FACULTY OF SCIENCE

SYLLABUS

FOR

M.Sc. (Hons. School) in Biotechnology

1st to 4th Semester

EXAMINATIONS

2018-2019

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<th>S.No.</th>
<th>Course/Paper</th>
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**M.Sc. 1st Year (1st Semester)**
Course No.: MHS(I)Sem-I-I/T

Paper: Animal Cell Culture Technology

Objective:

The major emphasis of this course is to introduce the students to the fields of Animal cell-culturing and Stem cell culturing and their importance to mankind. The students will also learn the techniques involved in in vitro animal cell culture.

Unit – I

Historical background of animal cell culture
Application of animal cell culture,
Aseptic Techniques, Equipment and material for ATC lab,
Cryo preservation and contamination.

Unit – II

Primary and established cell line cultures.
Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements.

Serum & protein free defined media and their application.

Unit – III

Measurement of viability and cytotoxicity

Biology and characterization of the cultured cells, measuring parameters of growth.
Basic techniques of mammalian cell culture in vitro; desegregation of tissue and primary culture; maintenance of cell culture; cell separation.

Scaling-up of animal cell culture

Unit – IV

Cell synchronization.

Cell cloning and micromanipulation.

Cell transformation and immortalization

Safety, bioethics and validation of animal cell culture laboratory.
Essential Readings:


Further Readings:


Practicals:-

1. Fumigation of cell culture lab
2. Sterilization of glassware and equipment
3. Preparation of cell culture media and trypsin solution
4. Observation of adherent (Fibroblastic, epithelial) and suspension cultures (Lymphoblast)
5. Growth curve assay to determine optimal confluency for sub-culturing
6. Subculturing of suspension and adherent cells
7. Cell counting by haemocytometer and plating of cells at 40%, 60% and 80% confluency.
8. Cryopreservation of cell lines
9. Revival of frozen stocks of cell lines
10. Estimation of cell viability by dye exclusion (Trypan blue) and dye uptake (fluorescein diacetate) test
11. Determination of the IC50 value of a drug using MTT assay
12. Wound healing assay to determine the rate of cell proliferation
13. Demonstration of cell cycle assay by flow cytometry

Course No.: MHS(I)Sem-I-II/T

Paper: Advanced Immunology

Objective:

This course will expose the students (a) to the functioning/importance of immunomodulators (b) why our body do not produce immune response against our own components,(c) why certain individuals produce undesirable immune-related reactions (c) how our body responds to the invasion by microbes (d) How can we induce our body to accept foreign components (e) why normal cells become cancerous cells and (f) various vaccines prepared to combat infections. Practical skills will be imparted to the students through critically designed practicals related to the subject.
Unit-I

**CYTOKINES:** Nomenclature, properties, functions, families and subfamilies, their receptors, JAK-STAT signal transduction pathways, cytokine antagonists, diseases related to cytokines.

**Chemokine biology:** Families and their receptors, signaling through G-protein coupled receptors, role in immune responses, therapeutics.

**HOST-PATHOGEN RELATIONSHIPS:** Current knowledge of immune responses approaches to prevention, diagnosis and treatment of *viral infection* (influenza), *bacterial infection* (Diphtheria, pertussis, tetanus, tuberculosis), *parasitic diseases* (malaria, African sleeping sickness, leishmaniasis, schistomiasis), *fungal diseases* and *emerging infectious diseases*.

Unit-II

**AIDS & OTHER IMMUNODEFICIENCIES:** Primary & secondary immunodeficiencies.

*Primary deficiencies:* Immune deficiencies of myeloid lineage, phagocytic number, adherence, chemotactic and killing defects.

*Humoral deficiencies:* Agammaglobulinemia, hypergammaglobulinemia, hypogammaglobulinemia, selective immune deficiencies, Ataxia telangiectasia.

*Cell mediated immunodeficiencies:* Di George syndrome.

*Combined immunodeficiencies:* SCID and Wiscott Aldrich Syndrome, Experimental models of immunodeficiency, nude and SCID mouse.

*AIDS and Other Acquired or Secondary Immunodeficiencies:* History/ spread, HIV testing, structure of HIV, pathogenesis, opportunistic infections, diagnosis and preventive/therapeutic approaches for AIDS.

**TOLERANCE AND AUTOIMMUNITY:** Basis of immunological tolerance, T cell tolerance to thymic and extra thymic antigens (clonal deletion and clonal anergy), Role of apoptosis, B cell tolerance (clonal abortion and clonal anergy), Factors affecting the induction and duration of tolerance. Failure of tolerance leading to autoimmunity.

*Organs specific autoimmune diseases:* Diseases mediated by *direct cellular damage* (Hashimoto’s thyroiditis, autoimmune anemia, goodpasture’s syndrome, insulin-dependent diabetes mellitus) and *stimulating* (graves’ disease) or *blocking auto-antibodies* (mysthenia gravis).

*Systemic autoimmune diseases:* Systemic lupus erythematosus, multiple sclerosis and rheumatoid arthritis.

Possible factors contributing to the autoimmune diseases. Their diagnosis as well as conventional and recent therapeutic approaches.
Unit-III

HYPERSENSITIVITY REACTIONS: Hypersensitivity reaction and Gell and Coomb classification.

*Type I hypersensitivity reaction:* components of IgE mediated hypersensitivity, intracellular events in mast cells degranulation, pharmacologic agents mediating reaction, late phase reactions, localized and systemic anaphylaxis atopic and anaphylactic disorders, detection and control.

*Type II Hypersensitivity:* Mechanism of type II hypersensitivity, roles of different cells in causing type II hypersensitivity reaction, incompatible blood transfusion (immediate and delayed reactions), hemolytic disease of new borne, drug hypersensitivity. Diagnosis/prevention/treatment of type II hypersensitivity reactions.

*Immune complex mediated type III hypersensitivity:* Localized and generalized reactions, Arthus reaction and serum sickness, diagnostic and therapeutic approaches. Basis for cell mediated immune response.

*Type IV Hypersensitivity:* Tuberculin and hypersensitivities to other agents, contact dermatitis, phases of delayed type hypersensitivity (DTH) response, cytokines participating in DTH response, *in vivo* & *in vitro* diagnostic tests.

THE COMPLEMENT SYSTEM: Complement and its components, functions of complement, complement activation by classical, alternative and lectin pathways and its biological consequences, regulation of complement system, diseases associated with complement deficiencies.


Unit-IV

APPLICATIONS OF IMMUNOLOGICAL PRINCIPLES IN THE DEVELOPMENT OF VACCINES: Active and passive immunization.

*Designing vaccines for active immunization:* Whole organism vaccines (live attenuated, inactivated), Subunit vaccines (toxoids, bacterial polysaccharide capsules, viral glycoproteins, pathogens proteins manufactured by recombinant techniques, synthetic peptides), Conjugate vaccine (polysaccharides against fungi, multivalent vaccines), DNA vaccines and Recombinant vector vaccines.

**Essential Readings:**


**Further Readings:**


**Practicals:-**

1. Widal test for serological diagnosis of enteric fever or typhoid.
2. Rapid Plasma Reagin test for the detection of reagin antibody from the serum of patients suffering from syphilis.
3. Detection of ‘Rheumatoid Factor’ by agglutination reaction.
4. Qualitative test for the determination of antigen by Dot ELISA.
5. Sandwich ELISA to detect the concentration of serum Ag against HIV.
6. Competitive ELISA to detect the concentration of antigen in the test sample.
7. Purification of IgG using Protein A beads/affinity chromatography and analysis of purified IgG on SDS-PAGE.
8. Demonstration/practical of Western blotting/ Nucleic acid-based tests (NAT) for HIV detection.
9. Blood typing to find out individual’s ‘donor group’ and ‘recipient group’ for transfusion of blood.
Course No.: MHS(I)Sem-I-III/T

Paper: Advanced Recombinant DNA Technology

Objective:

This course introduces the students to the advancements made in the field of rDNA Technology. Gene cloning strategies in eukaryotic system and DNA sequencing techniques, amplification of DNA and its practical ramifications have been included. Two technologies being used extensively in the field of Molecular Biology i.e. Phage display system and Yeast two hybrid system, the techniques used in creating specific mutation in the genome, importance of T-DNA and the applications of rDNA has also been covered. Practical skills will be imparted to the students through critically designed practicals related to the subject.

Unit I

Gene cloning vectors: vectors for yeast (2µplasmids, YIp, YEp, YRp) yeast artificial chromosomes, BAC and PAC.

Vectors for animal cells and selection markers, transformation / transfection.

DNA sequencing: Maxum Gilbert, Sanger’s Method, PyroSequencing, Hierarchical shotgun sequencing and whole genome shotgun sequencing.

Unit II

In vitro translation of proteins.

DNA amplification techniques: PCR (long, inverse, real time PCR, RACE etc.) ligase chain reaction and helicase dependent amplification.

Application of PCR in rDNA Technology.

Unit III

Phage display system its types and applications.

Yeast hybrid system for protein-protein interaction and its variations (one, two, three hybrid and reverse hybrid

Unit IV

Site directed mutagenesis: Cassette mutagenesis, primer extension, PCR method, bisulfite method and protein engineering.

T-DNA and Transposon Tagging

Role of gene tagging in gene analysis, Identification and isolation of genes through T-DNA or transposon.

Applications of rDNA Technology.
**Essential Readings:**


**Further Readings:**


**Practicals:-**

1. Isolation of metagenomic DNA from soil
2. Preparation of electrocompetent *E.coli* cells and their electroporation
3. Partial and complete digestion of genomic DNA by restriction enzymes
4. Southern blotting of DNA
5. Amplification of a gene by colony PCR
6. Error prone PCR
7. Isolation of RNA from bacteria
8. cDNA synthesis
9. Demonstration of real time PCR

**Course No.: MHS(I)Sem-I-IV/T**

**Paper: Advanced Molecular Biology**

**Objective:**

To impart in depth knowledge of (a) structural DNA and Proteins (b) Cell cycle and Signal transduction, (c) Cancer biology and (d) Molecular basis of AIDS

**Unit I**

Protein structure: Primary structure determination, modifications

Three dimensional structures of proteins: Secondary structure; the peptide group, helical structure,

Beta structure, non-repetitive structure

Quaternary structure and Protein folding

Fibrous and globular proteins,
Protein stability

Unit II

Different forms of DNA, supercoiling of DNA, DNA melting,
Repetitive sequences, cot and rot curves, C value paradox,
DNA protein interaction

Structural organization of chromatin, non-coding sequences, chromatin remodeling, CHIP assay

Regulation of eukaryotic gene expression

Unit III

Transposition and gene amplification

Antisense nucleic acid and its applications

Molecular basis of AIDS: infection, replication, functions of different genes, therapy

Cell cycle: Overview and control of cell cycle

Unit IV

Cancer: biology, causes, genetics, oncogenes, tumour suppressor genes, strategies for combating cancer.

Apoptosis: pathways and genes involved

Signal transduction, Types of signals, ligands and receptors, second messenger molecules

Signaling through

a. G-protein coupled cell surface receptors and small intracellular mediators,

b. Enzyme coupled cell surface receptors

Essential Readings:-


Further Readings:


Practicals:

1) Isolation and purification of nuclei
2) Isolation of Histones
3) Gel electrophoresis to visualize pattern of histones
4) Methylation specific PCR
5) Concentration and partial purification of lipase
   • Determination of protein concentration and lipase assay in culture supernatant
   • Precipitation of protein
     • By salting in
     • By salting out
   • Selection of ammonium sulphate concentration for partial purification of protein
   • Removal of ammonium sulphate
     • By sieve chromatography
     • By dialysis
6) Enzyme assay and determination of protein concentration, calculating the fold purification
7) Determination of secondary structure of protein
8) Effect of temperature on secondary structure of protein
9) Effect of temperature on tertiary structure of protein
10) MTT assay for cell viability and growth after treatment with anticancer drug.
11) Demonstration of apoptosis by
   • Apoptotic body formation
   • dye exclusion & dye-uptake methods
   • DNA laddering.
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Total Credits= 20  Total Marks = 500
Course No.: MHS(I)Sem-II-I/T

Paper: Bioinformatics

Objectives:

- To introduce bioinformatics concepts, principles, and techniques to students with life science background
- To impart knowledge about the existing tools for storage, retrieval, sharing and use of biological data
- To familiarize students with existing tools and resources for multiple sequence alignment, phylogenetic analysis, protein and genome analysis.

Unit I

Database- introduction, Primary, Secondary and composite databases.
Type and kind of databases. Literature search (PUBMED and MEDLINE).
Nucleic acid (GenBank, EMBL etc.). Protein databases (SWISS PROT, UNIPROT etc.)
Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc.
Motifs and Pattern Databases- PROSITE, Pfam, etc.

Unit II

Sequence retrieval (SRS, Entrez) and Data submission.
Sequence alignment: Local and Global alignment, matrices and algorithms for alignments
Similarity and Percent identity score (open, extended gap penalty).
Database Scanning and Sequence similarity searches. Algorithm of. Description of
FASTA and
BLAST algorithm.
BLAST programs (BLASTP, BLASTN etc).

Unit III

Multiple sequence alignment: introduction, types of multiple sequence alignment techniques.
Description of major softwares (MSA, CLUSTALW, PILEUP).
Phylogenetic analysis: applications and programs

Unit IV

Protein Structure : Protein structure classification, Structure Analysis, Secondary structure prediction methods, Homology and Comparative modeling
Genome Annotation: Pattern and repeat finding, Gene identification tools, Detecting Open Reading Frames.
Description of major gene prediction methods.
**Essential Readings:**


**Further Readings:**


**Practicals:-**

1) Application of the following protein databases in solving bioinformatics problems:
   - Primary Sequence Databases: SWISS PROT/UNIPROT, GenBank, EMBL
   - Primary Structure Databases: PDB, NDB
   - Secondary Sequence Databases: PROSITE, Pfam
   - Secondary Structure Databases: CATH, SCOP
   - Literature Search: Pubmed and Medline
2) Blast analysis and result interpretation
3) Identification of conserved domains in proteins using CDD and SMART tools
4) To study DNA translation and primer designing tools
5) To predict molecular weight and PI of proteins
6) To understand and use multiple sequence alignments Programs: Clustal W, Clustal Omega, T-Coffee, MUSCLE, PILEUP
7) To understand and use phylogenetic analysis programs: Phylip, Mega
8) Protein Structure Analysis
   - Secondary Structure Prediction of proteins using various methods
   - Homology Modeling and evaluation of proteins using various methods
9) Gene and Genome annotation tools: GRAIL, GENSCAN etc.
10) Repeat Masker ORF Finder etc.
Course No.: MHS(I)Sem-II-II/T

Paper: Microbial Biotechnology

Objective:
This paper emphasizes the importance of microbial genomics, proteomics and metabolic engineering for the welfare of mankind. Various approaches being adopted to discover new antimicrobial compounds, how recombinant proteins are secreted out in the environment by the host cells and the ability of microbial pathogens to cause various diseases at molecular level have been covered. The ability of microbes to synthesize unique proteins without the involvement of ribosomal machinery & Reporter genes and Biosensors, role of microbes in the production of energy rich compounds like bio-diesel/bio-hydrogen and bio-fertilizers has been included.

Unit-I

Applications of genomics in microbiology
Applications of proteomics in microbiology
Metabolic engineering for production of novel compounds

Unit-II

Secretary mechanisms of recombinant proteins
Microbial pathogenesis at molecular level
Novel strategies for development of new antimicrobial drugs

Unit-III

Biosynthesis of non-ribosomal proteins in microbes
Reporter genes and their applications in microbiology.
Biosensors and their applications.

Unit-IV

Microbes as Biofertilizers: Nitrogen fixers & phosphate solubilizers
Biofuels & Bioenergy: Bioethanol, Biodiesel, Biohydrogen

Essential Readings:


Further Readings:


Practicals:-

1. Reporter assay based on Lac Z gene
2. Quorum sensing system based reporter assay
3. To check antibiotic susceptibility of a given organism
4. To determine minimum inhibitory concentration of an antibiotic
5. Isolation of rhizobium from root nodules
6. Isolation of free living Nitrogen fixers from soil
7. Isolation of phosphate solublizing bacteria from roots

Course No.: MHS(I)Sem-II-III/T

Paper: Intellectual Property Rights, Biosafety and Bioethics

Objective:

To spread general awareness for the optimum utilization of biotechnology in the different sectors. The major emphasis of this course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products. The biotechnology students suppose to follow the regulatory framework important for the product safety and benefit for the society.

Unit I

General Introduction to intellectual property rights and its different forms.
Farmer’s Rights, Animal and Plant breeder’s rights.
Development of patent system in India.
WTO agreement and TRIPS, WIPO and Patent Cooperation treaty.
Patenting of organisms, Convention on biological diversity, Budapest treaty.

Unit II

Patents: Basic requirements of patentability, patentable subject matter, compulsory licensing, Patent infringements and revocation
Special issues in Biotechnology Patents: Disclosoure Requirements, Collaborative research, competitive research, Patent Litigation, Unfair competition.
Copyrights and related rights, Trademarks, Design, Geographical indications, Tradesecrets.
International treaties covering various forms of IPR.
Unit III

Public acceptance for biotechnology and biosafety issues
The Cartagena protocol on biosafety, Geneva Protocol,
Biosafety management: Key to the environmentally responsible use of biotechnology
Environment protection act. Kyoto protocol
Transgenic organisms and biosafety issues.

Unit IV

Ethical implications of biotechnological products and techniques.
Bioterrorism, Social and ethical implication of biological weapons
Biohazards: Concept of biohazards with cases highlighting importance.
GLP, GMP and Biosafety levels

Essential Readings:


Further Readings:


Practicals:-

1. Searching of Indian Patent databases
2. Searching of International Patent databases
   - USPTO
   - WIPO
   - PCT
3. Drafting the patent application
4. Patent filing process:
   - In India
   - In US
   - Under PCT
   - In individual countries
5. Good Lab Management Practices (GLMP).

Course No.: MHS(I)Sem-II-IV/T

Paper: Scientific Writing & Project Management

Objectives:

- To learn how to write effectively, concisely, and clearly
- To prepare an actual scientific manuscript or grant
- To enhance entrepreneurial skills by introducing biotechnology based project proposals.

Unit I

Overview of science writing
Structure in journal articles, review articles, grant proposals, and thesis

Unit II

Punctuation, style, and organization in scientific writing documents
Scientific literature: Gathering scientific data using the Library/Internet

Unit III

Funding agencies: National and international funding agencies for R & D projects.
Preparation of R & D projects for funding: Organization of a research project, identification of gap areas in the subject, aims and objectives of the projects, possible outcome of the project, funds requirements and justification(s).

Unit-IV

Project management in biotech-industry: Basis and technology for starting a new project, cost estimation, marketing strategies for biotechnological products, evaluation and advertisements.

Essential Readings:


**Further Readings:**


**Practicals:-**

1) To understand the contents of a scientific article and apply the writing strategies to the following:
   • Abstract of the given research/review article
   • Introduction of the given research article
   • Materials & Methods of the given research article
   • Discussion and Conclusion of the given research article
2) To understand the process of scientific literature review using pubmed
3) Editing exercises
   • Exercises to improve clarity and readability
   • Critical analysis of scientific documents in terms of clarity, readability, and style
4) To prepare poster presentation for the given topic
5) Case study on various R&D funding organizations in India
### Semester – III -( July-2018)

M.Sc. 2\textsuperscript{nd} Year (3\textsuperscript{rd} Semester)

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Total Credits= 20  Total Marks = 500
Course No.: MHS(II)Sem-III-I/T

Paper: Animal Biotechnology

Objective:

The major emphasis of this course is to introduce the students to the fields of Animal cell-culturing and Stem cell culturing and their importance to mankind. The students will also learn the techniques involved in \textit{in vitro} fertilization, organ/animal cloning, biodiversity conservation.

\textbf{Unit-I}

\textbf{Stem cells}: History, potency, classification (Embryonic stem cells, fetal stem cells, infant/umbilical cord, adult stem cells), identification, characterization and development of stem cells, infectious disease testing. Stem cell therapeutics, social, ethical religious and regulatory issues.

\textbf{Organotypic and histotypic cultures}: \textit{Organotypic culture}: Gas and nutrient exchange, structure integrity, growth, differentiation, advantages and applications. Methods, advantages and applications of histotypic culture.

\textbf{Unit-II}

\textbf{Three dimensional culture and tissue engineering}: Concept of tissue engineering, components of tissue engineering, cells imaging in 3D construct.

\textbf{Cell culture based vaccines}: Cells as virus host/cell culture based vaccines, cells as protein factory/cell expression system and cells as antigen presenter/personalized vaccine.


\textbf{Unit-III}

\textbf{Transgenic animals and their applications}: Concept of transgenics, steps (selection and isolation of desired genes, gene splicing), techniques of gene transfer, selection of clone containing DNA insert (PCR, DNA finger printing, Blotting techniques, DNA sequencing, Chromosome jumping, HGP, Genomic library, cDNA library) and application of transgenic animals (Food, environment, recombinant protein drugs \textit{etc.}). Safety and ethical issues of transgenic animals.

\textbf{Embryo transfer technology in cattle, animal cloning and in vitro fertilization (IVF)}:

History, various steps (Induction of superovulation, embryo collection and evaluation, embryo splitting, embryo sexing, embryo transfer \textit{etc.}) involved in transfer of embryos in cattle/farm animals and advantages of embryo transfer in farm animals.
Principle, methods, problems and prospects of animal cloning.

Infertility, egg/sperm donor, surrogate motherhood, in vitro fertilization, pre-Implantation genetic diagnosis (PGD), genomic imprinting and assisted reproduction.

Unit-IV

**Biotechnology in pest control:** Classes, advantages, examples and formulations of biopesticides. Transgenic Bt crops and strategies of pest resistance.

**Biotechnology in aquaculture:** Commercially production of catfish, channel fish, crayfish, tilapia, salmon, bullfrog, alligator etc. Innovations in fish farming, barriers and limitations to aquaculture, applications of aquatic biotechnology.

**Biotechnology in sericulture:** Features of Indian silk industry, properties of silk, mulberry/ non-mulberry silk, egg examination, cocoon, reeling of silk, biotechnology of sericulture.

**Essential Readings:**


**Further Readings:**


**Practicals:-**

1. Demonstration/practical on stem cells.
2. Isolation of *Bacillus thuringiensis* from soil using sodium acetate, heat treatment and selective medium.
3. Mass production of *Bacillus thuringiensis* by optimizing media/inoculum size/agitation and find out the generation time using the spectrophotometer.
4. ELISA test for detection of Bt crops.
5. Sex determination using PCR method.
6. Amplification of microsatellite locus by PCR for genotyping/disease diagnosis.
7. ARMS-PCR for genotyping of point mutation for genetic disorder and analysis of the PCR products on agarose gel.
8. SNP detection by RFLP for genetic screening.
9. Demonstration/practical on aquaculture.
10. Demonstration/class practical on sericulture.

**Course No: MHS(II)Sem-III-II/T**

**Paper: Plant Biotechnology**

**Objectives:**

To impart in depth knowledge about molecular strategies to support plant breeding programs, including molecular biodiversity analysis, quantitative genetics and molecular marker-trait associations. This course introduces the students in the advancement made in the field of plant biotechnology and molecular biology. This course develops strategies among the students to produce bio-products (metabolites, enzymes, recombinant proteins).
Unit I

Plant transformation technology: Introduction to *Agrobacterium* sp., basis of tumor formation, hairy roots,
Features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary and co-integrating vectors,
Constitutive, regulatory and tissue specific promoters used for transformation, Selectable markers and reporter genes.

Unit II

Application of Plant Transformation for productivity and performance:
Herbicide resistance: phosphinothricin, glyphosate, sulfonyle urea, atrazine,
Insect resistance: Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor,
Post-harvest losses, long shelf life to fruits and flowers: use of ACC synthase, polygalacturanase, ACC oxidase,
Male sterile lines, bar and barnase systems,

Unit III

Chloroplast Transformation: advantages, methods and vectors.

Metabolic Engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, flavonoid pathway, alkaloids, terpenoids,
Industrial enzymes, Plantibodies, Edible vaccines.
Plants for Biofuel, Bioremediations & Biosensors.

Unit IV

Regulatory RNAs: small RNAs (siRNA and miRNA) and their role in modern transgenic research.
Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL
**Essential Readings:**


**Further Readings:**


**Practicals:**

1. Isolation of DNA from plant cells.
2. Isolation of RNA from Plant cells.
3. Isolation of proteins from Plant cells.
5. Maintenance of *Agrobacterium* strains.
6. Methods for transfer of binary vector to *Agrobacterium*.
7. Arabidopsis plant regeneration from seeds.
8. Transformation of Arabidopsis plants by floral dip method.
9. Selection of transformed Arabidopsis seeds and generation of homozygous transformed lines.
10. GUS/GFP analysis in transformed plants.
11. RAPD analysis.
12. SSCP analysis

**Course No.: MHS(II)Sem-III-III/T**

**Paper: Emerging Technologies**

**Objective:**

This course is meant to update the students with the state of art technologies in the areas of genomics, proteomics, metabolomics and pharmacogenomics and their impact on industry and mankind at large.
Unit I

**Genomics**: Introduction to Genomics, Sequencing strategies for whole Genome Analysis, Sequence Data Analysis, Comparative Genomics, Genome Annotation, Structural and Functional Genomics, Global Analysis of Gene Expression, Transcriptomics & Microarray.

Unit II


Unit III

**Metabolomics**: Concept of Metabolomics, Metabolomic Engineering, Techniques for Metabolomics Engineering, Applications.

Unit IV

**Pharmacogenomics**: Introduction to Drug Design, Drug Design: In silico, automated, Structure based, High Throughput Screening, Technologies & Challenges of Pharmacogenomics.

**Essential Readings:**


**Further Readings:**


**Course No. MHS(II)Sem-III-IV/T**

**Paper: Trends in Biotechnology (Seminar)**

**Objective:**

The purpose of this course is to make the students know of the type of research going on all over the world in the field of biotechnology. Each student will be given a topic. He/she has to look up the literature and make a presentation in front to biotech faculty and students will submit the right up for the same.
Semester – IV - (January-2019)
M.Sc. 2\textsuperscript{nd} Year (4\textsuperscript{th} Semester)

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<th>S. No.</th>
<th>Course/Paper</th>
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<td>Research Project</td>
<td>MHS(II)Sem-IV-I</td>
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<td>a) Thesis</td>
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<td>b) Presentation &amp; Viva</td>
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<td>c) Internal Assessment</td>
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Total Credit = 20  Total Marks = 500

Course No. MHS(II)Sem-IV-I

Research Project

a) Thesis
b) Presentation & Viva
c) Internal Assessment

Objective:

The purpose of this course is to teach the students how to carry out research independently. Each student will be given a research project. He/she will work on a particular topic under the guidance of a faculty member. At the end of the experimental part each student will write the Thesis and defend his/her research work in front of faculty members of the department.