MASTER OF SCIENCE (M.Sc.)
IN
MOLECULAR BIOLOGY AND GENETIC ENGINEERING

PROGRAM STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

EMBLEM

EXPERT COMMITTEE INBIOSCIENCES (PG)
MAHATMA GANDHI UNIVERSITY

2019

EXPERT COMMITTEE IN BIOLOGICAL SCIENCES (PG)

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Former Head, Molecular Biology & Genomics Lab, RRI, Kottayam

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Table of Contents

M. Sc. Molecular Biology & Genetic Engineering

(Mahatma Gandhi University Regulations PGCSS2019 from 2019-20 Academic Year)

1. Aim of the Program

Molecular Biology is a coherent set of principles, concepts and applications pertaining to nucleic acids and proteins. In other words, it includes all the emergent properties of life from atoms to ecosystem. One of the larger goals of modern molecular biology is to elucidate the connections between the genotype and the phenotype of all organisms in terms of genetics and biochemistry at molecular level. It is concerned, particularly with the interactions between DNA, RNA and protein and learning how these interactions are regulated to metabolism. Genetic engineering as a tool of molecular biology provides all the techniques used to identify, replicate, modify and transfer the genetic material for the complete management of genomes.

2. Eligibility and Admission

Graduation in Biotechnology, Bioinformatics, Medicine, Veterinary science, Agriculture, Biophysics, Biochemistry, Chemical Science and other Biological Sciences from a university recognized by the UGC with not less than 55% marks in aggregate. Graduates of Biomedical Engineering and Biotech Engineering are also eligible. Selection of candidates for the above course will be on the basis of general merit in subjects of specialization in their graduation, performance in entrance examination and interview.

3. Medium of instruction and Assessment

Course of study will be extended over a period of two academic years under four semester system.

a. Scheme of examination

The examination for the award of degree will consist of theory and practical papers, dissertation and comprehensive viva-voce. There will be examinations at the end of each semester for theory and practicals. The entire programme consists of 17 papers distributed in I, II III and IV semester. The first, second & third semester includes 3 theory papers and 1 practical for each semester. Additionally three elective papers are included in the third and fourth semester (One elective in III semester and two elective in IV semester). For the research evaluation, Project work and Comprehensive viva are included in IV semester of the course as two papers. The dissertation

will be submitted at the end of 4th semester. There will be a presentation of project work along with the comprehensive viva-voce at the end of the 4th semester.

b. Dissertation

Each candidate will submit a dissertation in four copies of the research project undertaken by him/her at the end of 4th semester to the University for valuation.

c. Comprehensive Viva-voce

This will be held at the end of the 4th semester and will cover all the topics of course along with the presentation of the dissertation work.

4. Faculty under which the degree is Awarded

M.Sc. in Molecular Biology and Genetic Engineering

5. Specialization offered, if any

Nil

6. Note on compliance with the UGC minimum standards for the conduct and award of Post Graduate Degrees.

7. THE PROGRAM STRUCTURE

Semester	Course	Title of the paper		Teaching hrs/	Credit	Total Credit
	SEMESTER-I					
I	BS030101	Fundamental Genetics	Core	5	5	19
	BS030102	Molecular organization of Chromosome; Theory of Heredity	Core	5	5	
	BS030103	Molecular structure of Nucleic Acid; Gene Regulation & Expression	Core	5	5	
	BS030104	Biochemistry & Genetics -Practical-I	Core	10	4	
	SEMESTER-II					
II	BS030201	Biomolecules- Synthesis, Structure and Metabolism	Core	5	5	19
	BS030202	Molecular analysis of Biomolecules	Core	5	5	
	BS030203	Oncogenes, Immunopathogenisis and Diagonostics.	Core	5	5	
	BS030204	Microbiology, Immunology & Molecular biology -Practical-II	Core	10	4	
	SEMESTER-III					
III	BS030301	Genetic Engineering, Bioethics & IPR	Core	4	5	23
	BS030302	Transgenics- Animals and plants.	Core	4	5	
	BS030303	Genomics& Proteomics.	Core	4	5	
	BS860301	Elective paper-1, Concepts and Methods of Research	Elective	3	4	
	BS030304	PCR technology, Bioinformatics, Animal Cell & Tissue culture-Practical-III	Core	10	4	
	SEMESTER-IV					
IV	BS860402	Elective paper-2, Molecular Markers & Genome Analysis	Elective	5	4	19
	BS860403	Elective paper-3, Biotechnology Entrepreneurship	Elective	5	4	
	BS030401	Research Practical Training	Core	10	3	
	BS030402	Research Course work & Research Project	Core	5	5	
	BS030403	Comprehensive Viva-Voce	Core		3	

80 Credit

ELECTIVE PAPERS OF III & IV SEMESTER

Course Code	**Title of the Course**	
BS860301	Electives Group- A	**Concepts and Methods of Research**
BS860402		**Molecular Markers & Genome Analysis**
BS860403		**Biotechnology Entrepreneurship**
BS870301	Electives Group- B	**Molecular Diagnosis of viral diseases**
BS870402		**Recombinant drugs and their applications in Nano biotechnology**
BS870403		**Molecular therapy in Neurodegenerative disorders**

SEMESTER I

Papers	Subjects
BS030101	**Fundamental Genetics**
BS030102	**Molecular organization of Chromosome; Theory of Heredity**
BS030103	**Molecular structure of Nucleic Acid; Gene Regulation & Expression**
BS030104	**Biochemistry & Genetics -Practical-I**

Course name:BS030101: FUNDAMENTAL GENETICS

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

The course 'Fundamental Genetics' has been designed with an objective to reveal all the fundamental concepts of Genetics and provide a strong background in the principles of classical Mendelian genetics.

2. Course Content:

Unit 1: (10 Hrs)

Introduction to genetics - Great milestones in genetics, Levels of genetic analysis, Genetics in agriculture, medicine and society, Basic cell types, structure and evolutionary relationships, Overview of prokaryotic and eukaryotic cells.

Unit 2: (15 Hrs)

Basic principles of Heredity, Mendelian principle of inheritance - Experiments of Mendel, Principle of segregation of genes, Principle of independent assortment, test cross and back cross with unlinked genes, Extensions and modifications of Mendelian principles – Complete, incomplete & co-dominance, Penetrance and Expressivity, Gene interaction with epistasis. Application of probability and chi-square in genetics, Multiple alleles, Complex genetics of coat color in dogs, lethal alleles.

Unit 3: (20 Hrs)

Linkage, recombination and crossing over - Linked genes, Coupling and repulsion, Crossing over and recombination with linked genes, Linkage and recombination between two genes and three genes, Linkage mapping with recombination frequency, Physical chromosome mapping, Effect of multiple crossovers, Tetrad analysis.

Quantitative genetics & polygenic inheritance - Inheritance of quantitative traits, Genetic analysis of quantitative traits using statistics, Polygenic inheritance, Determining gene number for a polygenic character, Usage of heritability in predicting the variation of phenotypes.

Unit 4: (30 Hrs)

Genetics of organelles - Biology of mitochondria & chloroplasts. Mitochondrial genome, Chloroplast genome, Organelle heredity, Evolutionary origin of organelles, Cytoplasmic inheritance, Patterns of extra nuclear inheritance, Inter genomic exchange of genetic Information, Mitochondrial DNA & aging in human, Tracing human history through mitochondrial DNA, Human mitochondrial mapping. Maternal, paternal and infectious inheritance, Sex linked and sex influenced characters, Genetic maternal effect. Human pedigree analysis & applications- Study of human genetic characteristics, Pedigree analysis, Inheritance of autosomal and sex-linked characters, Genetic mapping in human pedigrees, Assessment of linkage in human pedigrees using Lod scores. Molecular markers in human pedigrees, Twin studies, Adoption studies, Genetic counseling, Eugenics, Genetic Testing (Pre-natal & Post-natal).

Unit 5: (15 Hrs)

Microbial genetics - Bacterial genetics, Mutant phenotype, Mechanism of genetic exchange, DNA-mediated transformation, Conjugation, Transduction, Genetic mapping in prokaryotes, Developmental genetics of drosophila, Population genetics, Environment and genetics, Clinical genetics, Evolutionary genetics.

3. Recommended Text books

1. Principles of Genetics by Snustad& Simmons, 6th edition
2. Genetics: A conceptual approach by Benjamin Pierce, 4th edition
3. Essential Genetics - A genomic perspective by Hartl& Jones, 4th edition

4. Recommended References

1. Genetics: A molecular approach by Peter Russell, 2nd edition
2. Principles of Genetics by Robert H Tamarin, 7th edition
3. Schaum's outline genetics by Elrod & Stansfield, 4th edition

Course name:BS030102: MOLECULAR ORGANIZATION OF CHROMOSOME; THEORY OF HEREDITY

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

The course provides a broad coverage of the knowledge, techniques and application of molecular organization of prokaryotic and eukaryotic chromosomes, chromosome anomalies, mutations and gene mapping. So the precise objectives are to understand the molecular organization of chromosomes in prokaryotes, eukaryotes and to give a detailed description of the mechanisms chromosome structural and numerical anomalies and mutations including genetic mapping. Successful completion of this course material will enable the students to understand the basic principles of the discipline, to have a broad over-view of molecular organization of chromosomes and to undertake advanced study in any of the various sub-disciplines.

2. Course content:

Unit 1: (20 Hrs)

An overview of Chromosome, Prokaryotic and Eukaryotic Chromosomes, Chromosome Theory of Heredity- Determinants, Factors and Genes are located on Chromosomes, relating Genetic crosses to Meiosis. Sex Chromosomes and Sex determination- Sex determination in Human, Drosophila and Other animals.Dosage Compensation- Hyper activation of X-linked genes in Male Drosophila and Inactivation of X-linked genes in Female Mammals.History of DNA molecule & discoveries since 1953 till date- Major contributions of Molecular biologists viz., Pauling, Corey, Fraser, Watson, Wilkins, Jerry Donohue, Rosalin Franklin in DNA research.

Unit 2: (10 Hrs)

Key events of the cell cycle and its regulation.Unique aspects of Eukaryotic Chromosome Replication, Nucleosome assembly during chromosome replication. Replication of chromosome termini

Unit 3:- (20 Hrs)

Cytological Techniques of Chromosome Analysis- Analysis of Mitotic Chromosomes, Human Karyotype, cytogenetic variation. Structural organization of Prokaryotic Chromosome - Prokaryotic Chromosome is packed into small space; Chromosomes of Prokaryotes are highly coiled. Structural organization of Eukaryotic Chromosome- Chromosome structure in Eukaryotes, Chemical composition of Eukaryotic Chromosomes, One large DNA molecule per Chromosome, 3 levels of DNA packaging in Eukaryotic Chromosomes, Structure of chromosome changes during the Cell cycle.

Unit 4:- (20 Hrs)

Chromosome Mutations- Nature of Mutation, Study of Mutations. Rearrangements of Chromosome Number- Polyploidy (Sterile polyploids, Fertile polyploids, Tissue-specific polyploidy and Polyteny); Aneuploidy (Trisomy, Monosomy, Deletions and Duplications of Chromosome segments), Aneuploidy is a Gain or Loss of individual chromosomes. Rearrangements of Chromosome Structure- Inversions, Translocations, Compound Chromosomes and Robertsonian Translocations.

Unit 5:- (20 Hrs)

Molecular Organization of Chromosomes- Unique and Repetitive Nucleotide sequences in Eukaryotic Genomes, Molecular structure of Centromere; Molecular structure of Telomere. Lampbrush chromosome, Polytene chromosome; Transposable elements are ubiquitous, Genomic instability caused by Transposable elements, Eukaryotic Transposable elements, Biological significance of Transposable elements; Genome size and Evolutionary Complexity; C- value paradox.

3. Recommended Text Books

1. Molecular biology of genes by Watson, Baker, bell, Gann, Levin &Losick, 5th edition
2. Cell & Molecular biology by Derobotis&Derobotis, 8th edition
3. Genes IX, by Lewin

4. Recommended References

1. Genetics: Analysis of genes and Genomes – Daniel L. Hartl, Elizabeth W.Jones.
2. Modern Genetic analysis by Griffith, Cebart, Lewontin& miller, 2nd edition.

Course name:BS030103: MOLECULAR STRUCTURE OF NUCLEIC ACID, GENE REGULATION AND EXPRESSION

Total Credits : 5

Total Hours : 90 Hrs.

1. Objective of the Course:

This part of the course deals with history of nucleic acid discovery, chemistry ,physical nature and how these molecules interact within the cell to promote proper growth, division, and development This course will emphasize the molecular structure of DNA, RNA, molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation in prokaryotes and eukaryotes. The course also explains techniques and experiments used to discern these mechanisms, often referring to the original scientific literature up to the level of RNA interference (RNAi).

2. Course content:

Unit 1:- (18 Hrs)

Physical and chemical nature of DNA- Genetic material, chemical nature, Double helix molecule, types of DNA. How genes function at molecular level- The central dogma, Replication, Transcription, Translation, post-transcriptional modifications in Eukaryotes, the interrupted gene. Supercoiling of DNA. Molecular biology of DNA replication- DNA replication is Semi-conservative, Messelson-Stahl experiment, Multiple origins and Bi-directional DNA replication in Eukaryotes, Replication of virus & theta-Replication of circular DNA molecules, Rolling circle replication, Plasmid DNA using a rolling circle, Unwinding, Stabilization and Stress relief, Initiation by Primosome complex, Chain elongation and proof reading, discontinuous replication of the lagging strand, Terminator sequencing of DNA.

Unit 2:- (12 Hrs)

Molecular mechanism of recombination- Homologous and site specific, Gene conversion, Mismatch repair, The Holiday model of recombination, Single strand break and repair model. Alteration of gene expression by DNA sequence rearrangements in *Salmonella, Trypanosoma* and others. Genomic position effects on gene expressions- Position effects, variegation effect and PEV.

Unit 3:- (20 Hrs)

Regulation of gene expression- Transcriptional control I & II, Expression of *lac* operon, Attenuation, Antitermination, Methylation, Yeast GAL regulatory pathway, Molecular mechanism of gene regulation- Transcriptional regulation in prokaryotes and eukaryotes, Lactose metabolism, The operon system of gene regulation, Regulation of Tryptophan operon, Regulation of bacteriophage

lambda, Epigenetic mechanisms of transcriptional regulation, Translational control and Programmed DNA arrangement.

Unit 4:- (20 Hrs)

RNA molecules & RNA processing- Gene structure, Structure and processing of mRNA, tRNA, rRNA, small interfering RNAs and micro RNAs, Regulation through RNA processing and decay, Alternative splicing, mRNA stability, co-separation through RNA turn over and RNA interference (RNAi).

Unit 5:- (20 Hrs)

Molecular mechanisms of mutation and DNA repair- Types of Mutations, Molecular basis of Mutation, Spontaneous Mutation, Reverse Mutation and Suppressor Mutations, Transposable elements, Mutagens, mechanism of DNA repair. The genetic code and translation- Molecular relation between Genotype & Phenotype, The genetic code, Process of translation and protein synthesis. Transposons, Retroviruses, and Retroposons.

3. Recommended Text Books

1. Molecular biology of genes by Watson, Baker, bell, Gann, Levin &Lodish, 5th edition.
2. DNA the secret of life by Watson, Bessy & Andrew, 1st edition.

4. Recommended References

1. Biochemistry & Molecular biology by Elliott & Elliott, 3rd edition.
2. Biochemistry of Nucleic acids by Adams, Knowler& Leader, 11th edition.
3. Molecular biology by Freifelder, 2nd edition.
4. Genetics – Analysis of Genes and Genomes by Daniel L.Hartl, Maryellen Ruvolo, 8th edition.
5. Genes VI by Benjamin Lewin, 6th edition.

Course name:BS030104: BIOCHEMISTRY & GENETICS –PRACTICAL- I

Total Credits : 4

Total Hours : 180 Hrs.(10 Hrs/week)

1. **Objectives of the Course:**

Molecular Biology and Genetic engineering is an area of multidisciplinary science involving a variety of distinct subjects, where living organisms or their useful parts are put into effective use to cater to the welfare of humanity. It enables us to produce a totally new organism by inserting specific useful traits, which it may not contain naturally within it. There are many advanced techniques which have stimulated the progress of the Molecular biology research. Our aim is to impart this knowledge by theoretical as well as practical methods through laboratory experiments.

2. **Course content:**

Unit 1:(80 Hrs)

Biochemistry

1. Preparation of Solutions: Molar, Normal and Percentage solutions and calculations
2. Calibration of pH meter and determination of pH of solutions
3. Preparation of Buffers: Phosphate buffer, Tris- HCl buffer, Citrate buffer, Acetate buffer
4. Isolation and Estimation of Proteins: Lowry's method, modified Lowry's method and Bradford method.
5. Isolation and Estimation of Total carbohydrates by Anthrone method
6. Isolation and Estimation of Reducing sugars by DNS method
7. Extraction and Estimation of Total lipids: Wet method: by chloroform/ Methanol extraction., Dry method - by Soxhlet extraction
8. Estimation of amino acids by Ninhydrin method
9. Estimation of growth hormones-IAA
10. Estimation of Antioxidants- Vitamin C
11. Enzyme Assays: Isolation and assay of Adenosine triphosphatase (ATPase), Peroxidase (POX). Determination of total enzyme activity and specific activity.
12. Factors affecting activity and determination of Kinetics of Peroxidase enzyme.

Unit 2 (6 Hrs)

Cytology

Cell division by Mitosis, Cell division by Meiosis:

Unit 3 (4 Hrs)

Genetic problems

Problems on Mendelian and non- Mendelian Inheritance

Unit 4 (90 Hrs)

Genomics- I

1. Isolation and purification of Genomic DNA from plant tissue
2. Isolation Genomic DNA from blood
3. Isolation of Genomic DNA from microbial source
4. Gel documentation of DNA by agarose gel electrophoresis
5. Spectrophotometric quantification of DNA.

3. Recommended Text Books

1. Laboratory Procedure Manual – Biotechnology Division, SSTM, Cochin
2. Molecular Cloning– Sambrook&Russels
3. Practical Biochemistry – David T Plummer

4. **Recommended References**

1. Genetics Conceptual Approach – Benjamin.A.Pierce
2. Cell Biology – de Robertis
3. Protein Purification – Robert Scoop

SEMESTER II

Papers	Subjects
BS030201	**Biomolecules- Synthesis, Structure and Metabolism**
BS030202	**Molecular analysis of Biomolecules**
BS030203	**Oncogenes, Immunopathogenisis and Diagonostics.**
BS030204	**Microbiology, Immunology & Molecular biology -Practical-II**

Course name:BS030201: Biomolecules- Synthesis, Structure and Metabolism

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

The course "BIOMOLECULES: Synthesis, Structure and Metabolism" has been designed to provide an in-depth understanding of the biomolecules at the level of biosynthesis, structure and function that is essential for further studies at the molecular level.

2. Course Content

Unit 1: (18 Hrs)

Nucleic acids and Proteins - DNA and RNA, Primary, secondary and complex structures of nucleotides, DNA sequence and function, Protein architecture: Primary, secondary, tertiary, quaternary structure, Structural domain and motif, Molecular model, 3D structure, Triple helix, Ramachandran plot.

Unit 2: (18 Hrs)

Protein synthesis – Molecular concepts, Transcription, mRNA processing, Post-transcriptional modifications, Translation, Protein translocation: post translational and co translational, Molecular mechanism of protein folding, Protein trafficking and signal transduction, Structure and function of signaling pathways. Proteome-wide analysis of protein regulation.

Unit 3: (18 Hrs)

Interaction proteomics: Protein-protein interaction, DNA-protein interaction, Micro sequencing of polypeptides, Protein engineering, Protein expression, Protein expression systems with current examples, Protein kinetics, fusion with fluorescent tag, fusion expression technology, Hypothetical protein.

Unit 4: (18 Hrs)

Introduction to Enzymes – Enzyme classification, Mechanism of enzyme action, Factors affecting enzyme action, Enzyme kinetics, Michaelis-Menton equation and LB plot, Regulatory Enzymes, Enzyme inhibition. Physiological process- Biochemistry of Polypeptide & steroid hormones, Hormones and their receptors: Insulin and related growth regulator hormones.

Unit 5: (18 Hrs)

Molecular mechanism of major metabolic pathways and their control- Photosynthesis: Light & dark reactions, Cellular Respiration: aerobic and anaerobic, Metabolism of Carbohydrates, Metabolism of triglycerides and fatty acids, Metabolism of amino acids, Metabolism of nucleotides, Integration of metabolic pathways, Inborn errors of metabolism.

3. Recommended Text Books

1. Principles of Biochemistry by Lehninger, 5th edition
2. Principles of Biochemistry, Voet and Voet, 3rd edition
3. Biochemistry by Jeremy Mark Berg, John L Tymoczko and LubertStryer
4. Plant Physiology by Salsibury F and Ross CW

4. Recommended References

1. Enzyme Technology by Ashok Pandey, Colin Well
2. Chromatographic Separations by Peta A Sewell, Brianclarke and David Kealy.

Course name:BS030202: Molecular analysis of biomolecules

Total Credits : 5

Total Hours : 90 Hrs.

1. **Objectives of the Course:**

The course provides a molecular view on the biomolecules of life thorough experimental and theoretical biophysical methods. An understanding of the molecular biophysical methods plays an important role in elucidating the mysteries of life's molecules and their assemblies, as well as the relationship between their structure and function. Students become familiar with the principles and scope of all the biophysical methods that can be utilized to unveil the fine scale structure of biomolecules. The introduced topics include thermodynamics, molecular modeling, microscopy, spectroscopy, chromatography and x-ray crystallography.

2. **Course content**:

Unit 1: (16 Hrs)

Thermodynamics- Hydrolysis of high energy molecules, Chemical kinetics, energy of Activation. Molecular modeling and molecular dynamics- Modeling of macro molecules Different types of interaction energy, Molecular potential, Bonding potential, non-bonding potential, Potential due to angle, Torsion strain, Electrostatic interaction. Molecular dynamics simulation for simple molecules.

Unit 2: (18 Hrs)

Microscopy- Light, Phase contrast, Fluorescence, Immunofluorescence and Confocal microscopy, Nemarski interference, Flow cytometry, Electron microscopy, TEM, SEM, STEM Functions of Electron microscope, Tissue processing, High resolution Autoradiography and X-ray diffraction, AFM. Centrifugation- gradiant& Ultra. Method of determination of size and shape of macromolecules- Molecular

Unit 3 (16 Hrs)

Absorption spectroscopy- Absorption spectroscopy of electronic states, Beer-Lambert's law, Extinction co-efficient, Spectral properties of a simple molecule, UV absorption for proteins-Peptide group domination & aromatic amino acid domination, Protein estimation. Nucleic acid absorption dominated by bases.

Unit 4: (20 Hrs)

Infrared spectroscopy- Principles of IR spectroscopy, Fourier transform of Infrared spectroscopy, Instrumentation and factors influencing vibrational frequency. NMR spectroscopy- Principles, Proton NMR of proteins, 13C NMR of proteins, 31P NMR studies, Fourier transform of

NMR spectroscopy, NMR spectra of nucleic acids, and Relaxation (ID spectra). X-ray crystallography Instrumentation, Fourier transformation and Applications.

Unit 5: (20 Hrs)

Biophysical & Biochemical aspects of electrophoresis, Types of Electrophoresis, Documentation of DNA, RNA, Protein- Glycoprotein, Lipoprotein. Acrylamide, Agarose, Denaturants-SDS, Urea, formaldehyde.2D electrophoresis, IEF, PFGE, Zymogram, Immuno electrophoresis. Chromatography- Techniques in purification- Ion exchange, adsorption, Size elution, gel filtration, Affinity, HPLC, GC/MS.

3. Recommended Text Books

1. Advanced techniques in biophysics by Jos Luis R Arronde and Alica Alonso.
2. Physical of the Life science by New man jay.
3. Integrated Molecular and cellular biophysics by Valerciaraicu and Aurelpopescu.
4. Biophysics by vasanthapattabi and N Gautham.
5. Introduction to Biophysical methods of protein and nucleic acid research by Jay. A Glasel, Murray P Deutcher and Murray P Deustcher.
6. An introduction to X-ray crystallography by Woolfson Michael M.
7. Light Microscopy in Biology by Alan J Lacey.
8. Practical Protein Chromatography by Andrew Kenney
9. Electron Microscopy by Dykstra.

4. Recommended References

1. Gel electrophoresis of proteins-A practical approach by B.D Hames and D. Rickwood.
2. Gel electrophoresis of nucleic acids-A practical approach by D. Rickwood and B.D Hames.
3. Chromatographic separations by Peta A Sewell, Brianclarke and David Kealy.
4. Chromatography and Separation science by SatinderAhuja.
5. Isoenzymes in Plant biology by Douglas E Soltis and Pamela S Soltis.

Course name:BS030203: Oncology, Immunopathogenesis and Diagnostics

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

Basic and applied research on oncogenes, immune system and molecular diagnostics of infectious diseases has developed new trend sets in the field of molecular biology for developing effective and powerful drugs as well as specific molecular kits for detecting the diseases. Hence this paper emphasizes the causes and metastasis of cancer, host-tumor interactions and cancer related genes. The curriculum also covers the type of immune system, the regulation of immune response and molecular technique of disease diagnosis.

2. Course Content

Unit1 :- (18 Hrs)

Cell cycle apoptosis and DNA repair. Tumor Biology: Definitions and Terminologies, concepts of clonality and kinetics of tumor cell growth. Tumorigenesis, Tumor progression and Mechanism of Metastasis., Molecular basis of Cancer: proto oncogenes oncogenes, tumor suppressor genes and DNA repair genes; Cellular and molecular hallmarks of cancer; Tumor angiogenesis, Evasion of Host DefenseKaryotypic and Epigenetic changes in tumors. Transformation process from the initial cellular damage and stepwise tumor evolution to the clinical picture.

Unit2 :- (18 Hrs)

Causes of Cancer- Carcinogenic agents and their cellular interactions: Chemical carcinogenesis- mechanism of chemical carcinogenesis and carcinogenic chemicals. Radiation carcinogenesis- UV rays, ionizing radiation, mechanism of radiation carcinogenesis, Viral carcinogenesis - DNA and RNA oncogenic viruses, mechanism of viral oncogenesis. Host tumor interactions, host factors affecting tumor cell growth, host defense against tumors, Clinical aspects of Cancer; Hereditary cancer. Trends in cancer Diagnostics- Biochemical histological and molecular methods.The major treatment principles of cancer (surgery, radiotherapy, hormonal treatment, and biological therapy).Novel and developing treatment strategies.Cancer epidemiology.Prevention.Clinical trials. Breast cancer: A case study.

Unit3 :- (18 Hrs)

Overview of immune system-Types of immunity: Innate and Acquired immune system; Antigens, Structure and function of antibody molecule, BCR and TCR; MHC I & II, Polymorphism, Immunoglobulin genes and antibody diversity; B-cell and T-cell maturation, activation and differentiation, Cytokines, Humoral and cell mediated immune response. Regulation of the immune

response.Principles of Hyper sensitivity reactions, Tolerance and auto immunity, Basics of Transplantation immunology, AIDS and other otherimmunodeficiencies.

Unit4 :- (18 Hrs)

Molecular structure and Function of Prokaryotic cells and its Components-.Bacterial Classification. Kinetics of Bacterial Growth- Different types of Bacterial cultures (Batch, Synchronous, Arithmetic), Growth phases, Growth Kinetics, Growth yields, Environmental factors affecting growth. Basic Concepts of Virology- General Characteristics of Viruses, differences between bacteria and viruses, Physical and Chemical structure of different viruses.

Unit 5 :- (18 Hrs)

Molecular diagnostics of infectious diseases and genetic disorders, Molecular markers, Application of markers in DNA typing, Telomere repeats, Telomerase and its significance, Differential expression of genes, Quantitation of gene expression, DNA micro array technology, types of micro arrays, micro array fabrication and hybridization; image processing, micro array gene expression data analysis, Gene Therapy , Direct, Indirect, competitive and sandwich ELISA.

3. Recommended Text Books

1. The Basic science of Oncology by Ian F Tannock.
2. Robbin's and Cotran's Pathologic Basis of Disease (9^{th} Ed) By Vinay Kumar, Abdul K Abbas and John C Aster.
3. Molecular biology of Human cancer-An advanced human text book by Wolfgang Arthur Schulz.
4. Kuby Immunology (6^{th} Ed) By Thomas J Kindt, Richard A Goldsby and Barbara A Osborne.

4. Recommended References

1. Molecular mechanism of Cancer by George F Faber.
2. Oncogenomics-Molecular approach to cancer by Charles Brenner.
3. Cancer-the role of genes, lifestyle and environment by Joseph Panno.

Course name:BS030204: Microbiology, Immunology & Molecular Biology –Practical II

Total Credits : 4

Total Hours : 180 Hrs.(10 Hrs /week)

1. **Objectives of the Course:**

Molecular Biology is a multidisciplinary science involving a variety of distinct areas *viz* genomics, proteomics, bioinformatics, GMOs where living organisms are put in to effective use for the benefit of humanity. Although there are a number of molecular methods, tools and techniques being followed in the research of biomolecules especially proteins and nucleic acids, our biotechnology students are not at all aware about its practical relevance in the industry and they do not have on hand experience in doing the experiments. So this course plan aims to provide a great insight to the post graduate students in molecular experiments in a simple and concise manner.

2. **Course content:**

Unit 1:- (40 Hrs)

Microbiology

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Culture transfer technique
    i. Slant to broth
    ii. Broth to slant
    iii. Slant to agar.
3. Isolation of discrete colonies from a mixed culture preparation.
4. Isolation of pure cultures from a spread- plate or streak- plate, slant culture
5. Cultural characteristics of microorganisms in Nutrient gelatin, Nutrient agar plates, Nutrient agar slant and Nutrient broth
6. Bacterial staining: Simple staining, Differential staining (gram stain)
7. Cultivation of microorganisms - Media for routine cultivation of bacteria, Serial dilution – agar plate procedure to quantitative viable cells
8. Bacterial Growth curve analysis and determination of generation time
9. Demonstration of antibiotic resistance / Susceptibility of microorganisms.
10. Isolation of soil bacteria. Through plating techniques

Unit 2:- (90 Hrs)

Molecular Biology-RNA & Proteins

1. Isolation of RNA from plant
2. Isolation of RNA from blood
3. Isolation of RNA from Microbes

4. Gel documentation of RNA by Formaldehyde gel electrophoresis and Quantitative analysis of RNA.
5. Isolation and purification of Plasmid DNA
6. Purification of enzyme proteins by salt precipitation
7. Purification of enzyme proteins by Dialysis
8. Purification of enzyme proteins by Ion exchange / Gel filtration chromatography (demo).

Unit 3:- (30 Hrs)

Immunology

1. Immuno diffusion techniques – Radial immuno diffusion, double immuno diffusion
2. Agglutination-Identification of human blood group by agglutination reaction
3. Determination of Antigen antibody interaction through ELISA,
4. Western blot analysis (Demonstration)

Unit 4:- (20 Hrs)

Analytical

1. Determination of soluble constituents in cell system by TLC
2. Determination of soluble constituents in cell system by HPLC (Demonstration)
3. Determination of soluble constituents in cell system by GC/MS (Demonstration)

3. Recommended Text Books

1. Laboratory Procedure Manual – Biotechnology Division, SSTM, Cochin
2. Molecular Cloning– Sambrook&Russels

4. Recommended References

1. Microbiology- A Lab Manual – Sherman Cappuccino
2. Practical Hand Book of Microbiology – Emanuel Goldman
3. General Microbiology – Roger Y Stainer
4. Cell Biology – de Robertis
5. Protein Purification – Robert Scoop

SEMESTER III

Papers	Subjects
BS030301	**Genetic Engineering, Bioethics & IPR**
BS030302	**Trangenics- Animals and plants.**
BS030303	**Genomics& Proteomics.**
BS860301	**Elective paper-1, Concepts and Methods of Research**
BS030304	**PCR technology, Bioinformatics, Animal Cell & Tissue culture techniques - Practical-III**

Course name:BS030301: Genetic Engineering, bioethics & IPR

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

In the third generation of Biotechnology, the discipline can be defined as to improve the biological function of an organism by adding genes from another organism. The concept of this science is based on the term 'Transgene'. Transgene is the genetically engineered gene added to a species and the organism containing a 'transgenic'. Based on the need, Microbes, plants, and animals are the faithful hosts as 'transgenic' for maintaining the functionality of 'transgene' in the system. Within the wide array of applications of transgenic production of pharmaceutical products, therapeutics, crops of rich nutritional quality, disease diagonosis, gene therapy, production of vaccines and MAPS, industrial enzymes and biofuels are the exciting areas of research today.

2. Course content:

Unit 1:- (18 Hrs)

Molecular biology- History, Scope and definition.Genetic engineering- Introduction and prospects in Post genomic era.Transgenic technology in India. How to clone a gene- Fundamental techniques of gene manipulation, Overview of the procedure, Gene library, Hybridization, Molecular cloning, Construction of DNA library, Library screening, Expression libraries, Restriction mapping, RFLP, DNA sequencing. Vectors- Plasmid vectors, Vectors based on the lambda Bacteriophage, Cosmids, Phasmids, M13 vectors, Expression vectors, vectors for cloning and expression in Eukaryotic cells, Super Vectors, YACs, BACs, PAC & MAC. Promoters- ubiquitous & tissue specific, Signal peptide sequences. Cutting and joining DNA- Restriction endonucleases, Ligation,

Alkaline phosphate, double digest, Modification of restriction fragment ends, Other ways of joining DNA molecules.

Unit 2:- (30 Hrs)

cDNA synthesis, RT PCR- PCR assay and Cell based DNA cloning:- The importance of DNA cloning, PCR Primers, Basic features and applications, Gradiant, Nested, Touch down, Hot start. Principles of cell based DNA cloning, Gene cloning strategies, Cloning system for amplifying different sized fragments, cloning system for producing single stranded and mutagenised DNA. Nucleic acid hybridization- preparation of nucleic acid probes, Principle of nucleic acid hybridization, Nucleic acid hybridization assays, DDRT and microarrays. Gene recombination and gene transfer- Bacterial conjugation, Transformation, Transduction, Episomes, Plasmids, Microinjection, Electroporation, Microprojectile, Shot gun method, Ultra sonication, Liposome fusion, Microlaser. Changing genes: Site directed mutagenesis and protein engineering- PCR based site directed mutagenesis, random mutagenesis, Use of Phage display techniques to facilitate in the selection of mutant peptides, Gene Shuffling, Production of chimeric proteins. Tools for analyzing gene expression- Northern Blot, in situ hybridization, RNase protection assay, RT-PCR, Real Time PCR, Western blot, in situ analysis, ELISA, Genetic engineering in Microbes- Cloning in *E.coli* and other bacteria

Unit 3:- (15 Hrs)

Introduction- General Introduction, Patent claims, Legal decision making process, Ownership of intellectual property Basic requirements of patentability- Patentable subject matter, Novelty and the public domain. Special issue in biotechnology patents- Disclosure requirements, Collaborative research, Competitive research, foreign patents.Patent litigation- Substantive aspects of patent litigation, Procedural aspects of patent litigation and recent developments in patent systems and patentability of biotechnological inventions.TRIPS and Patent Law- Patenting life, Patenting of genes and DNA sequences, Microbial piracy. Patenting of GMO, Transgenic crops, Marketing Strategies

UNIT 4: (12 Hrs)

Ethics and Bioethics: Benefit and Harm: Social Responsibility and Role of Media: Protecting Future Generations and Protection of the Environment. Biosafety aspects and Level of Risk Assessment- DBT at statuary. State level interventions, - Biodiversity board:Guidelines for Gene manipulation studies in India and at international level: GLP, GMP.

UNIT 5: (15 Hrs)

Gene silencing - Post transcriptional and transcriptional gene silencing, Mutants of gene silencing, RNA virus in plants, Virus induced gene silencing and its application. Genetic engineering and Public concerns- Ethical and environmental concerns on genetic engineering of plants.Plant genetic engineering future- Genetically engineered Food products, its safety, Labeling and regulatory challenges. 'Pharm' factories of the future, gene editing-CRISPR.

3. Recommended Text Books

1. Molecular cell biology by Harvey Lodish, Published by W. H. Freeman and company
2. Molecular biology of the gene by James.D .Watson,Published by Pearson education
3. Cell and Molecular biology by E.D.P. De Robertis, Published by Lippincutt William and wilkins
4. Molecular Biotechnology : Principles and applications 3rded by R BernadGlick,Published by ASM press, Washington
5. Patents for chemicals, pharmaceuticals and biotechnology by Philip. W. Grubb
6. Good laboratory practice by Jurg. P. Seiler
7. The Role of Intellectual Property Rights in Biotechnology Innovation. David Castle, 1st Edition.

4. Recommended References

1. Fundamental molecular biology by Lizabelth. A. Allison,Published by Blackwell publishers
2. PCR Applications protocols for functional genomics 1sted, By Michael A Innis , David H Gelfand& John J Sninsky,Published by Academic press
3. Molecular cloning : A Laboratory Manual Vol.I 3rded,by Joseph Sambrook& David W Russell Published by CSHL press,2000
4. Global Intellectual Property Rights: Knowledge, Access and Development. Peter Drahos and Ruth Mayne, 1st Edition.
5. Encyclopaedia of Intellectual Property Rights Volume I, II & III. Prabhas Chandra Sinha

Course name:BS030302: Trangenics- Animals and plants

Total Credits : 5

Total Hours : 90 Hrs.

1. Objectives of the Course:

In the third generation of Biotechnology, the discipline can be defined as to improve the biological function of an organism by adding genes from another organism. The concept of this science is based on the term 'Transgene'. Transgene is the genetically engineered gene added to a species and the organism containing a 'transgenic'. Based on the need, Microbes, plants, and animals are the faithful hosts as 'transgenic' for maintaining the functionality of 'transgene' in the system. Within the wide array of applications of transgenic production of pharmaceutical products, therapeutics, crops of rich nutritional quality, disease diagnosis, gene therapy, production of vaccines and MAPS, industrial enzymes and biofuels are the exciting areas of research today.

2. Course content:

Unit 1:- (25 Hrs)

Gene transfer to animal cells- An over view, Strategies for Gene transfer- Gene cloning vectors, Techniques for genetic engineering, Gene cloning, Gene transfer and expression of induced genes, Micro injection, Embryonic stem cell transfer, Retrovirus and gene transfer, Xenografting.Principles of animal cell and tissue culture- Techniques of animal cell and tissue culture, Enzymes in Genetic engineering. Transgenic animals- Development of transgenic science, Transgene DNA preparation, Microinjection technique, Embryo transfer, Transgenic animal models- Mice, Cows, Pig, Sheep, Goat, Birds, Fish, and Insects, Biotech products from Transgenic animals. Animal health biotechnology- Regulation and biosafety of animal testing: Regulation and biosafety of transgenic animals: patenting genetically engineered animals, Stem cell biology, somatic cell programming.

Unit 2:- (15 Hrs)

Plant tissue culture- History, scope.Micro propagation from callus to plants, Somatic embryo genesis, Culture environment, Plant cell culture media, Plant growth regulators and their biosynthesis and function, Culture types-Callus, Cell suspension culture, Protoplasts, Root cultures, Shoot tip and Meristem culture, Embryo culture, Microspore culture, Somaclonal variation, Polyploidy, Genetically engineered plants, Plant made pharmaceuticals, plasticity and Totipotency.

Unit 3:- (35 Hrs)

Plant secondary metabolites- Introduction to primary and secondary metabolites, Important pathway leading to the biosynthesis of secondary metabolites in plants, Metabolic products produced by in vitro culturing of plant cells, Selection of plant cells or tissues for the production of a specific

product, Culture system in secondary plant product biosynthesis- Batch continuous cultures and immobilized plant cells, Biotransformation of Precursors by cell culture, Metabolic engineering for production of secondary metabolites. Plant genome-organization and expression of plant genes- Gene structure and expression, Translation, Regulation of Gene expression, Implication of plant transformations, Plant promoters, terminators, reporters, and selectable markers. Plant transformation techniques-Cloning of plant cells and Manipulation of Plant genes, Cloning vector for plant cells, Agrobacteria mediated gene transfer- Biology & Molecular basis and its applications, Direct gene transfer methods, Development of plant vectors for transformation and features, Clean gene technology, Plant breeding vs Genetic engineering

Unit 4:- (15 Hrs)

Application of plant genetic engineering- Crop improvement, Herbicide resistance, Insect resistance, Virus Resistance, Tolerance- Drought, Cold, Salinity, Flooding, Aluminum. Plant as Bioreactors, Genetically engineered foods, Manufacture of pharmaceutical products in plants using modified plant viruses, Biofuels and bioplastics from genetically engineered oil seed rape and other crops as substitutes for fossil fuels

3. Recommended Text Books

1. Culture of animal cells, 5th edition, By Ian Freshney
2. Molecular cell Biology By Harvey Iodish
3. Molecular biology of gene By james D Watson
4. Plant Biotechnology – the genetic manipulation of plants. By Adrian Slater *et al.*, 2nd Edition

4. Recommended References

1. Cell and Molecular Biology by E.D.P Robertis.
2. Genetics by Pierce, 3rd edition.
3. Molecular Biotechnology: Principles and applications 3rd edition, By R Bernad Glick.

Course name:BS030303: Genomics and Proteomics

Total Credits : 5

Total Hours : 90 Hrs.

1. **Objectives of the Course:**

The course intends to enable the student in understanding the importance of genetic information in quality and quantitative analysis using statistical and computing methods with other related information of nucleic acid and proteins for solving the biological problems.

2. **Course content**:

Unit 1:- (18 Hrs)

Probability- Definition of probability, relative frequency, Probability distribution (Binomial, Poisson & Normal).Statistics- Measures of central tendency (Mean), Measure of Dispersion(Standard Deviation) Sampling theory, Statistical Hypothesis- Test of Significance, Test for proportion, means & standard deviations, Chi-square test of goodness of fit, t-test, F-test, Linear Correlation & Regression. Testing of genetic hypothesis- Testing goodness of fit to a genetic hypothesis, Chi-square method, Genetic analysis of quantitative traits using statistics (Correlation, Regression, Distributions).

Unit 2:- (18 Hrs)

About Genomics- History, Comparative genomics, Genome sequence strategies, genome assembly and annotation, need for structural genomics, approaches for target selection, functional genomics, and sequence comparison. Human Genome Project- An overview of the project, goals of the project, major scientific strategies 7 approaches used in HGP, expected scientific & medical benefits of the project, about the organizations behind this project, an overview of projects of other model organisms of Human Genome Project. Epigenome, Microbiome and Synthetic genome. Technologies used in HGP- RFLP, Microsatellite markers, STS, EST, DNA sequencing, DNA microarray, Next Generation sequencing. Gene expression profiling, Identification of SNPs, SNPs data bases (DbSNP).Metabolic pathways- Databases such as KEGG, EMP.

Unit 3:- (18 Hrs)

Computer applications- Internet, Basic concept, www, Internet protocol, TCP/IP, Browsers, Connection access, Gopher, Netscape, FTP Server, Remote Login & Telnet, Search engine, electronic mail. Introduction to genomic data and data organization. Sequence data bank- Introduction, Protein sequence, NBRF-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequence data bank, GenBank, EMBL, Nucleotide sequence data bank, AIDS virus sequence data bank, rRNA data bank, Structural data bank, PDB, CSD. Genome data bank- Metabolic pathway data, Microbial & cellular Data Banks, MSDN.Numerical coding systems of microbes.Hybridoma Data bank structure. Virus information system, Cell line information system, Important Data banks in Life Sciences.

Unit 4:- (18 Hrs)

Sequence analysis- Analysis of Tools for sequence Data Banks, Pair-wise alignment-NEEDLEMAN and Wunch algorithm, Smith Waterman. Multiple alignment-CLUSTAL, PRAS, BLAST, FASTA algorithms, Phylip, Sequence pattern, motifs and profiles.Secondary structure predictions- Algorithms, Chao-Fasman Algorithm, Hidden -Markov model.Primer designing- Primer designing softwares for RT-PCR and Real time PCR.

Unit 5:- (18 Hrs)

Protein structure prediction, homology modelling, swiss model, Rasmol, pymol, chimera,Protein arrays- Basic principles, Bioinformatics based tools for analysis of proteomics data, Data bases and Analysis tools. Protein-protein interactions- Databases such as DIP, PPI server and tools for analysis of protein-protein interactions. Identification of disease genes- Basic concept, Need for identification of disease genes, Role of Bioinformatics- OMIM database, Reference genome sequence, integrated genomic maps, computer aided drug design, docking.

3. Recommended Text Books

1. Principles of Biostatistics by Marcello Pagano, Published by Cengage learning
2. Current topics in computational molecular biology by Taojiang, Published by Tsinghua university press & Massachusetts institute of technology.
3. Bioinformatics, sequence and genome analysis by David W Mount, Published by cold spring harbor laboratory

4. Recommended References

1. Biostatistics, a guide to design analysis and discovery by Ronald .N. Forthofer, Published by Elseiver
2. Bioinformatics and molecular evolution by Paul. G. Higgs, Published by Blackwell publishers
3. Bioinformatics in the post genomic Era, by Jeff Avgen, Published by Addision Wesley.

Course name:BS030304: PCR technology, Bioinformatics, Cell & Tissue culture Techniques -Practical III

Total Credits : 4

Total Hours : 180 Hrs.(10 Hrs /week)

1. **Objectives of the Course:**

Molecular Biology is a multidisciplinary science involving a variety of distinct areas *viz* genomics, proteomics, bioinformatics, GMOs where living organisms are put in to effective use for the benefit of humanity. Although there are a number of molecular methods, tools and techniques being followed in the research of biomolecules especially proteins and nucleic acids, our biotechnology students are not at all aware about its practical relevance in the industry and they do not have on hand experience in doing the experiments. So this course plan aims to provide a great insight to the post graduate students in molecular experiments in a simple and concise manner.

2. **Course content:**

Unit 1:- (20 Hrs)

Bioinformatics

1. Basic applications of Bioinformatics
2. Tools in Bioinformatics – FAST PCR, BioEdit, NCBI
3. Sequence analysis – Coding & non-coding regions, ORF's, translation, aminoacid sequence analysis
4. Designing gene specific Primers, realtime primers
5. Multiple Sequence alignment, BLAST homology searches etc.
6. Restriction enzyme analysis
7. Cloning strategies for protein expression
8. Phylogenic analysis
9. Structure prediction in proteins
10. Conserved domain analyses etc.

Unit 2: - (90 Hrs)

Molecular Biology

1. Amplification of gene of interest by PCR
2. cDNA synthesis from total RNA
3. RT-PCR amplification of gene of interest
4. Agarose gel electrophoresis of PCR products
5. Cloning of genes into vectors
    i. Preparation of Competent cells

ii. Ligation of a gene in the vector
iii. Transformation of competent cells
iv. Preparation of recombinant plasmid.
v. Confirmation of recombinants by PCR and restriction enzyme analysis.

6. Quantitation of Genes by Real time PCR– Optimization of qPCR, Absolute quantification, relative quantification, analysis of data (demonstration)

Unit 3:- (20 Hrs)

Expression of recombinant protein(Demonstration)

1. Expression of recombinant protein
2. Transformation of recombinant plasmid in BL21 (DE3).
3. Induction of recombinant protein with IPTG
4. Analysis of recombinant protein by SDS-PAGE and determination of Molecular weight

Unit 4:- (20 Hrs)

Animal Cell culture (Demonstration)

1. Mammalian cell culture – introduction – Aseptic condition, medias, serums, growth supplements, culture wares, sterilization techniques etc
2. Culturing & sub-culturing of cell lines – Cell culture media preparation, cell seeding, trypsinization, cell counting, frozen storage
3. Determination of cytotoxicity towards compounds or drugs by MTT assay.

Unit 5:- (30 Hrs)

Plant Tissue Culture

1. Plant tissue culture: preparation of Stock solution and culture media, Callus culture – leaf or internode
2. Direct organogenesis from axillary node
3. Cell suspension culture
4. Encapsulation of zygotic embryo

3. Recommended Text Books

1. Laboratory Procedure Manual – Biotechnology Division, SSTM, Cochin
2. Molecular Cloning– Sambrook&Russels
3. Plant Tissue culture – Gahans
4. An introduction to Bioinformatics Algorithm – PavelPevzner

4. Recommended references

1. Bioinformatics: genomics and proteomics-Ruchisingh
2. Animal cell culture: a practical approach - R. Ian Freshney

SEMESTER IV

BS860402	**Elective paper-2, Molecular Markers & Genome Analysis**
BS860403	**Elective paper-3, Biotechnology Entrepreneurship**
BS030401	**Research Practical Training**
BS030402	**Research Course work & Research Project**
BS030403	**Paper Presentation & Comprehensive Viva-Voce**

Course name:BS030401: Research Practical Training

Total Credits : 3

Total Hrs:10hrs/week

1. **Objectives of the Course:**

As the last phase of the course plan, the IV semester is allotted for doing research on subject area related to Molecular biology and Genetic Engineering. Based on the selected research topic, the students have to undergone on-hand training on the molecular experiments that they learnt for the first three semesters under the guidance of the respective supervisor. This is to ensure confidence in handling the methodological part of the project work.

Course name:BS030402: Research Course Work & Research Project

Total Credits : 5

1. **Objectives of the Course:**

The objective of the programme is for evaluating the expertise and on hand experience of the student in handling research problems independently in the areas of molecular biology and genetic engineering. Prior to the lab work, the student has to do course work based on the area of research allotted for the project. A course work curriculum will be prepared by the research committee including all the research supervisors of the department.

Course name:BS030403: Paper Presentation & Comprehensive Viva-Voce

Total credits- 3

1. **Objectives of the course.**

After the completion of the research project and the submission of the dissertation for evaluation, the student has to make a PPT presentation of the research data before the board of examiners emphasizing the back ground of the work, methodology used, major observations of the result and its interpretation based on the objectives of the work. The student can highlight the participation and presentation of papers in National / International seminars during the course of the programme. Besides the presentation, the student has to attend the comprehensive viva which will cover all the subject areas of the course as per the curriculum.

ELECTIVE PAPERS OF III & IV SEMESTER

Course Code	**Title of the Course**	
BS860301	Electives Group A	Concepts and Methods of Research
BS860402		Molecular Markers & Genome Analysis
BS860403		Biotechnology Entrepreneurship
BS870301	Electives Group B	Molecular Diagnosis and viral diseases
BS870402		Recombinant drugs and Applications of Nano biotechnology
BS870403		Molecular therapy in Neurodegeneration

ELECTIVE PAPERS

Group A

Course name:BS860301: Elective Paper- I- Concepts and Methods of Research

Total Credits : 4

Total Hours : 54 Hrs.

1. **Objectives of the course**

Research is an essential ingredient for the conceptual advancement of every subject area, either art or science. The significance of research lies in its quality. Hence a systematic approach in doing research is inevitable for improving the quality of research. In the case of biotechnology, the methodological involvement in the subject has created a new link for connecting it with industry. Biological research is a long term process for improving the learning technology of scientists, researchers and students and for promoting confidence and expertise in handling experiments in the laboratory. So proper scientific care is inevitable in research from the level of selection of the problem, defining & designing the problem and collection & analysis of data. In other words the methods of research implemented in the study have greater impact for determining authenticity of the data. Moreover the application of research data for developing of processing technology and for the production of drugs, biofuels, functional foods, cosmetics, nutraceuticals, depending on the quality of the data at industrial scale. In the field of molecular biology and genetic engineering, the development of research and its practical implications are faster than any other discipline. So the objective of the curriculum is to provide the need and concept of research for the students at post graduate level.

2. **Course content:**

Unit 1:- (14Hrs)

Foundations of Research: Scope, Meaning, Objectives, Motivation, Utility and Significance; Concept of theory, deductive and inductive theory; Methods and Measurement of Research, Characteristics of scientific method, Qualitative and Quantitative Research; Research Design: Concept and Importance in Research – Features of a good research design; Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Identification of problem, scaling techniques and Data collection.

Unit 2:- (20Hrs)

Measures of central tendency (Mean), Measure of Dispersion(Standard Deviation) Sampling theory, Statistical Hypothesis- Test of Significance, Test for proportion, means & standard deviations,

Chi-square test of goodness of fit, t-test, F-test, Linear Correlation & Regression. Testing of genetic hypothesis- Testing goodness of fit to a genetic hypothesis, Chi-square method, Genetic analysis of quantitative traits using statistics (Correlation, Regression, Distributions).Probability- Definition of probability, relative frequency, Probability distribution (Binomial, Poisson & Normal).

Unit 3:- (20Hrs)

Interpretation of Data and Paper Writing – Layout of a Research Paper, Selection of Journals, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of computer tools / techniques for paper preparation, Software for the detection of Plagiarism. Preparation of Dissertation / Thesis, How to enjoy in writing thesis? Qualities of good thesis, Planning and rules for writing thesis, Resources for writing, Literature survey and References, Lay out of the thesis, Role of the Research supervisor and the Scholar, Software for thesis formatting; Importance of good presentation.

3. Recommended Text Books

1. Principles of Biostatistics by Marcello Pagano, Published by Cengage learning
2. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
3. Enjoy Writing Your Thesis or Dissertation – Daniel Holtom& Elizabeth Fisher , Imperial College Press
4. Research Methodology – C.R.Kothari

4. Recommended References

Select references from the Internet

Course name:BS860402: Elective Paper- II- Molecular Markers & Genome Analysis

Total Credits : 4

Total Hours : 90 Hrs.

1. Objectives of the course

This course has been designed to provide perspectives on experimental methods for analysis of natural genetic variation applied in molecular breeding and crop improvement. The first module describes characteristic features and organization of plant genome and its dynamic nature. The second module deals with different types of molecular markers, especially DNA markers and diverse genotyping tools, and the third module discusses applicability of markers for assessment of genetic diversity, linkage mapping for gene discovery and QTLs. Application of current molecular tools to complement conventional breeding methodologies for efficient tracking, screening and selection of desirable genetic backgrounds are also presented.

2. Course content:

Unit 1:- (20Hrs)

The dynamic plant genomes: Natural genetic variation; mechanisms and causes of DNA polymorphisms: Recombination and DNA rearrangements, Point mutations-to polyploidy;

Genome Organization: Nuclear and organellar genomes; Unique and repeat DNA sequences; Classification of Repeat elements: Tandem, Interspersed, Micro-satellites, Minisatellites, hyper-variability of VNTRs.

Unit 2:- (20Hrs)

Molecular markers, their choice, relative advantages and disadvantages: DNA based markers: Molecular basis of dominant and co-dominant markers, hybridization based markers: Restriction Fragment Length Polymorphism and PCR based markers: Randomly Amplified Polymorphic DNA, SSRs, SCARs, Inter-SSRs, Amplified Fragment Length Polymorphism, Microsatellite Polymorphic Loci, Intron spanning markers, SNPs and based marker assays (CAPs, dCAPs, molecular beacons, 5'nuclease assay/Taqman assays), Eco-TILLING (Targeting induced, local lesions in the genome), high-throughput genotyping techniques: GBS (genotyping by sequencing), Diversity ArrayTechnology (DArTs).

Unit 3:- (25Hrs)

Applications of marker technology:Assessment of genetic diversity: Introduction to geographical diversity, center of origin and diversity of plant species, gene pools (primary, secondary and tertiary), Genotyping tools as plant variety protection, DNA hybrid purity tests, diagnostics (transgenics, forensics).

Unit 4:- (25Hrs)

Genetic linkage mapping: Traits (simple and complex; continuous and dis-continuous variation), Construction of genetic linkage maps; types of mapping population; Linkage mapping software packages and interfaces.

Trait Mapping; Map based cloning/ positional cloning for gene discovery, Marker Assisted Selection (MAS), identification of genes/QTLs, Foreground and back ground selection for introgression of QTL by SSR markers..

3. Recommended Text Books

1. An Introduction to Genetic Analysis (WH Freeman & Co, 2000) by A.J. F. Griffiths., et al.
2. Plant Molecular Breeding (CRC Press, 2003) by H.J. Newbury
3. The Handbook of Plant Genome Mapping: Genetic and Physical Mapping (Wiley-Blackwell, 2005) by K. Meksem, G Kahl (Editors)

4. **Recommended References**

1. Molecular Markers in Plants (John & Sons, Inc. 2013) by Robert J. Henry
2. Marker-Assisted Plant Breeding: Principles and Practices (Springer, 2015) by B.D. Singh, A.K. Singh

Course name:BS860403: Elective Paper- III- Biotechnology Entrepreneurship

Total Credits : 4

Total Hours : 90 Hrs.

1. **Objectives of the course**

Biotechnology Industry is one of the strongest growing Industries of 21st century. So the possibilities of utilizing the theoretical and methodological concept of Biotechnology for the production of drugs, nutraceuticals, pharmaceuticals and others using biological processing, organisms or systems at industrial level has become an academic challenge at university level. Since molecular & Nano research areas in Biotechnology have occupied a comfortable space in the curriculum and course plan, their potential in Academic- Industry collaboration has opened new marketing avenues. Hence the students of Biotechnology especially molecular biology and Genetic Engineering should require a professional platform for utilizing what they learnt and experienced in the laboratories. Moreover they require adequate exposure on entrepreneurship linked with biotechnology.

2. **Course content:**

Unit 1:- (20Hrs)

Emerging trends and Products of biotechnology industry: Genome Engineering, Recombinant Drugs, Synthetic genes, Exosomes in Cancer nanomedicine, regenerative medicine, Artificial Intelligence, Gene Silencing Drugs.

Unit 2:- (20Hrs)

Biotechnology Commercialization Strategies, Academic Technologies and Collaborations, Ownership of Inventions, Confidential Disclosure Agreement (CDA), Non-Disclosure Agreements (NDA)

Unit 3:-(25Hrs)

Intellectual property rights and technology transfer Agreement, Inventions, and Rights to inventions, Confidentiality and Publication, Characteristics of Biotech License Agreement.

Unit 4:- (25Hrs)

Biotechnology employment opportunities in India, Government and Private Sectors: Agriculture, Nutraceuticals& Pharmaceuticals, Genetic Engineering, Biofuels, Biocatalysts. Top Biotech Companies in India. Start-up companies, Structure, Functional mode and Challenges and possibilities.

3. **Recommended Text Books**

1. Patzelt, Holger&Schweitzer, Lars & Behrens, Judith, 2012. "Biotechnology Entrepreneurship," Foundations and Trends(R) in Entrepreneurship, now publishers, vol. 8(2), pages 63-140.
2. Biotechnology Entrepreneurship, Starting, Managing, and Leading Biotech Companies, Editors: Craig Shimasaki, 1st edition. Imprint: Academic Press,Published Date: 28th April 2014.

4. **Recommended References**

1. Association of University Technology Managers (AUTM). AUTM U.S. Annual Licensing SurveyHighlights.http://www.autm.net/AM/Template.cfm?Section=FY_2011_Licensing_Activity_ Survey&Template=/CM/ContentDisplay.cfm&ContentID=8731/ [accessed 01.12.12].
2. Brookings Institute. University Start-ups: Critical for Improving Technology Transfer. http://www.brookings.edu/research/papers/ 2013/11/university-start-ups-technology-transfer-valdivia.
3. Steinberg F M and Raso J 1998 Biotech pharmaceuticals and biotherapy: an overview J. Pharm. Pharm. Sci. 1 48–59
4. Gibbs D F and Greenhalgh M E 1983 Biotechnology, Chemical Feedstocks, and Energy Utilization: Report Prepared for the Commission of the European Communities, Directorate-General for Research and Development, as Part of the FAST Programme (Dover, NH: Pinter)

ELECTIVE PAPERS

Group B

Course name:BS870301: Elective Paper- I- Molecular Diagnosis and Virus Diseases

Total Credits : 4

Total Hours : 54 Hrs.

1. Objectives of the course

The main objective of this elective paper is to provide the scope of clinical molecular biology in health science. Today the lack of rapid diagnosis of virus strains in serum samples of patients has become the major threat in the field of clinical treatment against virus infections.. The application of conventional diagnostic tests for detecting virus infections has reduced the intensity of the clinical management. The trend of developing recombinant antigen and its antibodies has revolutionised the prospects of ELISA in diagnosis more specific and sharp.

2. Course content:

Unit 1:- (10Hrs)

History and scope of diagnosis, Types, Significance of Moleculardiagnosis. Current trends and recent developments of molecular diagnosis.

Unit 2:- (14Hrs)

Recent out breaks of viruses, chikungunya, Dengue,H1N1, Nipha : Occurrence, distribution, structure and classification.

Unit 3:- (15Hrs)

Clinical diagnostic methods, Native antigen, Direct and indirect ELISA, Sand witch ELISA, PCR, Reverse Transcriptase PCR and Real Time PCR.

Unit 4:- (15Hrs)

Development of recombinant antigens, Expession of antigens, Prokaryotic and eukaryotic expression of protein, Production of antibodies

3. Recommended Text Books

1. Bailey and Scott's Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby
2. Medical Microbiology (1997). Edited by Greenwood. D, Slack. R and Peutherer. J, ELST Publishers.
3. Fundamental of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Sauders group.
4. Molecular Diagnostics for the Clinical Laboratorian 2nd ed. (2006). W.B.Coleman. Humana Press.

Course name:BS870402: Elective Paper- II- Recombinant Drugs and their applications in Nanotechnology

Total Credits : 4

Total Hours : 90 Hrs.

1. Objectives of the course

The production of natural and synthetic drugs in a cost effective way will be the greatest challenge in pharmaceutical industry today. Hence the application of recombinant DNA technology in the production of recombinant drugs by genetic and metabolic engineering has opened a new avenue in the field of drug industry. Moreover the interference of Nano technology in the production of drugs has made tremendous changes in maintaining the quality. So the objective of this paper is to elucidate the prospects of recombinant technology in health science.

2. Course content:

Unit 1:- (20Hrs)

Define recombinant drugs, societal impacts of recombinant drugs. Legal and ethical issues.Policies of India.

Unit 2:- (20Hrs)

Recombinant Drugs – Taxol, Artemesin, Vaccines, Antibodies. Genetic Engineering Methods and approaches, recombinant proteins

Unit 3:- (25Hrs)

Recombinant Tools in metabolic engineering, gene and enzyme mediated pathways, Transgenics.

Unit 4:- (25Hrs)

Nano Technology in biological systems, Importance of nano materials in health care.Nano Material- Synthesis & properties. Nano structured DNA templates. Probing DNA for controlled drug delivery.

3. Recommended References

1. https://ijme.in/articles/biotechnology-and-medicine-ethical-concerns/?galley=pdf
2. http://www.dbtindia.nic.in/wp-content/uploads/Regulations-Guidelines-for-Reocminant-DNA-Research-and-Biocontainment-2017.pdf
3. http://medind.nic.in/haa/t07/i1/haat07i1p1.pdf
4. http://www.mondaq.com/india/x/26049/Healthcare/Biotechnology+Laws+in+India
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14. https://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidances/UCM588857.pdf

Course name:BS870403: Elective Paper- III- Molecular therapy in Neurodegenerative disorders

Total Credits : 4

Total Hours : 90 Hrs.

1. **Objectives of the course**

Effective treatment of neurodegenerative diseases is one of the major constraints of health science in human system. Apart from the general approaches of the clinical management, the application of molecular therapy has lot of potential in curing neuro disorders. So the objective of this paper is to enlighten the students about the tools and techniques of molecular therapy in curing neuro degenerative diseases.

2. **Course content:**

Unit 1:- (20Hrs)

Neuro degenerative disorders- types of neurodegenerative diseases.Biochemical and molecular basis of disorders.Most prevalent Neuro degenerative disease in humans.

Unit 2:- (20Hrs)

Alzheimer's disease (AD). Cellular and Molecular symptoms.Marker genes of Alzheimer's disease.Molecular basis of Alzheimer's disease

Unit 3:- (25Hrs)

Therapeutic strategies major challenges for treatment. Novel approaches.

Unit 4:- (25 Hrs)

Vectors for gene therapy.Adeno Associated virus (AAV), Lentivectors (LV), Gene delivery methods, Invivo delivery of recombinant viral vectors, Recent achievements in gene therapy.

3. **Recommended References**

1. Neurodegenerative Disorders: A Clinical Guide. Edited by OrlaHardiman, Colin P. Doherty
2. https://pdfs.semanticscholar.org/5958/74663be070e0441687cab9f911b30d7c969d.pdf
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7. MODEL QUESTION PAPERS

M.Sc. Molecular Biology and Genetic Engineering

I Semester Model Questions

Subject-BS030101: Fundamental Genetics

Total Weight-30 **Time – 3 hours**

Part A-Short Answer Type Questions

(Write any of the eight of the following) 8x1wt=8

1. Differentiate sex influenced and sex limited characters
2. What is genetic maternal effect?
3. How an animal cell is structurally organized?
4. Explain pleotropic effects with an example
5. Differentiate between the coupling and repulsion of linked genes
6. Discuss the contributions of genetics to agriculture
7. What are the pre-natal diagnosis techniques used for genetic testing?
8. Explain multiple alleles with an example.
9. Comment on the effectiveness of clinical genetics for the society
10. How heritability can be used in predicting the phenotypes of the offspring?

Part B- Short Essay/ problem solving Type Questions

(Write any of the six of the following) 6x2wt=12

11. Explain different extra-chromosomal inheritance
12. Jacob and Susan have seven children, all of whom are boys. What is the probability that the next child will be a girl?
13. Explain the mechanism of genetic exchange in prokaryotes
14. How eugenics is important in genetic studies?
15. Explain the experiments of Mendel and its outcomes
16. Explain the inheritance pattern of quantitative traits
17. Explain the genetics of coat colour in dogs.
18. Waxy endosperm (wx), shrunken endosperm (sh), and yellow seedling (v) are encoded by three recessive genes in corn that are linked on chromosome 5. A corn plant homozygous for all three recessive alleles is crossed with a plant homozygous for all the dominant alleles. The resulting F1 are then crossed with a plant homozygous for the recessive alleles in a three-point testcross.

    The progeny of the testcross are:

wx	sh	V	87
Wx	Sh	v	94
Wx	Sh	V	3479

wx	sh	v	3478
Wx	sh	V	1515
wx	Sh	v	1531
wx	Sh	V	292
Wx	sh	v	280

i. Determine the order of these genes on the chromosome.
ii. Calculate the map distances between the genes.
iii. Determine the coefficient of coincidence and the interference among these genes.

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. How Mendelian ratios are altered in epistasis?
20. Explain different patterns of inheritance in humans
21. Explain the molecular mechanism behind the anterior-posterior and dorso-ventral axis determination in drosophila
22. How physical mapping methods are used to determine the physical positions of genes on particular chromosomes?

M.Sc. Molecular Biology and Genetic Engineering

I Semester Model Questions

Subject-BS030102: Molecular Organization of Chromosomes; Theory of heredity

Total Weight-30 **Time – 3 hours**

Part A-Short Answer Type Questions

(Write any of the eight of the following) **8x1wt=8**

1. Describe the changes in the chromosome structure during cell cycle
2. What are lampbrush chromosomes and what is their function?
3. Briefly describe genome complexity and C value paradox with its evolutionary significance.
4. Explain the molecular structure of centromere.
5. Briefly explain why, in humans and mammals, sex chromosome aneuploids are most common than autosomal aneuploids?
6. Give a concise account on the process of nucleosome assembly during replication.
7. Write a note on the chemical nature of eukaryotic chromosomes
8. What is Karyotyping? How can you analyze mitotic chromosomes?
9. Write the biological significance of transposition.
10. Give an account of the unique and repetitive sequences in eukaryotic chromosome.

Part B- Short Essay/ problem solving Type Questions

(Write any of the six of the following) **6x2wt=12**

11. Compare the molecular structure of prokaryotic and eukaryotic chromosome
12. Write notes on polyploidy.
13. Give an account on the levels of packaging of a metaphase chromosome.
14. Account on end replication problem and the significance of telomerase
15. Chromosomes are the carriers of gene. Justify.
16. Describe briefly the molecular events during meiosis.
17. Give a detailed note the various sex determination systems
18. Briefly detail the mechanism of retrotransposons?

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. Explain the different mechanisms of dosage compensation for X chromosome in various organisms
20. Give a detailed account on different types of transposable elements in prokaryotes
21. Describe in detail the various chromosomal structural aberrations and its consequences in meiosis
22. Describe in detail the key events during cell cycle and its regulation.

M.Sc. Molecular Biology and Genetic Engineering

I Semester Model Questions

Subject-BS030103: Molecular structure of Nucleic Acid; Gene Regulation & Expression

Total Weight-30 **Time – 3 hours**

Part A-Short Answer Type Questions

(Write any of the eight of the following) **8x1wt=8**

1. How gene function? Explain briefly?
2. What is a mutagen? Write a brief account on different types of chemical mutagens?
3. How Semi-conservative mechanism of replication was proved?
4. How replication is initiated by primosome complex formation?
5. Write a note on Site directed mutagenesis
6. How cDNA was synthesized from mRNA?
7. Explain RNA editing?
8. Define Zinc-finger motif?
9. What was the role of methylation in Chromatin remodelling?
10. What is histone modification?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) **6x2wt=12**

11. Describe the structure of tRNA?
12. Explain chloroplast inheritance with an example?
13. Give a brief account on SSB model recombination?
14. Explain briefly about genetic code?
15. Explain photoreactivation?
16. How does type II splicing differs from type I splicing?
17. How lactose regulate lac operon positively?
18. Explain a note on modes of replication?

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. Give detailed account of different steps involved in the translation of mRNA into polypeptide?
20. Describe the various molecular mechanisms of recombination?
21. How repressible operon regulates?
22. Define mutation? How they are classified, explain?

M.Sc Molecular Biology & Genetic Engineering

I Semester Model Questions Practical

Subject: BS030104- Biochemistry & Genetics - Practical I

Time - 4 Hours **Total – 15 weight**

Sl. No.	Name of Item/Experiment	Weights
1	Experiment No.1	5
2	Experiment No.2	3
3	Experiment No.3	3
4	Procedure Writing	1
5	Viva-Voce	1
6	Record	2
	Total	**15**

INSTRUCTIONS TO THE EXAMINERS

- All the questions shall be answered by the students with in the stipulated time.
- Each student should perform three experiments- one major experiment and three minor experiments**.**
- The students need to submit the principle and procedure in writing for those experiments which demand the same by the examiner.
- The questions of Viva should be asked exclusively from the practical syllabus (not from the theory syllabus)
- Examiners are requested to send the duly signed mark lists (Original & Duplicate), valued answer scripts, duly filled TA/DA bill, remuneration bill, memo of work done and duty certificate immediately after the completion of the examination to the chairman.

PART A - Major experiment (Selection by LOT) Weight 5

PART B- Minor experiment 1 (Selection by LOT) Weight 3

PART C Weight 3

i. Minor experiment 2 (Weight 3)

ii. Minor experiment 3 (Weight 3)

PART D - Procedure writing Weight 1

PART E - Viva voce Weight 1

PART F - Record Weight 2

M.Sc. Molecular Biology and Genetic Engineering

II Semester Model Questions

Subject-BS030201: Biomolecules: Synthesis, Structure and Metabolism

Total Weight-30 **Time – 3 hours**

Part A-Short Answer Type Questions

(Write any of the eight of the following) **8x1wt=8**

1. How protein stability is predicted using psi and phi angles?
2. Elucidate the Watson - Crick Model of DNA.
3. Give an account of fluorescent tagging of proteins.
4. What is HMP shunt pathway?
5. How do chaperones help in protein folding?
6. Explain the hypotheses regarding the mechanism of enzyme action
7. How does cAMP stimulate the phosphorylation of several proteins?
8. Explain TCA cycle and comment on its significance
9. Elucidate the chemiosmotic model for ATP synthesis.
10. Explain the light reaction in photosynthesis?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) **6x2wt=12**

11. Discuss the pathways involved in glycogen metabolism
12. Write notes on post translational modifications.
13. Describe about the structure and function of steroid and peptide hormones
14. What are the steps in β oxidation of linoleic acid?
15. Discuss any four diseases related to inborn errors of amino acid metabolism
16. How DNA-Protein interaction can be detected?
17. What are the biochemical reactions involved in pyrimidine metabolism?
18. Explain the procedure of micro sequencing.

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. Explain the structural architecture of proteins
20. How Michaelis-Menton equation is altered in the presence of competitive and uncompetitive inhibitors?
21. Explain the biochemical pathways involved in cellular respiration.
22. Discuss in detail how proteins are translocated to various organelles

M.Sc. Molecular Biology and Genetic Engineering

II Semester Model Questions

Subject-BS030202: Molecular analysis of Biomolecules

Total Weight-30 **Time – 3 hours**

Part A Short Answer Type Questions

(Write any of the Eight of the following) **8x1wt=8**

1. What is the principle of Spectrophotometry? Explain.
2. What is known as processional frequency?
3. How GC differs from GC/MS?
4. What is an IEF?
5. What are the steps involved in SEM fixation?
6. Write a note on centrifugation?
7. How RPM is converting to RCF?
8. What is processional frequency?
9. What is Gibbs free energy?
10. Write briefly about Agarose gel electrophoresis?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) **6x2wt=12**

11. How gradient centrifugation differs from differential centrifugation?
12. What is Nomarski interference?
13. Write a brief note on three laws of thermodynamics?
14. How a protein structure was modelled?
15. What are the factors affecting NMR spectroscopy?
16. What are high energy molecules? Explain it with an example?
17. What is bonding potential? Explain the potentials due to angle and strain briefly?
18. Write a brief account on HPLC and its role in biomolecular research?

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. Write a brief account on principle and instrumentation behind IR spectroscopy?
20. Write a brief account on SDS PAGE and how it differs from Native PAGE?
21. Write a note on different types and applications of microscopy in molecular biology research?
22. What is X-ray crystallography? How it works?

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II Semester Model Questions

Subject: BS030203 Oncology, Immunopathogenesis and Diagnostics

Total Weight- 30 **Time – 3 hours**

Part A Short Answer Type Questions

(Write any of the Eight of the following) 8x1wt=8

1. What are the different phases of clinical trials?
2. What are mixed tumors?
3. What is the difference between humoral and cell mediated immunity?
4. What are Cytokines?
5. Write a short note Differences between class I and II MHC molecules?
6. Describe any two hereditary cancer syndromes?
7. What are proto oncogenes ?
8. What is tumor metastasis?
9. What is Principle of gene profiling by micro array technology?
10. Short note about Oncogenic viruses?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) 6x2wt=12

11. What are the predisposing factors for breast cancer?
12. Explain the stepwise tumor evolution into clinical picture?
13. What is the intrinsic pathway of Apoptosis?
14. What are oncogenes and tumor suppressor genes? Suggest examples.
15. Explain the consequences of mutant state of TP53?
16. What are the major treatment options for breast cancer?
17. Discuss cancer Immunotherapy
18. What is Combination therapy for cancer?

Part C- Long Essay Type Questions

(Write any of the two of the following) 2x5wt=10

19. Briefly describe treatment modalities and treatment strategies of Cancer?

20. Illustrate cell cycle phases and checkpoints, and what happens if the checkpoints are affected by mutations?

21. Explain B and T cell differentiation and activation during immune response?

22. Explain the structure and function of Immuno globulins (various isoforms). How does Ig gene rearrangement take place?

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II Semester Model Questions Practical

Subject: BS030204 - Microbiology, Immunology & Molecular Biology (Practical II)

Time - 4 Hours **Total – 15 weight**

Sl. No.	Name of Item/Experiment	Weights
1	Experiment No.1	5
2	Experiment No.2	3
3	Experiment No.3	3
4	Procedure Writing	1
5	Viva-Voce	1
6	Record	2
	Total	**15**

INSTRUCTIONS TO THE EXAMINERS

- All the questions shall be answered by the students with in the stipulated time.
- Each student should perform three experiments- one major experiment and three minor experiments**.**
- The students need to submit the principle and procedure in writing for those experiments which demand the same by the examiner.
- The questions of Viva should be asked exclusively from the practical syllabus (not from the theory syllabus)
- Examiners are requested to send the duly signed mark lists (Original & Duplicate), valued answer scripts, duly filled TA/DA bill, remuneration bill, memo of work done and duty certificate immediately after the completion of the examination to the chairman.

Time - 4 Hours **Total – 15 weight**

PART A - Major experiment (Selection by LOT) Weight 5

PART B - Minor experiment 1 (Selection by LOT) Weight 3

PART C Minor experiment 2 Weight 3

PART D - Procedure writing Weight 1

PART E- Viva voce Weight 1

PART F - Record Weight 2

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III Semester Model Questions

Subject- BS030301-Genetic Engineering, bioethics & IPR

Total Weight-30 **Time – 3 hours**

Part A Short Answer Type Questions

(Write any of the Eight of the following) 8x1wt=8

1. What are the differences between absolute quantitation from relative quantification of the PCR product using real time PCR?
2. Write a short note on cDNA synthesis?
3. Briefly Explain YAC vector?
4. Explain the concept of Site directed mutagenesis?
5. What is Golden rice?
6. What are the basic requirements of patentability?
7. Mention two major bioethical concerns in genetically engineered crops/GMOs?
8. What is a gene expression library?
9. Give a brief account of DDRT?
10. What is the principle of micro array technology?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) 6x2wt=12

11. Write a brief note on Restriction endonucleases?
12. Describe the different steps involved in molecular cloning?
13. Give a brief account of genetic engineering of microbes?
14. What are the applications of PCR in molecular biology research?
15. What is patent litigation? Cite an appropriate case study of patent litigation?
16. What is TRIPs? Enumerate the importance of TRIPs in the area of IPR.
17. Explain farmer's privilege, farmer's right and plant breeder's rights?
18. Discuss gene silencing?

Part C- Long Essay Type Questions

(Write any of the two of the following) 2x5wt=10

19. Describe the various kinds of cloning vectors used in genetic engineering
20. Describe the principle and steps in nucleic acid hybridization
21. What is a patent? Explain the various steps involved in Patenting procedure
22. Elaborate on biosafety levels for experiments with micro-organisms?

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III Semester Model Questions

Subject-BS030302: Trangenics- Animals and plants.

Total Weight-30 **Time – 3 hours**

Part A Short Answer Type Questions

(Write any of the eight of the following) 8x1wt=8

1. How is transgenic fish produced? Illustrate with an example.
2. What are the advantages of embryonic stem cell transfer?
3. How do you identify and confirm transgene integration?
4. Describe polyploidy and explain its applications in the field of agriculture.
5. Give an account on cointegrate and binary vector systems in plants
6. How can we establish virus free plants from infected plants using plant tissue culture?
7. Give an account on plant made pharmaceuticals.
8. Write note on biofuel.
9. Explain Xenografting
10. Give an account on somatic embryogenesis.

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) 6x2wt=12

11. Discuss on the retrovirus mediated gene transfer with its advantages.
12. Give an account of in-vitro fertilization and embryo transfer.
13. Describe the steps involved in creating a cell line.
14. Illustrate metabolic engineering and its significance with suitable examples.
15. Explain in detail on Somatic Hybridization.
16. Discuss on important plant hormones and their biosynthesis.
17. Explain the molecular basis and application of agrobacterium mediated gene transfer
18. Give a brief account on the culture systems used for the production of secondary metabolites in plants.

Part C- Long Essay Type Questions

(Write any of the two of the following) 2x5wt=10

19. Describe the production and application of transgenic animal models, highlighting any three examples?
20. Give an account of gene transfer using embryonic stem cells?
21. Discuss in detail the applications of genetic engineering in agriculture.
22. Explain the various plant tissue culture types and applications for each method.

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III Semester Model Questions

Subject-BS030303: Genomics and Proteomics

Total Weight-30 **Time – 3 hours**

Part A Short Answer Type Questions

(Write any of the Eight of the following) 8x1wt=8

1. How do microarrays help in gene expression study?
2. What is RFLP? Explain the steps involved in it?
3. Explain pyrosequencing method
4. Write briefly about two protein DATA banks?
5. What is phylip? Explain.
6. Explain FTP and Telnet
7. What is epigenome?
8. Define gap and space?
9. What is known as gap penality?
10. Why BLAST differs from Clustal W?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) 6x2wt=12

11. Explain the features of SWISS-Prot
12. Write short notes on Microbiome
13. What are Microsatellites?
14. How Chao -Fasman algorithm is used for secondary structure prediction?
15. Write a brief account on phylogenetic analysis?
16. Write a brief account on Hidden Markov model?
17. Explain the steps involved in Homology modelling?
18. Five guinea pigs from same family having vitamin A deficiency. They are fed with certain quantity of carrot for a month. If the probability of recovery is 73 %, then what is the probability for 3 out of 5 will recover?

Part C- Long Essay Type Questions

(Write any of the two of the following) 2x5wt=10

19. Discuss on different nucleic acid databases and its importance.

20. Explain Smith Waterman algorithm with an example.

21. Briefly explain the features and format of protein structure databases

22. Write a brief account on CADD?

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III Semester

Model Question

Subject- BS860301: Elective paper 1 - Concepts and Methods of Research

Total Weight-30 Time – 3 hours

Part A-Short Answer Type Questions

(Write any of the Eight of the following) 8x1wt=8

1. Differentiate between qualitative and quantitative research.
2. What are the characteristics of scientific method?
3. Give an account of data collection methods.
4. What is use of t-test in data analysis?
5. Give an account of various software for thesis formatting
6. What are the ethical issues related to publishing?
7. Give an account of measures of central tendency.
8. What are the criteria for identifying a research problem?
9. Comment on plagiarism
10. What is the importance of a good presentation of thesis data?

Part B- Short Essay/ problem solving Type Questions

(Write any of the Six of the following) 6x2wt=12

11. Explain the procedure for testing of hypothesis.
12. Body weights of 11 female fishes and the numbers of eggs that they produce are:

Weight	Eggs
x	*y*
14	61
17	37
24	65
25	69
27	54
33	93
34	87
37	89
40	100
41	90
42	97

What are the correlation coefficient and the regression coefficient for body weight and egg number in these 11 fishes?

13. Differentiate between exploratory research design and descriptive research design.
14. What is the importance of literature survey in research?
15. Discuss the application of probability in genetic analysis.
16. How can quantitative traits be analysed using statistics?
17. Explain the concept of independent and dependent variables.
18. Briefly explain about the use of software's in paper preparation

Part C- Long Essay Type Questions

(Write any of the two of the following) **2x5wt=10**

19. Explain the layout of a research paper.
20. How does chi-square help in analyzing the biological data?
21. Discuss the major steps followed in writing a good thesis.
22. Discuss in detail about the concept and importance of research.

M.Sc. Molecular Biology & Genetic Engineering

III Semester model Questions, Practical

Subject: BS030304 - PCR technology, Bioinformatics, Cell & Tissue culture techniques (Practical III)

Time - 5 Hours **Total – 15 weight**

Sl. No.	Name of Item/Experiment	Weights
1	Experiment No.1	5
2	Experiment No.2	3
3	Experiment No.3	3
4	Procedure Writing	1
5	Viva-Voce	1
6	Record	2
	Total	**15**

INSTRUCTIONS TO THE EXAMINERS

- All the questions shall be answered by the students with in the stipulated time.
- Each student should perform three experiments- one major experiment and three minor experiments**.**
- The students need to submit the principle and procedure in writing for those experiments which demand the same by the examiner.
- The questions of Viva should be asked exclusively from the practical syllabus (not from the theory syllabus)
- Examiners are requested to send the duly signed mark lists (Original & Duplicate), valued answer scripts, duly filled TA/DA bill, remuneration bill, memo of work done and duty certificate immediately after the completion of the examination to the chairman.

PART A - Major experiment (Selection by LOT) Weight 5

PART B- Minor experiment 1 (Selection by LOT) Weight 3

PART C - Minor experiment 2 (Selection by LOT) Weight 3

PART D - Procedure writing Weight 1

PART E - Viva voce Weight 1

PART F - Record Weight 2

SCMS School of Technology & Management

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IV Semester Model Questions

Elective Paper –II BS860402 Molecular Markers & Genome Analysis

Total Weight-30 **Time – 3 hours**

Part A-Short Answer Type Questions

(Write any of the Eight of the following) 8x1wt=8

1. What are molecular beacons? Explain its significance
2. What are single nucleotide polymorphisms (SNPs)?
3. Give an account on markers. Justify the significance of molecular markers.
4. Explain Eco –TILLING.
5. Account on the various linkage mapping software packages and interfaces
6. List out the features of an ideal molecular marker.
7. Explain the applicability of CAPS technology for the development of functional markers.
8. Differentiate between hybridization probes and Taqman probes.
9. Give an account on PCR based markers.
10. Explain the mapping techniques used to identify QTLs.

Part B-Short Essay/ problem solving Type Questions

(Write any of the Sixof the following) 6x2wt=12

11. Compare and contrast RAPD and AFLP
12. Give an account on trait mapping and its application
13. Write a concise note on the point mutationsand its significance in genetic variations
14. Describe briefly the application of current molecular markers in plant biotechnology
15. Account on the organization on organelle genome and its significance in marker technology
16. Describe briefly the mechanisms and causes of DNA polymorphism
17. Give a detailed note on the various classes of repeat elements.
18. Describe the application of genotyping tools in diagnostics

Part C-Long Essay Type Questions

(Write any of the two of the following) 2x5wt=10

19. Write an essay on the various types of DNA based molecular markers.
20. Give a detailed account on dynamicity and complexity of plant genome.
21. Explain in detail about the linkage mapping
22. Describe in detail the various genotyping techniques.

SCMS School of Technology & Management

M.Sc. Molecular Biology and Genetic Engineering

IV Semester Model Question

Subject: Elective paper III:BS860403Biotechnology Entrepreneurship

Total Weight-30 Time – 3 hours

Part A-Short Answer Type Question

(Write any of the Eightof the following) 8x1wt=8

1. Write a short note on regenerative medicine and its relevance in Biotechnology industry?
2. What is meant by nutraceuticals?
3. Give an account of data collection methods.
4. What is a synthetic gene?
5. What is the importance of Academia –Industry collaborations?
6. What is Confidential Disclosure Agreement (CDA)?
7. What could be the possible applications of Artificial Intelligence?
8. Give a short note on confidentiality of publications?
9. What are the characteristics of Biotechnology license agreement?
10. What role can nanotechnology have in drug discovery?

Part B-Short Essay/ problem solving Type Questions

(Write any of the Sixof the following) 6x2wt=12

11. Present a hypothetical model for a Recombinant drug molecule?
12. What is technology transfer agreement?
13. What are the characteristics of Biotech License agreement?
14. What are the possibilities of Cancer Nano medicine in Indian and world health scenario?
15. Discuss the probable employment opportunities in India's private Pharmaceutical industry?
16. Comment on the current and Biofuel Industry possibilities world-wide?
17. Explain the application of gene silencing drugs in current therapies?
18. Discuss one commonly available recombinant drug in India?

. **Part C- Long Essay Type Questions**

(Write any of the two of the following) 2x5wt=10

19. Discuss the various strategies that can be applied for commercialization of Biotechnology products?
20. Discuss your idea of setting up a start-up Biotech company?
21. Explain the avenues of Intellectual property rights involved in Biotechnology entrepreneurship?
22. Elaborate the recent products and trends in Biotechnology Industry that may succeed in the socio economic conditions of India?

8. FORMAT OF AWARDS TO BE ISSUED TO STUDENTS

10.1 GRADE CARDS/ MARK CUM GRADE CARDS FOR EACH SEMESTER

10.2 CONSOLIDATED GRADE CARD

10.3 PROVISIONAL CERTIFICATE

10.4 DEGREE CERTIFICATE

General Instructions:

1. The document may be prepared in A4 size.
2. 12 point Times New Roman Font may be used.
3. Page number has to be provided
4. Footer has to be provided as shown in these sample sheets
5. Every Syllabus is envisaged to be presented in a common layout and format
6. It is requested that clauses which are to be included in the Regulation Document may be avoided in the Syllabus.
7. One hard copy may be spiral bound. The softcopy may be mailed to the address which will be intimated later.