FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. in Biotechnology (Semester System)
Under the Framework of Honors School System
(Regular Mode)

Choice Based Credit System (CBCS)

1st to 4th Semester

Department of Biotechnology,
Panjab University, Chandigarh

EXAMINATIONS 2019-20

--:O:--

## M.Sc. 1st Year (1st Semester)

### Semester – I (July 2019)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Course/Paper</th>
<th>Code</th>
<th>Credits</th>
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<tr>
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<td></td>
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<td>Course No.</td>
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<tr>
<td>1.</td>
<td>Animal Cell Culture Technology</td>
<td>MHS(I)Sem-I-I/T</td>
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<tr>
<td>2.</td>
<td>Advanced Immunology</td>
<td>MHS(I)Sem-I-II/T</td>
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<td>3.</td>
<td>Advanced Recombinant DNA Technology</td>
<td>MHS(I)Sem-I-III/T</td>
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<td>4.</td>
<td>Advanced Molecular Biology</td>
<td>MHS(I)Sem-I-IV/T</td>
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Total Credits = 20  Total Marks = 500

## M.Sc. 1st Year (2nd Semester)

### Semester – II (January-2020)

<table>
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<tr>
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<td>Bioinformatics</td>
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<td>Microbial Biotechnology</td>
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<td>3.</td>
<td>Entrepreneurship Development</td>
<td>MHS(I)Sem-II-III/T</td>
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<td>Scientific Writing &amp; Project Management</td>
<td>MHS(I)Sem-II-IV/T</td>
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Total Credits = 20  Total Marks = 500
Semester – III -(July-2019)
M.Sc. 2nd Year (3rd Semester)

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<td>Theory Marks</td>
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<td>Animal Biotechnology</td>
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<td>MHS(II)Sem-III-I/P 25</td>
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<td>2.</td>
<td>Plant Biotechnology</td>
<td>MHS(II)Sem-III-II/T 100</td>
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<td>4.</td>
<td>Trends in Biotechnology (Seminar)</td>
<td>MHS(II)Sem-III-IV 125</td>
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Total Credits= 20  Total Marks = 500

Semester – IV -(January-2020)
M.Sc. 2nd Year (4th Semester)

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<td>a)</td>
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<td>b)</td>
<td>Presentation &amp; Viva</td>
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<td>150</td>
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<td>c)</td>
<td>Internal Assessment</td>
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<td>100</td>
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Total Credit =20  Total Marks = 500

*One elective course will be run based on the choice opted by the maximum number of class students
* Mode-Regular-offered by the Department of Biotechnology, PU, Chandigarh
* Mode-SWAYAM or Study Webs of Active –Learning Mode

*Class seminars
PREAMBLE

The Department of Biotechnology at Panjab University came into existence as Centre for Biotechnology in 1989. In 1994 it was upgraded to full-fledged Department with the support from DBT, Govt. of India. In 2001, the Department was the first one to start B.Sc. (Hons. School) course in Biotechnology in North India and offer five years integrated B.Sc. and M.Sc. (Hons. School) degree in Biotechnology. The Department is supported by DST (FIST & PURSE) and UGC (SAP) grants and has research collaborations with IMTECH Chandigarh, CSIO Chandigarh, PGIMER Chandigarh, ICGEB Delhi, IHBT Palampur, IIIM Jammu, NDRI Karnal and NBGAR Karnal. MoU has been signed with NABI Mohali for collaborative research and teaching. Most of the faculty members have been trained abroad and have received prestigious national and international awards. The faculty of the Department publishes research papers in national and international journals of high impact. Most of the students enrolled for Ph.D. in the Department have their own fellowships. Good number of post graduate students qualifies NET (National Eligibility Tests UGC/CSIR) and join Ph.D. programs in premier research institutes of the country. Many students also go abroad to pursue their doctoral or post-doctoral work. Foreign students are also enrolled at PG and Ph.D. level through the cultural exchange program. Annual workshops/symposia/seminars are organized by the Department wherein eminent scientists are invited to deliver lectures and interact with students. The Department acts as a nodal agency to popularize biotechnology among the school and college students.

Vision of the department is to train human resource in the field of biotechnology and carry out research for the welfare of the society with the focus on environmental and health issues.

Major areas of research in the department are cancer epidemiology, cancer epigenetics, microbial and plant 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 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 immune-deficiencies.

**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 auto immunity.

**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 (myasthenia 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. ELISA to detect the concentration of serum Ag against HIV.
6. Purification of IgG using Protein A beads/affinity chromatography and analysis of purified IgG on SDS-PAGE.
7. Demonstration/practical of Western blotting/ Nucleic acid-based tests (NAT) for HIV detection.
8. 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

Importance of eukaryotic expression system.

Eukaryotic cloning vectors: 2µ yeast plasmid, YIp, YEp, YRp, yeast artificial chromosomes and Mammalian Artificial Chromosome. Vectors for animal cells

Eukaryotic expression vector : SV 40, vaccinia, retroviral and baculovirus promoter based expression vectors and selection markers, transformation / transfection.

Next Generation DNA sequencing: PyroSequencing, SMRT, Nanopore sequencing Hierarchical shotgun sequencing and whole genome shotgun sequencing.

Unit II

In vitro translation of proteins using rabbit reticulocyte lysate, wheat germplasm and E.coli lysate.

DNA amplification techniques and their applications: PCR (long, inverse, real time PCR, RACE etc.) ligase chain reaction and helicase dependent amplification.
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).
Site directed mutagenesis: Cassette mutagenesis and primer extension for protein
engineering.

Unit IV
Transposon Tagging: its role in gene analysis (Identification and isolation of genes).
Signature tagged mutagenesis.
Gene Silencing strategies: construction of gene knockout (single and double homologous
cross over), CRISPR CAS method, RNA interference.

Essential Readings:

Further Readings:

Practicals:-
1. Isolation of genomic DNA from animal tissue.
2. Partial and complete digestion of genomic DNA by restriction enzymes
3. Isolation of RNA from cell line and its qualitative and quantitative analysis.
4. cDNA synthesis and RT-PCR
5. Quantitation of DNA by Real Time PCR
6. Gene expression analysis by real time PCR
7. Demonstration of transposon mutagenesis.
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. Determination of protein purity by SDS-PAGE
2. Determination of secondary structure of protein
3. Effect of temperature on secondary structure of protein
4. Effect of chaotropic agent on secondary structure of protein
5. Effect of temperature on tertiary structure of protein
6. Effect of chaotropic agent on tertiary structure of protein
7. Cell cycle demonstration by flow cytometry
8. Growth of normal cells and cancer cells in cell culture
9. MTT assay for cell viability and growth after treatment with anticancer drug
10. Demonstration of apoptosis by
    - Apoptotic body formation
    - dye exclusion or dye-uptake methods
    - DNA laddering.
11. Isolation and purification of nuclei from tissue
12. Isolation of Histones
13. Analysis of histones on PAGE
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.
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
Scope of Microbial Biotechnology. Genetically engineered microbes (Bacteria and yeast) for Industrial applications. Biosynthesis of non-ribosomal proteins in microbes. Pro and prebiotics, Next Generation Probiotics.

Unit-II
Microbes as Biofertilizers: Nitrogen fixers such as Rhizobium, Azotobacter, Azospirilla, Cyanobacteria and other nitrogen fixing bacteria. Phosphate Solubilizing bacteria: Vescicular arbuscular mycorrhiza; Plant growth promoting rhizobacteria (PGPR); Quality control of bio inoculants; Methods of inoculation and constraints. Bioreporters and Reporting genes: types, sources and application. Microbes as biowarfare agents.

Unit-III
Biosensors: Basic components of biosensor and their types, applications in medical and research fields. Biofuels and Bioenergy: Why we need alternative fuels (Biodiesel, Bioethanol and Biohydrogen); What is biodiesel, Transesterification reactions; Microbes used for Biodiesel production (bacterial, fungal, yeast and algal sources). Production schemes for Bioethanol; Food vs. Fuel crises, challenges for the future. Biohydrogen from algal strains; Bacterial Biohydrogen: dark fermentation and photo fermentation, metabolic engineering of strains.

Unit-IV
Microbial genomics and its applications in drug development, reverse vaccinology. Scope of Metabolic engineering and its use in production of novel compounds (Bioplastics, L-valine Production in E.coli, increasing biomass by transfer of Hemoglobin gene). Metagenomics and its industrial applications.

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
8. Isolation of Metagenomic DNA.

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

Objective: This course will enlighten the students with the basic concepts of entrepreneurship, knowledge of business planning, financing and marketing management essential to the success of the entrepreneur. It will help in understanding the industry by taking examples of biotechnology derived products, services and ventures along with the regulatory and IPR issues.

Unit I


Unit II

Financing and marketing management: Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management. Meaning and Importance, Marketing-mix, product management – Product line,
Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

Unit III

Regulatory and IPR issues in biotechnology industry: Patents, intellectual property, IPO, WPO, USPO, Regulatory clearances, Rules and Regulations

Unit IV

Biotechnology industry: Biotechnology derived products and services, product valuation, examples of successful products and ventures.

SUGGESTED READING:

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 Scientific Writing: Aims and Forms.
Scientific literature: Gathering scientific data using the Library/ Internet ( Journals, abstracts).

Unit II

Material, Methods and Tools: Tables, Figures, Collecting and Citing the literature, Equations and Formulas, punctuation, style and their organization in scientific writing document.


Unit III

Journal Articles/ Papers: Nature of Journal articles, Types of journals and Basic decision of authors for publication, The Parts of a paper, Proofreading/Editing of the paper.
Poster presentation
Grant Reports and Proposals: Types of grant reports and grant related documents, grant writing strategy.
Unit IV

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 requirement and justification(s), submission of reports, utilization of funds.

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. 2nd Year (3rd Semester)

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<td>Emerging Technologies</td>
<td>MHS(II)Sem-III-III/T</td>
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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 in vitro fertilization, organ/animal cloning, biodiversity conservation.

Unit-I
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.

Organotypic and histotypic cultures: Organotypic culture: Gas and nutrient exchange, structure integrity, growth, differentiation, advantages and applications. Methods, advantages and applications of histotypic culture.

Unit-II
Three dimensional culture and tissue engineering: Concept of tissue engineering, components of tissue engineering, cells imaging in 3D construct.

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.


Unit-III
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 etc.). Safety and ethical issues of transgenic animals.

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 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. Various methods of nuclear transformation: viral vectors and their applications, Vectors-less or direct DNA transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing.

Unit II

Unit III
Chloroplast Transformation: advantages, methods and vectors.

**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.
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.