation reaction, Agglutination, Radioimmunoassay, ELISA, Western Blotting, Major Histocimpatibility Complex, General structure and function of MHC, MHC Molecules and Genes, Antigen Processing and presentation, T-Cell Receptors T-Cell Maturation and Differentiation, B-Cell Generation, Activation & Differentiation.

Immune Effecter Mechanism - Cytokinesis (Properties, receptors, antagonisis & secretion) The complement system (functions, components, activation, regulation and deficiencies)

Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity, Inflammation, Hypersensitive reactions (Type I,II,III and delayed type (DTH)

Immunology in Health & Disease-Immune response to infectious disceases: viral, bacterial and protozon, Vaccines, AIDS and other Immuno deficiencies, Genetically designed vaccines. BCG, TB & Leprosy, DNA vaccines.

Transplantation and Autoimmunity-Organ specific autoimmune diseases, Systemic autoimmune diseases, Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigens. Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

PLANT & ANIMAL VIROLOGY

UNIT I

Inroduction: Definition of Virus, structure of virus particle, physiochemical properties of virus particles; properties of viral nucleic acids, viral proteins, serological relationships. Virus of Algae, Fungi, Ferns, Gymnosperms; Disease symptoms; macroscopic, systemic; Agents inducing virus-like symptoms.

UNIT II

Purification and composition of plant viruses: Isolation, components, architecture and assembly of virus particles; chemical and biochemical studies, architecture of rod shaped viruses, isometric, icosahedra enveloped viruses.

Histological changes: necrosis, hypoplasia, and hyperplasia.

Cytological Effects: Methods, effects on cell structure, virus-induced structure in cytoplasm, cytological structure reassembly those induced by viruses.

UNIT III

Genome Organization: General properties of double stranded DNA viruses, single stranded DNA viruses, double stranded RNA viruses and single stranded RNA viruses.

Expression of viral genomes: virus entry and uncoating, viral genome expression, synthesis of m-RNA, plant viral genome strategies.

Bacteriophage structure organization; Replication, one step growth curve, eclipse phase, phage production, burst size, lysogenic cycle.

Viral replication: mutation, recombination.

UNIT IV

Paramyxo virus: measles virus, parainfluenzae virus, and mumps virus.

Phabdovirus: Rabies virus.

Taga virus: Arbovirus, Rubella virus.

Poxviruses: small pox and hepatitis virus.

Yellow leaf curl of tomato, tobacco mosaic virus, sugar cane mosaic.

ENZYME TECHNOLOGY

UNIT I

Enzyme: Classification, active sites and specificity kinetics, Ramchandran plot: Factors affecting the rate of enzyme catalysis, interrelationships between initial velocity and substrate concentration, Michaelis-Menten equation, significance of Km, reaction order, methods of plotting kinetics data.

UNIT II

Rapid reaction kinetics, relaxation kinetics, enzyme inhibition, (reversible, competitive, non competitive, mixied type and irreversible inhibitions)

Kinetics of bisubstrate reactions (random, ordered, ping pong and bibi mechanism).

UNIT III

Active site determination, regulation of enzymes; activation, covalent modification, feedback inhibition, allosteric control.

Immobilization of Enzyme, Enzyme Engineering, Biosensor.

UNIT IV

Enzyme Preparations and Use: Sources of Enzyme, Screening novel Enzymes, Media and Bioreactor for Enzyme Production, Preparation of Enzyme, Preparation of Enzyme for sale, Use of different enzyme.

Suggested Readings:

3. Webb.
4. Production & Application, W. Gerhartz.

BIOINFORMATICS

UNIT I

Introduction to Bioinformatics: Scope of Bioinformatics, Elementary commands and protocols, ftp, telnet, http. Primer on information theory.

Introduction to Homology: Introduction to Homology (with special mention to Charles Darwin, Sir Richard Owen, Willie Henning, Alfred Russel Wallace).

UNIT II

Special Topics in Bioinformatics: DNA mapping and sequencing, Map alignment, Large scale sequencing methods Shotgun and Sanger method.

Sequencing Alignment and Dynamic Programming: Heuristic Alignment algorithms. Global sequence alignments-Neddleman-Wunsch Algorithm Smith-Waterman Algorithm-Local sequence alignments (Amino acid substitution Matrices (PAM, BLOSUM).

UNIT III

Primary Database and Their Use: Introduction to Biological databases, Organization and management of databases. Searching and retrieval of information from the World Wide Web. Structure databases - PDB (Protein Data Bank), Molecular Modeling Databases (MMDB). Primary Databases NCBL, EMBL, DDBJ.

Secondary Databases: Introduction to Secondary Databases Organization and management of databases Swissprot, PIR, KEGG

UNIT IV

Biochemical Data Bases: Introduction to BioChemical databases-organization and Management of databases. KEGG, EXGESCY, BRENDA, WIT.

Evolutionary Trees and Phylogeny: Multiple sequence alignment and phylogenetic analysis

TEXT BOOKS:

1. Bioinformatics Basics. Applications in Biological Science and Medicine by Hooman H. Rashidi and Lukas K.Buehler CAC Press 2000.

2. Algorithms on Strings Trees and Sequences Dan Gusfiled. Cambridge University Press 1997.

COMPUTATIONAL METHOD FOR BIOLOGICAL SEQUENCE ANALYSIS

UNIT I

Elements of Molecular Biology.

Nucleic Acid, protein, central dogma, Transcription and Translation

Comparison of Biological Sequence

Biological sequence, Alignment, Types of Alignment.

UNIT II

Computational Methods and online Approaches

Tools including BLAST and FASTA database, database formats, sequence alignment, scoring matrices including PAM, BLOUSM, DNA scoring matrices, MSA, pair wise and global alignment, phylogenetics analysis, Dynamic programming method.

UNIT III

Genomic Sequencing and Sequence assembly.

Genomic Mapping Sequencing, BAC, EST's Sequence Assembly, Clone contigs, sequence Assembly.

UNIT IV

Analysis and Modeling of Metabolic pathway.

Introduction, a model for approximating complicated metabolic activities, model generation for fining targets for Experimentation.

Text Books: Bioinformatics-A Practical Guide to the Analysis of Genes and Protein;
Baxevanis A. B, Quellette B.F.F (EDS); 2001

PHARMACEUTICAL BIOTECHNOLOGY

Unit – I

Introduction to Physical Pharmaceutics - Metrology and Calculations, Molecular structure, properties and States of Matter, Solutions, Phase Equilibra, Micromeritic and Powder Rheology, Surface and Interfacial Phenomena, Dispersion Systems, Diffusion & Dissolution, Kinetics and drug stability, Viscosity & Rheology

Unit – II

Polymer Science and Applications.

Formulations and Development, Packaging

Unit – III

I

ntroduction to Industrial Processing, Transport Phenomena (Fluid Flow, Heat Transfer and Mass Transfer)

Particulate Technology (Particle Size, Size reduction, Size Separation, Powder Flow and Compaction)

Unit – IV

Unit Operations (Mixing, Evaporation, Filtration, Centrifugation, Extraction, Distillation, and Drying)

Materials of Pharmaceutical Plant Construction, Good Manufacturing Practice (GMP's) Guidelines

Semester – VI

BIOETHICS, BIO SAFETY AND INTELLECTUAL PROPERTY RIGHTS

UNIT I

BIOETHICS: Introduction to Bioethics. Social and ethical issues in Biotechnology

UNIT II

BIOSAFETY: Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products

UNIT III

REGULATORY AFFAIRS: Regulatory requirements for drugs and Biologics. GLP. GMP, WTO guidelines

UNIT IV

INTELLECTUAL PROPERTY RIGHTS:

Intellectual property rights, and Intellectual Property protection, patents and methods of application of patents, Trade Secrets copyrights, Trade Marks, legal implications, farmers rights, plant breeder's rights. International and National conventions on biotechnology and related areas.

TEXT BOOKS:

1. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.

2. Sasson A. Biotechnologies in developing countries present and future,

UNESCO publishers, 1993.

MOLECULAR MECHANISM AND GENE EXPRESSION

UNIT I

Prokaryotic & Eukaryotic Genomes and their topology, DNA-Protein Interactions.

UNIT II

RNA transcription & transcriptional control, DNA Replication, Transcription in Yeast, RNA Processing, Translation.

UNIT III

Gene Pool, Allele frequency, genotype frequency, Hardy-Weinberg equilibrium & its complications, Non-random breeding, Genetic drift, Genetic Load Gene Flow, Selection, Intensity of Selection pressure.

UNIT IV

Mechanism of Gene Expression in Prokaryotic & Eukaryotics.

Inbreeding & artificial selection, natural selection & polymorphism, neutral theory & evolution specialization.

TEXT BOOKS:

5. Edward J. Kormondy
6. M.C. Dash
7. Robert H. Tomarin
8. R.W.Old &S.B. Primrose

ENVIRONMENTAL BIOTECHNOLOGY

UNIT I

Environmental Biotechnology: Definition & Scope, Concepts and dynamics or ecosystem, components, food chain and energy flow productivity Biogeochemical cycles; types of ecosystem, population ecology and biological control community structure and org. Environmental pollution; sustainable development economic importance of microbes, plants and animals

UNIT II

Environment Pollution: types of pollution, Methods for measurement of pollution, Air pollution, Water pollution,Soil & Agriculture pollution, Noise & Radiation pollution

Microbiology & Biochemistry of Waste Water, **Waste Water Treatment**: Aerobic Process, Aerobic Waste Water Treatment,Activated sludge, Oxygen ditches, trickling filter,Towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes, anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors.Treatment scheme of waste water of dairy, distillery, tannery, sugar and antibiotic industry

UNIT III

Solid Wastes: Sources, Solid Waste Management, Anaerobic Digestion of Waste Biogas Production, Methanogenesis, Vermicomposting Xenobiotic Compounds, Hazardous Wastes, Biodegradation of Xenobiotics, decay behavior & degradative plasmids, oil pollution, surfactants, pesticides, Bioremediation of contaminated soils and waste land. Bioremediation, Biotechnology Applications to Hazardous Waste Management & Examples

UNIT IV

Integrated Pest Management (IPM)

Global Environmental Problems

Ozone layer: Ozone Depletion & UV-B, Ozone in the Atmosphere, Ozone Chemistry**,** Ozone Reaction Mechanisms, High Level Ozone, Low Level Ozone, How does ozone absorb UV light?, Stratospheric Ozone Depletion, Ozone Depletion Process, Ozone Links, Ozone Depletion Glossary

Green House Effect: Global Warming Acid Rain

UNIT I

Basis and Development of Industrial fermentation Processes.

Screening, Detection and assay of Fermentation products, Stock Cultures, Fermentation Media, Inoculum Preparation.

UNIT II

Typical Fermentation Process:

Antibiotic Fermentation: Penicillin, Streptomycin

Anaerobic Fermentation: Acetone, Butanol Fermentation, Brewing, Industrial Alcohol Lactic Acid.

UNIT III

Environmental Control of Metabolic Pathways: Glycerol from Yeast, Glycerol from *Bacillus subtilis.*

Genetic Control of Metabolic Pathways: Indirect or Dual Fermentation, Direct Fermentation.

UNIT IV

Microbial Oxidative Transformation of substrate:

Vitamins & Growth Stimulates - Riboflavin, Vitamin A, Vitamin B_{12}, Gibberellins.

Enzymes as Fermentation Products: Amylases, Proteolytic enzymes, Pectinases, Invertases.

Organic Acid: Citric Acid, Fumaric Acid, Itaconic Acid, Kojie Acid & Bacterial gluconic & α-ketoglutanic Acid Fermentation.

Text Books:

3. Prescott & Dunn's
4. L.C. Casida

EMERGING AREAS IN BIOINFORMATICS

UNIT I

Introduction to Computational Molecular Biology: Introduction to active areas of research in Computational Molecular Biology, Functional Genomics, Comparative Genomics, Dynamic Programming, Graphical representation of biochemical systems, S-systems equations, steady state analysis, Model refinements,

UNIT II

Genomics: DNA Sequence assembly and gene identification. Homology based gene prediction. SNPs and applications. Methods of studying gene expression, EST approach,
Dendograms and its interpretation

UNIT-III

Proteomics: Introduction to proteins. Protein identification, structure and function determination. Structure comparison methods. Prediction of secondary structure from sequence. Protein homology modeling, Protein threading. Protein ab initio structure prediction. Protein design emphasis on structural Bioinformatics.

UNIT IV

Micro Arrays: Basics of Micro array

Drug Design: Drug discovery cycle, Role of Bioinformatics in Drug discovery

Taxonomy and Phylogeny: Basic concepts in systematics, Molecular evolution, Definition and description of Phylogenetic trees and types of trees

TEXT BOOKS:

1. David W Mount. Bioinformatics- Sequence and genome analysis. CSHL.

3. Jonathan Pevsner . Bioinformatics and Functional Genomics. A Jhon Wiely & Sons, Inc., Publication

OPERATIONAL RESEARCH

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – III

Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Hypothesis – Fundamentals of Hypothesis Testing, Standard Error, Point and Interval Estimates, Important Non-Parametric Tests: Sign, Run, Kruskal, Wallis tests and Mann-Whitney Test.

Unit – IV

Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

Research Report: Types of Reports, Styles of reporting, Seeps in drafting reports, Editing the final draft, Evaluating the final draft.

Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Semester – VII

ANIMAL BIOTECHNOLOGY

Unit I

Structure and Organization of animal cell; Equipments and materials for animal cell culture technology; Primary and established cell line cultures; Introduction to the balanced salt solutions and simple growth medium,

Unit II

Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements; Serum & protein free defined media and their application.

Unit III

Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth;

Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.

Unit IV

Cell synchronization; Cell cloning and micromanipulation; Cell transformation; Application of animal cell culture; Scaling-up of animal cell culture.

Stem cell cultures, embryonic stem cells and their applications; Cell culture based vaccines, Somatic cell genetics, Organ and histotypic cultures; Measurement of cell death; Apoptosis;

TEXT BOOKS:

1. Culture of Animal Cells, (3rd Edition), F1. Ian Froshney. Wiley-Liss.

2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, OXFORD.

PLANT CELL & TISSUE CULTURE

UNIT I

Introduction to tissue culture: Cleaning, sterilization, sterile handling of tissue culture labs. Synthetic medium for plant tissue culture, nutritional requirement of cells in vitro, totipotency, concepts of differentiation, redifferentiation, and growth controls.

UNIT II

Somatic embryogenesis, Synthetic seeds; anther, pollen and ovary culture, Significance and advantages of haploid plants.

Use of plant tissue culture techniques for micropropagation and cloning; application agriculture, horticulture and forestry; in sexual imcompatibility.

UNIT-III

In vitro production of commercially important secondary metabolites and natural products; hairy root cultures, elicitors, factors affecting yield application of immobilization and bioreactors in Secondary metabolite production from plant cell culture.

UNIT IV

Cryopiology of plant cell cultures and establishment of gene banks.

Protoplast isolation and fusion, somatic hybridization, cybrids.

Production of virus free plants by meristem tip and other tissue culture techniques.

Text Books:

3. R. Ian Freshney, Wiley-Liss.
4. Matin Clyness, Springer.
3. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice. 2004

PLANT BIOTECHNOLOGY

UNIT I

Plant Transformation Technology: Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment.

UNIT II

Plant Genetic Engineering for Productivity and Performance I (Biotic Stress)

Herbicide resistance, Insect resistance, Fungus resistance, Bacteria resistance, virus resistance,.

Plant Genetic Engineering for Productivity and Performance II (Abiotic Stress)

Abiotic stress tolerance; Drought, temperature, salt

UNIT III

Molecular Farming & Industrial Products: Application of Plant biotechnology for the production of quality oil, Industrial enzymes, Therapeutic Proteins, Antigens (edible vaccine).

.**UNIT IV**

Metabolic Engineering: Metabolic engineering for plant primary metabolites and secondary metabolites.

Pest Management: male sterile technology; orle of juvenile hormones, pheromones and its anqalogues for pest management, development of genetically engineered microbial bio-control agents.

PROTEIN ENGINEERING

UNIT I

Protein Structure: Introduction, Overview of protein structure, Higher level structure,

Protein post-translational modification, Protein stability and folding.

Protein Sources: Introduction, Microorganisms as sources of proteins, Proteins from plants, Animal tissue as a protein source, Direct chemical synthesis, Conclusion.

UNIT II

Protein Purification and Characterization: Introduction, Initial recovery of proteins,

Removal of whole cells and cell debrisConcentration and primary purification, Column

chromatography, Protein inactivation and stabilization, Protein characterization.

Large-Scale Protein Purification: Some general principles, Therapeutic protein production: some special issues, Range and medical significance of impurities potentially present in protein-based therapeutic products, Labelling and packing of finished products.

UNIT III

Therapeutic Proteins: Introduction, Blood products, Haemophilia A and B, Anticoagulants, Thrombolytic agents, Additional blood-related products, Vaccine technology, Vaccines for AIDS.

Therapeutic Antibodies and Enzymes: Introduction, Antibodies for in vivo application,

Therapeutic enzymes.

UNIT IV

Hormones and Growth Factors used Therapeutically: Introduction, Insulin,Glucagon,

Gonadotrophins, Growth hormone, Erythropoietin, Other growth factors, Thyrotrophin,

Corticotrophin, Prolactin, Peptide Regulatory Factors.

Interferons, Interleukins and Additional Regulatory Factors: Regulatory factors;

cytokines versus hormones, Interferons, Interleukins, Tumour necrosis factors, Colonystimulating factors, Cytokine toxicity.

UNIT V

Proteins Used for Analytical Purposes: Introduction, Enzymes as diagnostic/analytical

reagents, Biosensors, Antibodies as analytical reagents.

Non-catalytic Industrial Proteins: Introduction, Functional properties of proteins, Milk and milk

proteins, Animal and microbial proteins, Sweet and taste modifying proteins.

MOLECULAR MODELING AND DRUG DESIGN

UNIT I

Introduction to Molecular Modelling: Introduction to Molecular Modelling. What are models used for? Areas of application – Single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co-ordinate systems two – matrix, potential energy surface.

UNIT II

Molecular Dynamics: Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching, Systematic search. Applications to protein folding

Comparative Protein Modeling: Modelling by Homology-the alignment, construction of frame work, selecting variable regions, side chain placement and refinement, validation of protein models – Ramchandran plot, threading and ab initio modeling.

UNIT III

Analog Based Drug Design: Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modelling in drug discovery.

UNIT IV

Structure Based Drug Design: 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies.

Further Applications on the Design of New Molecules: 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility

TEXTBOOKS:

1. Principles and applications of modelling by Leach

2. Molecular Modelling by Hans Pieter,Heltje & Gerd Folkens, VCH.

ARTIFICIAL NEURAL NETWORKS

UNIT I

Historical background, Why is learning hard?

UNIT II

Memorization, generalization and function approximation, Linear Associators, Perceptrons and Capacity, Multilayer
neural networks, Maximum Likelihood and Gradient Descent learning, Stochastic gradient descent for
supervised learning,

UNIT III

The back propagation algorithm, Aspects of Learning Theory and Generalization, Bias vs. variance,
Overtraining, pruning and regularization, VC dimension and how much data is enough?

UNIT IV

Neural networks and analog VLSI, Selected Applications

Semester –VIII

BIOENERGY ENGINEERING

UNIT I

Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification. - Chemical composition and properties of different biomass materials and bio-fuels – Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels- Energy plantations -Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass.

UNIT II

Biogas, Technology: Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues-. Microbial and biochemical aspects- Operating parameters for biogas production. Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application-High rate digesters for industrial waste water treatment.

UNIT III

Bio-Ethanol and Bio-Diesel Technology: Production of Fuel Ethanol By Fermentation Of Sugars. Gasohol as a Substitute for Leaded Petrol. - Trans-Esterification of Oils to Produce Bio-Diesel.

UNIT IV

Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno-cellulose biomass – Biomass processing for liquid fuel production - Pyrolysis of biomass-Pyrolysis regime, effect of particle size, temperature, and products obtained. Thermo-chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen. Design and operation of Fixed and Fluidized Bed Gasifiers.

UNIT V

Combustion Of Biomass And Cogeneration Systems: Combustion Of Woody Biomass: Theory, Calculations And Design Of Equipments. Cogeneration In Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration.

BIOSENSORS

UNIT I

Introduction to MEMS

UNIT II

Biosensors: Definition, History, Properties of biosensors, Design features of Biosensors, The Biological Component,

Signal Transduction: Amperometric Biosensors, Potentiometric Biosensors, Detection of H+ cation, Detections of NH4+ cation, Detection of CN- anion, Calorimetric biosensors, Optical Biosensors, Measuring the change in light reflectance, Measuring luminescence, Pizo-electric

biosensors, Immunosensors, Commercial examples of biosensors. Biosensors markets-Opportunities and obstacles.

UNIT III

Biomedical sensors Sensors and transducers: an overview, measurement systems, Classification of Biomedical sensors and trnsducers, who do we need Biomedical sensors and Transducers? Important Design considerations and system calibration, the future of Biosensors and Transducers, Sensing Layer: The importance of computers in sensors and Transducer technology, Recent Engineering Solutions to Health care using Biosensors and Transducers, Modern health care solutions.

BIOPROCESS PLANT DESIGN

UNIT I

Introduction; general design information; Mass and energy balance;

Flow sheeting; Piping and instrumentation; Materials of construction for bioprocess plants; Mechanical design of process equipment;

UNIT II

Vessels for biotechnology application; Design of fermenters; Design considerations for maintaining sterility ofprocess streams processing equipment;

UNIT III

Selection and specification of equipment for handling fluids and solids; Selection, specification, design of heatand mass transfer equipment used in bioprocess industries;

UNIT IV

Design of facilities for cleaning of process equipment used in biochemical industries; Utilities of biotechnology production plants; Process economics; Bioprocess validation; Safety considerations;Case studies.

Transgenic Technology

Unit – I

Introduction to Transgenic Animal Technology, Transgenic Animal Production Focusing on the Mouse Model, DNA Microinjection and Transgenic Animal Production, Factors Affecting Transgenic Animal Production

Unit – II

Gene Targeting in Embryonic Stem Cells: History and Methodology, Stem Cells of the Embryo, Gene Targeting in Embryonic Stem Cells,
Gene Targeting in Embryonic Stem Cells: Conditional Technologies, Introduction, Conditional Modeling, Cre-loxP System Review, Development and Testing Cre-loxP and Transgenic Models
Retrovirus: Mediated Gene Transfer

Unit – III

Nuclear Transfer Technologies: Introduction and Discussion, Materials and Equipment, Preparation of Microtools, Nuclear Transfer of preimplantation Embryos, Nuclear Transfer of Embryonic Stem Cells and Somatic Cells. Production of Transgenic Laboratory and Domestic Animal Species,Production of Transgenic Rats, Rabbits, Fish, Frog & Poultry: Introduction, Importance of Rats, Contributions from Transgenic Rats. Nuclear Transfer Technology in Cattle, Sheep, and Swine

Unit – IV

Transgenic Plants; Transformation- Plant Transformatrion; Agrobacterium-Mediated Gene Transfer Production Hairy Root Cultures and Transgenic Plant
Regeneration: Organogenesis from Transformed Tomato Explants, Genetic Transformation of Conifers Utilizing Somatic Embryogenesis
Selectable Markers: Antibiotic and Herbicide Resistance, Histochemical and Fluor metric Assays.
Transgene integration, Expression, and Localization; Risk Assessment; Transgenic Crops

NANO BIOTECHNOLOGY

Unit-I

BASIC CONCEPT: Definition of nano scale with reference to biosystems, Scope and future prospects.

TOOLS OF NANOSCIENCE: Scanning probe instrument, spectroscopy, electron microscopy.

Unit-II

TOOLS FOR NANOSTRUCTRE: Molecular synthesis, Self assembly, Polymerisation, Nanoscale lithography, e-beam lithography.

SMART MATERIALS: Heterogenous nano structre and composites, nanoscale biostructres.

Unit-III

HYBRID COMPUTERS: Protein-hybrid computers, role of genetically engineered polymer proteins.

DIRECTED SYNTHESIS: Molecular biology of biosynthesis and molecular design.

Unit-IV

APPLICATIONS: Drugs-Photodynamic therapy, molecular motors, neuroelecronic interphases, development of nanoluminiscent tags.

BIOSYNTHESIS OF DESIGNER COMPOUNDS: Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials.

Textbooks:

1. M.Ratner and D.Ratner,Nanotechnology –a gentle introduction to the next big idea, Pearson education , 2007.

2. R.R.Birge, Proetin based computers, Scientific American , 1995.

Semester - IX

Genomics

Unit – I

Genome evolution and phylogenetics: Origin of genomes, Acquisition of new genes, DNA sequencing – chemical and enzymatic methods, the origins of introns, DNA and RNA fingerprinting, the human genome

Structural Genomics: Technology, Data Bases (NCBI and Plant Databases), Sequence Comparison Techniques (BLAST etc.), Genome, Annotation

Comparative Genomics: Phylogeny, Synteny (comparison of grass genomes), COGS (Clusters of orthologous genes, NCBI web site), Metabolic Reconstruction, The Basic Principles and Methodology, Pathway

Functional Genomics: ESTs, Digital Northerns, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Micro array Chips, Cancer and genomic micro arrays, Examples for Application of Microarrays, Micro array Data Analysis; Gene finding tools

Unit – II

Genotyping Background and SNPs: SNPs II and TOGA, AFLP and RFLP analysis, Arabidopsis KO Strategies; Pharmacogenomics; Ethical considerations of genetic testing. Introduction to proteomics; protein function and expression; essential proteins; Protein function from structure; Rational drug design; Lethal mutants

Interaction networks: Yeast genome-wide interaction studies

Unit – III

Introduction to proteomics: How to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, Current concepts of co-immunoprecipitation for protein interaction analysis, chromatography, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF mass spectrometry and nanospray MS, Phage Display, Protein chips; Two-hybrid methods, Synthetic lethal screens, Proteome-wide interaction maps, TAP tags, GFP tags, Synthetic Lethal Screens, Inteins and Protein Splicing for interaction analysis; Micro Arrays-Affimetrics and spotted array concepts

Protein Structure and Function: Structure function relationship Protein-protein interactions – Large molecular complexes – RNA polymerase II, ribosome; Unstructured

proteins – Current concepts and examples, the fly-casting mechanism; Current Degradation Concept, The N-end rule and PEST sequences, control of ubiquitination, the proteasome, SUMO Protein-protein interactions in health and disease; Molecular mechanisms in disease

Unit – IV

Posttranslational modifications – concepts of how protein function is rapidly and dynamically modulated through posttranslational modifications, how posttranslational modifications precede altered transcription levels. Structure determination – experimental and theoretical methods

Evolution and Design of Protein Function: Metabolic networks – Metabolic pathways, Metabolic regulation, Genome-Proteome Connection, DNA micro arrays and Analysis of metabolic control

Pollution Protection Fundamentals

Unit – I

Pollution Prevention in Industries: Environment friendly chemical processes-Properties and fates of environmental contaminants-Regulations for clean environment and implications for industries, Improved manufacturing operations.

Unit – II

Life cycle assessment and environmetal Audit: Life cycle assessment and pollution prevention econimics, Hazard and risk analysis, Pollution prevention planning, Design for the environment.

Conservetion of Materials and Energy: Water energy and reagent conservation, Residuals management, Economic Recovery and Recycling of wastes, Case studies.

Unit – III

Total quality environment management and Ems 14000: Muncipal pollution prevention programmes, environment Management system-14000-Systematic, Structured and Documented Response to Environmental Issues, Auditable and Time Targeted Environmental Improvement Programs.

Unit – IV

Hierarchy of Environment Management Practices: Waste-specific pollution prevention, waste pregeneration focus on minimization/ recycling, Waste-specific post-release-to environment forcus: recycling/ remediation.

Biotechnology & Management

Unit – I

Hazards: Chemical hazards classification. Radiation hazards and control of exposure to radiation. Types of fire and fire prevention methods. Mechanical hazards. Electrical hazards

Psychology and Hygiene: Industrial psychology Industrial hygiene. Safety in plant site selection and plant layout. Industrial lighting and ventilation. Industrial noise.

Unit – II

Occupational diseases and control: Occupational diseases and prevention methods. Safe housekeeping Instrumentation for safe operation. Personal protective equipments. Safety in chemical operations and processes.

Unit – III

Management: Safety organization – safety committee – safety education and training. Management process. Philosophy and need for Industrial safety. Role of Government in Industrial safety.

Unit – IV

Psychology and Hygiene: Industrial psychology Industrial hygiene. Safety in plant site selection and plant layout. Industrial lighting and ventilation. Industrial noise.

Laws: Factory Act. ESI Act, Environmental Act. Workment - comperation Act. Advantages of adopting safety laws.

Semester – X

INDUSTRIAL TRAINING & PROJECT

Singhania University

Pacheri Bari, Distt. Jhunjhunu (Raj.)

Phone No.-01593 271299, 300, Fax No. – 01593 271003

M. Tech. in Biotechnology

Course Structure

Semester – I

S. No.	Code	Name of Subject	
1	M.Tech.BT 111	Operational Research	
2	M.Tech.BT 112	Plant Biotechnology	
3	M.Tech.BT 113	Applied Microbiology	
4	M.Tech.BT 114	Food Technology	

5	Elective Paper - I (Any One)	
6	Seminar	
7	Practical	

Elective Paper-I

S. No.	Code	Name of Subject	
1	M.Tech.BT 115	Introduction to Nano-Biotechnology	
2	M.Tech.BT 116	Biochemistry & Metabolic Engineering	
3	M.Tech.BT 117	Computational Biology	

Semester – II

S. No.	Code	Name of Subject	
1	M.Tech.BT 121	Recombinant DNA Technology & Cancer Biology	
2	M.Tech.BT 122	Industrial Biotechnology	
3	M.Tech.BT 123	Environmental Biotechnology	
4	M.Tech.BT 124	Enzyme Technology	
5	M.Tech.BT 125	Down Stream Processing	
6	Elective Paper - II (Any One)		
7	Project		
8	Practical		

Elective Paper-II

S. No.	Code	Name of Subject	

1	M.Tech.BT 126	Drug Designing	
2	M.Tech.BT 127	Instrumentation	
3	M.Tech.BT 128	Pharmaceutical Biotechnology	

Semester – III

S. No.	Code	Name of Subject	
1	M.Tech.BT 131	Immunology & Monoclonal Hybridization Technology	
2	M.Tech.BT 132	Animal Biotechnology	
3	M.Tech.BT 133	Transgenic Technology	
4	M.Tech.BT 134	Genomics	
5	Elective Paper - III (Any One)		
6	Practical		

Elective Paper-III

S. No.	Code	Name of Subject	
1	M.Tech.BT 135	IPR, Biosafty / Bioethics	
2	M.Tech.BT 136	Pollution Protection Fundamentals	
3	M.Tech.BT 137	Biotechnology & Management	

Semester – IV

Project (Industrial & Training Project)

Semester-I

Operational Research

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – III

Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Hypothesis – Fundamentals of Hypothesis Testing, Standard Error, Point and Interval Estimates, Important Non-Parametric Tests: Sign, Run, Kruskal, Wallis tests and Mann-Whitney Test.

Unit – IV

Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

Research Report: Types of Reports, Styles of reporting, Seeps in drafting reports, Editing the final draft, Evaluating the final draft.

Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Biochemistry & Metabolic Engineering

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit-I

Structure of Biomolecules, Metabolism of Carbohydrates, Lipids, Proteins, Amino acids and Nucleic acids, Photosynthesis.

Signal Transduction emphasizing the importance of G-Proteins, Regulation of Metabolism for the production of primary and Secondary Metabolites with case studies.

Unit-II

Enzyme and Enzyme Kinetics: Key characteristics of an enzyme, enzymes as catalysts, basic concepts of thermodynamics as they apply to chemical reactions, Michaelis-Menten equation, reversible and irreversible enzyme inhibition, effects of competitive and noncompetitive inhibitors on the K_m and V_{max} of the treated enzyme, allosteric enzyme, kinetics of allosteric enzymes to enzymes observing Michaelis-Menten kinetics, Catalytic strategies used in enzyme reactions.

Unit-III

Modes of Regulation: Different levels of regulation-protein synthesis/ degradation, allosteric regulation, reversible covalent modification, proteolytic processing, Requirements for ATP in synthesis and degradation cycle, Reversibility of the different methods of regulation, Consequences of misregulation

Unit-IV

Regulation of metabolic pathways: Glycoliysis/ Glycogenolysis, Phosphogluconate/ Citric Acid Cycle, Oxidative Phophorylation, Fatty acid oxidation, Fatty Acid Biosynthesis, Amino Acid Oxidation.

Applied Microbiology

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit-I

Introduction to biotechnology and biochemical engineering:

Chronological development of industrial biotechnology, Range of biotechnology products, Components of a microbial bioprocess.

Sterilization:

Media sterilization; kinetics of thermal death of cells and spores, design of batch and continuous thermal sterilization, sterilization of air and filter design, Radiation and chemical sterilization.

Unit-II

Bioenergetics and stoichiometry:

Thermodynamics, mass and energy balances in microbial metabolism, cell growth and product formation; metabolic heat generation. Heat transfer requirements of microbial cultivations including correlations for the determination of heat transfer coefficients.

Transport phenomena in bioprocess systems:

Examples of transport of mass, momentum and energy. Oxygen requirements of microbial cultures. Oxygen mass transfer fundamentals, Oxygen transfer and oxygen demand. Oxygen transfer by aeration and agitation. Determination of oxygen transfer coefficient by various methods including sulfite oxidation, dynamic gassing out and oxygen balance methods. Factors affecting oxygen transfer coefficient.

Unit-III

Kinetics of microbial growth, substrate utilization and product formation:

growth phases of a batch culture, Monod's model including the effects of inhibition, determination of kinetic parameters by batch, fed batch and continuous culture and analysis of chemo stat performance.

Structured models:

compartmental & metabolic models; Product formation kinetics: Gaden's and Deindoerfer's classifications, chemically & genetically structured models; Kinetics of growth & product formation by filamentous organisms.

Unit-IV

Analysis and monitoring of bioreactors:

The Ideal Batch reactor, Continuous Stirred Tank Reactor (CSTR), series of CSTRs, Fed-batch and Plug flow Reactors. Analysis of alternate bioreactor configurations including cell-recycle, air-lift and immobilized-cell bioreactors. Methods for online and offline monitoring of bioreactors, bioprocess control methodologies.

Scale-up of microbial bioreactors :

Various approaches to scale-up including regime analysis and scale-down; Scale-up methods by currently used rules-of-thumb viz. constant P/V, kLa etc.

NANO BIOTECHNOLOGY

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit-I

BASIC CONCEPT: Definition of nano scale with reference to biosystems, Scope and future prospects.

TOOLS OF NANOSCIENCE: Scanning probe instrument, spectroscopy, electron microscopy.

Unit-II

TOOLS FOR NANOSTRUCTRE: Molecular synthesis, Self assembly, Polymerisation, Nanoscale lithography, e-beam lithography.

SMART MATERIALS: Heterogenous nano structre and composites, nanoscale biostructres.

Unit-III

HYBRID COMPUTERS: Protein-hybrid computers, role of genetically engineered polymer proteins.

DIRECTED SYNTHESIS: Molecular biology of biosynthesis and molecular design.

Unit-IV

APPLICATIONS: Drugs-Photodynamic therapy, molecular motors, neuroelecronic interphases, development of nanoluminiscent tags.

BIOSYNTHESIS OF DESIGNER COMPOUNDS: Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials.

Textbooks:

1. M.Ratner and D.Ratner,Nanotechnology –a gentle introduction to the next big idea, Pearson education , 2007.

2. R.R.Birge, Proetin based computers, Scientific American , 1995.

Plant Biotechnology

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Gene delivery method in intact and cultured tissues and cells, Agrobacterium, Ti-Plasmid, cointegration and binary vectors, viral vectors, direct DNA uptake, microinjection delivery, use of 35S and other promoters, genetic markers, use of reporter genes.

Unit – II

Techniques for production of transgenic plants resistant/ tolerant to herbicides; pathogens, pests and abiotic stresses (drought, salt, frost), transgenic plants for production of molecules of commercial importance.

Unit – III

Mycorhiza; its importance in agriculture and forestry, plant diseases; general account, predators, parasites, insects, viruses, antagonistic fungi and bacteria, biological control of pests and diseases of crop plants, bio-pesticides, insecticidal activated compounds of botanicals.

Unit – IV

Application : Insect resistance; virus resistance; seed protein quality; suppression of endogenous genes; male sterility; biochemical ; problems gene transfer; safety regulation and transgenic plants.

Stress Resistance Plant: Salt tolerance, freezing tolerances, chilling tolerance, and drought & food tolerance.

Food Technology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

UNIT -1

INTRODUCTION TO FOOD SCIENCE & TECHNOLOGY: Fundamentals and Aims of food science and technology. Interdisciplinary approach, Nutritive value of foods, Food as a source of energy, Food Health and disease.

FOOD CHEMISTRY: Food chemistry-definition and importance, water in food, water activity and shelf life of food. Carbohydrates- functional properties of sugars and polysaccharides in foods. Lipids: use of lipids in foods, physical and chemical properties, effects of processing on functional properties and nutritive value. Protein and amino acids: physical and chemical properties, distribution, amount and functions of proteins in foods, functional properties, effect of processing.-Losses of vitamins and minerals due to processing.

UNIT –II

FOOD MICROBIOLOGY: Microbial growth pattern, Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products. Contaminants of foods-stuffs, Fisheries, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, standards for different foods. Food borne intoxicants and mycotoxins.

FOOD Preservation: Principles of food preservation: Physical ,chemical ,and biological methods of preservations. Bioprocessing of meat, Fisheries, vegetables, diary products. Irradiated foods.

UNIT –III

Food Biotechnology: Biotechnology in relation to food industry, Enzymes in foods and food industry, Nature and type of starters,Role of starters in Fermented foods, Fermentation of Milk products-Fermented soy and peanut milk, Fruit and cereal based beverages, Non beverage plant products. Mycoprotein production.

FOOD Additives and ANALYSIS: Sampling techniques and theory and practice of chemical and physical methods of food analysis for determination of food composition; Pigments in food, food flavours, food additives and toxicants. Natural sweeteners and artificial sweeteners and their role in controlling diseases and deficiencies, Nutraceuticals, and Functional Foods

UNIT –IV

FOOD PROCESSING: Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging.

FOOD QUALITY ASSURANCE: Objectives, importance and functions of quality control. Methods of quality, assessment of food materials-fruits, vegetables, cereals, dairy products, meat, poultry. Food regulations, grades and standards, Concept of Codex Almentarious/HACCP/USFDA/ISO 9000 series etc. Food laws and standards.

Text Books:

1 Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.

2 Food processing and Preservation PHI private ltd,New Delhi

3 Food Microbiology fourth edition William C.Frazier, Tata Mc Graw Hill

4 Food Microbiology 2nd Edition, Michael P.Doyle ,ASM press

Computational Biology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Software and hardware for interactive computer graphics; Implementation of device drivers; Line and circle drawing algorithms; 3-D transformation, windowing, clipping, perspective and input routines;

Unit – II

Data structure, hidden surface removal, hidden surface removal, color shading techniques; scaling, translation, rotation, reflection; viewing

Unit – III

Transformations; Programming practices with standard graphics libraries like open GL; Graphical display of molecules, background objects, dihedral;

Unit – IV

Retrieving and displaying biological structures; Comparing structure, homology modeling or protein structure; Digital images and image processing.

Semester- II

Recombinant DNA Technology & Cancer Biology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Basic tools of genetic engineering

Restriction endonucleases, DNA modifying enzymes, Vectors: plasmids, phage vectors, cosmids, phagemids, Yeast cloning vectors, Animal viruses, Ti plasmids and Cauliflower Mosaic Virus, yeast artificial chromosomes, bacterial artificial chromosome

Cloning and introduction of cloned genes into host cells

Cloning & Cloning strategies in yeast, *E. coli* and *B. subtilis*, PCR product cloning (TA cloning), construction and screening of genomic and cDNA library, Bacterial transformation, Introduction of DNA into eukaryotic (plant & animal) cell

Unit – II

Recombinant DNA techniques: Restriction analysis, Sequencing of protein and DNA, Molecular probes (production, labeling and uses), P.C.R., Blotting and hybridization techniques, mutagenesis, mRNA isolation and cDNA synthesis, DNA fingerprinting, RFLP, RAPD

Selection of rDNA clones and their expression products: Direct and indirect methods, Drug resistance, gene inactivation, DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting). Protein synthesis in mini and maxi cells, Genetic changes for overproduction of biomolecules such as insulin, interferons and growth hormones

Unit – III

Tailoring model plants and animals: Transfer of gene in animal oocyte, *in vivo* cloning of animals, gene transfer, gene therapy and transgenic animals, techniques and experiments involved in creating transgenic mice, homologous recombination knockout mice. Transgenic plants

Unit – IV

Applications of Recombinant DNA Technology: Laboratory, industrial and environmental applications, Nucleic acid sequence as diagnostic tools, DNA fingerprinting in consideration to clinical diagnosis & forensics, New drugs and therapies for genetic diseases.

Safety guidelines of rDNA research, containment facilities and its disposal.

Industrial Biotechnology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Basis and Development of Industrial fermentation Processes.

Screening, Detection and assay of Fermentation products, Stock Cultures, Fermentation Media, Inoculum Preparation.

Unit – II

Typical Fermentation Process:

Antibiotic Fermentation: Penicillin, Streptomycin

Anaerobic Fermentation: Acetone, Butanol Fermentation, Brewing, Industrial Alcohol Lactic Acid.

Unit – III

Environmental Control of Metabolic Pathways: Glycerol from Yeast, Glycerol from *Bacillus subtilis.*

Genetic Control of Metabolic Pathways: Indirect or Dual Fermentation, Direct Fermentation.

Unit – IV

Microbial Oxidative Transformation of substrate:

Vitamins & Growth Stimulates - Riboflavin, Vitamin A, Vitamin B_{12}, Gibberellins.

Enzymes as Fermentation Products: Amylases, Proteolytic enzymes, Pectinases, Invertases.

Organic Acid: Citric Acid, Fumaric Acid, Itaconic Acid, Kojie Acid & Bacterial gluconic & α-ketoglutanic Acid Fermentation.

Text Books:

1. Prescott & Dunn's
2. L.C. Casida

Environmental Biotechnology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Treatment of municipal wastes and industrial effluents (Physico-chemical, biological analysis of waste water), Rr. Sec and test waste water treatment sludge treatment and disposal treatment of wastes from paper, textile, dairy, petrochemical and pharmaceutical industry .

Unit – II

Bioremediation and phytoremediation of toxic compounds like pesticides, hydrocarbons, polymers, surfactants Renewable and non-renewable energy resources, clean fuel technology, biofuels.

Unit – III

Biofertilizers and biopesticides – a cleaner agricultural practice, concept of N2 - fixation, azolla, cyanobacteria, Rhizobium and VAM as biofertilizers.

Unit – IV

Bemoaning – microbe assisted microbial leaching, bioaccumulation and bio sorption

Biosensors and biomarkers for ecotoxicity measurement.

EIA and Environmental audit.

Enzyme Technology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Enzymes: Introduction and scope, Nomenclature, Mechanism of Catalysis, Industrial applications. Enzyme Kinetics: Single substrate steady state kinetics; King-Altman's method; Inhibitors and activators; Multisubstrate

Unit – II

Immobilization of Enzymes: Advantages, Carriers, adsorption, covalent coupling, cross-linking and entrapment methods, Micro-environmental effects

Systems; Effect of pH and temperature; Allosteric enzymes.

Unit – III

Enzyme Reactors: reactors for batch/continuous enzymatic processing, Choice of reactor type: idealized enzyme reactor systems; Mass Transfer in Enzyme Reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Unit – IV

Bio-process Design: Physical parameters, reactor operational stability; Immobilized cells.

Challenges and future trends: Enzyme catalysis in organic media; Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from Extreme Thermophilic and Hyperthermophilic Archaea and Bacteria. ; Application of enzyme: Industrial, Analytical and Medical.

Down Stream Processing

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Characteristics of biotechnology products. Overview of a bioprocess including upstream and downstream processing, Flocculation and conditioning of broth

Unit – II

Principles, operation, design and scale-up of the following:

Mechanical methods: Cell disintegration, separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and microfiltration.

Unit – III

Primary isolation methods including solvent extraction, aqueous two-phase extraction, sorption, precipitation, ultrafiltration.

Purification methods: Fractional precipitation, electrophoresis and various kinds of chromatographic methods based on size, charge, hydrophobic interactions, adsorption, and biological affinity.

Unit – IV

Membrane based separation: Dialysis, Electrodialysis, and Reverse osmosis Crystallization, Drying and Formulations

New and Emerging techniques: Pervaporation, Supercritical fluid extraction.

Drug Designing

Maximum Marks: 100 **Times Allowed:** 3 Hrs

Unit – I

Drug targets classification: DNA, RNA, post-translational, processing enzymes, metabolic enzymes involved in nucleic acid synthesis, Gproteincoupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane) proteins, ligand-gated ion channels (oligomeric transmembrane proteins), transporters (multi-transmembrane proteins);

Unit – II

Target discovery and validation strategies: Genomics (new target discovery), biological activity directed and other types of screening, natural products, combinatorial chemistry; General overview modeling methodologies, structure based drug, design, protein structure determination: X-ray, protein homology and alternative techniques

Structure-based design: 'de novo' design methodologies: indirect drug design, pharmacophore development and receptor mapping, 3Ddatabase searching techniques, new strategies and recent technologies in drug design.

Unit – III

Design and development of combinatorial libraries for new lead generation: The molecular diversity problem, drug characterization – principles of equilibria, diffusion and kinetics, preformulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physico-chemical properties calculation, chemiometrics in drug design.

Unit – IV

QSAR: Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development.

Instrumentation

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Ultracentrifugation: Viscosity and diffusion, Sedimentation equilibrium and sedimentation velocity methods, Analytical and Preparative centrifuges, application of density gradient and differential centrifugation.

Electrophoresis: Paper and gel electrophoresis, Immunoelectrophoresis, Isoelectric focussing, Two - dimensional electrophoresis, Capillary electrophoresis.

Unit – II

Chromatography: Paper, TLC gas chromatography, gel filtration, ion-exchange chromatography, affinity chromatography and HPLC, FPLC, adsorption and desorption

Spectroscopy: UV and visible Spectroscopy, Spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Mossbauer, MALDITOF, ORD and Circular Dichroism, Nuclear Magnetic Resonance and Electron Spin Resonance Spectroscopy, Magnetic Resonance Imaging.

Unit – III

Microscopy: Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Polarization and Fluorescence microscopy.

Diffraction techniques: X -Ray diffraction, Electron diffraction, Neutron Diffraction, Lasers and holography

Unit – IV

Radioisotope Techniques: Radio tracers, GM Counter, Proportional and Scintillation Counters, Autoradiography, Radio -immunoassay.

Cell disruption Techniques, Dialysis and Ultrafiltration.

Pharmaceutical Biotechnology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Introduction to Physical Pharmaceutics - Metrology and Calculations, Molecular structure, properties and States of Matter, Solutions, Phase Equilibra, Micromeritic and Powder Rheology, Surface and Interfacial Phenomena, Dispersion Systems, Diffusion & Dissolution, Kinetics and drug stability, Viscosity & Rheology

Unit – II

Polymer Science and Applications.

Formulations and Development, Packaging

Unit – III

Introduction to Industrial Processing, Transport Phenomena (Fluid Flow, Heat Transfer and Mass Transfer)

Particulate Technology (Particle Size, Size reduction, Size Separation, Powder Flow and Compaction)

Unit – IV

Unit Operations (Mixing, Evaporation, Filtration, Centrifugation, Extraction, Distillation, and Drying)

Materials of Pharmaceutical Plant Construction, Good Manufacturing Practice (GMP's) Guidelines

Semester-III

Immunology & Monoclonal Hybridization Technology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Phylogeny of Immune System, Innate and acquired immunity.

Cells and organ of immune system: Hematopoiesis and differentiation, lymphocyte trafficking, B-Lymphocytes, T -Lymphocytes, macrophages, dendritic cells, natural killer cell, activated killer cells, eosinophils, neutrophils and mast cells,

Unit – II

Nature and Biology of antigens and super antigens, antibody structure, types and function, molecular biology diversity, and regulation of antibody production, antibody engineering, complement system, idiotype network

Major Histocompatibilty: Complex, antigen processing and presentation, BCR and TCR, B cell and T cell BIOLOGY

Unit – III

Humoral and cell mediated immune responses, cytokines and their role in immune regulation, immunological Tolerance, Hypersensitivity.

Autoimmunity and AIDS, Tumor immunology, Immunity to infectious agents

Unit – IV

Tissue and organ transplantation, Vaccination and immunotoxin

Immunological Techniques: Immuno-diffusion, immunoelectrophoresis, ELISA, RIA, immunofluoresence, FACS, western blotting. HLA typing, complementation fixation

Production of monoclonal antibodies and their application.

Animal Biotechnology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

History of animal cell and organ culture, Requirements for animal cell, tissue and organ culture, Establishment of cell culture, types of cell lines Cultivation of animal cell *en masse* in bioreactor, methods for scale-up, immobilized cell culture, insect cell culture, somatic cell culture, organ culture, and embryo culture. Valuable products from cell culture, production of commercial products from insect culture, Production of recombinant tissue plasminogen activator, blood factor VIII, erythropoietin etc.

Unit – II

Hybridoma technology, Monoclonal antibodies- production and application, Stem cell technology and tissue engineering

Advanced Plant Cell technology: Introduction: Definition and technologies, Plant Cell & Tissue Culture Technologies: A brief description, technology and potential application of organ and meristem culture, anther/pollen culture, callus, suspension cultures and protoplast culture. **Unit – III**

Embryogenesis: Plant regeneration through meristem, callus cultures and somatic embryogenesis, production, preservation and use of somatic embryos as propagules; Artificial Seeds and Automation of Somatic Embryo Production: Principles, technology of automation and the application; Embryo Culture; Haploid Plant Production.

Cryopreservation: Storage of germplasm; Protoplast Culture; Somatic Hybridization, Induction & Utilization of Somatic Variants; Secondary Metabolite Production through cell cultures.

Unit – IV

Cell Cultures: Principles and the technology, pharmaceutical, pigments & beverage production; Commercialization of tissue culture technology: Concept of commercialization and the need, design of a tissue culture laboratory and its management. Plant cell reactors-types of reactors, Comparison of

reactor performances, Immobilized plant cell reactors, Novel design concepts Mutation, somaclonal variation, its genetic basis and application in crop improvement. Genetic engineering of plant cells. Molecular basis of DNA markers and their applications; Molecular marker maps, mapping; RAPD, RFLP.

Transgenic Technology

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Introduction to Transgenic Animal Technology, Transgenic Animal Production Focusing on the Mouse Model, DNA Microinjection and Transgenic Animal Production, Factors Affecting Transgenic Animal Production

Unit – II

Gene Targeting in Embryonic Stem Cells: History and Methodology, Stem Cells of the Embryo, Gene Targeting in Embryonic Stem Cells,
Gene Targeting in Embryonic Stem Cells: Conditional Technologies, Introduction, Conditional Modeling, Cre-loxP System Review, Development and Testing Cre-loxP and Transgenic Models
Retrovirus: Mediated Gene Transfer

Unit – III

Nuclear Transfer Technologies: Introduction and Discussion, Materials and Equipment, Preparation of Microtools, Nuclear Transfer of preimplantation Embryos, Nuclear Transfer of Embryonic Stem Cells and Somatic Cells. Production of Transgenic Laboratory and Domestic Animal Species,Production of Transgenic Rats, Rabbits, Fish, Frog & Poultry: Introduction, Importance of Rats, Contributions from Transgenic Rats. Nuclear Transfer Technology in Cattle, Sheep, and Swine

Unit – IV

Transgenic Plants; Transformation- Plant Transformatrion; Agrobacterium-Mediated Gene Transfer Production Hairy Root Cultures and Transgenic Plant

Regeneration: Organogenesis from Transformed Tomato Explants, Genetic Transformation of Conifers Utilizing Somatic Embryogenesis

Selectable Markers: Antibiotic and Herbicide Resistance, Histochemical and Fluor metric Assays.

Transgene integration, Expression, and Localization; Risk Assessment; Transgenic Crops

Genomics

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Genome evolution and phylogenetics: Origin of genomes, Acquisition of new genes, DNA sequencing – chemical and enzymatic methods, the origins of introns, DNA and RNA fingerprinting, the human genome

Structural Genomics: Technology, Data Bases (NCBI and Plant Databases), Sequence Comparison Techniques (BLAST etc.), Genome, Annotation

Comparative Genomics: Phylogeny, Synteny (comparison of grass genomes), COGS (Clusters of orthologous genes, NCBI web site), Metabolic Reconstruction, The Basic Principles and Methodology, Pathway

Functional Genomics: ESTs, Digital Northerns, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Micro array Chips, Cancer and genomic micro arrays, Examples for Application of Microarrays, Micro array Data Analysis; Gene finding tools

Unit – II

Genotyping Background and SNPs: SNPs II and TOGA, AFLP and RFLP analysis, Arabidopsis KO Strategies; Pharmacogenomics; Ethical considerations of genetic testing. Introduction to proteomics; protein function and expression; essential proteins; Protein function from structure; Rational drug design; Lethal mutants

Interaction networks: Yeast genome-wide interaction studies

Unit – III

Introduction to proteomics: How to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, Current concepts of co-immunoprecipitation for protein interaction analysis, chromatography, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF mass spectrometry and nanospray MS, Phage Display, Protein chips; Two-hybrid methods, Synthetic lethal screens, Proteome-wide interaction maps, TAP tags, GFP tags, Synthetic Lethal

Screens, Inteins and Protein Splicing for interaction analysis; Micro Arrays-Affimetrics and spotted array concepts

Protein Structure and Function: Structure function relationship Protein-protein interactions – Large molecular complexes – RNA polymerase II, ribosome; Unstructured

proteins – Current concepts and examples, the fly-casting mechanism; Current Degradation Concept, The N-end rule and PEST sequences, control of ubiquitination, the proteasome, SUMO Protein-protein interactions in health and disease; Molecular mechanisms in disease

Unit – IV

Posttranslational modifications – concepts of how protein function is rapidly and dynamically modulated through posttranslational modifications, how posttranslational modifications precede altered transcription levels. Structure determination – experimental and theoretical methods

Evolution and Design of Protein Function: Metabolic networks – Metabolic pathways, Metabolic regulation, Genome-Proteome Connection, DNA micro arrays and Analysis of metabolic control

IPR, Biosafty / Bioethics

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Concept of intellectual property overview of Intellectual property law and its origins, copy rights and related rights, Trade marks, Geographical indications, Industrial Designs, Patents and standards for patentability, protection of undisclosed information (Trade secrets).

Unit – II

IPR at National level international perspective of Intellectual property, ethical conflicts with IPR. Biopiracy Benefits sharing.

Unit – III

Biosafety Regulation bodies in National and International level

Biosafety laws, guidelines, protocols and conventions.

Unit – IV

Implications of laws and Regulations on the Biotechnology industry.

Ethical Implications of Biotechnology products and techniques

Pollution Protection Fundamentals

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Pollution Prevention in Industries: Environment friendly chemical processes-Properties and fates of environmental contaminants-Regulations for clean environment and implications for industries, Improved manufacturing operations.

Unit – II

Life cycle assessment and environmetal Audit: Life cycle assessment and pollution prevention econimics, Hazard and risk analysis, Pollution prevention planning, Design for the environment.

Conservetion of Materials and Energy: Water energy and reagent conservation, Residuals management, Economic Recovery and Recycling of wastes, Case studies.

Unit – III

Total quality environment management and Ems 14000: Muncipal pollution prevention programmes, environment Management system-14000-Systematic, Structured and Documented Response to Environmental Issues, Auditable and Time Targeted Environmental Improvement Programs.

Unit – IV

Hierarchy of Environment Management Practices: Waste-specific pollution prevention, waste pregeneration focus on minimization/ recycling, Waste-specific post-release-to environment forcus: recycling/ remediation.

Biotechnology & Management

Maximum Marks: 100 **Times Allowed: 3 Hrs**

Unit – I

Hazards: Chemical hazards classification. Radiation hazards and control of exposure to radiation. Types of fire and fire prevention methods. Mechanical hazards. Electrical hazards

Psychology and Hygiene: Industrial psychology Industrial hygiene. Safety in plant site selection and plant layout. Industrial lighting and ventilation. Industrial noise.

Unit – II

Occupational diseases and control: Occupational diseases and prevention methods. Safe housekeeping Instrumentation for safe operation. Personal protective equipments. Safety in chemical operations and processes.

Unit – III

Management: Safety organization – safety committee – safety education and training. Management process. Philosophy and need for Industrial safety. Role of Government in Industrial safety.

Unit – IV

Psychology and Hygiene: Industrial psychology Industrial hygiene. Safety in plant site selection and plant layout. Industrial lighting and ventilation. Industrial noise.

Laws: Factory Act. ESI Act, Environmental Act. Workment - comperation Act. Advantages of adopting safety laws.

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M.Sc. in Biotechnology

Course Structure

Semester – I

S. No.	Code	Name of Subject	
1	M.Sc.BT.111	Biomolecules	
2	M.Sc.BT.121	Enzyme Technology	
3	M.Sc.BT.131	Immunology	
4	M.Sc.BT.141	Instrumentation	
5	Practical		

Semester – II

S. No.	Code	Name of Subject	
1	M.Sc.BT.112	Genetic Engineering	
2	M.Sc.BT.122	Molecular Genetics	
3	M.Sc.BT.132	Environmental Biotechnology	
4	M.Sc.BT.142	Bioprocess & Biochemical Engineering	
5	Practical		

Semester – III

S. No.	Code	Name of Subject	
1	M.Sc.BT.113	Molecular Biology	
2	M.Sc.BT.123	Biostatics	
3	M.Sc.BT.133	Applied Biotechnology	
4	M.Sc.BT.143	Bioinformatics & Computer Application	
5	Practical		

Semester – IV

S. No.	Code	Name of Subject	
1	M.Sc.BT.114	Plant Biotechnology	
2	M.Sc.BT.124	Animal Biotechnology	
3	M.Sc.BT.134	Virology	
4	M.Sc.BT.144	Project And Training	

Biomolecules

Principles of thermodynamics, first and second law, concept of free energy high energy compounds, Amino acids and peptides- classification, chemical reactions and physical properties.

Proteins-classification, heirarchy in structure, Ramachandran map. Protein sequencing, Glyco and lipoproteins-structure and function. Sugars-Classification and reactions, Polysaccharides-types, structural features, methods for compositional analysis.

Lipids-Classification, structure and functions, glycero phospholopids, sphignolopids, cholesterol and its biosynthesis. Polynucleotides: biosynthesis of purines and pyrimidines, de novo and salvage pathway.

Secondary metabolities inliving systems:Alkaloids,Steroids and Flavonoids.Macromolecules and super molecular assembilies-like membranes,ribosomes,chromosomes.

Yogesh kumar jangir choyal

Enzyme Technology

Introduction to Enzymes: Enzyme nomenclature, enzyme commission numbers, and classification of enzymes. Enzyme activity, Specific activity and turn over number, Marker enzymes.

Enzyme Kinetics: Steady state, pre-steady state, equilibrium kinetics, Michaelis and Menten Equation and its derivation, Different methods to calculate the K_m and V_{max} and their significance.

Factor affecting enzyme activity and catalysis: pH, subsrate and enzyme concentration, Temperature, coenzyme and cofactors, Mechanism of action of enzymes involving two/more substrates. Role of metal ions in enzyme catalysis. Enzyme inhibition, different types of inhibitors & activators.

Structure and function of enzymes: Lysozyme, chymotrypsin, DNA polymerase, RNase, proteases. Enzyme regulation and control of their activity. Introduction to allosteric enzymes and isozymes.

Enzyme Technology: Immobilization of enzymes and their application, commercial production of enzymes, Isolation and purification of Enzyme, Preparation of purification chart, RNA-catalysis, Catalytic antibodies-abzymes, Protein and Enzyme engineering: Design and construction of novel enzymes.

Immunology

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phaagocytic barriers, Inflammation, Adaptic immunity.

Cells and Organs of Immune System: Lymphoid cells; stem cells, B and T Lymphocytes, Natural killer cells, Mononuclear phagocytes, Granulocytic cells.

Organs: Thymus, Bone Marrow, Lymphatic system, Lymph nodes, Spleen.

Antigens and Antibodies:-Antigens: Structure, properites, types, Epitopes, Haptens. Antibodies: Structure and function, Antibody mediated functions, Antibody classes and biological activies, Monoclonal Antibodies.

Antigen-Antibody Interaction:-Precipitation reaction, Agglutination, Radioimmunoassay, ELISA, Western Blotting, Major Histocimpatibility Complex, General structure and function of MHC, MHC Molecules and Genes, Antigen Processing and presentation, T-Cell Receptors T-Cell Maturation and Differentiation, B-Cell Generation, Activation & Differentiation.

Immune Effecter Mechanism - Cytokinesis (Properties, receptors, antagonisis & secretion) The complement system (functions, components, activation, regulation and deficiencies) Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity, Inflammation, Hypersensitive reactions (Type I,II,III and delayed type (DTH)

Immunology in Health & Disease-Immune response to infectious disceases: viral, bacterial and protozon, Vaccines, AIDS and other Immuno deficiencies, Genetically designed vaccines. BCG, TB & Leprosy, DNA vaccines.

Transplantation and Autoimmunity-Organ specific autoimmune diseases, Systemic autoimmune diseases, Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigens. Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

INSTRUMENTATION & ITS BIOLOGICAL APPLICATION

Spectroscopy: interaction of radiation with matter, absorption of radiation, emision of radiation, Beer-Lambert relationship components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, Fluorimetric methods, atomic absorption spectroscopy techniques, flame emission photometry, magnetic resonance spectroscopy, Applications of different spectroscopic techniques.

Separation methods: principles of separation techniques, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC, ELISA. Applications of chromatographic techniques in biology.

Membrane filtration and dialysis, electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis. Isoelectric focussing, isotachophoresis, capillary electrophoresis, elution parameters, immunoelectrophoresis, Applications of electrophoresis in biology.

Centrifugation: Preparative and analytical centrifuges, sedimentation analysis, RCF, zonal and equilibrium density gradients, Ultracentrifuge.

Microscopy: light, phase-contrast, fluorescence and electron microscopy.

Radioisotopes: nature of radioactivity, types of radioactivity, radioactive decay, units of radioactivity.

Detection and measurement of radioactivity. Geiger counters, scintillation counters, autoradiography.

Semester – II

Genetic Engineering

Introduction: Historical background, Restriction enzymes and modifying enzymes, Restriction mapping, Construction of chimaeric DNA- staggered cleavage, Addition of poly dA and dT tails, Blunt end ligation, Gene cloning.

Cloning and Expression Vectors: Vehicles for gene cloning, Plasmids, Bacteriophages, Cosmids and Phagemids as vectors, P1 vectors, F- factor based vectors, Plant and animal viruses as vector, Artificial chromosomes as vectors (YAC, BAC, PAC and MAC vectors), Expression vactors- use of promoters and expression cassettes, Bacculoviruses as expression vectors, Virus expression vectors, Binary and shuttle vectors.

Isolation Sequencing and Synthesis of Genes: Methods of gene isolation, Construction and screening of genomic and cDNA libraries, Chromosome walking, Chromosome jumping, Transposone tagging, Map based cloning, DNA sequencing Techniques (Maxam Gilbert's chemical degradation methods and Sanger's dideoxy chain termination method), Automated DNA sequencing, and Organochernical gene synthesis.

Molecular Probes and PCR: Molecular probes, Labeling of probes, Radioactive vs. Non radioactive labeling, Uses of molecular probes. Polymerase Chain Reaction- basic principle, Modified PCR (Inverse PCR, Anchored PCR, PCR for mutagenesis, asymmetric PCR, RTPCR,

PCR walking), Gene cloning Vs. Polymerase chain reaction; Applications of PCR in biotechnology, Ligase chain reaction.

Molecular Markers and DNA Chip Technology: Molecular-Markers-types and applications, Construction of molecular maps (genetic and physical maps), DNA chip Technology & Microarrays (a Brief account).

Genomics and Proteomics: Whole genome sequencing and functional genomics (a brief account), Applications of genomics and Proteomics with special reference to *Arabidopsis* and Rice.

Molecular Genetics

History, Scope of genetics, Mendelian law of inheritance, Variations of mendelian analysis, Linkage and crossing over, Linkage mapping, Sex determination and Sex linked inheritance, Gene Mapping.

Microbial Genetics: gene transfer mechanism in microbe- transformation, transduction, conjugation and recombination, Horizontal gene transfer, genetics of model organism- Neurospora, Yeast and *E.coli*.

Mutation: Types of mutation, molecular mechanism of mutation, chromosomal mutations changes-changes in the structure and number of chromosomes, polyploidy, types of DNA repair.

Gene concept: Classical concept, fine structure of gene, molecular concept of the gene, transposons. Pseudo genes, overlapping gene, oncogene, repeated gene, gene amplification, Gene interaction, Genetic disorder and disease- Cystic fibrosis, Sickel cell anemia, Alzheimer's disease etc., Gene therapy. Lytic and Lysogenic cycles, IS, and Tn elements in bacteria, Bacterial plasmids, gene regulation during development, *E coil* recombination system.

ENVIRONMENTAL BIOTECHNOLOGY

Environment-basic concepts and issues; Water: Natural (scarce)resource and its management, Sources of water pollution and biological treatment processes and their microbiology: Aerobic Processes-Oxidation ponds, rotating discs, rotating drums; Anaerobic processes-Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors.

Microbiology of degradation of xenobiotics in Environment-Ecological hydrocarbons, oil pollution, surfactants,pesticides.

Solid wastes: Sources and management(composting, wormiculture and methane production), bioremediation of contaminated soils and waste-land; Biopesticides in integrated pest management.

Global environmental problems: UV-B and Ozone depletion, Green house effect and acid rain, their effects and biotechnological approaches for management. Methodology of environmental management-the problem solving approach, its limitations.

BIOPROCESS & BIOCHEMICAL ENGINEERING

Introduction to Bioprocess Engineering, Classification of Bioreactor types, specialized bioreactors(pulsed, fluidised, photobioreactors etc).

Isolation preservation and maintenance of industrial microrganisms, media for industrial fermentation, Air and media sterilization.

Types of Fermentation processes: Analysis of batch, fed batch and continuous bioreactions, stability of micrkobial reactors, analysis of mixed microbial populations.

Measurement and control of bioprocess parameters, Downstream processing: Introduction, Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, Drying and crystallization.

Whole Cell immobilization and their industrial Applications.

Industrial Production of chemicals utilizing wastes: Alcohol(ethanol)Acids(citric, acetic and gluconic),solvents(glycerol, acetone, butand), antibiotics(Penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid),Single Cell Protein.

Use of microbes in mineral beneficiation and oil recovery.

Introduction to food Technology, Principles of food processing, Elementary idea of canning and packing, sterilization and pasteurization of Food Products, Food Preservation.

Semester – III

MOLECULAR BIOLOGY

Introduction to Molecular Biology and Genetic.DNA Replication. Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and accessory proteins involved in DNA replication.DNA Repair and Recombination.

Transcription-Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and machanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing. Mdifications in RNA.5'Cap formation,Transcription,3'-end processing and polydenylation, splicing, Editing, Nuclear export of mRNA, m-RNA stability.

Translation-Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins. Protein Localization. Synthesis of Secretory and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxismes, Receptor mediated endocytosis.

Oncogenes and Tumor Suppressor Genes-Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

Antisense and Ribozyme Technology-Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disrption of RNA structure and capping, Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for disigning ribozymes, Applications of antisense and ribozyme technology.

Homologous Recombination-Holiday junction, gene targeting, genedisruption, FLP/FRT and

Cre/Lox recombination, Rec A and other recombinases.

Molecular Mapping of Genome-Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization in genome analysis: RELP,RAPD and AFLP analysis, Molecular marker linked to diseased resistance genes, Application of RFLP in forensic, diseases prognosis, genetic counselling, and Pedigree, varietal etc. Animal trafficking and poaching; Germplasm maintenance, taxonomy and bio-diversity.

Biostatistics

Importance and scope in biological experiments; Elements of Probability - Mathematical, Statistical and Axiomatic Definitions; Addition and multiplication. Therorems; Probability Distribution Function-Binomial, Poisson and Normal; Area under Normal Probability Distribution Curve.

Measures of Central Tendency - Arithmetic, Geometric and Harmonic Means; Measures of Dispersion - Range, Quartile Deviation, Variance, Standard Deviation, Coefficient of Variation; Confidence Limits of population Mean; Tests of Significance- Hypotheses and Errors; Student t test-Population mean equals a postulated value, Equality of 2 independent population means (Equal and Unequal Variances), Equality of 2 dependent means of a population.

Analysis of Variance-One way classification with equal and unequal sample sizes, Two way classification with one observation per cell, Completely Randomized Design, Randomized Block

Design; Multiple Comparison-Isd and Duncan's New Multiple Range test; Introducation to 2^ Factorial Design.

Relation between two variable; Linear Regression - Regression diagram and equation, significance test, prediction of dependent variable from the independent one; Linear Correlation - Scatter diagrams, correlation coefficient standard error, significance tests: Relationship between Correlation and Regression coefficients; Chi-square tests for goodness of fit, tests for association between attributes, Yate's Correction factor; Analysis of Covariance (One way classification)

Applied Biotechnology

Industrial Biotechnology: Microbial strain of industrial importance, microbial production of antibiotics (penicillin , streptomycin & tetracycline),Vitamins (Vit B12), amino acids (glutamic acid) & enzymes (amylase, protease, invertase & pectinase), microbial production of alcoholic beverages (whisky & brandy), vinegar, citric acid, acetic acid, glycerol, acetone, foods–SCP, Biotransformation of steroids and pesticides.

Agricultural Biotechnology: Role of biofertilizers and biopesticides in sustainable development, petrocrops, aquaculture, Improvement of nutritional value of seed storage protein,

starch, oil. Transgenic plants for increased shelf life molecular mapping of genes of agricultural importance, sericulture, transgenic fish Plant Variety Protection Act, Plant breeders rights, International Convention on biological diversity.

Food Biotechnology: Prokaryotic & Eukaryotic based products (fermented meats, milk products , yoghurt, cheese, cereal, wine, beer), Impact of biotechnology on microbial testing of food, current/traditional methodology and new approaches (use of gene probes, RDT, Bioluminescence), Safety evaluation of genetically engineered enzyme/novel food products, Natural Control of Micro Organism and preservation, Biogums, Bio-colours Fumaric acid, sweetener, fat substitutes, natural & modified starch, fats & oils food.

Frontiers in Biotechnology: Stem Cell Technology, Human Cloning Ethical issues & risks associated with it, Nano biotechnology:– Introduction to nanoscience, size matter, tools for measuring nanostructure Biosencer development and application, Nanofabrication, Nanotech impact on types of DNA chips & their production, SNP and genome mismatch signals, functional proteomics – RT PCR Human Genome Project , Bioterrorism.

Bioinformatics and Computer Application

Introduction of Bioinformatics: The nature of chemical bonds, Introduction to Genes and Proteins, Nucleotides, Orientation, Base pairing, The central dogma, Promoter sequences, Genetic Code, ORFs, Introns and Exons, Slice variants, Protein structure, Primary, Secondary, Tertiary and Quaternary, The notation of homology. Introduction to Data Generating Techniques: Restriction Enzymes, Gel Electrophoresis, Blotting and Hybridization, Cloning, PCR. Biological databases, Search engines, Public databases: PubMED, EMBL, GenBanK, PDB, Swiss-Port. Genomics and Proteomics: Prokaryotic genomes, Eukaryotic Genomes, Gene Structure, GC Content in Eukaryotic genomes, Gene Expression, Protein Classification, 2D–Electrophoresis, Mass spectrometry, Microarray technology, X–ray crystallography, NMR, Sequence and Phylogeny Analysis, Detecting ORFs, Outline of sequence alignment, Introduction to BLAST, Multiple sequence alignment, Phylogenetic analysis.

Introduction to computer fundamental, Organization, low- Level and high-level languages, Permanent storage of number system, flow charts and programming techniques (Logic and algorithm) Decimal to binary and vice-versa; binary coded decimal number.

Introduction to MS-Office software covering word-processing, spreadsheets and presentation software. Introduction to Hardware graphics/ Corel draw.

Application of computer in Biostatistical problems. Frequently table of single discrete viable, bubble sort, computation of mean, variance and standard deviation, t-test, correlation coefficient.

Computer in biology: Sequence databases; sequence analysis of proteins and nucleic acids, structure prediction, simple molecular modeling, computer aided drug designing.

PLANT BIOTECHNOLOGY

Plant tissue culture: Cleaning, sterilization, sterile handling of tissue culture of plant. Nutritional requirement for in vitro culture. Concept of cellular totipotency, single cell culture, micro propagation, somoclonal variation and its application for plant improvement, somatic embryogenesis, anther and ovule culture, haploid and double-haploid production.

Protoplast culture: Isolation ,fusion and culture, somatic hybridization, selection system for hybrids , cybrid production and their application in crop improvement, cryobiology of plant cell culture and establishment of gene banks, production of virus free plants using meristem culture.

Plant cloning vectors: Ti and Ri plasmid and viral vectors (CaMV based vectors, Gemini virus, TMV based vectors). Mechanism of DNA transfer, role of virulence genes, use of 35S promoters, genetic markers, use of reporter genes, methods of nuclear transfer, particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing , herbicide , insect and salt resistance , Plant DNA fingerprinting - Hybridization and PCR based markers (RFLP, SSRs, RAPD, QTLS , SCARS , AFLP etc.)

Transgenic plants:-commercial status and public acceptance, Bio-safety guidelines for research involving GMO's, benefits and risks. Socio economic impact and ecological consideration of GMO's, Gene flow, IPR and IPP. Patenting of biological.

ANIMAL BIOTECHNOLOGY

Structure and organization of animal cell,Cell physiology.Equipments and materials for animal cell sulture technology.Primary and established cell line cultures.

Introduction to the balance salt solutions and simple growth medium.Brief discussion on the chemical,physical and metabolic functions of different constituents of culture medium.Role of carbon dioxide.Role of serum and supplements.

Serum & protein free defined media and their application.measurement of viability and cytotoxicity.Biology and characterization of cultured cells,measuring parameters of growth.

Basic techniques of mammalian cell culture in vitro;disaggregation of tissue and primary culture;maintenance of cell culture;cell separation.Scaling-up of animal cell culture,Cell synchronization.

Cell cloning,micromanipulation and types of cloning.Cell transformation.Application of animal

cell culture.

Stem cell culture,embryonic stem cells and their applications.Cell culture based vaccines.Somatic cell genetics.

Organ and histotypic cultures.Measurement of cell death.
Apoptosis.Three dimensional culture and tissue engineering.

Virology

Brief outline on discovery of viruses, nomenclature and classification of viruses(LHT system; Classification as per VII report of the international committee on taxonomy of viruses),distinctive properties of viruses; morphology and ultrastructure; capsids and their arrangements; envelopes and their compsition; viral genome, their types and structure; virus related agents(viroids, prions),Bacteriophage-structural organization; replication, one step growth curve; eclipse phase; phage production; burst sizw; lysogenic cycle brief details of X 174,t7,t4 M13,Mu,Lambda and PI.

Cultivation of viruses in embryonated eggs, experimental animals and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; assay of viruses-physical and chemical methods (Protein, nucleic acid, electron microscopy),brief account of assay of viruses using serological techniques. Infectivity assay (plaque method, end point method).

Effects of viruses on plants; appearance of plants; histogy, physiology and cytology of plants; common virus diseases of plants; paddy, tomato and sugarcane; viruses of cyanobnacteria, algae, fungi, replication of plant viruses; type species of plant viruses like TMV, Cauliflower mosaic virus and potato virus X; transimission of plant viruses with vectors(insects, nematodes, fungi)and without vectors(contact, seed and pollens).Brief account of diagnostic techniques in plants;infectivity assay of plant viruses, indicator plants, isolation and purification of plant viruses, serological methods, histochemical tests. Prevention of crop loss due to virus infection-virus-free planting material; vector control.

Animal and human viruses-epidemiology replication, pathogenicity, diagnosis prevention and treatment of RNA Viruses, Picorna, Orthomyxo, Parmyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40;Hepatitis viruses. Viral vaccines(conventional vaccines, genetic recombinant vaccines used in national immunmization programmes with examples) interferons, and antiviral drugs.

Project & Training

Dissertation.The Project work will involve in depth practical work on a problem suggessted by the supervisor of the candidate.The student will submit the dissertation of the work done.The dissertation submitted by the candidate shall be evaluated by one external expert,head of the department and supervisor of the candidate.The seminars, in-plant training and industrial visit reports will also be submitted by the candidate to the Head of the Department who will submit these to the external examiner.The examination shall be held in the department and the

disertation etc.will NOT be required to be mailed to the external examiner.The distribution of the marks will be as under.

Disertation	100 marks
Viva Voce	50 marks
Seminar reports	25 marks
Industry visit report	25 marks
Total	200 marks

M.SC. Botany

Semester – I

S. No.	Code	Name of Subject	
1	BOM101	Phycology	
2	BOM102	Mycology	
3	BOM103	Microbiology	
4	BOM104	Taxonomy of Angiosperms	
5	BOM105	Biofertilizer	
5		Practical	

Semester – II

S. No.	Code	Name of Subject	
1	BOM201	Plant Ecology	
2	BOM202	Bryophytes, Pteridophytes and Gymnosperms	
3	BOM203	Cytogenetics and Plant Breeding	
4	BOM204	Plant Physiology	
5	BOM205	Herbal Medicine	
		Practical	

Semester – III

S. No.	Code	Name of Subject	
1	BOM301	Plant Biochemistry and Biotechnology	
2	BOM302	Cell and Molecular Biology	
3	BOM303	Environmental Management, Computer Application and Biostatistics	
4	BOM304	Biochemical and Molecular Techniques, and	
5	BOM305	Bioinformatics	
		Practical	

Semester – IV

S. No.	Code	Name of Subject	
1	BOM401	Air Pollution and Climate Change	
2	BOM402	Photobiology and Molecular Biology of Cyanobacteria	
3	BOM403	Plant Cell and Tissue Culture	
4	BOM404	Water Pollution Management	
5		Practical	

SEMESTER I

BOM101: Phycology

1. Principles, criteria (pigments, flagellation, food reserve and eye spots) and systems of classification
2. Cyanophyta: cell structure, heterocyst and akinete development, chromatic adaptation, thallus organization and reproduction
3. A brief account of thallus organization and reproduction in Chlorophyta, Phaeophyta and Rhodophyta; alternation of generation in Phaeophyta and post -fertilization development and site of meiosis in Rhodophyta
4. A brief account of Xanthophyta, Chrysophyta, Bacillariophyta, Pyrrophyta, Euglenophyta, Eustigmatophyta, Prasinophyta and Prochlorophyta
5. Algae in diverse habitats, algal blooms and Phycoviruses
6. Algae as food, biofertilizers and source of phycocolloids

BOM102: Mycology

1. Introduction, scope and general principles of classification of fungi

2. Myxomycotina: Plasmodiophorales

3. Mastigomycotina: Chytridiales, Blastocladiales, Saprolegniales and Peronosporales

4. Zygomycotina:Mucorales and Entomophthorales

5. Ascomycotina: Endomycetales, Protomycetales, Taphrinales, Erysiphales, Eurotiales, Sphaeriales,Helotiales, Phacidiales and Pezizales

6. Basidiomycotina: Uredinales, Ustilaginales, Lycoperdales, Nidulariales, Sclerodermatales, Phallales,Agaricales, Aphyllophorales, Tremellales and Auriculariales

7. Deuteromycotina: Sphaeropsidales, Melanconiales, Moniliales and Mycelia sterilia

8. Lichens: Thallus structure, reproduction and economic importance

BOM103: Microbiology

1. Introduction: A brief idea of microbial diversity; present status and future challenges; a general account of Archaea

2. Nutritional types of microorganisms, Rhizobium-legume symbiosis and mycorrhiza

3. Anoxygenic photosynthesis with special reference to light reaction in purple bacteria; methanogenesis

4. Genetics of bacteria: Genetic recombination- an overview; mechanisms of transformation, conjugation and transduction in bacteria; role of microorganisms in genetic engineering

5. Lytic cycle in T even phages and its regulation; lysogeny and its regulation in lambda phage; a brief account of viroids and prions

6. Water-borne pathogenic microbes; role of microbes in wastewater treatment with special reference to activated sludge

7. Basic design of a fermentor; biosensors; bioremediation of hydrocarbon and metal polluted waters

BOM104: Angiosperms

1. Systematics: Outline of classification of Angiosperms; Hutchinson, Takhtajan, Cronquist, merits and demerits
2. Botanical nomenclature: International code of Botanic Nomenclature; principles: Rules and recommendations; priority; typification; Rules of effective and valid publications; retention and choice of names
3. Taxonomic featues, systematic phylogeny and economic importance of families: Magnoliaceae, Capparidaceae, Combretaceae, Rosaceae, Asteraceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Orchidacae, Zingiberaceae, Araceae, Cyperaceae and Poaceae
4. Numerical taxonomy: Aims and objectives, characters and attributes, OTUs, coding, cluster analysis, merits and demerits
5. Chemotaxonomy: Role of phytochemicals (non-protein amino acids, alkaloids, betalins, cynogenic glucosides, silica, gypsum, raphides, glucosinolate, flavonoids, terpenoids) in taxonomy
6. Biosystematics: concepts; biosystematic categories; methods in experimental taxonomy
7. Embryology in relation to taxonomy
8. Molecular approaches to plant taxonomy: Application of DNA markers in angiosperm taxonomy; molecular phylogeny
9. Self incompatibility: Structural and biochemical aspects; methods to overcome incompatibility – mixed pollination, bud pollination; intra -ovarian pollination, in vitro pollination
10. Experimental embryology: Haploid production; diploidization of haploids, importance of haploids; embyro culture; culture of differentiated and mature embryos; role of natural plant extracts and growth hormones; embryo-nurse endosperm transplantation; culturing of embryonal segments; practical aspects of embryo culture

BOM105M: Biofertilizer Technology

1. Biofertilizers: Definition and types, importance of biofertlizers in agriculture
2. Characteristics of biofertilizers: Rhizobium, Azotobactor, Azospirillum, Phosphate-solubilizing microorganisms, cyanobacteria, Azolla, Mycorrhizae
3. Symbiosis: Physiology, biochemistry and molecular genetics of symbiosis
4. Enzymes and their regulation: Nitrogenase, hydrogenase
5. Production technology: Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers
6. Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings
7. Extension, promotion and marketing: Extension strategies, diagnosis for the effectiveness of inoculation, improvement in distribution system

SEMESTER II

BOM201: Plant Ecology

1. Population concepts: Characteristics, dynamics and control
2. Vegetation organization and characteristics: Concepts of community and continuum; community coefficients, interspecific associations, ordination; ecological niche; species diversity (α, β, γ)
3. Ecological succession: Models and mechanisms of ecological succession; changes in ecosystem properties during succession

4. Ecosystem organization: Structure and functions; primary production (methods of measurement,global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways,ecological efficiencies); decomposition (mechanism, controlling factors); ecosystem nutrient cycles

5. Ecosystem stability: Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion

6. Biological diversity: Concept and levels; distribution and global patterns; terrestrial biodiversity hot spots; role of biodiversity in ecosystem functions; IUCN categories of threat; inventory;conservation, protected area network.

7. Environmental pollution: Kinds, sources, effects on plants and ecosystems

8. Global change: Greenhouse gases, consequences of climate change; ozone layer depletion, causes and consequences

BOM202: Bryophytes, Pteridophytes and Gymnosperms

Bryophytes:

1. Classification of Bryophytes

2. Comparative account of gametophyte structure

3. Sporophytic structure and evolution; Peristome structure and its significance in the

classification of Mosses

4. Economic importance of Bryophytes

Pteridophytes:

1. Classification of Pteridophytes

2. Early vascular plants: Rhyniophyta, Trimerophytophyta and Zosterophylophyta

3. Brief account of the range of structure and reproduction in Ferns

4. Telome concept, apogamy and apospory, heterospory and seed habit

5. Economic importance of Pteridophytes

Gymnosperms:

1. Classification of Gymnosperms

2. Kinds of fossils, process of fossilization

3. General account of Glossopteridaceae

4. Comparative study of Coniferales (Pinaceae, Cupressaceae, Araucariaceae, Podocarpaceae, Cephalotaxaceae, Taxodiaceae), Taxales and Gnetales (Gnetaceae, Ephedraceae and Welwitschiaceae)

5. Economic importance of Gymnosperms

BOM203: Cytogenetics and Plant Breeding

1. Chromatin organization and replication: Chemical constituents- DNA and histones, nucleosome and higher order organization, DNA packaging and genetic activity, nucleosome assembly and deassembly

2. Cytogenetics of haploids: Haploidy/monopolidy, meiosis and breeding behaviour of haploids, uses of haploids in plant breeding and genetic studies

3. Aneu- and euploids: Induction and characterization of monosomics, trisomics and nullisomics, aneupolid gene mapping, inheritance pattern in autopolyploids, status of allopolyploids in plant evolution

4. Chromosome banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics 5. Organization of eukaryotic genetic material: Nuclear DNA and C-value paradox, DNA content

and adaptability, repetitive DNA, split genes, overlapping genes

6. Plant breeding and crop improvement: Objectives and scope of plant breeding, hybridization in self- and cross-pollinated crops, genetic basis of inbreeding depression and heterosis, breeding for disease and insect resistance, transgenes and transgenic plants

7. Alien gene transfer through chromosome: Transfer of gene through individual chromosome, characterization and utility of alien addition and substitution lines

8. Physical and genetic mapping using molecular markers

BOM204: Plant Physiology

1. Water relations: Properties of water, water in tissues and cells, measurement of cellular water

2. Transport of water and solutes: Uptake of water, comparison of xylem and phloem transports, phloem loading and unloading, passive and active transports, soil-plant-atmosphere continuum

3. Photosynthesis: Basic principles of light absorption, excitation energy transfer, electron transport, proton electrochemical potential, evolution of photosynthetic processes, photosynthetic quantum yield and energy conversion efficiency and photorespiration

4. Physiological responses to abiotic stresses: Light, temperature, water and salts; acclimation of physiological processes under abiotic stresses

5. Sensory photobiology: History, discovery of phytochromes and cryptochromes and their photochemical and biochemical properties, photophysiology of light induced repsonses Cellular localisation, molecular mechanism of action of photomorphogenetic receptors, signalling and gene expression

6. Plant growth regulators: Physiological effects and mechanism of action of plant growth hormones, hormone receptors, signal transduction and gene expression

7. The flowering process: Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development

BOM205M: Herbal Medicine

1. Medicinal plant research scenario in India
2. Diagnostic features, bioactive molecules and therapeutic value of some common medicinal plants
3. Standardisation of herbal drugs
4. Commercial cultivation of medicinal plants
5. Conservation of medicinal plants
6. Neutraceuticals and medicinal food
7. Bioprospecting, biopiracy and protection of traditional medicinal knowledge (IPR)

SEMESTER III

BOM301: Plant Biochemistry and Biotechnology

1. Energetics of metabolic processes: Energy rich phosphate compounds, electron transport and phosphorylation, β -oxidation of lipids

2. Enzymology: General aspects, prosthetic groups and coenzymes, mechanism of catalysis, kinetics, Michaelis-Menten equation, bisubstrate reactions, active sites, factors contributing to the catalytic efficiency, enzyme inhibition, regulatory enzymes, ribozymes

3. Biological nitrogen fixation: Nitrogenase enzyme, substrates for nitrogenase, reaction mechanism, strategies to exclude oxygen and need to control hydrogen evolution

4. Inorganic nitrogen and sulphur metabolism: Introduction, nitrate transport, nitrate and nitrite reductase, inhibitors of nitrate and nitrite reductases, localization and regulation of nitrate and nitrite reductases,

sulphate uptake, activation and transfer, assimilatory pathways of sulphate reduction

5. Biosynthesis of proteins: Transcription and translation, regulation of protein and enzyme synthesis (lac operon)

6. Plant cell and tissue culture: Concept of cellular differentiation and totipotency, clonal propagation, artificial seeds, somaclones, production of secondary metabolites/natural products, cryopreservation and germplasm storage

7. Recombinant DNA technology: Gene transfer

8. Basic concept of genomics and proteomics

BOM302: Cell and Molecular Biology

1. Cell: Concept, structural organization of plant cell

2. Mitochondria: Structure, genome organization, protein import and mitochondrial assembly

3. Chloroplast: Structure, genome organization, import and sorting of chloroplast proteins

4. Endoplasmic reticulum: Structure, translocation of secretory proteins across ER membrane, insertion of protein into ER membrane, protein folding and processing

5. Golgi apparatus: Organization, protein glycosylation, protein sorting and export from Golgi, the vesicular transport mechanism

6. Nucleus: Nuclear envelope, nuclear pore complex, trafficking between nucleus and cytoplasm .

7. Gene and genome: Fine structure of gene, genome organization

8. DNA/gene manipulating enzymes: Endonuclease, exonulcease, ligase, polymerase, phosphatase,
transcriptase, transferase, topoisomerase

9. DNA replication: Various models, speed of replication, collaboration of proteins, process and termination of replication

10. DNA damage and repair: Thymine dimer, 6-4 photoproducts, photoreactivation, excision repair

11. Genetic recombination: Holliday, Potter & Dressler, Meselson and Radding and Szostak model of
genetic recombination

12. Gene cloning: Cloning vectors, molecular cloning and construction of DNA libraries

13. Mobile genetic elements: Insertion elements, transposons

BOM303: Environmental Management, Computer Application and Biostatistics

1. Introduction and scope of environmental management

2. Basic concepts of sustainable development

3. Environmental impact assessment (EIA), general guidelines for the preparation of environmental
impact statement

4. Scope and types of environmental audit, energy audit, cost benefit analysis

5. Environmental management plan, ISO 14000 standards and certification

6. Environmental risk management and environmental safety norms

7. International summits and treaties related with environment

Computer Application

1. Basic concepts of computer hardware

2. Operating systems-Windows, Unix and Linux

3. Use of common application software in biology: word processing, spreadsheets, graphics and database

4. Introduction to web browsing software and search engines with special reference to online bioscience resources

Biostatistics

1. General concepts and terminology

2. Sampling methods

3. Measures of location, scale and shape

4. Contingency tables and chi-square test

5. Comparison of means: t-test, multiple range tests

6. Simple experimental design and analysis of variance

7. Correlation and regression analysis

8. Introduction to multivariate methods

BOM304: Biochemical and Molecular Techniques, and Bioinformatics

1. Electrophoresis: Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis, native PAGE, SDS-PAGE, 2D electrophoresis, mass spectrometry

2. Isolation and purification: Genomic and plasmid DNA; RNA; proteins

3. Isoelectric focusing (IEF): Principles, kinds of pH gradients used in IEF- free carrier ampholytes, immobilized pH gradients

4. Blotting: Principles, types of blotting, immunoblotting - Southern, Northern, Western and Dot blots 5. DNA amplification and genome mapping: PCR, RT-PCR, RFLPs, RAPD, FISH

6. Genome expression analysis: Microarray, EST, SAGE

7. DNA sequencing: Various methods of DNA sequencing

8. Gene silencing: RNA interference (RNAi)

9. Chromatography: Gel filtration, ion exchange & affinity chromatography, TLC, HPLC, GC-basic concept

10. Spectroscopy: basic concept, NMR & ESR spectroscopy

11. Microscopy: Phase contrast, confocal, fluorescence, scanning & transmission electron microscopy

12. Bioinformatics: Database, sequence analysis, phylogenetic inference package, sites and centres

BOM305M: Biodiversity and its Conservation

1. Introduction to biodiversity

2. Levels of biodiversity: Genetic, species, community and ecosystem

3. Magnitude and distribution: Diversity gradients and related hypotheses, methods for biodiversity monitoring, megadiversity zones and hot spots

4. Biodiversity and ecosystem functions: Concepts and models

5. Biodiversity and ecosystem services: Provisioning, regulating, supporting and cultural

6. Threats to biodiversity: Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book

7. Strategies for biodiversity conservation: Principles of biodiversity conservation, in-situ and ex-situ conservation strategies; Biodiversity act

SEMESTER IV

BOM401: Air Pollution and Climate Change

1. Atmospheric composition and climate; Gaseous and particulate pollutants, emission trends and scenarios; climate change, drivers of climate change, greenhouse gas emission scenarios; indoor air pollution

2. Sulphur derivatives: Sources and cycling of sulphur, effects on plants, human health and ecosystems, mechanism of toxicity, resistance and buffering, sulphur metabolism, threshold and injury

3. Nitrogen derivatives: Formation and sources; deposition, uptake, metabolism, critical load; effects on plants, human health and ecosystems

4. Fluoride derivatives: Sources and cycling, bioaccumulation, threshold and injury; effects on plants, human health and ecosystems

5. Oxidants: Formation and sources, photochemical smog; effects on plants and human health, mechanism of toxicity, resistance, critical load

6. Stratospheric ozone depletion: Phenomenon, causes, irradiation scenarios; effects of enhanced UV-B on plants, microbes and human health, biological action spectra

7. Greenhouse effects: Process; consequences, global warming, sea level rise, albedo, oceanic influences, agriculture, natural vegetation; effects of increased CO2 on plants; human implications

8. Acid rain: Formation, dispersion and deposition, trends; consequences on soil fertility, rivers and lakes; effects on plants, leaf injury, buffering, reproduction; forest decline; effects on fisheries

9. Biomonitoring of air pollution: Concept, active and passive monitoring; bioindicator parameters; air pollution tolerance indices; control of air pollution by plants, green belt design

BOM402: Photobiology and Molecular Biology of Cyanobacteria

1. Molecular aspects of cyanobacterial nitrogen fixation: Genetic structure of the N2 fixation system, molecular mechanisms of heterocyst differentiation and metabolism, genetic aspects of nitate, nitrite and ammonia assimilation

2. Accessory light harvesting complex: Phycobilisomes, phycobiliproteins, linker polypeptides, energy transfer, gene organization, chromatic adaptation and gene expression

3. Photobiology: Photobiological and molecular aspects of UV-induced damage and repair in cyanobacteria

4. Molecular mechanisms of photoprotection: Mycosporine-like amino acids (MAAs), scytonemin

5. Cyanobacterial toxins: Types of cyanobacterial toxin, molecular tools for the identification of toxic cyanobacteria, biochemical and molecular aspects of toxin production, ecological implications

6. Basic strategies for the generation of transgenic cyanobacteria

BOM403: Plant Cell and Tissue Culture

1. Historical perspectives

2. Principles of plant tissue culture: Organization of laboratory, media composition and preparation, aseptic manipulation

3. Cell culture and cell cloning

4. Cellular totipotency: Process and mechanism

5. Somatic embryogenesis: Induction and controlling factors

6. Organogenesis: Process and controlling factors

7. Haploids: Androgenic and gynogenic; obtention and promises

8. Somatic hybridization: Isolation, culture and fusion of protoplasts: regeneration of hybrids and cybrids

9. Clonal propagation: Micropropagation

10. Somaclonal and gametoclonal variation and their selection

11. Transgenic plants: Method of transformation, selection, identification, molecular analysis for confirmation
and application

12. Germplasm conservation and synthetic seed technology

13. Industrial application: Suspension culture, hairy root culture and bioreactors

BOM404: Water Pollution Management

1. Freshwater: Classification of water bodies; physico-chemical and biological properties of freshwater; water quality at euphotic and profundal zones; drinking, bathing and irrigational water quality standards
2. Water pollution sources: Major sources of water pollution; Physico-chemical and biological properties of sewage; quality of industrial effluents produced from textile, dairy, leather, thermal power and chemical industries
3. Effect on water quality: Changes in water quality due to discharge of city sewage; industrial effluents; effects on phytoplankton productivity; bio-indicators of water pollution
4. Domestic wastewater treatment: Various stages of treatment of sewage with special reference to advanced wastewater treatments; biological treatment of wastewater
5. Industrial wastewater treatment: Treatment of industrial effluents released from textile, dairy, leather, thermal power and chemical industries
6. Disinfection of treated water: Ozonization of secondary treated wastewater; chemical and other methods for disinfection
7. Water management strategies: Rain water harvesting, use of rain water, recharging of ground water; use of domestic waste water; recycling of waste water; recycling of industrial effluents after treatment
8. Water pollution monitoring and management bodies: Important organizations involved in water
pollution monitoring in India and role of NGOs in water pollution management

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M.Sc. ZOOLOGY

Semester-I
ZOM101 Non Chordata & Chordata
ZOM102 Entomology & Fish Biology
ZOM103 Vertebrate Endocrinology
ZOM104 Analytical and Molecular Techniques & Microscopy
ZOM105 Practical

Semester-II
ZOM201 Cytogenetics & Genetics
ZOM202 Biochemistry & Cell Structure and Function
ZOM203 Histology and Histochemistry & Bioinformatics
ZOM204 Mammalian Physiology & Neurobiology
ZOM208 Practical

Semester-III
ZOM301 Developmental Biology & Immunology
ZOM302 Hormones And Diseases
ZOM303 Evolutionary Biology
ZOM304 Molecular Biology
ZOM305 Practical

Semester-IV
ZOM401 Animal Behaviour & Environmental Biology
ZOM402 Evolution & Parasitology
ZOM403 Insect Physiology
ZOM404 Molecular Endocrinology And Mammalian Reproductive Physiology
ZOM405 Practical

SEMESTER I

ZOM 101: NON CHORDATA & CHORDATA

Section A: Non Chordata
1. Protozoa
1.1 Nucleus and reproduction
1.2 Colonial protozoans and theories of the origin of metazoans
2. Porifera: canal system
3. Cnidaria
3.1 Nematocysts
3.2 Polymorphism in Siphonophora
4. Annelida
4.1 Adaptive radiation in polychaetes
4.2 Trochophore larva: structure and significance
5. Mollusca
5.1 Nervous system
5.2 Modifications of foot
6. Arthropoda
6.1 Affinities of trilobites
6.2 Crustacean larvae and their significance
7. Echinodermata: larval forms and their significance
8. Salient features and affinities of
8.1 Placozoa
8.2 Mesozoa
8.3 Rotifera
8.4 Phoronida
8.5 Sipuncula
Section B: Chordata
1. Characteristic features and affinities of the following
1.1 Protochordata
1.1.1 Hemichordata
1.1.2 Urochordata
1.1.3 Cephalochordata
1.2 Cyclostomes
2. Transition from agnatha to gnathostomata
3. Origin of the following
3.1 Fish
3.2 Amphibia
3.3 Reptile
3.4 Bird
3.5 Mammal
4. Adaptive radiation in vertebrates
4.1 Aquatic
4.2 Terrestrial
4.3 Aerial

4.4 Arboreal
4.5 Fossorial
5. Parental care in amphibians
6. Skull in reptiles
7. Venom in ophidians
8. Flightless birds
9. Modification of beak, feet and palate in birds

Books Recommended
1. Barnes: Invertebrate Zoology (4th ed 1980, Holt-Saunders International)
2. Barnes: The Invertebrates – A synthesis (3rd ed 2001, Blackwell)
3. Hunter: Life of Invertebrates (1979, Collier Macmillan)
4. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
5. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
6. Harvey et al: The Vertebrate Life (2006)

ZOM 102: ENTOMOLOGY & FISH BIOLOGY

Section A: Entomology
1. Importance and taxonomic richness of insects
2. External anatomy
2.1 Segmentation and tagmosis
2.2 Integument: structure and functions of cuticle, sclerotization and colouration
2.3 Head: types of head and antennae
2.4 Thorax: legs and wings
3. Internal anatomy and physiology
3.1 Nervous system
3.2 Endocrine system and function of hormones
3.3 Circulatory system: heart and haemolymph
3.4 Respiratory system
3.4.1 Aerial respiration: spiracles, trachea and tracheoles
3.4.2 Aquatic respiration
3.5 Digestive system
3.5.1 Structure of gut
3.5.2 Digestion and absorption of food
3.6 Excretory system and waste disposal
3.6.1 Malpighian tubules
3.6.2 Nitrogen excretion
3.7 Reproduction
3.7.1 Female and male systems
3.7.2 Physiology of reproduction
4. Sensory system
4.1 Tactile mechanoreceptor and position receptor
4.2 Compound eye
5. Applied Entomology
5.1 Insects as friends and foes
5.2 Insect plant-interaction
5.3 General methods of insect pest management
5.4 Medical entomology: insects as vectors of diseases and their control
Section B: Fish Biology
1. Major groups of living fishes
2. Nutritional value and economic importance of fishes
3. Fins: origin, types and function
4. Respiratory organs
4.1 Water breathing
4.2 Air-breathing

5. Swim bladder
6. Electric organs
7. Poisonous and venomous fishes
8. Fish migration
9. Fisheries
9.1 Definition and classification
9.2 Outlines of fish culture in ponds
10. Ichthyology and its scope
Books Recommended
Entomology
1. Atwal: Agricultural Pests of India and South East Asia (1986, Kalyani Publishers)
2. Chapman: The Insects: structure and function (4th ed, 1998, ELBS)
3. Imms: A general text book of entomology, 2 vols (1997, Asia Publishing House)
4. Pillay: Aquaculture: Principles and Practices Fishing News Books (2005, First Indian reprint)
5. Srivastava: A Textbook of Fishery Science and Indian Fisheries (1985, Kitab Mahal)

ZOM 103: VERTEBRATE ENDOCRINOLOGY

Section A: Comparative Endocrinology
1. Vertebrate endocrine system
2. Hypothalamo-hypophysial system
2.1 Neurosecretion
2.2 Hypothalamic neurosecretory centers
2.3 Neurohypophysis
2.3.1 General organization
2.3.2 Median eminence: structure and function
2.3.3 Octapeptide hormones
2.4. Adenohypophysis
2.4.1 General organization
2.4.2 Distribution of pituitary cell types and functions (teleost model)
3. Urophysis: structure and function
4. Pineal organ: structure and function
5. Comparative anatomy of thyroid gland and its role in metamorphosis (amphibian model)
6. Comparative anatomy of adrenocortical and medullary homologues
7. Gonads
7.1 Structure of testis and ovary
7.2 Steroidogenic sites
7.3 Steroid hormones and their functions
8. Endocrine control of colour change with emphasis on pars intermedia function in amphibians
9. Endocrine control of osmoregulation in fish
Section B: Mammalian Endocrinology
1. Mechanism of hormone action
1.1 Protein hormones
1.1.1 Membrane receptors
1.1.2 G-proteins
1.1.3 Cyclic AMP signaling cascade
1.1.4 PKC signaling pathway

1.2 Steroid hormones (genomic and nongenomic pathways)

2. Hypothalamo-hypophysial System

2.1 General organization
2.2 Neurohypophysial octapeptides (oxytocin and vasopressin)
2.3 Hypophysiotropic hormones: chemistry, localization and actions
2.4 Adenohypophysial hormones: chemistry and physiological roles of
2.4.1 Somatotropin and prolactin
2.4.2 Glycoprotein hormones (FSH, LH and TSH)
2.4.3 Pro-opiomelanocortin (ACTH, MSH, _-LPH and _-endorphin)
2.5 Neural control of adenohypophysis

3. Thyroid hormones: biosynthesis, control of secretion and physiological roles

4. Steroid hormones: biosynthetic pathways

5. Testis: organization and physiological roles of androgens

6. Ovary: organization and physiological roles of estrogen, progesterone,relaxin and inhibin

7 Adrenal cortex

7.1 Organization
7.2 Control of mineralocorticoid and glucocorticoid hormones
7.3 Physiological role of glucocorticoids and mineralocorticoids

8. Adrenal medulla: catecholamine biosynthesis, release and physiological role

9 Role of parathormone, calcitonin and vitamin D in calcium homeostasis

10. Endocrine pancreas: biosynthesis and physiological actions of insulin and glucagon

11. Gastrointestinal hormones (secretin, gastrin and cholecystokinin)

Books Recommended

1. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
2. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
3. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
4. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)

ZOM 104: ANALYTICAL AND MOLECULAR TECHNIQUES & MICROSCOPY

Section A: Analytical and Molecular Techniques

1. Buffers

1.1 pH and its determination
1.2 Preparation of buffer

2. Centrifugation

2.1 Basic principles
2.2 Types of rotors
2.3 Clinical, high speed and ultracentrifuge

3. Spectrophotometry

3.1 Types of spectrophotometer
3.2 Beer-Lambert's law, molar extinction coefficient
3.3 Absorption spectrum
3.4 Principles of UV- Vis spectrophotometry

4. Electrophoresis

4.1 Principles
4.2 Agarose- and polyacrylamide gel
4.3 Isoelectrofocussing
4.4 Two-dimensional

5. Chromatography

5.1 Principles
5.2 Paper and thin layer chromatography
5.3 Column chromatography
5.3.1 Gel filtration
5.3.2 Ion exchange
5.3.3 Affinity

5.4 Introduction to FPLC and HPLC
5.5 Introduction to mass spectrometry: MALDI-TOF
6. Introduction to NMR and X-ray crystallography
7. Radio-tracer techniques
7.1 Unit of radioactivity and half-life
7.2 Measurement of radioactivity (_ and _ emission)
7.3 Applications of radioisotopes
7.4 Safety measures
8. Detection of proteins
8.1 Western blotting
8.2 ELISA
9. DNA-protein and protein-protein interactions
9.1 South-Western
9.2 DNA foot printing
9.3 EMSA
9.4 Yeast two-hybrid
9.5 Phage display
9.6 Far Western
10. Recombinant DNA techniques
10.1 Restriction enzymes
10.2 Cloning vectors
10.3 Preparation and screening of cDNA and genomic DNA libraries
10.4 Southern and Northern hybridizations
10.5 *In situ* hybridization
10.6 Polymerase chain reaction: principles and applications
11. Introduction to DNA sequencing
Books Recommended
1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd ed 1993, Benjamin/Cumin)
2. Freifelder: Physical Biochemistry (2nd ed 1982, Freeman)
3. Holme and Peck: Analytical Biochemistry (3rd ed 1998, Tata McGraw Hill)

Section B: Microscopy
1. Basic principles of microscopy
2. Types of microscopes and their biological applications
2.1 Bright-field microscope: numerical aperture, limit of resolution, types of objectives, ocular and stage micrometers
2.2 Dark-field microscope
2.3 Phase-contrast microscope
2.4 Differential interference contrast microscope
2.5 Fluorescence microscope
2.6 Confocal microscope
2.7 Atomic force microscopy
2.8 Transmission and scanning electron microscopes
3. Photomicrography and image processing
Books recommended
1. Alberts et al: Molecular Biology of the Cell (2002, Garland)
2. Karp: Cell and Molecular Biology (2007, Wiley)
3. Lodish et al: Molecular Cell Biology (2007, Freeman)
4. Pollard & Earnshaw: Cell Biology (2002, Saunders)
5. Ruthman: Methods in Cell Research (1970, Bell & Sons)

SEMESTER II

ZOM 201: CYTOGENETICS & GENETICS

1. Eukaryotic chromatin structure and chromsome organization

1.1 Classes of DNA

1.2 Chromosomal proteins: histones and their modifications, non-histone proteins, scaffold/matrix proteins

1.3 Levels of chromatin condensation at interphase and metaphase stages

1.4 Nuclear matrix and organization of interphase nucleus

1.5 Centromere, kinetochore and telomere

1.6 Metaphase chromosome banding

1.7 Chromosome and chromatid type aberrations

2. Giant chromosomes: models for studies on chromosome organization and gene expression

3. Cell division

3.1 Mitosis

3.1.1 Role of maturation promoting factor

3.1.2 Chromosomal movement
3.1.3 Exit from mitosis
3.1.4 Cytokinesis
3.2 Meiosis
3.2.1 Chromosome pairing and recombination
3.2.2 Genetic regulation of meiosis

4. Human cytogenetics

4.1 Karyotype and nomenclature of metaphase chromosome bands
4.2 Chromosome anomalies and disease
4.3 Types of chromosomal anomalies
4.4 Common syndromes caused by aneuploidy, mosaicism, deletion and duplication
4.5 Chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt lymphoma, retinoblastoma and Wilms' tumour)
4.6 Fragile site and X-linked mental retardation

5. Mendel's laws and their chromosomal basis

6. Extensions of Mendelism

2.1 Dominance relationships
2.2 Epistasis
2.3 Pleiotropy
2.4 Expressivity and penetrance

7. Methods of gene mapping

3.1 3-point test cross in *Drosophila*
3.2 Gene mapping in human by linkage analysis in pedigrees
3.3 Tetrad analysis in *Neurospora*
3.4 Gene mapping in bacteria by conjugation, transformation and transduction

8. Gene mutation and DNA repair

4.1 Types of gene mutations
4.2 Methods for detection of induced mutations
4.3 P-element insertional mutagenesis in *Drosophila*
4.4 DNA damage and repair

9. Nature of the gene and its functions

5.1 Evolution of the concept of gene
5.2 Fine structure of gene (*rII* locus)
5.3 Regulation of gene activity in *lac* and *trp* operons of *E.coli*
5.4 Introduction to gene regulation in eukaryotes
5.4.1 Organization of a typical eukaryotic gene
5.4.2 Transcription factors, enhancers and silencers
5.4.3 Transcriptional and post-transcriptional regulation
5.4.4 Noncoding genes

10. Organization and function of mitochondrial DNA

11. Quantitative inheritance

12. Applications and implications of genetic engineering

8.1 Genetic manipulations in plants and animals
8.2 Detection of genetic disorders
8.3 Gene therapy

ZOM 202: BIOCHEMISTRY & CELL STRUCTURE AND FUNCTION

Section A: Biochemistry

1. Laws of thermodynamics and their applications

1.1 Concept of free energy and calculations based on free energy change

2. Protein structure

2.1 Primary structure, peptide bond
2.2 Secondary structure
2.2.1 α-helix, β-pleated sheet and bends
2.2.2 Prediction of secondary structure, Ramachandran plot
2.3 Tertiary structure

2.3.1 Forces stabilizing tertiary structure
2.3.2 Domains and motifs
2.4 Quaternary structure
3. Enzymes
3.1 Enzyme kinetics
3.1.1 Lowering of activation energy
3.1.2 Derivation of Michaelis-Menten equation, related calculations And Michaelis-Menten and Lineweaver-Burk plots
3.2 Mechanism of action
3.2.1 Active site, substrate binding, transition state analogues and abzyme
3.2.2 Acid-base and covalent catalysis (chymotrypsin, carboxypeptidase)
3.2.3 Concepts of regulation of enzyme activity
4. Metabolism
4.1 Concept of metabolic pathways
4.2 Energy transduction: glucose and fatty-acids as energy source
5. Nucleic acids
5.1 Structure, folding motifs, conformational flexibility and supercoiling
5.2 Mechanism of DNA replication
5.2.1 DNA polymerases
5.2.2 Origin of replication and formation of primosome
5.2.3 Replication fork and replisome
5.2.4 Termination of replication
5.3 Transcription unit
5.4 Mechanism of transcription
5.4.1 RNA polymerases
5.4.2 Formation of pre-initiation complex at RNA pol II promoter
5.5 Processing of hnRNA
5.5.1 Capping
5.5.2 Poly(A) tailing
5.5.3 Splicing
5.6 Genetic code
5.7 Mechanism of translation
5.7.1 Role of ribosomes and tRNAs
5.7.2 Formation of initiation complex
5.7.3 Elongation and termination

Section- B: Cell Structure and Function
1. Prokaryotes
1.1 Viruses: structure and replication
1.1.1 Bacteriophage (Lambda phage, phi x 174)
1.1.2 Animal DNA virus (SV 40)
1.1.3 Retroviruses (HIV)
1.2. Bacteria
1.2.1 Structure and reproduction of *E. coli*
1.2.2 Plasmid and their functions
2. Eukaryotes
2.1 Cell Membrane
2.1.1 Lipid bi-layer and membrane proteins
2.1.2 Transport across the cell membrane
2.1.2.1 Channels and transporters
2.1.2.2 Diffusion, osmosis and measurement of osmotic pressure
2.1.2.3 Active transport: mechanism and related calculations
2.2 Targeting and sorting of proteins
2.2.1 Signal peptide and SRP dependent targeting of translational complex
2.2.2 Processing of proteins in RER
2.2.3 Processing through Golgi complex: targeting to plasma membrane and lysosome

2.2.4 Targeting of nuclear and mitochondrial proteins
2.3 Mitochondria
2.3.1 Structure: assemblies of respiratory chain and $F_0 F_1$ - ATPase
2.3.2 Oxidative phosphorylation: mechanism and chemiosmotic concept
2.3.3 Bioenergetics of ATP and other high energy phosphate compounds.
2.4 Nucleolus: structure and biogenesis of ribosomes
2.5 Cytoskeleton: organization of microtubules, microfilaments and intermediary filaments
2.6 Cell signaling
2.6.1 Cell-cell interaction
2.6.2 Chemical mediators
2.6.3 Signaling through cell surface and intracellular receptors
2.7 Apoptosis: mechanism and significance
2.8 Cell transformation and malignancy

ZOM 203: HISTOLOGY AND HISTOCHEMISTRY & BIOINFORMATICS
Section A: Histology and Histochemistry
1. Fixation and tissue processing
1.1 Types of fixatives
1.2 Chemistry of fixation
1.3 Choice of fixatives
1.4 Dehydration
1.5 Clearing and embedding
2. Microtomy
2.1 Types of microtomes
2.2 Sectioning of paraffin blocks
3. Staining of paraffin sections
3.1 Principle and methods of staining
3.2 Histological stains: haematoxylin and eosin
4. Principles and methods of histochemical localization and identification of the following
4.1 Carbohydrate moieties
4.1.1 Glycogen and glycoproteins with oxidizable vicinal diols by periodic acid Schiff method
4.1.2 Glycoproteins with carboxyl groups and/or *O*-sulphate esters by alcian blue methods
4.1.3. Role of lectin in carbohydrate histochemistry
4.2 Protein end groups
4.2.1 General protein localization by bromophenol blue method
4.2.2 $-NH_2$ groups by ninhydrin-Schiff method
4.2.3 – SS- groups by performic acid –Schiff and performic acid- alcian blue methods
4.3 Lipids moieties
4.3.1 General lipids by Sudan black B method
4.3.2 Neutral lipids by Sudan III and Sudan IV methods
4.3.3 Differentiation of neutral lipids from acidic lipids by nile blue sulphate method
4.4 Nucleic acids
4.4.1 Methyl green pyronin-Y for DNA and RNA
4.4.2 Feulgen reaction for DNA
4.5 Enzymes
4.5.1 Principles of enzyme histochemistry
4.5.2 Acid and alkaline phosphatases by metal precipitation and azo dye methods
5. Basic principles of immunohistochemistry
6. Enzyme as histochemical reagent
Section B: Bioinformatics
1. Introduction and scope of bioinformatics: a concept of digital laboratory
2. Basics of computers (CPU, I/O units), operating systems (Windows, UNIX), networks (LAN, WAN) and information technology

3. Concept of hypertext and internet protocol (HTTP, TCP/IP)
4. Basics of home-pages, web-pages and uniform resource locators (URL)
5. Introduction to data archiving systems (FASTA format, Accession, and GI-Number)
6. Basic features and management systems of following
6.1 Nucleic acid sequences database
6.2 Genome databases
6.3 Protein sequence, structures and interacting proteins databases
6.4 Literature databases
6.5 Biodiversity and ecosystem based databases
7. Introduction to data retrieval systems
7.1 Search engines
7.2 Entrez, sequence retrieval system (SRS) and protein identification resource (PIR)
8. Introduction to molecular sequence analysis software packages and tools
8.1 Prediction of motifs, folds and domains
8.2 Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP)
9. Applications of bioinformatics
9.1 Clinical informatics
9.2 Cheminformatic resources and pharmacoinformatics

ZOM 204: MAMMALIAN PHYSIOLOGY & NEUROBIOLOGY
Section A: Mammalian Physiology
1. Circulation
1.1 Blood
1.1.1 Haemopoiesis
1.1.2 Haemostasis
1.2 Lymph: composition and dynamics
1.3 Heart
1.3.1 Origin and conduction of cardiac impulse
1.3.2 ECG and cardiac cycle
1.3.3 Myocardial infarction
2. Respiration
2.1 Pulmonary ventilation
2.1.1 Respiratory centers: organization and function
2.1.2 Surfactant
2.2 Gaseous exchange
2.3 Haemoglobin and gaseous transport
2.4 Basal metabolic rate and its measurement
2.5 Respiratory adjustments
2.5.1 Hypoxia and oxygen therapy
2.5.2 Dyspnea
2.5.3 Respiratory buffering
3. Excretion
3.1 Urine formation and regulation
3.2 Acid-base balance and homeostasis
3.3 Renal function tests
4. Muscle
4.1 Types of contraction
4.2 Muscle proteins
4.3 Mechanism of contraction and energetics
4.4 Muscular dystrophy
5. Digestion and nutrition
5.1 Digestion and absorption of macronutrients and their regulation
5.2 Obesity and starvation
Section B: Neurobiology
1. Plasticity of brain and neurogenesis
2. Organization of nervous system

2.1 Brain structure
2.2 Neurons and glia
2.3 Cerebrospinal fluid
2.4 Neural network
2.5 Blood brain barrier
2.6 Autonomic nervous system

3. Axonal and synaptic transmission

3.1 Types of neurons
3.2 Membrane potential and action potential
3.3 Types of synapses
3.4 Excitatory and inhibitory post-synaptic potential
3.5 Chemical transmission, neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides

4. Learning and memory: types and molecular basis

5. Brain and behavior: motivation and sleep

6. Brain imaging: CAT, PET and MRI

7. Brain aging

8. Neuropathology

8.1 Strokes
8.2 Epilepsy
8.3 Alzheimer disease
8.4 Huntington disease
8.5 Parkinson disease

SEMESTER III

ZOM 301: DEVELOPMENTAL BIOLOGY & IMMUNOLOGY

Section A: Developmental Biology

1. Fertilization in sea urchin and mammals

1.1 Recognition of gametes and acrosomal reaction
1.2 Prevention of polyspermy and gamete fusion
1.3 Activation of egg metabolism

2. Early development

2.1 Cleavage: patterns
2.2 Formation of blastula in amphibians
2.3 Gastrulation: fate maps, cell movement and formation of germ layers in echinoderms, ambhibians and birds
2.4 General concept of potency, commitment, specification, induction, competence and determination
2.5 Differentiation and pattern formation
2.5.1 Stalk and fruiting body formation in *Dictyostellium*
2.5.2 Origin of anterior-posterior and dorsal-ventral polarity in *Drosophila*: role of maternal, segmentation and homeotic genes
2.5.3 Organization of HOX gene in vertebrates
2.5.4 Axis formation in amphibians: Nieuwkoop Centre and primary organizer
2.5.5 Axis formation in birds and mammals: role of pattern forming genes

3. Late embryonic development

3.1 Vulva formation in *Caenorhabditis*
3.2 Formation of neural tube in vertebrates
3.3 Development of limb in vertebrates: role of HOX and other pattern forming genes

4. Hormonal regulation of metamorphosis in insects and amphibians

5. Regeneration of Salamander limbs: polar coordinate model

6. Senescence

7. Stem cells and their applications

Section B: Immunology

1. Immune system

1.1 Innate and adaptive immunity
1.2 Immune cells: types and production
1.3 Immune tolerance
1.4 Concept of clonal selection
1.5 Complement system

2. Humoral immunity

2.1 Antigen and haptens
2.2 Primary and secondary response
2.3 Antibody: types, structure and functions
2.4 Generation of antibody diversity
2.5 Class switching

3. Cell mediated immunity

3.1 T-cell receptors
3.2 MHC complexes
3.3 Antigen: processing and presentation
3.4 T helper cell and lymphocyte activation
3.5 Role of cytotoxic T-cell

4. Concept of vaccination

Books Recommended

1. Alberts et al: Molecular Biology of the Cell (4th ed 2002, Garland)
2. Balinsky: An introduction to Embryology (5th ed 1981, Saunders)

ZOM 302M: HORMONES AND DISEASES

1. Scope of endocrinology

2. Pituitary gland

2.1 General organization and hormones
2.2 Diseases: dwarfism, gigantism, acromegaly, diabetes insipidus

3. Thyroid

3.1 General organization and hormones
3.2 Diseases: goiter, myxoedema, cretinism

4. Parathyroid gland

4.1 General organization and hormones
4.2 Diseases: osteoporosis and tetany

5. Islets of Langerhans

5.1 General organization and hormones
5.2 Disease: diabetes mellitus (type I and type II)

6. Adrenal gland

6.1 General organization and hormones
6.2 Diseases: Addison's disease, Cushing's syndrome

7. Testis

7.1 General organization and hormones
7.2 Male infertility
7.3 Cryptorchidism

8. Ovary

8.1 General organization and hormones
8.2 Diseases: polycystic ovarian disease, hirsutism, and hyperandrogenism

9. Hormones and cancer

10. Hormones and stress

11. Obesity, and eating disorders

12. Melatonin, sleep disorders, and jet lag

Books Recommended

1. Hadley, M.C.: Endocrinology, Prentice Hall, International Edition, 2000
2. Wilson and Foster, Williams Text Book of Endocrinology 10th edition, W.B. Saunders Company Philadelphia, 2005

ZOM303M: EVOLUTIONARY BIOLOGY

1. Evolutionary time scale and geological eras

2. Origin and early history of life

2.1 Theories about the origin of life
2.2 Theories about the origin of cell

3. Organic evolution: concept and evidences

(comparative anatomy, embryology, biogeography, palaeontology, genetics, biochemistry and physiology)

4. Theories of evolution: Lamarckism, Darwinism and Modern theories

5. Population as unit of evolution

5.1 Gene frequencies in Mendelian population
5.2 Hardy-Weinberg Equilibrium
5.3 Major evolutionary forces

6. Species and phylogenetic relationships
6.1 Concepts of species
6.2 Modes of speciation
6.3 Phylogenetic relationships
7. Evolution at molecular level
7.1 Genomic and proteomic changes
7.2 Molecular clock
7.3 Molecular phylogeny
8. Evolution of man
8.1 Hominid evolution: anatomical, geographical and cultural
8.2 Ancestry of *Homo sapiens*: molecular phylogenetic relationship
8.3 Peopling of continents
9. Environmental contexts of evolutionary changes
9.1 Environment and global climate patterns
9.2 Responses to environmental variation
9.3 History of biodiversity and extinction
9.4 Adaptation to specific habitats with examples
10. Evolution of behaviour
10.1 Behaviour as phenotypic traits
10.2 Adaptive value of behaviour
10.3 Role of behaviour in evolution
10.4 Interactions among species (competition, predation, parasitism, mutualism and mimicry)
11. Evolution of reproductive mechanisms: asexual and sexual reproduction; evolution of cleidoic egg
12. Biochemical evolution: metabolic pattern changes (autotrophic, heterotrophic, anaerobic and aerobic)
Books Recommended
1. Coyne and Orr: Speciation(2004, Sinauer)
2. Dobzhansky et al: 1976 Evolution (2004, Surjeet Publ)
3. Dodson: Evolution: Process and Product (1964, Reinhold Publishing Corp)
4. Freeman and Herron: Evolutionary Analysis (1998, Prentice Hall)
5. Futuyma: Evolutionary Biology(1998, Sinauer)

ZOM 304: MOLECULAR BIOLOGY
Course I: Nucleic Acids
1. Eukaryotic genome
1.1 Introduction to structural and functional genomics
1.2 Denaturation and renaturation of DNA, unique and repetitive DNA sequences (LINEs, SINEs)
1.3 Chromatin organization
1.3.1 Nucleosomes and higher order structures
1.3.2 Histones and non-histone chromosomal proteins
1.3.3 Telomere
1.3.4 Chromatin modifications
2. DNA replication
2.1 DNA polymerases
2.2 ARS and initiation in yeast
2.3 Eukaryotic chromatin replication and regulation
3. DNA repair and recombination
4. Human genome: mapping, characteristics and implications
5. Transcription and its regulation
5.1 RNA polymerases in eukaryotes
5.2 Transcription factors: general and specific
5.3 Assembly of pre-initiation complex and initiation
5.4 Elongation and elongation factors

5.5 Enhanceosomes
5.6 Transcriptome
5.7 Promoter analysis and characterization
5.7.1 Expression system: transient and stable
5.7.2 Deletion mapping
5.7.3 S1/RNase mapping
5.7.4 Chromatin immunoprecipitation (ChIP)
5.7.5 Electrophoretic mobility shift assay
5.7.6 DNase I footprinting

6. Post transcriptional processing and regulation

6.1 Introns: types and mechanisms of splicing
6.2 RNA editing
6.3 Post transcriptional gene silencing (RNA interference)

7. Catalytic RNA and its role

8. Genetic engineering

8.1 Tools
8.1.1 Restriction enzymes and other enzymes for DNA manipulation
8.1.2 Vector types: cloning and expression
8.1.3 Probes
8.2 Cloning strategies
8.2.1 cDNA and genomic libraries
8.2.2 Positional cloning
8.3 Screening of clones
8.3.1 Preparation of probes
8.3.2 Hybridization: Southern, Northern (colony/plaque), immuno-screening
8.4 Characterization of clones
8.4.1 Sequencing
8.4.2 Microarray
8.5 PCR and its applications
8.6 Application: transgenic organisms and genetically modified organisms (GMOs), animal cloning, site-directed mutagenesis, generation of knock-out animals, gene therapy, DNA drugs
8.7 Ethical and social issues

SEMESTER IV

ZOM 401: ANIMAL BEHAVIOUR & ENVIRONMENTAL BIOLOGY

Section A: Animal Behaviour

1. Introduction to behaviour

2. Patterns of behaviour

3. Genetic and neural basis of behaviour

3.1 Genetic basis

3.2 Bird song development

3.3 Biological rhythms

4. Habitat selection and foraging behaviour

5. Animal signals and communication

5.1 Evolution of animal signals

5.2 Honesty and deceit in communication

6. Sexual conflict

6.1 Parental care

6.2 Sexual selection

7. Social organization

7.1 Theories of social behaviour

7.2 Altruism in eusocial animals

Section B: Environmental Biology

1. Introduction to environmental biology

2. Ecological principles

2.1 Concept of ecosystem

2.2 Energy flow

3. Population ecology

3.1 Population dynamics

3.1.1 Population growth form

3.1.2 r- and k-selections and carrying capacity
3.2 Biological communities and species interactions
3.2.1 Types of interactions between two species
3.2.2 Interspecific competition
4. Environmental health and toxicology
4.1 Types of environmental health hazards
4.2 Pollution: air, water, solid waste and radioactive
4.3 Bioaccumulation and biomagnification
5. Conservation and management of natural resources
5.1 Soil and mineral resources
5.2 Biodiversity: benefits and threats
5.3 Endangered species management and biodiversity protection

ZOM 402: EVOLUTION & PARASITOLOGY
Section A: Evolution
1. An overview of evolutionary thoughts, development and the concept of synthetic theory.
2. Population genetics
2.1 Gene frequencies in Mendelian population
2.2 Hardy-Weinberg equilibrium
2.3 Conditions for the maintenance of genetic equilibrium
3. Elemental forces of evolution
3.1 Mutation
3.2 Selection (types of selection, selection coefficient, selection in natural populations)
3.3 Random genetic drift
3.4 Migration
4. Chromosomal, allozyme and DNA polymorphisms
4.1 Adaptive genetic polymorphism
4.2 Balanced polymorphism and heterosis
4.3 Genetic coadaptation and linkage disequilibrium
5. Isolating mechanisms
6. Concepts of species and models of speciation:allopatric, sympatric and stasipatric
7. Phylogenetic relationships
7.1 Chromosome phylogeny in *Drosophila* (based on inversion polymorphism)
7.2 Molecular phylogenies
7.3 Neutral theory
7.4 Molecular clock
Section B: Parasitology
1. Parasites and parasitism
1.1 General consideration
1.2 Type of parasites
1.3 Type of hosts
1.4 Symbiosis and commensalisms
2. Molecular interaction between host and parasite and evasion of immunity
3. Protozoan parasites
3.1 Distribution, habit and habitat, structure, life cycle and diseases caused by
3.1.1 *Entamoeba histolytica*
3.1.2 *Leishmania donovani*
4. Helminth parasites
4.1 General characters, organization and larval forms of Platyhelminthes and Nemathelminthes
4.2 Distribution, habit and habitat, structure, life cycle and diseases caused by
4.2.1 *Echinococcus granulosus*
4.2.2 *Schistosoma haematobium*
4.2.3 *Wuchereria bancroft*

ZOM 302B: INSECT PHYSIOLOGY

Course I: Insect Physiology I

1. Digestive system

1.1 Digestion
1.2 Absorption
1.3 Nutrition
1.3.1 Nutritional requirements
1.3.2 Ectosymbiotic fungi
1.3.3 Endosymbionts

2. Fat body: physiology and biochemistry

3. Excretory system

3.1 Organs of excretion
3.2 Nitrogenous excretion
3.2.1 Excretory products
3.2.2 Storage excretion
3.3 Production of urine and its hormonal regulation
3.3.1 Terrestrial and salt water insects
3.3.2 Control of diuresis
3.3.3 Water regulation
3.3.4 Detoxification

4. Circulatory system

4.1 Circulation
4.2 Haemocytes
4.2.1 Type
4.2.2 Origin and longevity
4.2.3 Haemopoietic organs
4.2.4 Changes in haemocyte population
4.3 Immunity
4.3.1 Cell mediated immunity
4.3.2 Humoral immunity
4.4. Haemolymph proteins
4.4.1 Methods of study: protein purification, sequence analysis, immunological techniques
4.4.2 Storage proteins: synthesis, uptake and their role
4.4.3 Vitellogenin and its receptor mediated uptake by ovary
4.4.4 Antibacterial proteins
4.4.5 Lectins
4.4.6 Protease inhibitors
4.4.7 Enzymes in haemolymph
4.4.8 Peptides: neuropeptides and humoral factors
4.4.9 Chromoproteins
4.4.10 Specific transport proteins

5. Reproduction

5.1 Anatomy of reproductive organs
5.2 Spermatogenesis and oogenesis
5.3 Mating, insemination, oviposition
5.4 Special modes of reproduction

ZOM 404: MOLECULAR ENDOCRINOLOGY AND MAMMALIAN REPRODUCTIVE PHYSIOLOGY

Course I: Neuroendocrinology and Non-classical Hormones

1. Neuroendocrinology

1.1 Hypophysiotropic hormones: localization, secretion and mechanism of action
1.1.1 TRH
1.1.2 GnRH
1.1.3 CRH
1.1.4 GHRH and PACAP
1.1.5 Somatostatin
1.1.6Monoamines
1.2 Adenohypophysis
1.2.1 Role of transcription factors in pituitary differentiation
1.2.2 Paracrine/autocrine secretions
1.2.3 Neural control of ACTH, TSH, prolactin and growth hormone
1.3 Pineal gland
1.3.1 Pineal, biological clock and calendar
1.3.2 Melatonin and photoperiodic measurement

2. Non - classical hormones

2.1 Growth factors: cellular origin, secretion and functions
2.1.1 Epidermal growth factor family (EGF and TGFα)
2.1.2 Transforming growth factor β family (TGF β, anti-Mullerian hormone, inhibins and activins)
2.1.3 Platelet-derived growth factor family
2.1.4 Fibroblast growth factor family
2.1.5 Insulin family (IGF-1 and IGF-II)
2.1.6 Nerve growth factor family
2.1.7 Hematopoietic growth factors (erythropoietin, thrombopoietin and colony stimulating factor)
2.1.8 Immunoinflammatory hormones (interleukines, TNFα and TNFβ)
2.2 Eicosanoids (prostaglandins, thromboxanes and leukotrines)
2.3 Leptin

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M.Sc. in Microbiology

Course Structure

Semester – I

S. No.	Code	Name of Subject	
1	M.Sc.Micro.111	Bacteriology & Phycology	
2	M.Sc.Micro.121	Mycology & Virology	
3	M.Sc.Micro.131	Immunology	
4	M.Sc.Micro.141	Instrumentation & Its Biological Application	

5	Practical	

Semester – II

S. No.	Code	Name of Subject	
1	M.Sc.Micro.112	Industrial Microbiology & Food Microbiology	
2	M.Sc.Micro.122	R-DNA Technology & Microbial Production of Recombinant Molecule	
3	M.Sc.Micro.132	Environmental Microbiology & Microbial Biodiversity	
4	M.Sc.Micro.142	Biochemistry & Microbial Physiology	
5	Practical		

Semester – III

S. No.	Code	Name of Subject	
1	M.Sc.Micro.211	Molecular Biology & microbial Genetics	
2	M.Sc.Micro.221	Biostatistics	
3	M.Sc.Micro.231	Medical microbiology	
4	M.Sc.Micro.241	Bioinformatics and computer application	
5	Practical		

Semester – IV

Project (Industrial & Training Project)

Semester – I

BACTERIOLOGY AND PHYCOLOGY

Unit – I

Classification of microorganisms; Haeckel's three kingdom concept, Whittaker's five kingdoms concept. Modern trends in classification. Classification and salient features of Bacteria according to Bergey's manual of systematic Bacteriology

Unit – II

-Gram- Nagative Bacteria: Spirochaetes, Aerobic or microaerophilic curved rods, Aerobic rod and cocci, Facultative aerobic rods, Anaerobers, Rickettsias and chalmydias, Anoxygenic phototrophs, Oxygenic phototrophs, 'Gliding bacteria, Sheathed bacteria Budding and/or appendages bacteria, and Chemolithotrophs.

-Gram- positive Bacteria : Cocci, Endospore forming bacteria, Regularly shaped rods, irregularly shaped rods, Mycobacteria, Actinomycetes.

-Archaeobacteria: Methanotrophs, Halophiles, and Sulfur- dependent archaeobacteria.

Unit – III

Morphology & ultrastructure of bacteria; morphological types, cell walls, cell walls synthesis, capsule, antigenic properties, cell membrane, Structure and functions of flagella, cilia, pili, chromosome, sporulation. Reserve food materials. Dormancy.

Cultivation of bacteria; anaerobic, aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements, factors affecting growth, control of bacteria-physical and chemical agents. Types of bacteria on the basis of energy and nutritional requirement. Pure culture techniques (spread plate, pour plate, streak plate), preservation methods.

Unit - IV

An introduction of Algae, General features and classification of algae. Occurrence, thallus organization and reproduction in chlorophyceae euglenophyceae, phaeophyceae, pyrrophyceae and diatoms.

Algal ecology & biotechnology. Economic importance of algae. Lichen, ascolichen, basidiolichen, deuterolichen.

MYCOLOGY AND VIROLOGY

Unit – I

An Introduction to fungi-History, genral features of fungi, Classification of fungi. Fungi and Ecosystem: Nutrition of fungi, Vitamin requirements, Saprophytism, parasitism, mutualism. Symbiotic associations of fungi: The Mycorrihizae and Lichens. Homothalism, Heterothallism, Heterokaryosis, The Parasexual cycle, Sex Hormones in

Fungi. Fungi as insect symbiont. Mycotoxins and Mycotoxicoses. Attack on fungi by other microbes. Fungal diseases of Plants. Economic Importance of fungi.

Unit - II

General Virology Breif outline on discovery of viruses, nomencature and classfication of viruses : distinctive properties of viruses; morphology & ultrastructure; capsidids & their arrangements; types of envelops and their composition-viral genome, their types and stuctures; virus related agents (viroids, prions)

Genral methods of Diagnosis and serology Cultivation of viruses in embryonated eggs, experimental animals , cell cultures; Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell lines and transgenicsystems; serological methods - heamagglutination & HAI; compliment fixation;immunofluorescenemethods,ELSA and Rodiommunoassays; assay of virusesphysical and chemial methods (Protein, nucleic acid, radioactivity, trackers,electron mocroscipy)-Infectivity assay (plague method, end point method)-Infectivity of plant viruses.

Unit – III

Bacterial viruses Becteriophage structural organisation; life cycle;one step growth curve;transcription; DNA replication; eclipse phase; phase production; burst size; lysogenic cycle; bacteriophase typing; application in bacterial genetics; brief details on M13,Mu, T3,T4 and Lamda P1

Plant viruses Classifications and nomenclature; effects of viruseson plant; appearence of plants;histology,physiology and cytology of plants; common virusesof cynabacteria, algae, fungi;life cycle;type species of plant viruseslike TMVm, Cauliflower Mosiac Virus and Potato virusX; transmission of plant viruses with vectors and with out vectors; diagnostic techniques in seeds; seed stocks and diseased plants; Prevention of crop loss due to virusinfection - virus -free planting material; vector control

Unit – IV

Animal Viruses Classfication and nomenculture of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses Picorna, Ortho myxo, paramyxo, Toga and other arthopod viuses, Rohabdo, Rota HIV and other Oncogenic Viruses; DNA viruses; Pox, Herps, Adeno SV40; Hepatitis viruses, viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunisation programmes with examples, newer generation vaccines including DNA Vaccines with examples) interferons and antiviral drugs.

IMMUNOLOGY

Unit –I

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptic immunity.

Cells and Organs of Immune System: Lymphoid cells; stem cells, B and T Lymphocytes, Natural killer cells, Mononuclear phagocytes, Granulocytic cells. Organs: Thymus, Bone Marrow, Lymphatic system, Lymph nodes, Spleen.

Unit – II

Antigens and Antibodies:-Antigens: Structure, properites, types, Epitopes, Haptens. Antibodies: Structure and function, Antibody mediated functions, Antibody classes and biological activies, Monoclonal Antibodies

Antigen-Antibody Interaction:-Precipitation reaction, Agglutination, Radioimmunoassay, ELISA, Western Blotting, Major Histocimpatibility Complex, General structure and function of MHC, MHC Molecules and Genes, Antigen Processing and presentation-T-Cell Receptors T-Cell Maturation and Differentiation, B-Cell Generation, Activation & Differentiation.

Unit –III

Immune Effecter Mechanism-Cytokinesis (Properties, receptors, antagonisis & secretion) -The complement system (functions, components, activation, regulation and deficiencies) -Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity

-Inflammation
-Hypersensitive reactions (Type I, II, III and delayed type (DTH)

Immunology in Health & Disease-Immune response to infectious diseases: viral, bacterial and protozoan.

-Vaccines, AIDS and other Immuno deficiencies, genetically designed vaccines. BCG, TB & Leprosy, DNA vaccines.

Unit –IV

Transplantation and Autoimmunity-Organ specific autoimmune diseases, Systemic autoimmune diseases,

-Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigens. Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

INSTRUMENTATION & ITS BIOLOGICAL APPLICATION

Unit 1

1. Spectroscopy: interaction of radiation with matter, absorption of radiation, emision of radiation, Beer-Lambert relationship components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry,
2. Fluorimetric methods,atomic absorption spectroscopy techniques,flame emission photometry, magnetic resonance spectroscopy,
3. Applications of different spectroscopic techniques.

Unit 2

1. Separation methods: principles of separation techniques, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC, ELISA.
2. Applications of chromatographic techniques in biology.

Unit 3

1. Membrane filtration and dialysis, electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis.
2. Isoelectric focussing, isotachophoresis, capillary electrophoresis, elution parameters, immunoelectrophoresis,
3. Applications of electrophoresis in biology.

Unit 4

1. Centrifugation: Preparative and analytical centrifuges, sedimentation analysis, RCF, zonal and equilibrium density gradients, Ultracentrifuge.
2. Microscopy: light, phase-contrast, fluorescence and electron microscopy.

Unit 5

1. Radioisotopes: nature of radioactivity, types of radioactivity, radioactive decay, units of radioactivity.
2. Detection and measurement of radioactivity. Geiger counters, scintillation counters, autoradiography.
3. Biochemical uses of isotopes (tracers, radio immunoassay).

Semester – II

INDUSTRIAL MICROBIOLOGY AND FOOD MICROBIOLOGY

Unit 1

Introduction, history and scope of industrial microbiology, major types of microorganism used in fermentation, primary & secondary screening, industrial strain improvement-strategies, selection and improvement of recombinant organisms.

Unit 2

Design and operation of various types of reactors, main components, peripheral parts and accessories, various control systems.

Unit 3

Media preparation, sterilization, kinetics of thermal death of Micro-organisms, batch, continuous and fed batch process, aeration and agitation, foam and antifoam, microbial growth kinetics, measurement of growth, effect of pH, temp, and nutrient conc. on growth.

Unit 4

Down stream processing, filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction, Electrokinetic's dialysis, flotation.

Unit 5

Industrial production of alcohol, citric, acid, solvents, amino acids, enzymes (amylase, proteases, celluloses) antibiotics, steroids and large-scale production of recombinant molecules - interferon, human proteins, vaccines.

Unit 6

Microorganisms important in food microbiology: Molds, Yeasts and Bacteria-General characteristics, classification and importance. Principles of food preservaton. Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food-Extrinsic and Intrinsic factors; Chemical preservatives and Food additives. Canning, processing for Heat treatment-D, Z, and F values and working out treatment parameters.

Unit 7

Contamination and spoilage; Cereals, sugar products, vegetables, fruits, meat and meat products, Milk products, fish and sea foods-poultry-spoilage of canned food. Detection of spoilage and characterisation. Food-borne infections and intoxications: Bacterial and nonbacterial-with example of infective and toxic types-*Brucella, Bacillus, Clostridium,Escherichia, Salmonella, Staphylococcus,Vibrio, Yersinia;* Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks-laboratory testing procedures; Prevention measures-Food sanitation in manufacture and retail trade; Food control agencies and its regulations, Plant sanitation-Employee's Health standards-waste treatment-disposal-quality control.

Unit 8

Fermented foods: bread, cheese, vinegar, fermented vegetables,fermented dairy products, oriental Fermented foods, their quality standards and control; Experimental and Induction methods,microbial cells as food (single cell proteins) and mushroom cultivation. Fermented beverages: beer and wine. Genetically modified foods.

RECOMBINANT DNA TECHNOLOGY AND MICROBIAL PRODUCTION OF RECOMBINANT MOLECULES

Unit 1

Core techniques and essential enzymes used in rDNA technology. Restriction digestion, ligation and transformation

Unit 2

Cloning vectors-plasmids, phages and comids. Cloning strategies. Cloning and selection of individual genes, gene libraries:cDNA and genomic libraries

Unit 3

Specialised cloning strategies, Expression vectors, promoter probe vectors, vectors for library construction - artificial chromosomes

Unit 4

PCR methods and application, DNA sequencing methods, dideoxy and chemical methods Sequence assembly. Automated sequencing Genome sequencing and physical mapping of genomes.

Unit 5

Requirement of recombinant molecules: in pharmaceutical, health, in research laboratories, agricultural and industrial sectors. Criteria of purity.

Unit 6

Rationale for the design of vectors for the over expressin of recombinant proteins: selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, purification tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems.

Unit 7

Over expression conditions, production of inclusion bodies, solubilization of insoluble proteins Purification protocols and up scaling. Determination of purity and activity of over expressed proteins.

ENVIRONMENTAL MICROBIOLOGY AND MICROBIAL DIVERSITY

Unit 1

Aero biology : Droplet nuclei, aerosal, assessment of air quality,-solid - liquid - impingment methods,- Breif account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures.

Unit 2

Aquatic microbiology: Water ecosystems - types -fresh water(ponds, lake, streams)- marinehabitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coralreefs). Zonations of Water ecosystems -upwelling -eutrophicaltion - food chain. Potability of water- microbial assessment of water quality- water purification - brief account of major water borne diseases and their control measures.

Unit 3

Soil Microbiology : Classification of Soil- Physical and chemicals characteristics, microflora of various soil types (bacteria and nematodes in revelence to soil types; rhizosphere- phyllosphere- brief account of microbial interactions symboisis- mutualism- commensalism -competition - amensalism- synergims - parasitims- predation ; biogeochemical cycles and their organisms, - carbon introgen - phosphorous and sulphur, biofertilizers- biological nitrogen fixation - nitrogenase enzyme - nif genis; symbiotic nitrogen fixation - (Rhizobium, Frankia)- non-symbiotic microbes- Azotobacter- Azospirillium - vesicular arbuscular mycorrhizae-VAM)- ecto, endo, entendomycorrhizae- rumen microbiology

Unit 4

Waste treatment : Wastes - types- solid and liquid wastes characterization- solid - liquid; treatments- physical, chemical, biological- aerobic- anaeorobic -primary - secondary- tratiary; solid waste tratment - saccharification- gasification- composting, utilization fo solid wastes - (SCP, mushroom,yeast): fuel(ethanol, methane) fertilizer(composting), liquid waste treatment- trickling- activated sludge- oxidation pomd- oxidation ditch. Subterranean microbes and biomediation

Unit 5

Positive and negative roles of microbes in environment: biodegradation of recalcitrant compounds - lignin - pesticides; bioaccumulation of metals and detoxification -biopesticides; biodeterioration- of paper- leather, wood textiles- metal corrosion- mode of deterioration- organisms involved -its disadvantages- mode of prevention. Gmo and theirimpact

Unit 6

Introduction to microbial diversity, distribution, abundance, ecology. Oxygenic photosynthetic microbes adn anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulphur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Unculturable and culturable bacteria-conventional and molecular methods of studying microbial diversity.

Unit 7

Microbial diversity in anoxic ecosystem - methanogens - reduction of carbon monoxide - reduction of iron, sulphur, manganese, nitrate and oxygen- Microbial transformation of carbon, phosphorus, sulphur, nitrogen and mercury. Extermophiles - acidophilic, alkalophilic; thermophilic, and oxmophilic microbes, mechanisms and adoption. Halophiles- membrance variation - electron transport; application of halophiles and extremophiles.

BIOCHEMISTRY & MICROBIAL PHYSIOLOGY

Unit - I

Chemical foundation of (i)$p^{H,}$ $p^{k,}$ acids, bases, buffers, weak bonds, free energy resonance, isomerisation. **Carbohydrates:**Monosaccharides and their relationship structure of sugars, stereo isomerism and optical isomers of sugars. Reactions of aldehyde and ketone group, ring structure and tautomeric forms, mutarotation, reaction of sufars to OH groups. Important derivatives of monosaccharides, disaccharides and trisaccharides. Structure, occurrence and biological importance of structural polysaccharides e.g. cellulose, chitin, agar, alginic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides Storage food polysacchorides: glycogen, starch.

Unit - II

Lipids : Building block of lipids, fatty acids, glycerol, sphingosine. Definition and classification of lipids, Classification of fatty acids, physico-chemical properties of fatty acids. Systematic nomenclature and classes of glycerides. Properties and function of

phospholipids, prostaglandins. Classes, structure and synthesis. Lipoproteins-classification, composition and their importance. Role of liipids in cellular architecture and functions.

Unit - III

Nucleic acids Importance of nucleic acids in living systems, general composition of nucleic acids, purine and pyrimidine bases, tautomeric forms of bases, reactions of purines an pyrimidines, structure of nucleosides and nucleotides, deoxynucleotides, cyclic nucleotides and polynucleotides. Interaction of nucleic acids with protein molecules.

Proteins: Covalent properties of proteins - Structure & chemistry of amino acids; Proteins Sequencing, covalent modification, splicing Primary, Secondary, tertiary and quarternary (folding patterns). Globular and fibrous proteins.

Unit - IV

Enzymes As biocatalyst, classification, specificity, active site,activity unit isozymes. Enzyme kinetics; Michaelis-Menton: Mention equation for simple enzymes, determination of kinetic parameters, multistep-reactions and rate limiting steps, enzymes, inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

Unit – V

Respiratory metabolism Embden Meyer Hof pathway-Entner Doudroff pathway - glyoxalate pathway-Krebs cycle-oxidative and substrate level phosphorylation - reverse TCA cycle - gluconeogenesis - Pasteur effect; fermentation of carbohydrates-homo and heterolactic fermentations.

Assimilation of nitrogen dinitrogen -nitrate nitrogen - ammonia- synthesis of major amino acids - polyamines; Synthesis of polysaccharides- peptidoglycan-biopolymers as cell components.

Semester – III

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Unit – I

Nucleic acids as genetic information carries : experimental evidence. DNA structure : historical aspects and current concepts, melting of DNA replication: general principles, various modes of replication, isolation and properties of DNApolymerases, proof reading continous and discontinous sysnthesis, Asymmetric & dimeric nature of DNA

polymerases iii and simultaneous, synthesis of leading and lagging stands, DN polymerases, exonuclease activity in eukaryotic DNA polymerases, superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases.

Unit – II

Initiation of replication of single standardDNA. Construction of replication fork in test tube. Retroviruses and their unique mode of DNA synthesis. Relation between replication and cell cycle. Inhibitors or DNA replication. repair pathways-methyl-directed mismatchrepair, very short patch repair, nucleotide excision repair, base excision repair, recombination, repair SOS system. Structural features of RNA and relation to function . Initiator and elongator class of tRNA, ribosome binding site on mRNA and corresponding site on rRNA. peptidyl transferase activity of 23S tRNA. Transcription: general principles, basic appartatus, types of RNA polymerases, steps : initiation, clongation and termination, inhibitors of RNA syntheses. Polycistronic and monocistronic RNAs. Control of transcription by interaction between RNA polymerases and parometer regions, use of alternate sigma factors, controlled termination : attenuation and altitermination

Unit – III

Regulation of gene expression: operon concept, catabolite repression instability of bacterial RNA, positive and negative regulation , inducers and corepressors. Negative regulation - E. coli lacoperon; positive regulation . E.coli ara operon; regulation by atenuation his and trp operons; antitermination - N protein and nut sites in I. DNA binding sites on DNA, Global regulatoryresponses : heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA syntheses.

Unit – IV

Maturation and processing of RNA : methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of m RNA; cutting and modification of tRNA degradation system. Catalytic RNA group I and group II intron splicing RNase P

Basic features of the genetic code. Protein synthesis : steps, details of initiation, elongation and termination, role of various factors in the above steps, inhibitors of proteinssynthesis. Synthesis of exported proteins on membrane- bound ribosomes, singal hypothesis. In vitro transcription and translation systems.

Gene transfer mechanisms- transformation, transduction, conjugation and transfection. Mechanisms and applications. Genetic analysis of microbes, Bacteria and yeast

Biostatistics

Importance and scope in biological experiments; Elements of Probability - Mathematical, Statistical and Axiomatic Definitions; Addition and multiplication. Therorems; Probability Distribution Function-Binomial, Poisson and Normal; Area under Normal Probability Distribution Curve.

Measures of Central Tendency - Arithmetic, Geometric and Harmonic Means; Measures of Dispersion - Range, Quartile Deviation, Variance, Standard Deviation, Coefficient of Variation; Confidence Limits of population Mean; Tests of Significance- Hypotheses and Errors; Student t test-Population mean equals a postulated value, Equality of 2 independent population means (Equal and Unequal Variances), Equality of 2 dependent means of a population.

Analysis of Variance-One way classification with equal and unequal sample sizes, Two way classification with one observation per cell, Completely Randomized Design, Randomized Block Design; Multiple Comparison-Isd and Duncan's New Multiple Range test; Introducation to 2^ Factorial Design.

Relation between two variable; Linear Regression - Regression diagram and equation, significance test, prediction of dependent variable from the independent one; Linear Correlation- Scatter diagrams, correlation coefficient standard error, significance tests: Relationship between

Correlation and Regression coefficients; Chi-square tests for goodness of fit, tests for association between attributes, Yate's Correction factor; Analysis of Covariance (One way classification)

MEDICAL MICROBIOLOGY

Unit 1

Early discovery of panthogenic microorganisms; developmentof bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important micro organisms; Normal microbial flora of human body; role of the resident flora; normal flora and the human host

Unit 2

Estsblishment, spreading, tissue damage and anti- phagocytic factors; mechanism of bacterial adhesion , colonization and invasion of mucous membranes of respritory, enteric and unogenital tracts, Role of aggressins, deplymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response

Unit 3

Clasifications; pathogenic bacteria. Staphylococcus, Streptococcus, Pncumococcus, Neisseria, Cornebacterium Bacillus, clostridium, Non-sporing Anaerobes, Organisms belonging to Enterbacteriacca, Vibrios, Non fermenting gram negative bacilli Yersinsa; Haemophilus; Bordetella, Brucella; Mycobacteria, Spirochaetes, Anctiomycetes; Rickettsiac, Chalmdiac

Unit 4

General properties of Viruses; Viruses Host interactions ; Pox viruses ; Herps virus; Picarno Viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses(AIDS). Dermatophytes, dimophic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis

Unit 5

Laboratory control of antimicrobial therapy; various methods of drug susceptiblity testing, antibiotic assay in body fluids. Brief account on available vaccines and Schedules; passive prophylactic measures; Noscomical infection, common types of hospital infections and their diagnosis and control

Unit 6

Prolaryotic & eukaryotic signalling mechanissms: eukaryatic cell to cell signaling, endocrine signaling, Ajlikins, prokaryotic signaling, quoreem sensing and bacterial pheromones, intracellular signaling, signaling pathways.

Unit 7

Injection and cell -cell interactions; bacterial adherence: basic principles, effects of adhesion on bacteria, effect of adhesion on host cells. Bacterial invasion of host cells; mechanism, consequence of invasion, and survival after invasion. Protein toxins: agents of diseases.

Bioinformatics and Computer Application

Introduction of Bioinformatics: The nature of chemical bonds, Introduction to Genes and Proteins, Nucleotides, Orientation, Base pairing, The central dogma, Promoter sequences, Genetic Code, ORFs, Introns and Exons, Slice variants, Protein structure, Primary, Secondary, Tertiary and Quaternary, The notation of homology. Introduction to Data Generating Techniques: Restriction Enzymes, Gel Electrophoresis, Blotting and Hybridization, Cloning, PCR. Biological databases, Search engines, Public databases: PubMED, EMBL, GenBanK, PDB, Swiss-Port. Genomics and Proteomics: Prokaryotic genomes, Eukaryotic Genomes, Gene Structure, GC Content in Eukaryotic genomes, Gene Expression, Protein Classification, 2D–Electrophoresis, Mass spectrometry, Microarray technology, X–ray crystallography, NMR, Sequence and Phylogeny Analysis, Detecting ORFs, Outline of sequence alignment, Introduction to BLAST, Multiple sequence alignment, Phylogenetic analysis.

Introduction to computer fundamental, Organization, low- Level and high-level languages, Permanent storage of number system, flow charts and programming techniques (Logic and algorithm) Decimal to binary and vice-versa; binary coded decimal number.

Introduction to MS-Office software covering word-processing, spreadsheets and presentation software. Introduction to Hardware graphics/ Corel draw.

Application of computer in Biostatistical problems. Frequently table of single discrete viable, bubble sort, computation of mean, variance and standard deviation, t-test, correlation coefficient.

Computer in biology: Sequence databases; sequence analysis of proteins and nucleic acids, structure prediction, simple molecular modeling, computer aided drug designing.

Project & Training

Dissertation.The Project work will involve in depth practical work on a problem suggessted by the supervisor of the candidate.The student will submit the dissertation of the work done.The dissertation submitted by the candidate shall be evaluated by one external expert,head of the department and supervisor of the candidate.The seminars, in-plant training and industrial visit reports will also be submitted by the candidate to the Head of the Department who will submit these to the external examiner.The examination shall be held in the department and the disertation etc.will NOT be required to be mailed to the external examiner.The distribution of the marks will be as under.

Disertation 100 marks

Viva Voce	50 marks
Seminar reports	25 marks
Industry visit report	25 marks
Total	200 marks

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M.PHIL. – BIOTECHNOLOGY

Scheme of Examination

S.No.	Paper Code	Name of Paper	Max. Marks	Duration
1.	M.PhilBT 111	Biostatistics	100	3 Hrs.
2.	M.PhilBT 112	Modern Molecular Biology	100	3 Hrs.
3.	M.PhilBT 113	Plant & Animal Biotechnology	100	3 Hrs.
4.	M.PhilBT 114	Dissertation	100	-
Total			400	

Paper – I

Biostatistics (M.PhilBT 111)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – III

Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Hypothesis – Fundamentals of Hypothesis Testing, Standard Error, Point and Interval Estimates, Important Non-Parametric Tests: Sign, Run, Kruskal, Wallis tests and Mann-Whitney Test.

Unit – IV

Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

Research Report: Types of Reports, Styles of reporting, Seeps in drafting reports, Editing the final draft, Evaluating the final draft.

Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Paper – II

Modern Molecular Biology (M.PhilBT 112)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Genome Organization in prokaryotes: Viral genome, bacterial genomes, genome size, content and complexity, clusters and repeats, overlapping genes, pseudogenes.

Genome organization in eukaryotes: Eukaryotic genomes, chromosome structure and DNA sequence organization, organization of genes in chromosomes, interrupted genes, repetitive DNA, chromatin remodeling.

Unit – II

Molecular mechanism of gene regulation: Regulation of gene expression in prokaryotes, regulation of gene expression in eukaryotes, promoters, enhancers, silencers and insulators, post-transcriptional and post-translational events, DNA-protein interactions.

Unit – III

Cellular signaling and trafficking: Cell signaling and signal transduction, protein trafficking, protein localization and molecular chaperones.

Cellular physiology and molecular biology of specialized tissues: Molecular biology of cancer and ageing, molecular and genetic control of apoptosis, mechanism of HIV infection.

Unit – IV

Genomics and proteomics: Cloning a genome, genome sequencing, sequence comparisons and alignment, data mining for gene hunting, useful tools and websites on the internet for genome sequencing, gene arrays, comparative genomics, proteomics, metabolomics, pathway analysis.

Ref. books: T.A. Brown, Frief Fielder, Primrose.

Paper – III

Plant & Animal Biotechnology (M.PhilBT 113)

Maximum Marks: **100** **Times Allowed:** **3 Hrs.**

Unit – I

Gene delivery method in intact and cultured tissues and cells, Agrobacterium, Ti-Plasmid, cointegration and binary vectors, viral vectors, direct DNA uptake, microinjection delivery, use of 35S and other promoters, genetic markers, use of reporter genes.

Techniques for production of transgenic plants resistant/ tolerant to herbicides; pathogens, pests and abiotic stresses (drought, salt, frost), transgenic plants for production of molecules of commercial importance.

Unit – II

Mycorhiza; its importance in agriculture and forestry, plant diseases; general account, predators, parasites, insects, viruses, antagonistic fungi and bacteria, biological control of pests and diseases of crop plants, bio-pesticides, insecticidal activated compounds of botanicals.

Unit – III

Embryo transfer technology, principles and application, production of transgenic animals; pig, sheep, goat and cows, Techniques and applications of gene therapy, vector engineering, strategies of gene delivery, gene replacements/ augmentation, gene corrections, gene editing, gene regulation and silencing.

Unit – IV

Aquaculture and marine biotechnology sex reversal in fish, sterile fish culture, transgenic fish, carp production systems; marine and fresh water pearl oyster culturing, shrimp farming, formulation of feeds, cell culture based vaccines.

Ref. books: P.K. Gupta, Ian Freshney.

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M.PHIL. – Microbiology

Scheme of Examination

S.No.	Paper Code	Name of Paper	Max. Marks	Duration
1.	M.PhilMicro. 111	Biostatistics	100	3 Hrs.
2.	M.PhilMicro. 112	Modern Molecular Biology	100	3 Hrs.
3.	M.PhilMicro. 113	Industrial Microbiology	100	3 Hrs.
4.	M.PhilMicro. 114	Dissertation	100	-
Total			400	

Paper – I

Biostatistics (M.Phil.Micro. 111)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – III

Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Hypothesis – Fundamentals of Hypothesis Testing, Standard Error, Point and Interval Estimates, Important Non-Parametric Tests: Sign, Run, Kruskal, Wallis tests and Mann-Whitney Test.

Unit – IV

Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

Research Report: Types of Reports, Styles of reporting, Seeps in drafting reports, Editing the final draft, Evaluating the final draft.

Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Paper – II

Modern Molecular Biology (M.Phil.Micro. 112)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Genome Organization in prokaryotes: Viral genome, bacterial genomes, genome size, content and complexity, clusters and repeats, overlapping genes, pseudogenes.

Genome organization in eukaryotes: Eukaryotic genomes, chromosome structure and DNA sequence organization, organization of genes in chromosomes, interrupted genes, repetitive DNA, chromatin remodeling.

Unit – II

Molecular mechanism of gene regulation: Regulation of gene expression in prokaryotes, regulation of gene expression in eukaryotes, promoters, enhancers, silencers and insulators, post-transcriptional and post-translational events, DNA-protein interactions.

Unit – III

Cellular signaling and trafficking: Cell signaling and signal transduction, protein trafficking, protein localization and molecular chaperones.

Cellular physiology and molecular biology of specialized tissues: Molecular biology of cancer and ageing, molecular and genetic control of apoptosis, mechanism of HIV infection.

Unit – IV

Genomics and proteomics: Cloning a genome, genome sequencing, sequence comparisons and alignment, data mining for gene hunting, useful tools and websites on the internet for genome sequencing, gene arrays, comparative genomics, proteomics, metabolomics, pathway analysis.

Ref. books: T.A. Brown, Frief Fielder, Primrose.

Paper-III

INDUSTRIAL MICROBIOLOGY (M.Phil.Micro. 113)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit 1

Introduction, history and scope of industrial microbiology, major types of microorganism used in fermentation, primary & secondary screening, industrial strain improvement-strategies, selection and improvement of recombinant organisms.

Unit 2

Design and operation of various types of reactors, main components, peripheral parts and accessories, various control systems.

Unit 3

Media preparation, sterilization, kinetics of thermal death of Micro-organisms, batch, continuous and fed batch process, aeration and agitation, foam and antifoam, microbial growth kinetics, measurement of growth, effect of pH, temp, and nutrient conc. on growth.

Unit 4

Down stream processing, filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction, Electrokinetic's dialysis, flotation.

Unit 5

Industrial production of alcohol, citric, acid, solvents, amino acids, enzymes (amylase, proteases, celluloses) antibiotics, steroids and large-scale production of recombinant molecules - interferon, human proteins, vaccines.

Unit 6

Microorganisms important in food microbiology: Molds, Yeasts and Bacteria-General characteristics, classification and importance. Principles of food preservaton. Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food-Extrinsic and Intrinsic factors; Chemical preservatives and Food additives. Canning, processing for Heat treatment-D, Z, and F values and working out treatment parameters.

Unit 7

Contamination and spoilage; Cereals, sugar products, vegetables, fruits, meat and meat products, Milk products, fish and sea foods-poultry-spoilage of canned food. Detection of spoilage and characterisation. Food-borne infections and intoxications: Bacterial and nonbacterial-with example of infective and toxic types-*Brucella, Bacillus, Clostridium,Escherichia, Salmonella, Staphylococcus,Vibrio, Yersinia;* Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks-laboratory testing procedures; Prevention measures-Food sanitation in manufacture and retail trade; Food control agencies and its regulations, Plant sanitation-Employee's Health standards-waste treatment-disposal-quality control.

Unit 8

Fermented foods: bread, cheese, vinegar, fermented vegetables,fermented dairy products, oriental Fermented foods, their quality standards and control; Experimental and Induction methods,microbial cells as food (single cell proteins) and mushroom cultivation. Fermented beverages: beer and wine. Genetically modified foods.

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M.PHIL. – BOTANY

Scheme of Examination

S.No.	Paper Code	Name of Paper	Max. Marks	Duration
1.	M.PhilBOT. 111	Biostatistics	100	3 Hrs.
2.	M.PhilBOT. 112	Modern Molecular Biology	100	3 Hrs.
3.	M.PhilBOT. 113	Plant Physiology	100	3 Hrs.
4.	M.PhilBOT. 114	Dissertation	100	-
Total			400	

Paper – I

Biostatistics (M.PhilBOT. 111)

Maximum Marks: 100 **Times Allowed:** 3 Hrs.

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – III

Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Hypothesis – Fundamentals of Hypothesis Testing, Standard Error, Point and Interval Estimates, Important Non-Parametric Tests: Sign, Run, Kruskal, Wallis tests and Mann-Whitney Test.

Unit – IV

Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

Research Report: Types of Reports, Styles of reporting, Seeps in drafting reports, Editing the final draft, Evaluating the final draft.

Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Paper – II

Modern Molecular Biology (M.PhilBOT. 112)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Genome Organization in prokaryotes: Viral genome, bacterial genomes, genome size, content and complexity, clusters and repeats, overlapping genes, pseudogenes.

Genome organization in eukaryotes: Eukaryotic genomes, chromosome structure and DNA sequence organization, organization of genes in chromosomes, interrupted genes, repetitive DNA, chromatin remodeling.

Unit – II

Molecular mechanism of gene regulation: Regulation of gene expression in prokaryotes, regulation of gene expression in eukaryotes, promoters, enhancers, silencers and insulators, post-transcriptional and post-translational events, DNA-protein interactions.

Unit – III

Cellular signaling and trafficking: Cell signaling and signal transduction, protein trafficking, protein localization and molecular chaperones.

Cellular physiology and molecular biology of specialized tissues: Molecular biology of cancer and ageing, molecular and genetic control of apoptosis, mechanism of HIV infection.

Unit – IV

Genomics and proteomics: Cloning a genome, genome sequencing, sequence comparisons and alignment, data mining for gene hunting, useful tools and websites on the internet for genome sequencing, gene arrays, comparative genomics, proteomics, metabolomics, pathway analysis.

Ref. books: T.A. Brown, Frief Fielder, Primrose.

Paper – III

Plant Physiology (M.Phil.BOT 113)

Maximum Marks: 100 **Times Allowed: 3 Hrs.**

Unit – I

Diffusion and water potential, Osmosis, Photosynthesis, Chloroplasts and Light, Photosynthesis-Environmental and agricultural aspects, Transpiration, The Ascent of sap, Mineral Nutrition, Absorption of mineral salts, Transport in the phloem.

Unit – II

Enzymes, Proteins, Amino Acids, Carbon Dioxide fixation and Carbohydrate synthesis, Respiration, Assimilation of Nitrogen and Sulfur, Lipids and Other natural products.

Unit – III

Growth and Development, Hormones and Growth regulators- Auxins and Gibberellins, Hormones and Growth Regulators-Cytokinins, Ethylene, Abscisic Acid, and Other Compounds, Differential Growth and Differentiation, Photomorphogenesis, Biological Clock, Growth Responses to temperature, Photoperiodism.

Unit – III

Environmental Physiology – Environment, Principles of plant response to environment, Ecotypes: The role of Genetics, Plant Adaptations to the radiation environment, Allelochemics and Allelopathy, Herbivory.

Stress Physiology – Stress, Stressful environments, Water Stress: Drought, Cold, and Salt, Mechanisms of plant response to water and related stresses, Chilling Injury, High-Temperature Stress, Acidic soils, Other Stresses.

Ref. books: 1. Salisbury & Ross-Plant Physiology.

2. V.K. Jain-Introduction to Plant Physiology.

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M.PHIL. – Zoology

Scheme of Examination

S.No.	Paper Code	Name of Paper	Max. Marks	Duration
1.	M.PhilZool. 111	Biostatistics	100	3 Hrs.
2.	M.PhilZool. 112	Modern Molecular Biology	100	3 Hrs.
3.	M.PhilZool. 113	Animal Physiology	100	3 Hrs.
4.	M.PhilZool. 114	Dissertation	100	-
Total			400	

Paper – I

Biostatistics (M.PhilZool. 111)

Maximum Marks: 100 **Times Allowed:** 3 Hrs.

Unit – I

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature.

Unit – II

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling.

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Unit – III

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Parametric Tests: Testing of significance- Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Co-efficient. Chi-square tests, ANOVA-One way and two ways.

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Ref. books:

1. Statistical Methods by S.P. Gupta.

2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

Paper – II

Modern Molecular Biology (M.PhilZool. 112)

Maximum Marks: 100 **Times Allowed:** 3 Hrs.

Unit – I

Genome Organization in prokaryotes: Viral genome, bacterial genomes, genome size, content and complexity, clusters and repeats, overlapping genes, pseudogenes.

Genome organization in eukaryotes: Eukaryotic genomes, chromosome structure and DNA sequence organization, organization of genes in chromosomes, interrupted genes, repetitive DNA, chromatin remodeling.

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Unit – IV

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Ref. books: T.A. Brown, Frief Fielder, Primrose.

Paper-III

Animal Physiology (M.PhilZool. 113)

Maximum Marks: **100** **Times Allowed:** **3 Hrs.**

Unit – I

Thermoregulation and cold Tolerance: Basic Principles of metabolism, Endotherms Vs Ectotherms Counter-Current heat exchanger, Torpor, hibernation and aestivation, Adaptations to very cold environments

Ionic and Osmotic Balance: Osmoregulation vs. osmoconfirming, Osmoregulation in aquatic and terrestrial environments, Kidney function and diversity, Other osmoregulatory organs, Nitrogenous waste excretion

Unit – II

Gas Exchange and Acid-base Balance: Oxygen and Carbon dioxide transport in blood, The role of hemoglobin, Responses to altitude and hypoxia, Swim bladder inflation in fish, Regulation of body Ph, Gas transfer in air and water; gas exchanger design and function.

Muscle Function and Movement: Anatomy of muscle, Regulation of contraction, Excitation-contraction coupling, Molecular theory of muscle contraction.

Unit – III

Nervous System: Anatomy of nervous system, Neurons and membrane excitation, Electrochemical potentials, Action potentials, Transmission between neurons, Synapses and neurotransmitters.

Sensory Transduction: Sensing the environment, Auditory receptors, Chemoreceptors;taste and smell, homing in salmon, Mechanorceptors tactile systems and escape responses, Vision and Photoreception, Thermoreception and infrared detection, prey detection in snakes, Echolocation and bats.

Unit – IV

Digestion and Metabolism: Nutritional uptake and distribution, Effects of starvation.

Endocrinology: Aims and scope of endocrinology, Discovery of hormones, Hormones as messengers, Classification of hormones, Phylogeny of endocrine glands, Ontogeny of endocrine glands, Neuroendocrine system and neurosecretion, General principles, structure and hormone action, Hormones, Growth and Development, Hormones and Reproduction

Stress Biology: Basic concept of environmental stress and strain concept of elastic and plastic strain; stress resistance, stress avoidance and stress tolerance, Adaptation, Acclimation and acclimatization, Concept of homeostasis, Physiological response to oxygen deficient stress, Physiological response to body exercise, Meditation, yoga and their effects.

Ref. books: Animal Physiology: Adaptation and Environment, Schiemdt Neilsen. Cambridge, Text Book of Endocrinology, R.H.Williams. W.B. Saunders.