Ch. Charan Singh University, Meerut –250004

DEPARTMENT OF BIOTECHNOLOGY (SFS COURSE)

M.Sc. BIOTECHNOLOGY, 2009

Distribution of Marks in different courses:

I Semester	**Course Title**	**Theory External**	**Theory Internal**	**Total Marks**
Course I	Fundamental of Genetics	50	50	100
Course II	Cytogenetics and Molecular Genetics	50	50	100
Course III	Statistical Methods and Bioinformatics in Biology	50	50	100
Course IV	Tools and Techniques in Biotechnology	50	50	100
Practical I (4 hours)		100(External)	100(Internal)	200
Total Marks		300	300	600

II Semester	**Course Title**	**Theory External**	**Theory Internal**	**Total Marks**
Course V	Fundamentals of Biochemistry	50	50	100
Course VI	Plant Genetic Resources: - Conservation and Sustainable use	50	50	100
Course VII	Biotechnology in Crop improvement	50	50	100
Course VIII	Recombinant DNA Technology and Genetic Engineering	50	50	100
Practical II (4 hours)		100 (External)	100(Internal)	200
Total Marks		100	300	600

III Semester	**Course Title**	**Theory External**	**Theory** Internal	**Total Marks**
Course IX	Microbial, Industrial and Environmental Biotechnology	50	50	100
Course X	Concepts of Nanotechnology	50	50	100
Course XI	Animal biotechnology and Immunology	50	50	100
Course XII	Genomics and Proteomics	50	50	100
Practical III (4 hours)		100(external)	100(Internal)	200
Total Marks		300	300	600

IV Semester	**Course Title**	Dissertation, presentation, viva-voce	**Total Marks**
	Project	400	400
Grand Total of Marks		2200	2200

A minimum of 30% marks separately in internal and external assessment of each course and an aggregate of 40% marks in all the courses is required for passing. In case of failing to obtain 30 % marks in internal assessment of any paper, the candidate will not be eligible to appear in external examination of that course.

CURRICULUM: M.Sc. BIOTECHNOLOGY (2009)

I Semester

1. Fundamental of Genetics

2. Cytogenetics and Molecular Genetics

3. Statistical Methods and Bioinformatics in Biology

4. Tools and Techniques in Biotechnology

Lab.: Fundamental of Genetics; Cytogenetics and Molecular Genetics; Statistical Methods and Bioinformatics in Biology; Tools and Techniques in Biotechnology

II Semester

5. Fundamentals of Biochemistry
6. Plant Genetic Resources: - Conservation and Sustainable use
7. Biotechnology in Crop improvement
8. Recombinant DNA Technology and Genetic Engineering

Lab.: Fundamentals of Biochemistry; Plant Genetic Resources: - Conservation and Sustainable use; Biotechnology in Crop improvement; Recombinant DNA Technology and Genetic Engineering

III Semester

9. Microbial, Industrial and Environmental Biotechnology
10. Concepts of Nanotechnology
11. Animal biotechnology and Immunology
12. Genomics and Proteomics

Lab.: Microbial, Industrial and Environmental Biotechnology; Concepts of Nanotechnology; Animal Biotechnology and Immunology; Genomics and Proteomics

IV Semester

Project: 1. Report of work

2. Presentation of work.

3. Viva-voce examination.

Course-I

Fundamental of Genetics

Unit-I

Introduction: History of Genetics, its scope and significance, Mendel's experiments, Principles of Segregation and Law of Independent Assortment, Lethality and Interaction of genes**.**
(4)

Unit-II

Linkage and crossing over: Linkage in higher eukaryotes, Coupling and Repulsion Hypothesis, measurement of Linkage, Detection of linkage, Breakdown of Linkage, Four- strand crossing over, Three-Point Test cross, cytological basis of crossing over, Interference and Coincidence, Crossing over and Chisma formation, Factor affecting recombination frequencies.
(4)

Unit-III

Genetics of Sex Determination and Differentiation: Sex-linked, Sex- limited and Sex- influenced traits in *Drosophila* and Human beings, Theories of Sex-determination- Chromosomal theory, environmental theory and genic balance theory, Sex- determination in dioeciously plants, Sex reversal and Gynandromorphs, Human sex anomalies (Klinefelter's Syndrome and Turner's Syndrome), brief idea of Dosage Compensation and Lyon's hypothesis. **(6)**

Unit-IV

Mutation and Mutagenic Agents: Brief history of mutation, physical and chemical Mutagens, Detection of mutation in *Drosophila* (CIB method, Muller-5 method), Detection of mutation in plants and their practical application in crop improvement.

(6)

Unit-IV

Multiple Alleles: Concepts of multiple alleles, self incompatibility alleles in Nicotiana, coat color in rodents, Blood group in Humans, antigen-antibody interaction in inheritance of A, B, AB and O blood groups, H-antigens, MNS system, Rh Factor, Epitasis and multiple allelism (Bombay blood group).
(6)

Unit-V

Genetics of Inbreeding Depression and Heterosis: Definition and Historical aspects of heterosis and Inbreeding depression, manifestation and application of heterosis, apomixis and fixation of heterosis, application of molecular marker in heterosis breeding**.** **(8)**

Unit-VI

Extra -chromosomal Inheritance: Criteria for extra- chromosomal inheritance, plastid inheritance in *Mirabilis,* iojapa in corn, Kappa particles in *Paramecium*, Coiling in snails, male sterility in plants**.** **(6)**

Unit-VII

Biochemical Genetics: Inborn errors of Metabolism in man, eye transplantation in *Drosophila*, biochemical mutations in Neurospora, biosynthetic pathways and biochemical mutations**.** **(4)**

Unit-VIII

Concepts of Genes: Classical and modern gene concepts, Pseudoallelism, position effects, intragenic crossing over and complementation (cistron, recon, muton), Benzer's work on rII locus in T4 phases. **(6)**

Course-II

Cytogenetics and Molecular Genetics

PART-A: - Cytogenetics

Unit-I

Cell Division: Cell Cycle, differences between mitosis and meiosis, mechanism of chromosome moment, reduction division and equational division, double reduction. **(6)**

Unit-II

Duplication and deficiencies: Classification, methods of production, meiotic pairing and Phenotypic effects. (4)

Unit-III

Translocation: - Classification, methods of production, identification, meiotic pairing and role in evolution. (4)

Unit-IV

Inversion: Classification, methods of production, identification, meiotic pairing and crossing over in different regions, Role in evolution. (6)

Unit-V

Trisomic and Tetrasomic: - Classification, methods of production, Identification, meiotic pairing and utility in Chromosome mapping. (2)

Unit-VI

Monosomic and Nullisomic: - Methods of Production, Identification, meiotic behavior, monosomic analysis, alien additions/substitution lines. (2)

PART-B: - Molecular Genetics

Unit-VII

Genetic Material: DNA and RNA as genetic material (experimental evidences), structure of DNA(including Z-DNA and 5- hasisekharan's RL model), super coiling of DNA, Different type of RNAs and their roles, difference between DNA and RNA. (6)

Unit-VIII

DNA Duplication (in prokaryotes and Eukaryotes):- Unwinding proteins, Role of RNA Polymerases and DNA polymerases in prokaryotic and eukaryotic DNA replication, Semi-conservative, Discontinuous and Bi-directional replication, RNA primers, Role of proteins in prokaryotic and eukaryotic DNA replication, Models of replication. (8)

Unit-IX

Organization of Genetic Material: Chromosome ultra structure and nucleosome concept, packing of DNA as nucleosomes in eukaryotes, techniques used for discovery of nucleosome, structure and assembly of nucleosomes, solenoid, phasing of nucleosomes, DNA concept and C-value paradox, repetitive and unique sequences, overlapping, pseudo, crying and split genes, satellite DNA's, selfish DNA. (8)

Unit-X

Genetic Code (including mitochondrial genetic code):- Deciphering of code in vitro and in vivo (use of mutations-base replacement, frame-shift and suppressor mutation). (4)

Course-III

Statistical Methods and Bioinformatics in Biology

PART-I: Statistical Methods

Unit-I

Presentation of Data: Frequency distributions, graphical presentation of data by histogram, frequency polygon, frequency curve, and cumulative frequency curves. (4)

Unit-II

Measures of central tendency and dispersion: - Mean, Median, Mode and their simple properties (without derivations), and calculation of median by graphs, range, mean derivation, standard deviations, coefficient of variation. (6)

Unit-III

Test of Significance: - Sampling distribution of mean and standard error, large scale sample tests(tests for an assumed mean and equality of two population means with known S.D.), small sample tests(t-tests for an assumed mean and equality of means of two populations when sample observations are independent, paired and unpaired t- test, t- test for correlation and regression coefficients), t-test for comparison of variances of two populations, chi-square test for independent of attributes, goodness of fit and homogeneity of samples. (10)

Unit-IV

Experimental Designs: Principles of experimental designs, completely randomized, randomized block and Latin square designs, simple factorial experiments (mathematical derivation not required), analysis of variance (ANOVA) and its uses. (8)

PART-II: Bioinformatics

Unit-V

Introduction: - History, aims of Bioinformatics, Definition and Concepts, Components of Bioinformatics, Basic tools, Scope of Bioinformatics in molecular biology and Computers, Role of internet in Bioinformatics, Applications of Bioinformatics. (6)

Unit-VI

Bioinformatics- Approaches and applications: - Introduction, DNA-the staff of life, molecular sequence alignments, databases, molecular visualization integrated molecular biology database.

(8)

Unit-VII

Protein and Nucleic acid databases: - Introduction, Protein and Nucleic acid databases, databases accession, database searching, NCBI based study. (8)

Course-IV

Tools and Techniques in Biotechnology

Unit-I

Microscopy: Principles, Resolving Power and applications of Light Microscopy, Electron Microscopy (SEM, TEM) and Confocal Microscopy. (6)

Unit-II

Centrifugation: Brief history, type of centrifugation, theory of centrifugation, types of centrifuges and centrifugation techniques, Types of rotors. (8)

Unit-III

Electrophoresis: - History, Principles, Application and factor affecting of electrophoresis with detail reference to Agarose, PAGE, PFGE, Capillary electrophoresis, continuous, 2D-PAGE, IEF. (8)

Unit-IV

Nuclear Magnetic Resonance Spectroscopy: - History of NMR, theory and principles of NMR, NMR spectrometer, Detection of frequencies and Measurement by NMR. (6)

Unit-V

Radioisotope Technique: - Nature of Radioactivity, characteristics of different radiolabels, detection and measurement in Radioactivity, applications of radioisotopes in biological sciences.

(6)

Unit-VI

Spectroscopy: - Introduction, theory and principles of different types of Spectroscopy and their applications in biotechnology. (6)

Unit-VII

Chromatography: - General principles and techniques of HPLC, LPLC, GLC, Adsorption Chromatography, partition chromatography, IEC, permeation Chromatography, Affinity Chromatography. (10)

Course-V

Fundamentals of Biochemistry

Unit-I

Structural and Biochemical Organization: - Amino Acids, Carbohydrates, Lipids and Fatty Acids and Nucleotides. (6)

Unit-II

Secondary metabolites: - Hormones, Alkaloids, Porphyrins. (6)

Unit-III

Enzymology: - Enzymes, Elementary Kinetics, Mechanism of enzymes action, assay types, reaction rates, Extremozymes engineering, enzyme activity and substrate specificity, Non-aqueous enzymology, coenzymes and vitamins, Isozymes and allosteric enzymes. (12)

Unit-IV

Protein as base unit: - Structure and function, Protein folding, Protein sequencing, Ramachandran's plot and Protein catabolism (10)

Unit-V

Major intermediary metabolic pathways, biosynthesis and catabolism of saturated and unsaturated fatty acid, nucleotides. (8)

Unit-VI

Glycolysis, Kreb's cycle, ETS of respiration and oxidative phosphorylation substrate level phosphorylation, Anaplerotic pathway. (8)

Course-VI

Plant Genetic Resources: - Conservation and Sustainable use.

Unit-I

Biological species: Concepts and its limitation**.** (2)

Unit-II

Centers of Diversity and Centers of Origin. (2)

Unit-III

A brief idea of the evolution of crop plants: - Wheat, Barley, Rice, Maize, Cotton, Sugarcane, Potato, Cole crops, Rapeseeds and mustard. (6)

Unit-III

Biodiversity vs. Genetic Resources: - Definition and Explanation, alpha vs. beta biodiversity and methods of their study, present levels of Biodiversity and rate of loss of biodiversity, causes for the loss of biodiversity, uses of biodiversity, extent of biodiversity in plants, exploration and germplasm collection, introduction and exchange of PGR, Red Data Books and Endangered plant species. (8)

Unit-IV

Plant Genetic Resources: - Different kinds of PGR, Taxonomical Classification of PGR, Basic, derived and molecular, core collections, principles of germplasm characterization, evaluation, maintenance and regeneration, Plant quarantine aspects- Sanitary and Phytosanitary Systems (SPS). (8)

Unit-V

Techniques for conservation of plant germplasm: - *In-situ* and *Ex-situ* methods of conservation, Cryopreservation of genetic materials. Gene banks and Cryobanks. (2)

Unit-VI

IPGRI, NBPGR, FAO and CGIAR: - Their role is conservation of PGR. (6)

Unit-VII

Future Harvest Centers and CBD: -A Brief Idea, CBD and Cartagena protocol. (6)

Unit-VIII

UPOV, Plant Breeders Rights (PBRs) and farmers Right (FRs), Protection of plant varieties and farmers right act (PPV and FRA) 2001. (4)

Unit-IX

PGR and IPRs (Intellectual Property Rights):- Patents, copyrights, Trademarks, GATT and TRIPs, Terminator and Traitor Techniques (v-GURT and t- GURT), Biodiversity Bill 2002, Geographic indicator bill. (6)

Course-VII

Biotechnology in Crop improvement

Unit-I

Plant organ, tissue and cell culture: - Somaclonal variation and its use in crop improvement, embryo culture and its utility in hybridization programmes, Anther culture, haploid production and their uses, micro propagation in horticultural crops and forestry and its uses, artificial seeds, techniques of protoplast culture, regeneration and somatic cell hybridization, achievements , limitations, utility in improvement of crop plants. (12)

Unit-II

Biofertilizers, Bioinsecticides and Molecular Farming. Concept and utility (4)

Unit-III

Methods of Gene Transfer in Plants: *Agarobacterium* mediated gene transfer, direct DNA delivery methods (microinjection, particle gun, electrophoration). (6)

Unit-IV

Hybridization: - Distant hybridization and Somatic hybridization in crop improvement. (4)

Unit-V

Transgenic Plants in dicots and monocots: - Utility of Transgenic in basic studies and in crop improvement (resistance for herbicides, viruses, insects and abiotic stresses, Barnase and Barstar for hybrid seed production), Biosafety issues including risks associated with transgenic crops, biosafety regulations. (8)

Unit-VI

Improvement of Nutritional quality of plants: - seed storage proteins e.g. Glycinin, Conglycinin, Legumin, Phytohaemaglutinin, Phaseolin, Prolamins, Albumins and Designer-proteins, Engineering for vitamins and Iron-Deficiency, Engineering Traits related to hybrid seed Production (e.g. Male Sterility) (8)

Unit-VII

Plant genome Programs: - Impact of genetically modified crops and genomics research in agriculture and biology, Evaluation of Transgenic plants as to their commercial value, Efficacy and Environmental concerns, Legislation for Transgenic plants, Economic viability of Transgenic plants (8)

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Course-VIII

Recombinant DNA Technology and Genetic Engineering

Unit-I

Genetic Engineering: - Definition and explanation, scope of GE, Concept and importance of GE, RDT in prokaryotes and eukaryotes, Restriction enzymes, modifying enzymes, Isoschizomers and cloning into mutagenesis, DNA Fingerprinting. (12)

Unit-II

Cloning and expression vectors:-Plasmid, Phage, M13, Phagemid, BAC, YAC, MAC, Expression vectors, Use of Promoters, Expression through Strong and Regulatable Promoters, Binary and Shuttle Vectors. (8)

Unit-III

Libraries and molecular probes: - Construction and Screening of genomic and cDNA libraries, BAC libraries and assembly of BACs into contigs, Molecular probes and their preparation, labeling and applications, Southern, Northern, Western blotting, Chromosome walking, Chromosome jumping. (12)

Unit-IV

Polymerase Chain Reaction: - Basic principles and its modifications, designing of primers, Different schemes of PCR, application of PCR, RACEs, Electronic PCR (e-PCR), RT- PCR, Real- Time PCR (8)

Unit-V

Gene Sequencing: - Different methods of gene isolation, techniques for sequencing (Maxam & Gilbert degradation method, Sanger's Dideoxy method), Organo-chemical gene synthesis mechanism, cDNA using reverse transcriptase. (10)

Course-IX

Microbial, Industrial and Environmental Biotechnology

Unit-I

Introduction: - Concepts, Growth curve, sterilization techniques, Isolation and Characterization. (2)

UNIT II

Microbes: - Definition, classification, sources of useful microbes and their characteristics. (4)

Unit-III

Use of Microbes in food and dairy, single cell proteins, physiological aspects SCP from CO_2, waste materials and renewable resources, improvement in single cell protein production, Probiotic foods. (8)

Unit-IV

Industrial source of enzymes: - Cellulases, Xylanases, Pectinases, Amylase, Lipase and Proteases their production and applications. (6)

Unit-V

Commercial production of important antibiotics, amino acids, insulin, steroids, Fermentation and production of Ethanol, Acetone, Butanol, Glycerol, Vitamins and Alkaloid (8)

Unit-VI

Pollution: - Types, causes, Prevention and Control, methods of reducing environmental impacts of chemicals, weedicides, Pesticides and fertilizers, Biotechnological advances in pollution control through GEMs, Sewage treatment, Newer approaches to sewage treatment, treatment of solid waste, Energy production- Bio-fuels. (8)

Unit-VII

Bioremediation and pollution control through microbes and plants, Biodegradation of Natural Products, microbial desulphurization, biodegradation of xenobiotics, hydrocarbons. (8)

Unit-VIII

Biotechnology of fermentation: Methods and types of fermentation, dual/multiple fermentation, continuous fermentation and late nutrient addition, growth kinetics of microorganisms, fermenter systems and fermentation. (6)

Course-X

Concepts of Nano-biotechnology

Unit-I

Introduction: - Concept, scope, vision, application, present and future prospects in biological sciences. (6)

Unit-II

Applications of Quantum Dots in Biology: - An overview, Introduction, General properties, applications. (6)

Unit-III

Assembly and Characterization of Bio-molecules: - Gold Nano-particle conjugates and their use in intracellular imaging (introduction, different methods). (6)

Unit-IV

Surface-functionalized Nano-particles for controlled drug delivery: - Introduction and different Methods. (4)

Unit-V

Structural DNA nanotechnology- An overview: - Introduction, DNA objects, DNA Arrays, DNA nanomechanical devices, DNA based computational studies. (8)

Unit-VI

Nanostructure DNA templates: - Introduction, synthesis and purification of Plasmid templates, Fabrication and preparation of ultrathin carbon-coated TEM Grids, Preparation of Q-Cds/pUCLen4 or Q-Cds/Φx174 RF11 samples, their characterization. (8)

Unit-VII

Probing DNA structure with Nanoparticles: -Introduction, Different methods. (4)

Unit-VIII

Synthetic Nanoscale Elements for Delivery of Material into Viable cells: - Introduction, different Material required, Different methods. (8)

Course-XI

Animal biotechnology and Immunology

Part-A: Animal Biotechnology

Unit-I

Introduction: - Animal Tissue and Organ Culture, Plasma clot method, Raft method, Agar-gel method, Grid method, cyclic exposure to medium and Gas phase, advantages, limitations and applications, artificial skin. (6)

Unit-II

Cell Culture: - Substrate and suspension culture, Culture Media, natural and artificial, initiation of cell culture, sub-cultures, Evaluation and Maintenance of cell culture lines, Large scale culture of cell lines, Monolayer, Suspension culture, Immobilized cultures, Somatic cell fusion, mechanism and applications, cell culture products and their applications, Interferon's. (8)

Unit-III

Cloning: -In-vitro Fertilization and Embryo transfer, Application of Embryo transfer technology, Embryo transfer in cattle, , Animal cloning, Ethical and Social Issues relating to Human cloning, Transgenic and their future Prospective. (8)

PART B: Immunology

Unit-IV

Introduction: - History, concept and Scope of Immunology. (2)

Unit-V

Immunity: - Innate and Acquired immunity, Passive and Active Immunity, Lymph and organs, Humoral and Cell Mediated immunity, Specificity and Memory, Transplantation immunity, Major Histocompatibility Complex (MHC) and Complements. (6)

Unit-VI

Interactions: - Antigen-Antibody reactions, Antigen type-hapten, Immunoglobulin's (fine structure of IGg and diversity), serological reactions, Agglutination, Precipitation, Immuno-electrophoresis, ELISA, RIA, Immuno-electromicroscopy. (6)

Unit-VII

Hybridoma Technology: - Monoclonal antibody production, myeloma cell lines, Fusion of myeloma cells without antibody producing B-cells, selection and screening methods for positive hybrids, production, purification and characterization of monoclonal antibodies without Hybridoma, Genetic manipulation of immunoglobins. (6)

Unit-VIII

Diseases and Vaccines: - T-cell cloning, mechanism of antigen recognition by T-and B-lymphocytes, Genetic control of immune response, autoimmune diseases, immunodiagnosis, AIDS, types of vaccines, Strategies for the development of vaccines, infectious diseases. (8)

Course-XII

Genomics and Proteomics

PART A: Genomics

Unit-I

Origin and Evolution of genomics: - Origin of genomics, the first DNA genomes, microcollinearity and lack of it, DNA based phylogenetic trees, genomes and human evolution, evolution of nuclear and organellar (mitochondrial and Chloroplast genome, the concept of minimal genome and possibility of synthesizing it. (6)

Unit-II

Molecular maps of genomes and comparative genomics: - Genetic maps, physical maps, EST and transcript maps, functional maps, comparative genomics and collinearity/synteny in maps.(4)

Unit-III

Whole Genome sequencing: - Whole genome shotgun sequencing, clone-by-clone or 'hiererchical stotgun' sequencing, microbial genomes (including yeast), plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human). (6)

Unit-IV

Annotation of whole genome sequence and functional genomics: - *In silico* methods, insertion mutagenesis (T-DNA and transport insertion), TILLING, management of data, gene expression and transcript profiling, EST contigs and unigene sets, use of DNA chips and microarrays. (6)

Unit-V

Pharmacogenomics: - Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, use of SNP in pharmacogenomics, pharmacogenomics and industry. (6)

PART B: Proteomics

Unit-VI

Study and Scope: - Introduction, definition concepts and approaches of proteomics studies and activities. (2)

Unit-VII

Quantitative and Qualitative proteome analysis technique: - Separation technique- 2D-PAGE, 2-DE (BN-PAGE), image analysis, Mass- spectrophotometery, LC-TMS, MALDI, and SALDI (8)

Unit-VIII

Protein interaction and Protein complex: - Protein interaction, DNA- Protein interaction, Yeast two hybrid system and their applications. (4)

Unit-IX

Drug Discovery and Development: - Current issues, drug targets, Drug efficacy, Drug toxicology, Protein chips and Antibody Microarray. (4)

Unit-X

Cancer Proteomics: - An overview of cancer, origin and types of cancer, proteomics in cancer research, techniques of proteomics in cancer research, future approaches of proteomics and cancer research. (4)