SYLLABI AND COURSE OF STUDY FOR

M.Sc PROGRAM IN BIOTECHNOLOGY

BASED ON CHOICE BASED CREDIT SYSTEM

A candidate has to obtain minimum of 24 credits in a semester; 12 credits compulsorily are to be opted from “Core Courses”, while the remaining 12 credits can be obtained from the electives in the following manner

➢ A candidate can obtain a maximum of 8 credits within his/her own department out of the discipline centric courses offered by the department.

➢ A candidate shall obtain 4 credits from the “Electives” offered by the Departments other than his/her own. A candidate has to obtain 2 credits from open electives outside the faculty and two credits from generic electives within the faculty.

Note: The students are advised in their own interest to contact the Course Advisor in the department before filling up their choices for allied and general electives

EFFECTIVE FROM, 2017
## Choice Based Credit Courses in BIOTECHNOLOGY

### CORE COURSES (COMPULSORY 12 CREDITS EACH SEMESTER)

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<tr>
<th>Sr. No.</th>
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## Generic and Open Electives (GE/OE): These courses are open to students of other Departments except Biotechnology

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Books Recommended:
3. Cell Biology: Organelle Structure and Function by David Sadava


Books Recommended:


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<td>Course title: Immune biology</td>
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Unit I: Overview of the Immune system: Historical perspective, Types of Immunity – Innate and Adaptive Immunity – Cell and Humoral immunity– Haematopoiesis – Cells of Immune System (B cell, T cell, APC, NK Cells) Lymphoid organs – Primary (Thymus, Bone marrow, Bursa of Fabricus), Secondary Lymphoid Organs – Lymph node, Spleen, Payer’s patches (GALT), Tonsils (MALT) – Development and maturation of Lymphocytes, Cytokines and their role in immune regulation. Immunological tolerance Cell mediated cytotoxicity, Mechanism of T-cell & NK- cell mediated lysis.

Unit II: Antigens and Antigen recognition Molecules – Antigen Characteristics and Antibody Diversity (IgG, IgM, IgA, IgD and IgE) – Structure, properties – Antigen processing and presentation, Detection of antigen – antibody interreaction – precipitation, agglutination, cytolysis, complement fixation, flocculation, opsonisation, immunofluorescence, ELISA – Monoclonal antibody

Unit III: Immune system in Health and Disease: Immunization and Immunization schedule – vaccines (attenuated, heat killed vaccines) – Types of Vaccine, Transplantation , Types of grafts, Graft rejection, Graft versus Host Disease , Clinical Transplantation


Books recommended

3) Abul K. Abbas, Andrew H.L, Shiv Pillai, “Cellular and Molecular Immunology” 7/e Saunders Publications
4) The Immune system– peter Parham Garland science, 2/e, 2001
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<td>Molecular Biology-II</td>
</tr>
<tr>
<td>3</td>
<td>BT-17203-CR</td>
<td>Advanced Enzymology</td>
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</table>
UNIT-I: General structure, organization & Molecular basis of Shoot Apical Meristem(SAM) & Root Apical meristem (RAM). Totipotency of Plant cell, Plant cell cycle, Role of various hormones in regulating plant cell cycle, Micropropagation (Seed V/S Soma), Stages & methods of micropropagation. Production of virus free plants. Tissue culture media (Composition & preparation), Role of micro, macro nutrients & other components present in tissue culture media, Commonly used media (Murashige and Skoog etc) Initiation and Maintenance of callus and suspension culture, Single cell clones Organogenesis: Basis, applications & control of Somaclonal variation. Somatic embryogenesis- acquisition of embryogenic competency, factors & genes influencing the embryogenic competency of cell during somatic embryogenesis, Synthetic seeds. Embryo rescue.

UNIT-II: Protoplast isolation (mechanical & enzymatic methods), maintenance, purification, viability, Culture and fusion (Spontaneous & induced fusion, sodium nitrate, calcium ion, PEG, electrofusion). Identification & Selection of hybrid cells and regeneration of hybrid plants; Symmetric & Asymmetric hybrids, Cybrids-formation and applications. Anther, pollen and ovary culture for the production of haploid homozygous lines, Molecular mapping, Introduction to genetic and physical maps, physical mapping.

UNIT-III: Plant Transformation Technology; Morphology of Agrobacterium tumefaciens, Features of Ti Plasmids, Opines and its Types, Basis of tumor formation, Factors influencing binding of Agrobacterium to plant, Mechanism of T-DNA transfer & Role of virulent proteins in (Formation of T-DNA strand, movement of T-Complex & Integration of T-DNA into Plant genome), Features of Binary vectors & its Types (pBIN19, pGreen, pCAMBIA, etc), Promoters used in Ti vectors (CaMV 35S and other promoters), Use of reporter genes(Opine synthase, CAT, GUS, LUX, GFP) and selectable markers (antibiotic & herbicide resistant genes, Metabolic intermediates etc) Generation of marker free plants (using Cre-Lox & other Excision techniques), Vector less or direct DNA transfer (Particle bombardment, Electroporation, WHISKERS, Pollen tube entry, Floral dip, Liposome mediated,etc). Plant transformation for productivity and performance with special example of Herbicide resistance (Glyphosate & Phosphinothricin resistance), Insect resistance (Bt based plants), Disease resistance (Role of R-proteins & other molecules), long shelf fruit and flowers, Stress tolerance (water deficit stress, Role of osmoprotectants and other molecules).

UNIT-IV: Molecular farming: Methodology involved in the production of Golden rice, Metabolic engineering of carbohydrates (Starch and fructan production), lipids (production of shorter & longer chain fatty acids, Modification of the degree of saturation). Production of Biodegradable plastic, Production Therapeutic protein in plants (Hirudin, Glucocerebrosidase, etc), Purification strategies for proteins-Oleosin partitioning Technology, Plantibodies (full length, scFv, Minibody, Diabody, Bispecific) Edible Vaccines, Manipulation of Shikimate pathway for the production of Vitamin E, Chloroplast Transformation (Mechanism & Advantages), Principle & applications of Gene termination technology, Concerns about Genetically modified plants.
Books Recommended:

4. Agrobacterium: From Biology to Biotechnology: Tzfi,Tzvi,Citovsky,Vitaly: Springer verlag


Books Recommended:


UNIT-II: Classification of multi substrate reactions with examples of each class. Ping-pong bi-bi mechanism, Random order mechanism, compulsory order mechanism, Kinetics of multi substrate reactions. General rate equation of Alberty. Derivation of rate expression for ping-pong & ordered Bi -Bi reaction mechanism. Primary and secondary plots for determination of kinetic constants for Multisubstrate reactions. Investigation of reaction mechanism using steady state methods. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Methods of examining enzymes-complex’s, trapping E-S Complex, Use of substrate analogs, chemical modifications and protease treatment, Site directed mutagenesis & effect of changing pH. Flexibility & conformational mobility of enzymes.


Books Recommended:
1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer,
2. Horwood Publishing
3. Fundamentals of Enzyme kinetics by Athel Cornish-Bowden, Portland press
4. Fundamentals of Enzymology by Nicholas Price and Lewis Stevens,
5. Oxford University Press
6. Enzyme Structure and Mechanism by Alan Fersht, W. H. Freeman
7. Enzymology by T. Devasena, Oxford University Press
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<td>3</td>
<td>BT-17303-CR</td>
<td>Bioprocess Engineering and Fermentation technology</td>
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Books Recommended:
4. DNA recombinant Technology and molecular techniques by M U Hussain: Black Prints India INC
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**UNIT-I:** Structure and organization of Animal Cell, Primary and established Cell lines, Setting up of Tissue culture facility; Equipments and facilities needed. Contaminations in cell culture; Types and their eradication/contamination control, Precautions in handling of cell lines. Introduction to balanced salt solutions and simple/complete growth medium, Role of CO2, serum and supplements. Serum components necessary for growth of cells in culture. Serum and serum free defined media. Limitations and applications of serum and serum free media.


**Books Recommended:**


UNIT-IV: Applications of enzymes in food processing. Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Applications of Microbes in food process operations and production. Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

Books Recommended:
# 4th Semester
## Core papers

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The objective of this semester is to expose students with broader needs of Research. Students will choose their project advisor upfront based on interest and their merit in the first two semesters.

The students in consultation with their faculty advisor will prepare a synopsis of the project to be pursued. In the following months, the synopsis should include the rationale, objectives, proposed methodology and significance of the study. The students shall make an open presentation of the synopsis during the fourth week of the semester.

The project will be based upon research and actual bench work, carried under the guidance of faculty supervisor and in close collaboration with the research group. The students are expected to put in at least six working hours daily for a maximum of six months. The students will participate in Journal club and Lab meetings of the research group. Project report will be submitted and will be evaluated at the end of 4th semester.

Part 1 of the project will be based upon introduction to the subject and a general review of the literature pertaining to the project. The students should be encouraged to write a review of the problem or on a related topic.

Part 2 of the project will be based on the actual experimental work, presentation and analysis of the data generated. The project report should consist of Abstract, Rationale, Review of literature, Methodology, Results and discussion, and bibliography. Two examiners will evaluate the project reports of the students. The examiners will be nominated by the
Head of the department from the panel of examiners proposed by the Project advisor, one of them will be the advisor. The examiners should be either from the department or from allied departments.

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Each student under the supervision of a faculty advisor will deliver a seminar on a topic related to his/her Project work. The seminars will be conducted in 10th week of the semester. Two faculty members nominated by the Head of the department will evaluate the seminars. The journal club will consist of a research paper presentation to be assigned and evaluated by the Project advisor.

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The students should make an open presentation defending their project work. One external expert and two faculty members nominated by the Head of the department will evaluate the presentation. The presentation will be open to all the students, scholars and teachers of the department and other allied departments.

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Project viva will be conducted by one expert and all the faculty members of the department.
Discipline Centric Electives (DC) offered by the Department under CBCS

Course No: BT-17104-DCE
Course title: Biotechniques
Credits: Three
Maximum marks 75

UNIT-I: Electrophoresis and Blotting Techniques: Basic principles & types of electrophoresis, Agarose gel electrophoresis, PAGE, SDS-PAGE and isoelectric focusing. Blotting techniques: Southern, Northern, Western, Far-western, South-western and their applications. Determination of antigen antibody concentration by immunodiffusion, immunoelectrophoresis, ELISA.


Books Recommended:
2. Principles of Radioactive Techniques, Use & Handling. BARC
3. Biological Centrifugation (The Basics) by Dr John Graham
4. Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk . WILEY.
5. Basics of Centrifugation. ThermoFisher
Course No: BT-17105 - DCE
Course title: Microbiology

Credits: Three

UNIT-I: Bacteria: Morphology of Bacterial cell, Classification of bacteria on various criteria’s, Structure & function Cell wall (Peptidoglycan), Outer membrane of Gram Negative bacteria; cell wall and cell membrane synthesis, Flagella and motility, cell inclusions like endospore (mechanism of endospore formation), Gas vesicles etc. Bacterial growth phase, Generation time, Kinetics of growth, Physical features influencing growth (temperature, pH).


Books Recommended:

UNIT-II: Presentation of variation by figures; data representation: Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram. Confidence Intervals: Confidence Intervals for a Single Population Mean, Z and t Statistics for Two Independent Samples. Paired t Test. Principles of test of significance: One-Tailed Versus Two-Tailed Tests, p-Values, Type I and Type II Errors, The Power Function, Two-Sample t Test (Independent Samples with a Common Variance). Students t-test, ANOVA: Comparison of means in one or two groups (student’s t-test). Comparison of means in three or more groups (ANOVA), F-test.

Practicals:
Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients, t-test, ANOVA. Use of bar diagram, histogram, scatter plots, bubble plot, etc. graphical tools in EXCEL for presentation of data.

Books Recommended:
1. Introduction to Biostatistics and Research Methods by Sunder Rao and J Richards
2. Medical Statistics by David Machin, Michael J Campbell and Stephen J Walters, John Wiley and Sons
UNIT-I
Carbohydrate metabolism: Glycolysis and Fermentation, Gluconeogenesis, Glycogen synthesis/degradation, TCA cycle and oxidative phosphorylation, Pentose Phosphate Pathway

UNIT-II
Protein Metabolism: Transamination and deamination reactions and their clinical significance. Urea Cycle. Inborn errors of amino acid metabolism.

UNIT-III

BOOKS RECOMMENDED:
1. Principles of Biochemistry by David Lee Nelson, Albert L. Lehninger, Michael M. Cox
Publisher: W.H. Freeman
2. Biochemistry By Donald Voet, Judith G. Voet

Course No: BT-17205-DCE Maximum marks 50
Course title: Spectroscopy and Microscopy
Credits: Two


UNIT-III: Principle and applications of bright-field, confocal (immunofluorescence), and super-resolution microscopy (STORM, STED, PALM), Electron microscopy, atomic force microscopy AFM (contact and tapping mode). Force spectroscopy: Principle and applications of AFM cantilevers, optical tweezers and magnetic tweezers in biological research.
<table>
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<th>BT-17206 -DCE</th>
<th>Maximum marks</th>
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<td>Laboratory Course II</td>
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1. Media Preparation
2. Isolation of Genomic DNA and RNA.
3. Agarose Gel electrophoresis and Quantification of DNA and RNA.
4. Immunoprecipitation (IP).
5. SDS-PAGE and Western Blotting.
7. Effect of temperature and pH on enzyme activity.
8. Determination of Kinetic constants Km and V max.
9. Preparation of plant tissue culture media.
10. Plant Tissue Culture

UNIT-II: Genomic revolution and Research in the post-genome (sequencing) era: History, organization, goals and value of the Human Genome Project. Modern molecular and cytogenetic methods (Modern PCR methods, FISH, MLPA, arrayCGH, Parent of Origin Effects, Prenatal Diagnosis, chorionic villus sampling (CVS), Preimplantation Genetic Diagnosis (PGD).

Books Recommended:
1. Thompson and Thompson: Genetics in Medicine, Elsevier publications.
2. Emery's Elements of Medical Genetics. Elsevier

Course No: BT-17305-DCE
Course title: Fundamentals of Systems Biology: Networks and Noise
Credits: Three
Maximum marks 75

Unit-I

Unit-II

Unit-III
Proteomics; LC-MS/MS, identification of proteins in complex mixtures and its role in systems biology. Genome sequencing; library preparations, barcoding and sequencing methods (Mi-seq, Hi-seq). Transcriptomics; RNA-seq (method/analysis (determination of RPKM values) and applications. Chromosome conformation capture (3C, 4C, 5C and HiC). Chromatin-immuno precipitation coupled to sequencing (ChIP-seq)

Books Recommended:
1. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon
2. A First Course in Systems Biology by Eberhard Voit
Course No: BT-17306-DCE
Course title: Laboratory Course III
Credits: Three

1. Competent cell preparation
2. Bacterial Transformation
3. Plasmid Isolation
4. PCR gene amplification.
5. Restriction Digestion
6. Gene cloning
7. GST protein expression and purification
Generic and Open Electives (GE/OE): These courses are open to students of other departments except students of Biotechnology department.

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<tr>
<td>Course title:</td>
<td>Biochemical Techniques</td>
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<td>Credits:</td>
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Books Recommended:
7. Principles of Radioactive Techniques, Use & Handling. BARC
8. Biological Centrifugation (The Basics) by Dr John Graham
9. Chromatography: Basic Principles, Sample Preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk. WILEY.


Books Recommended:
2. Janeway's Immunobiology, Garland Scierne
3. Essential Immunology by Delvis, Martin, Burton and Roitt

Course No: BT-17002GE  Maximum marks  50  
Course title: Cancer Immunology  
Credits: Two

UNIT-I: Cell as a basic unit of life, Structure and function of various cell organelles (Plasma membrane, Nucleus, Mitochondria, Chloroplast, Golgi Bodies, Endoplasmic reticulum. Molecules of life: Basic idea of life molecules- DNA, RNA, Proteins, Carbohydrates and Lipids, their structure & functions


Books Recommended:
Principles of Biochemistry by David David Lee Nelson, Albert L. Lehninger, Michael M. COX, Publisher: W.H. Freeman


Books Recommended:
1. Review Journals Like Antioxidant Redox Signaling. Internet Resources: Pubmed, Google, Google Scholar.


UNIT-III, Epigenetics, Chromatin Boundaries: S. cerevisiae Silencing, S. pombe Centromeric Heterochromatin, RNAi-directed Silencing. Epigenetic reprogramming in mammals, Epigenetic mechanisms regulating ES cell differentiation, Bivalent Chromatin Marks in maintaining stem cell pluripotency, Epigenetics and pathologies, Epigenetic therapies.

Recommended References:
2. Epigenetics by David Allis, Thomas Jenuwein, Danny Reinberg and Marie- Laure Caparros
Course No: BT-17005GE
Course title: Molecular Mechanisms of Plant Life
Credits: Two

Maximum marks 50


Books recommended
1. Handbook of Plant Science by Keith Roberts (Volume I &II), Wiley-Interscience

Course No: BT-17006GE
Course title: Bioinformatics
Credits: Two

Maximum marks 50


Books Recommended:
1. Developing Bioinformatics Computer Skills by Cynthia Gibas, Per Jambeck
3. Bioinformatics: Sequence and Genome Analysis by David W. Mount
UNIT-I: Historical perspective, Types of Immunity – Innate and Adaptive Immunity – Cell and Humoral immunity, Primary (Thymus, Bone marrow, Bursa of Fabricus), Secondary Lymphoid Organs – Lymph node, Spleen, antigen – antibody interaction – precipitation, agglutination.

UNIT-II: Immunization and Immunization schedule – vaccines (attenuated, heat killed vaccines) – Types of Vaccine – Vaccination Schedule in India.

Books recommended:

2. Janeway's Immunobiology, Garland Scierence
Unit I

Unit II

Textbook:
1. Title: Bioethics, an introduction for the biosciences  Author: Ben Mepham Publisher: Oxford University, UK Year: 2013 Edition: 2nd
3. Title: The Biological Foundations of Bioethics Author: Tim Lewens Publisher: OUP, Oxford Year: 2015 Edition: 1st

UNIT-I: From central dogma to ncRNA and now functional RNA: Overview of ncRNA and their important role in current research. Biogenesis of Small (miRNA, piRNA, esiRNA) and long non-coding RNA (lncRNA) and their importance in gene regulation and disease pathogenesis. MicroRNA (miRNA) and lncRNA pathways in Neurodevelopmental and Neurodegenerative disorders will be provided as an example.

UNIT-II: Non-Coding RNA (NcRNA) and neural stem cells (NSCs): miRNAs, and self-renewal and proliferation of NSCs. LncRNAs and proliferation of NSCs. NSC survival controlled by ncRNAs. NSC differentiation and cell fate determination mediated by ncRNA. NcRNA as a tool for stem cell based therapy.

Recommended references:
1. The RNA world, CSHL press.
UNIT-I:
Amino acids: Structure and classifications. Standard and non standard amino-acids, Essential amino-acids, Derived amino acids, Non protein amino acids, Optical activity of amino acids, Stereo-chemical representations, D and L system, RS system, Chemical and physical properties, Acid base characteristics, Titration of acidic, basic and neutral amino acids, Analysis of titration graphs. Proteins: Peptide bond formation and characteristics, oligo and polypeptides, Biological roles of small peptides.


Books Recommended:
1. Biochemistry by Donald Voet and Judith G Voet, John Wiley & Sons
2. Protein Structure and Function by David Whitford, John Wiley & Sons, UK