SYLLABUS for M. Sc. BIOTECHNOLOGY
Choice Based Credit System (Semester Pattern)
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Effective from 2018-2019

Candidates opting for this course are advised to go through the direction relating to the course "DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)" which is available on R. T. M. Nagpur University website.
The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Biotechnology

M. Sc. Biotechnology Semester I											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
							External Marks	Internal Ass			
		Th	Pract	Total						Th	Pract
Core 1 **(1T1)**	Paper 1: **Cell Biology and Enzymology**	4	-	4	4	3	80	20	100	40	
Core 2 **(1T2)**	Paper 2: **Molecular Biology**	4	-	4	4	3	80	20	100	40	
Core 3 **(1T3)**	Paper 3: **Biomolecules**	4	-	4	4	3	80	20	100	40	
Core 4 **(1T4)**	Paper 4: **Biophysical Techniques**	4	-	4	4	3	80	20	100	40	
Pract. Core 1 & 2 **(1P1)**	Practical 1: **Cell Biology and Enzymology**	-	8	8	4	3-8*	100**	-	100		40
Pract. Core 3 & 4 **(1P2)**	Practical 2: **Macromolecules & Analytical Techniques**	-	8	8	4	3-8*	100**	-	100		40
Seminar 1 **(1S1)**	Seminar 1	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

M. Sc. Biotechnology Semester II											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
		Th	Pract	Total			External Marks	Internal Ass		Th	Pract
Core 5 **(2T1)**	Paper 5: **Microbiology**	4	-	4	4	3	80	20	100	40	
Core 6 **(2T2)**	Paper 6: **Immunology**	4	-	4	4	3	80	20	100	40	
Core 7 **(2T3)**	Paper 7: **Fundamentals of Genetic Engineering**	4	-	4	4	3	80	20	100	40	
Core 8 **(2T4)**	Paper 8: **Applied Molecular Biology**	4	-	4	4	3	80	20	100	40	
Pract. Core 5 & 6 **(2P1)**	Practical 3: **Microbiology & Immunology**	-	8	8	4	3-8*	100**	-	100		40
Pract. Core 7 & 8 **(2P2)**	Practical 4: **Genetic Engineering & Applied Molecular Biology**	-	8	8	4	3-8*	100**	-	100		40
Seminar 2 **(2S1)**	Seminar 2	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

M. Sc. Biotechnology Semester III											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
		Th	Pract	Total			External Marks	Internal Ass		Th	Pract
Core 9 **(3T1)**	Paper 9: **Genetic Engineering & its Applications**	4	-	4	4	3	80	20	100	40	
Core 10 **(3T2)**	Paper 10: **Plant Biotechnology**	4	-	4	4	3	80	20	100	40	
Core Elective 1 **(3T3)**	**Paper 11: A) Industrial Biotechnology I (3T3A) OR B) Environmental Biotechnology I (3T3B)**	4	-	4	4	3	80	20	100	40	
Foundation Course 1 / Core Subject Centric 1 **(3T4)**	Paper 12: **Introductory Biotechnology (3T4A) / Diagnostic Medical Biotechnology (3T4B)**	4	-	4	4	3	80	20	100	40	
Pract. Core 9 & 10 **(3P1)**	Practical 5: **Genetic Engineering & Plant Biotechnology**	-	8	8	4	3-8*	100**	-	100		40
Pract. Core Elective 1 **(3P2)**	**Practical 6: A) Industrial Biotechnology OR B) Environmental Biotechnology**	-	8	8	4	3-8*	100**	-	100		40
Seminar 3 **(3S1)**	Seminar 3	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

M. Sc. Biotechnology Semester IV											
Code	Theory / Practical	Teaching scheme (Hours / Week)			Credits	Examination Scheme					
						Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
		Th	Pract	Total			External Marks	Internal Ass		Th	Pract
Core 11 **(4T1)**	Paper 13: **Animal Biotechnology**	4	-	4	4	3	80	20	100	40	
Core 12 **(4T2)**	Paper 14: **Biostatistics, Bioinformatics, Ethics & Patenting**	4	-	4	4	3	80	20	100	40	
Core Elective 2 **(4T3)**	**Paper 15: A) Industrial Biotechnology II (4T3A) OR B) Environnemental Biotechnology II (4T3B)**	4	-	4	4	3	80	20	100	40	
Foundation Course 2 / Core Subject Centric 2 **(4T4)**	Paper 16: **Basic rDNA Technology (4T4A)/ Therapeutic Medical Biotechnology (4T4B)**	4	-	4	4	3	80	20	100	40	
Pract. Core 11, 12 & Elective 2 **(4P1)**	**Practical 7: Animal Biotechnology, Biostatistics, Bioinformatics, Ethics & Patenting And A) Industrial Biotechnology II OR B) Environmental Biotechnology**	-	8	8	4	3-8*	100**	-	100		40
Project **(4PROJ 1)**	Project	-	8	8	4	3-8*	100**	-	100		40
Seminar 4 **(4S1)**	Seminar 4	2	-	2	1			25	25	10	
	TOTAL	**18**	**16**	**34**	**25**		**520**	**105**	**625**	**170**	**80**

Note: Th = Theory; Pr = Practical/lab, * = If required, for two days.

** = The Practical and Project shall be evaluated by both the External and Internal Examiner in the respective Department / Center / Affiliated College.

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M. Sc. BIOTECHNOLOGY
Semester I
Paper – I (Code: 1T1)
Cell Biology and Enzymology

UNIT I:
Structure and function of cell organelles:
Plasma membrane: transport of nutrients, ions and macromolecules.
Cell walls: Archaea, Bacteria, plant cells.
Mitochondria: Electron Transport Chain and Oxidative Phosphorylation.
Chloroplasts: Chlorophyll, carotenoids and photosynthesis.
Golgi complex: Endoplasmic reticulum, lysosomes, peroxisomes (functions).

UNIT II:
Cell cycle: Molecular events in S. cerevisiae.
Cell signaling: Signal transduction in animal and plant cells (tyrosine kinase, light induced signaling)

UNIT III:
Basic Enzymology
Basics: Enzyme nomenclature, classification and specificity. Concept of coenzymes.
Mechanism of enzyme action: Models, catalysis by proximity effect, acid-base catalysis, electrostatic interaction, metal ion catalysis, nucleophilic and electrophilic catalysis,
Concept of multienzyme complexes: fatty acid synthase and pyruvate dehydrogenase complexes.
Concept of enzyme regulation: Allosteric (example ATCase), chemical modification and calmodulin mediated regulation.

UNIT IV:
Basic aspects of enzyme kinetics: Michaelis-Menten equation (derivation, significance and transformation). Two substrate kinetics. Modifying factors of enzyme kinetics, enzyme inhibition and types of inhibitors.
Enzyme Engineering
Immobilization of Enzymes

M. Sc. BIOTECHNOLOGY
Semester I
Paper – II (Code: 1T2)
Molecular Biology

UNIT I:
DNA Replication: Prokaryotic and Eukaryotic DNA replication, mechanisms of DNA replication, fidelity of replication, enzymes and accessory proteins involved in DNA replication.
Gene mutations: Types of mutations. Suppression. Ames' test.
DNA Repair: Direct repair, Ada protein, NER, BER, MMR, SOS repair, Transcription-repair coupling, repair of double-strand breaks.

UNIT II:
Prokaryotic Transcription: RNA Polymerase holoenzyme and apoenzyme, different sigma factors, details of initiation, elongation, termination.
Eukaryotic Transcription: Three types of RNA polymerases. Promoter of RNA polymerase II. Enhancers. General and inducible transcription factors.
Modifications of RNA: 5' cap formation, polyadenylation, splicing of nuclear pre-mRNA, mRNA stability.

UNIT III

Genetic code: characteristics, deciphering the code.
Protein biosynthesis: Prokaryotic and eukaryotic translation, the translational machinery, mechanism of initiation, elongation and termination.

UNIT IV
Regulation of expression in prokaryotes: lac operon, ara operon, trp operon, negative autogenous control.
Regulation of expression in eukaryotes: Britten-Davidson model. DNA binding and activation domains of transcription factors. Packaging of chromosomes and its relation to transcription regulation. Regulation of translation by 3' and 5' UTR motifs.

M. Sc. BIOTECHNOLOGY
Semester I
Paper – III (Code: 1T3)
Biomolecules

UNIT I:
Chemistry of Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans.

UNIT II:
Chemistry of Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, sterols, terpenes, lipoproteins (LDL, VLDL, HDL, IDL). Lipid micelles, Liposomes.

UNIT III:
Proteins: Amino acids and peptides. Primary, secondary, and tertiary structures. Protein sequencing, protease mapping. Ramachandran plot. Collagen structure. Domain structure, models of protein folding, methods of study of protein folding, roles of chaperones and chaperonins.

UNIT IV:
Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Novel structures. DNA bending and bendability. Denaturation and renaturation studies and their applications, nucleic acid hybridization. Topological structure of DNA.

M. Sc. BIOTECHNOLOGY
Semester I
Paper – IV (Code: 1T4)
Biophysical Techniques

UNIT I:
Spectrophotometry: UV-Visible spectrophotometry, fluorescence spectrophotometry, absorption and emission spectrophotometry, IR, NMR, Lumionometry.
Basic introduction to Raman and Mass spectrophotometry.

UNIT II:
Chromatography: Basic principles and techniques of partition, adsorption, gel filtration, affinity, and ion exchange chromatography. Concept of GLC and HPLC.

UNIT III:
Electrophoresis: Gel electrophoresis (Agarose, PAGE, SDS PAGE), Disc gel electrophoresis, Gradient electrophoresis, Pulsed field gel electrophoresis, capillary electrophoresis.
Viscosity: Determination of conformational changes through viscosity.

UNIT IV:
Centrifugation
Basic principles, Mathematics & theory (RCF, Sedimentation coefficient etc)
Types of centrifuge: microcentrifuge, high speed & ultracentrifuges.

Differential & density gradient centrifugation, Isolation of cell components using centrifugation technique.
Radioactivity
Radioactive & stable isotopes, Pattern and rate of radioactive decay, Units of radioactivity.
Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique),
Applications of isotopes in Biotechnology: Principles of tracer techniques, Its advantages and limitations, Distribution studies, Isotope dilution technique, Metabolic studies, Clinical application. Radioimmunoassay.

M. Sc. BIOTECHNOLOGY
Semester I
LAB I (Code: 1P1)
Cell Biology and Enzymology

1. Determination of activity of calcium ATPase of plasma membrane.
2. Subcellular fractionation and assay of marker enzymes.
3. Assay of activity of LDH.
4. Cell motility and flagellar staining.
5. Cell types of plants- maceration of various tissue explant and identification of xylem, trachied, stomata, root hair, etc.
6. Determination of activity of sodium/potassium ATPase of plasma membrane.
7. Isolation of neutrophils and demonstration of phagocytosis.
8. Determination of osmotic fragility of RBC membrane.
9. Assay of activity of beta-galactosidase
10. Assay of activity of acid phosphatase,
11. Enzyme purification by crystallization - urease.
12. Immobilization of enzymes (Invertase/ Protease/ Amylase.) by Na alginate method.
13. Whole cell immobilization (Yeast) by Na Alginate and the estimation of alcohol produced.
14. Effect of NaCl on amylase activity
15. Inhibition of alkaline phosphatase activity by EDTA
16. Estimation of lipase activity by titrimetric method
17. Effect of Temperature on activity of Amylase / Alkaline phosphatase and determination of optimum temperature.
18. Effect of Substrate concentration on activity of Amylase / Alkaline phosphatase and determination of optimum substrate concentration.
19. Effect of pH on activity of Amylase / Alkaline phosphatase and determination of optimum pH
20. Isolation of chlorophyll and xanthophyll from spinach leaves.
21. Effect of inhibitors on respiratory chain.
22. Study of Mitosis and Meiosis
23. Study of mutations by Ames Test.
24. Assay of Activity of SGOT & SGPT.
25. Isolation, Purity determination and quantitation of DNA by UV method.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. BIOTECHNOLOGY
Semester I
LAB II (Code: 1P2)
Macromolecules & Analytical Techniques

1. Separation of proteins / lipids by ion exchange chromatography
2. Separation of lipids / amino acids by thin layer chromatography
3. Polyacrylamide gel electrophoresis: a) native enzyme preparation, b) SDS-PAGE of proteins.
4. Introduction to measurements: balance and pipetting, preparation of solutions of given molarity and normality.
5. Measurement of pH: buffering capacity, to determine pKa value and hence the dissociation constant of a given acid using pH meter.

6. Colorimetry: To determine the dissociation constant of a given indicator colorimetrically and to prepare buffer solutions in the pH range 2.2 to 8.0
7. Colorimetry: Assay of DNA by diphenylamine method.
8. Colorimetry: Assay of RNA by orcinol method.
9. Potentiometry: To determine redox potential of Fe++ and Fe+++.
10. Conductometry: to determine cell constant of 0.1 M KCl.
11. Conductometry: Titration of strong acid vs strong base, to find out equivalent conductance of salt formed.
12. Viscometry: Effect of temperature on the viscosity of DNA using Ostwald's viscometer.
13. Viscometry: To determine molecular weight of protein and DNA.
14. Viscometry: To determine changes in the conformation of bovine serum albumin by viscosity measurements, effect of pH on conformation of BSA.
15. Spectrophotometry: To study the absorption spectrum of hemoglobin and NADH
16. Determination of Tm of nucleic acid
17. The validity of beers law for colorimetric estimation of creatinine.
18. The ultraviolet absorption of proteins and amino acids.
19. Estimation of proteins by Lowry"s and Bradford method.
20. Estimation of protein by E280/E260 method.
21. Fractionation of proteins: Salt precipitation, solvent precipitation, isoelectric precipitation, dialysis, centrifugation.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. Sem I
Seminar (Code: 1S1)

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M. Sc. BIOTECHNOLOGY
Semester II
Paper – I (Code: 2T1)
Microbiology

UNIT I:
Eukaryae and Viruses

- Algae: General characteristics, Applications in biotechnology.
- Fungi and slime moulds: General characteristics, applications in biotechnology.
- Viruses: Nature, symmetry, capsid structure, nucleic acid.
- Quantification of viruses
- Life cycles: T4 and lambda.
- Viroids and prions.

UNIT II:
General Microbiology and Taxonomy

- Prokaryotes: bacterial structure and morphology, endospore forming bacteria, pseudomonas, mycobacteria, archaebacteria.
- Microbial classification: 16s rRNA sequence and bacterial phylogeny.
- Bacterial genetic system: recombination (transformation, conjugation, transduction and transposition) Plasmids, salient features of the E. coli genetic map.

UNIT III:
Microbial Physiology

- Nutrition: nutritional classification, behavior, cultivation, isolation, media and their types, maintenance of culture.
- Growth: Measurement of growth, growth curve, continuous and synchronous culture, factors affecting microbial growth.

UNIT IV:
Microbial Control

- Microbial control: methods and dynamics of sterilization, mechanisms of control, biocontrol and preservation.
- Concept of chemotherapy, chemotherapeutic agents, mechanisms of action.
- Drug resistance, MDR, assessment and management of drug resistance.

M. Sc. BIOTECHNOLOGY
Semester II
Paper – II (Code: 2T2)
Immunology

UNIT I:
Immunology- fundamental concepts and anatomy of the immune system
Components of innate and acquired immunity; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system;; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, HLA typing, flow cytometry, Microarrays.

UNIT II:
Immune responses generated by B and T lymphocytes
Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants;Basis of self —non-self discrimination; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses, Hapten-carrier system

UNIT III:
Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

UNIT IV:

Clinical Immunology

Hypersensitivity — Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; immunosuppressive therapy; Cancer immunotherapy. Apoptosis, transgenic mice, Gene knock outs.

M. Sc. BIOTECHNOLOGY
Semester II
Paper – III (Code: 2T3)
Fundamentals of Genetic Engineering

UNIT I:

- Restriction endonucleases and modification methylases
- Other enzymes needed in genetic engineering: exonucleases and endonucleases, ligases, polymerases, DNA modification enzymes and topoisomerases.
- Gene isolation and purification: general methods (shotgun method for producing gene library, cloning specific genes by hybridization and reverse transcriptase methods, direct selection of a gene)

UNIT II:

- Insertion of DNA and ligation: Berg's terminal transferase method (dA:dT joints); Boyer-Cohen-Chang experiment (cohesive ends), Butt joints (T4 DNA ligase); current ligation techniques (blunt-end ligation, complementary end ligation, linkers, adaptors, homopolymer tailing.

UNIT III:

Construction of Genomic DNA library and its applications

- Construction of cDNA Library: Method, problems to be addressed, advantages and disadvantages compared to the genomic DNA library, uses
- Screening of recombinants: Screening by complementation, southern hybridization, northern hybridization, colony lift, western blotting, immunoprecipitation, south-western screening. Synthesis and labeling of probes.
- DNA sequencing: Sanger-Coulson dideoxynucleotide method, Maxam-Gilbert chemical cleavage method, multiplex DNA sequencing, automated DNA sequencing. Basic idea of oligonucleotide synthesis.

UNIT IV:

Cloning vectors

- Plasmids as vectors, general characteristics of plasmids, bacterial vector plasmids, yeast vector plasmids,
- yeast artificial chromosomes
- Phage Vectors (lambda, M13).
- Cosmid vectors.
- Animal virus derived vectors – SV 40 and retroviral vectors

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M. Sc. BIOTECHNOLOGY
Semester II
Paper – IV (Code: 2T4)
Applied Molecular Biology

UNIT I:

Recombination and Genome Mapping,

- Homologous recombination: Holiday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, RecA and other recombinases.
- Molecular mapping of genome: Genetic and physical maps, choice of mapping population, southern and fluorescence in situ hybridization for genome analysis, RFLP, RAPD, and AFLP analysis, molecular

markers linked to disease resistance genes, application of molecular markers in forensic, disease prognosis, genetic counseling, pedigree etc.

UNIT II:

Antisense, Ribozymes and Epigenetics

- Antisense and ribozyme technology: Molecular mechanism of antisense molecule, biochemistry of ribozyme, hammerhead ribozymes, applications of antisense and ribozyme technologies.
- Epigenetics: chromatin marking systems, Direct chemical modification of DNA, Basic concepts of RNAi.

UNIT III:

Cancer Biology

- Methods to study cancer: Animal models. Role of tissue culture in study of cancer. Combination of tissue culture and animal models.
- DNA Viruses and cancer: Polyoma virus, SV40, adenovirus
- Genetics of Cancer: Oncogenes (ras, myc), suppressor genes (p53, Rb).

UNIT IV:

- Angiogenesis: Brief idea of healthy vasculature, definition of angiogenesis, basic process of tumor induced angiogenesis, Hypoxia induced factor (HIF), basics of pro- and anti- angiogenic factors, positive and negative factors affecting angiogenesis.
- Metastatsis: Stages of metastatic progression, prerequisites for metastasis (properties a cell must acquire for metastasis), epithelial-mesenchymal transition, biochemical parameters acquired by metastatic cells.
- Basic idea of Cancer stem cells.

M. Sc. BIOTECHNOLOGY
Semester II
LAB I (Code: 2P1)
Microbiology & Immunology

1. Production of microbial products in bioreactors/fermentors.
2. Immobilization of cells/enzymes.
3. Cleanliness, media preparation, sterilization, culturing methods, dilution techniques.
4. Staining techniques in microbiology; simple staining, gram staining, spore staining capsule staining, flagella staining.
5. Isolation of pure culture by different techniques.
6. Replica plating technique.
7. Propagation of viruses.
8. Assay of viruses.
9. Purification of immunoglobulins, qualitative assessment.
10. Demonstration of immunochemical reactions (blood group, Widal, VDRL, pregnancy, ELISA)
11. Blood film preparation and identification of cells.
12. Ouchterlony immunodiffusion,
13. Determination of albumin by radial immunodiffusion.
14. Biochemical tests for identification of Bacteria – Oxidase, catalase, IMViC test, etc.
15. Isolation of antibiotic resistant bacteria from waste / sewage water.
16. Motility of bacteria by hanging drop method.
17. Assay of antibiotics by disc diffusion method.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. BIOTECHNOLOGY
Semester II
LAB II (Code: 2P2)
Genetic Engineering & Applied Molecular Biology

1. Induction of β-galactosidase in strains of E. coli (I+ and I-).
2. Southern blotting.
3. Isolation of genomic DNA.
4. Western blotting.
5. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.
6. Isolation of RNA.
7. Restriction fragment length polymorphism.
8. Ames test.
9. Isolation of plasmid DNA (miniprep and alkaline bulk method)
10. Isolation of RNA
11. Isolation of polyA RNA using oligodT columns
12. Estimation of RNA by Orcinol method
13. Estimation of DNA by diphenylamine method
14. Estimation of DNA by E260 method
15. Isolation of Lambda phage DNA.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. Sem II
Seminar (Code: 2S1)

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M. Sc. BIOTECHNOLOGY
Semester III
Paper – I (Code: 3T1)
Genetic Engineering & its Applications

UNIT I:

- Transformation: DNA uptake by bacterial cells.
- Transfection: Chemical and physical methods, Viral vectors. Polyethylene glycol, DEAE-dextran, calcium phosphate coprecipitation, dimethyl sulfoxide, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection
- Amplification of DNA: Polymerase chain reaction.

UNIT II:

Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their application, Biological and physical transformation methods. Chloroplast transformation.

UNIT III:

- Expression of heterologous genes: expression of eukaryotic genes in bacteria, expression of heterologous genes in yeast, insect and mammalian cells.
- Salient features of expression vectors.
- Processing of recombinant proteins: Refolding and stabilization.
- Industrial Products of Protein engineering

UNIT IV:

- Phage Display: Production of monoclonal bodies by phage display technique using filamentous phage vectors.
- Gene Therapy: somatic and germline, gene replacement, in vivo and ex vivo gene delivery, retrovirus gene transfer system, advantages and disadvantages of adenovirus, adeno-associated virus, herpes virus vectors, gene correction, replacement/augmentation, editing, regulation and silencing. Gene therapy of human diseases

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M. Sc. BIOTECHNOLOGY
Semester III
Paper – II (Code: 3T2)
Plant Biotechnology

UNIT I:

- Conventional plant breeding (introductory).
- Introduction to cell and Tissue culture. Tissue culture as a technique to produce novel plants and hybrids.
- Tissue culture media (composition and preparation)
- Callus and suspension cultures: initiation and maintenance of callus and suspension cultures; single cell clones.
- Organogenesis. Embryogenesis; transfer and establishment of whole plants in soil.

UNIT II:

- Shoot tip culture: rapid clonal propagation and production of virus free plants.
- Embryo culture and embryo rescue.
- Hybrid plants: protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid.
- Production of haploid plants: anther, pollen and ovary cultures for production of haploid plants and homozygous lines.

- Germplasm conservation: cryopreservation, slow growth cultures and DNA banking for germplasm conservation.

UNIT III:

- Applications of plant transformation for productivity and performance
- Herbicide resistance, phosphoinothricine glyphosate, sulfonyl urea, atrazin, insect resistance, Bt genes, non-Bt-like protease inhibitor, virus resistance, coat protein mediated nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP,
- antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

UNIT IV:

- Plant metabolic engineering and industrial products: plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.
- Molecular marker aided breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellite, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), QTL, map based cloning, molecular marker assisted selection.
- Green House Technology

M. Sc. BIOTECHNOLOGY
Semester III
(NOTE: Candidates can choose any one elective paper from Core elective A or B)

Paper – III (Core Elective A) (Code: 3T3A)
Industrial Biotechnology I

UNIT I:
Bioreactors:

- Bioreactor function, utility, types of bioreactor. Modes of bioreactor operations. Main components of the bioreactor and their functions.
- Bioreactors
  a) Design/configuration of a basic fermentor; individual parts and probes for on-line monitoring of process.
  b) Concept of Batch and Continuous process, fed-batch semi-continuous systems; aerobic and anaerobic fermentors
  c) Submerged/liquid state and solid state fermentations

UNIT II
Types of Bioreactors:

- Continuous stirred tank and plug flow reactors
- Packed bed and fluidized bed reactors
- Trickle bed, immobilized bed, air lift, rotary disc reactors. Reactors with cell recycle.

UNIT III:
Immobilized reactor systems:

- Immobilization techniques for cells (physical adsorption, ionic binding, covalent binding, lattice entrapment, membrane entrapment, micro encapsulation) and enzymes (covalent binding, entrapment, micro encapsulation, cross-linking, adsorption, ionic binding, affinity binding, chelation, disulfide bonds)
- Immobilized enzyme kinetics
- Types of immobilized reactors

UNIT IV:
Scope of Downstream Processing:

- Importance of Down Stream Processing (DSP) in biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics. Cell Disruption

Methods: Various cell disruption methods, need for cell disruption for (Homogenizer, French press & Dynomill) intracellular products, cell disruption equipment. Applications in bio-processing. Flocculation: Principles of flocculation various flocculating agents, applications in bio-processing. Coagulation: Principles of coagulations and its applications in bio-processing

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M. Sc. BIOTECHNOLOGY
Semester III
(NOTE: Candidates can choose any one elective paper from Core elective A or B)

Paper – III (Core Elective B) (Code: 3T3B)
Environmental Biotechnology I
Environmental Science & Bioresources

UNIT I:
Introduction to environmental Science: Environmental ethics: Environmentalism, Environment & Religion, Environmental education, Need for environmental education. Environmental Pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, Soil pollution, thermal pollution, marine pollution, solid water pollution.

UNIT II:
Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes. Biotechnological processes: Bioconversion, Bioaccumulation, Bioconcentration, Biomagnification, Biodegradation.

UNIT III:
Energy & Biofuels: Non conventional or renewable sources of energy, Energy from Biomass, Biofertilizers, Biosensors and biochips, Biofilters, Biofuel cells,

UNIT IV:
Biofertilizers, Biopestisides and Integrated pest management: Bacterial biofertilizers, algal biofertilizers, Aquatic ferns as biofertilizers, Fungi as biofertilizers, earthworm as biofertilizers, biopestisides, Integrated pest management.

M. Sc. BIOTECHNOLOGY
Semester III
(NOTE: Candidates of other M. Sc. Subjects can choose this paper from Biotechnology subject)
Paper – IV (Foundation Paper I) (Code: 3T4A)
Introductory Biotechnology

UNIT I:
Basics of Proteins

- Amino acids: Structures of amino acids found in proteins, classification, peptide bond structure; Protein Structure:
- Primary (basic idea of sequencing and amino acid composition), secondary (alpha and beta structures), tertiary and quaternary structures

UNIT II:
Nucleic acids

- Nucleoside, Nucleotides, Bases; Basic Structure of DNA (Watson Crick structure) and RNA.

UNIT III:
Genes and chromosomes

- Gene definition, prokaryotic and eukaryotic gene structure; Structure of chromatin (nucleosome, 30 nm fiber, solenoid structure); basic understanding of chromosome structure; centromeres, telomeres, Unique genes and gene families

UNIT IV:

Enzymes

- Overview, Enzyme classification with specific examples. Characteristics of enzymes, Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Enzyme activity, international units, specific activity
- Introduction to Enzymes used in biotechnology: Restriction enzymes, exonucleases and endonucleases, ligases, polymerases, DNA modification enzymes and topoisomerases

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M.Sc. Biotechnology (CBCS)
Semester-III
(Candidate can opt for this paper in their main subject of postgraduation ONLY).
Paper-IV: (Core Subject Centric I) (Code: 3T4B)
Diagnostic Medical Biotechnology

Molecular and Nanomolecular Diagnostics

Unit I

Host pathogen interactions in disease process (Bacterial: Tuberculosis and Staphylococcal Diseases & Viral: Influenza and HIV/AIDS); Disease pathology and clinical spectrum; Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen. Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatic tools for molecular diagnosis.

Unit II

Concept of Genomics, Human disease genes; DNA polymorphism including those involved in disease (Ex: Hemoglobin and the anemias); Phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; 'disease' gene vs. 'susceptibility' gene; SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation); Polymorphism detection without sequence information: SSCP. Single nucleotide polymorphism and disease association; High throughput DNA sequencing and diagnosis; and Array based techniques in diagnosis.

Unit III

Outline of a typical proteomics experiment, clinical proteomics and disease biomarkers. Isolation of proteins and other molecules associated with disease; 2D analysis of such proteins by sequencing individual spots by Mass Spectrometry; Protein Microarray; Present methods for diagnosis of Specific diseases like Tuberculosis and AIDS; Ethics in Molecular Diagnosis

Unit IV

Nanomolecular diagnostics and Biosensor: Introduction to Nanodiagnostics, Nanoarrays for diagnostics, detection of single DNA, self-assembled protein nanoarrays, protein nanobiochip nanoparticles for molecular diagnostics, DNA nanomachines, Nanobiosensor, CNT biosensor, DNA nanosensor, Nanowire biosensor, application of nanodiagnostics.

Texts/References

1. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition, Academic Press, 2005.
2. Willey J. Prescott, Harley, and Klein's Microbiology-7th international ed./Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. New York: McGraw-Hill Higher Education; 2008.
3. Lela Buchingham and Maribeth L Flawsm, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA, 2007.
4. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2007.
5. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.
6. Challa S.S.R. Kumar, Nanomaterials for medical diagnosis and therapy, Viley-VCH, 2007.
7. Dr.Parag Diwan and Ashish Bharadwaj (Eds), Nano Medicines, Pentagon Press, 2006.

M. Sc. BIOTECHNOLOGY
Semester III
LAB I (Code: 3P1)
Genetic Engineering & Plant Biotechnology

1. Recombinant DNA technology: in vitro DNA ligation and transformation of E. coli.
2. Recombinant DNA technology: characterization of transformants.
3. Northern blotting
4. Agarose gel electrophoresis and restriction mapping of DNA.
5. Construction of restriction map of plasmid DNA
6. Cloning in plasmid/phagemid vectors.
7. DNA sequencing.
8. Gene expression in E coli and analysis of gene product
9. Demonstration of technique of PCR
10. Demonstration of technique of RT-PCR
11. Replica plating technique.
12. Propagation of viruses.
13. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.
14. Restriction fragment length polymorphism.
15. Ames test.
16. Quantitation of DNA by various methods.
17. Preparation of plant tissue culture media.
18. Surface sterilization.
19. Organ culture.
20. Callus propagation, organogenesis, transfer of plants to soil.
21. Protoplast isolation and culture.
22. Anther culture: production of haploids.
23. Cytological examination of regenerated plants.
24. Micropropagation of banana, citrus Papaya, Sugarcane etc.
25. Effect of various growth hormones on cell divisions and cell proliferation
26. Isolation, purification and culture of protoplast
27. Artificial seed preparation
28. Cytological examination of regenerated plants
29. Agrobacterium culture and selection of transformants.
30. Hardening of tissue culture raised plants.
31. Transfer of plants to soil.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. BIOTECHNOLOGY
Semester III
LAB II (Core Elective A) (Code: 3P2)
Industrial Biotechnology

1. Immobilization of cells/enzymes
2. Determination of rheological constant.
3. Determination of oxygen transfer rate, volumetric transfer coefficient.
4. Microbial production of Alcohol
5. Microbial production of antibiotics
6. Production of microbial products in fermentors / bioreactors
7. Preparation and formulation of microbial biopestisides / biofertilizers.
8. Study of patenting procedure
9. Preparation of proposal for patenting.

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. BIOTECHNOLOGY
Semester III
LAB II (Core Elective B) (Code: 3P2)
Environmental Biotechnology

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water
3. Determination of Hardness and alkalinity of water sample.
4. Determination of dissolved oxygen concentration of water sample
5. Determination of biological oxygen demand of sewage sample
6. Determination of chemical oxygen demand (COD) of sewage sample.
7. Analysis of oligodynamic action.
8. Determine the efficiency of removal of air pollutant using fibrous air filter.
9. Preparation and formulation of microbial biopesticide (bacteria, fungi and viruses
10. Production of microbial fertilizers (Rhizobium, Azotobacter and AMF).

Note: Candidates must perform at least 6 practicals in the semester.

M. Sc. Sem III
Seminar (Code: 3S1)

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M. Sc. BIOTECHNOLOGY
Semester IV
Paper – I (Code: 4T1)
Animal Biotechnology

UNIT I:

- Animal Cell Culture: Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations.
- Culture medium: natural media, synthetic media, sera. Introduction to 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 di oxide, serum and supplements.
- Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

UNIT II:

- Primary Culture: Behavior of cells, properties, utility. Explant culture; suspension culture.
- Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation.
- Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

UNIT III:

- Scaling up of animal cell culture. Cell transformation.
- Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics.
- Apoptosis: Measurement of cell death. Apoptosis (death domain, role of cytochrome C)

UNIT IV:

- Commercial applications of cell culture: Tissue culture as a screening system; cytotoxicity and diagnostic tests. Mass production of biologically important compounds (e.g. Vaccines). Harvesting of products, purification, and assays.
- Three dimensional cultures and tissue engineering.

M. Sc. BIOTECHNOLOGY
Semester IV
Paper – II (Code: 4T2)
Biostatistics, Bioinformatics, Ethics & Patenting

UNIT I:

Biostatistics

- Measures of central tendency: mean, mode, and median.
- Measures of dispersion: range, mean deviation, standard deviation.
- Methods of sampling, sampling error, non-sampling errors, standard error.
- Chi-square test, meaning of correlation and regression.
- Cluster analysis: phylogenetic clustering by simple matching coefficients.
- Presentation of statistical data: tabulation (simple tables, frequency distribution table); charts and diagrams (bar charts, histograms, pie charts, dendrogram).
- Research designs with basic principles and field layout.

UNIT II:

Bioinformatics

- Computer concept: computer organization, hardware, software, operating system (windows, unix, brief list of computer languages).
- Concept of networking: internet, internet concepts, web browsing, public domain resources in biology.
- Concept of database management: brief idea of data types, data structures, searching, sorting, designing a database, genomic, proteomic, and metabolic pathways databases.

- Computer analysis of genetic sequences: general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PuBMed.
- Proteomics: basic issues and concepts, protein sequences and alignment, protein structure prediction.
- Bioinformatics tools in drug design.

UNIT III:

Ethics:

- Benefits of biotechnology, ELSI of biotechnology, recombinant therapeutic products for human health care, genetic modifications and food consumption, release of genetically engineered organisms, applications of human genetic rDNA research, human embryonic stem cell research.

UNIT IV:

Patenting

- Patent and Trademark, Biotechnology products and processes, Intellectual property rights, Plant breeders rights, biotechnology in developing countries. Biosafty and its implementation, Quality control in Biotechnology.

M. Sc. BIOTECHNOLOGY

Semester IV

(NOTE: Depending on the Core elective subject chosen in Semester III, Candidates shall pursue the same core elective subject in semester IV)

Paper – III (Core Elective A) (Code: 4T3A)

Industrial Biotechnology II

UNIT I:

Bioprocess Engineering Concepts:

- Mass transfer, heat transfer, mixing, rheology of fermentation fluids, residence time distribution, substrate utilization and yield-coefficients, oxygen transfer and oxygen sag.

UNIT II:

Process Optimization and Control:

- Optimization parameters, medium formulation, process optimization techniques:classical, Plackett-Burman design, ANOVA, central; composite design, response surface methodology with example.; medium formulation: classical, experimental design technique, fractional factorial design with egs.
- Concept of control: turbidostatic and chemostatic control, open loop and feedback control
- Advanced control policies: model predictive control, cascade control, PID control, programmed control

UNIT III:

Scale up & Biosensor Technology:

- basic principles of scale-up
- bases of scale up, scale down
- Biosensors

UNIT VI:

Production of Primary & Secondary Metabolite:

1. Primary Metabolites:

- A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, lactic acid, acetic acid etc); amino acids (glutamic acid, phenyalanine, aspartic acid etc.) and alcohols (ethanol, butanol etc.)

2. Secondary Metabolites:

- Brief Study of production processes for various classes of secondary metabolites: antibiotics: beta-lactams (penicillin), aminoglycosides (streptomycin) macrolides (erythromycin), vitamins and steroids.

M. Sc. BIOTECHNOLOGY

Semester IV

(NOTE: Depending on the Core elective subject chosen in Semester III, Candidates shall pursue the same core elective subject in semester IV)

Paper – III (Core Elective B) (Code: 4T3B)

Environmental Biotechnology II
Applied Environmental Biotechnology

UNIT I:
Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation.
Solid waste pollution and its management: Current practice of solid waste management, composting systems, vermicomposting, sewage treatment.

UNIT II:
Bioabsorption and Bioleaching of heavy metals: Cadmium, Lead, Mercury, Metal binding targets and organisms, Bioabsorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

UNIT III:
Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), Biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.

UNIT IV:
Xenobitics in environment: Biodegradation of Hydrocarbons, Substituted hydrocarbons, Surfactant, Pesticides, Lignin, Tannin, Synthetic dyes, Biotransformation: Oxidation reactions: Cytochrome P450 monooxygenase system, Alcohol and aldehyde dehydrogenases, Peroxidases. Reduction reactions: Cytochrome P450 and flavin dependent reactions. Hydrolysis reactions: Carboxyl esterases. Conjugation reactions: Gluthione S transferases. Regulation of biotransformation.

M. Sc. BIOTECHNOLOGY
Semester IV
(NOTE: Candidates of other M. Sc. Subjects can choose this paper from Biotechnology subject)
Paper – IV (Foundation Paper II) (Code: 4T4A)
Basic rDNA Technology

UNIT I:
History of Gene cloning

- Boyer-Cohen-Chang experiment. Patenting of the recombinant DNA technique; Berg's role in gene cloning history, Change in medicinal science after discovery of recombinant DNA technology (brief mention of how we produce human insulin today, somatostatin and other therapeutic products, very brief overview of how we may treat diseases through gene therapy)
- Why do we clone genes? (amplification and/or heterologous gene expression). Basic steps of gene cloning:
- Agarose gel electrophoresis; 2D Electrophoresis; Pulsed field gel electrophoresis; SDS PAGE; 16S rDNA sequencing for bacterial identification; ITS region sequencing for fungal identification; RFLP; RAPD

Unit II:
Basic process of recombinant DNA technology

- Cutting and joining of DNA. Vectors: concept, types of vectors (plasmids, phage, virus), Essential qualities that a vector must possess
- Types of vectors: pBR322, cosmids, lambda phage

Unit III:
Basic process of recombinant DNA technology

- Transformation and Transfection – basic techniques. Selectable markers (antibiotic resistance, lacZ), Selection process, Screening.

Unit IV:

Applications of gene cloning

- Insulin, Somatostatin, BT Cotton, production of human proteins and drugs, recombinant vaccines, agricultural applications, production of transgenic animals, human gene therapy

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M.Sc. Biotechnology (CBCS)
Semester-IV
(Candidate can opt for this paper in their main subject of postgraduation ONLY).
Paper-IV: (Core Subject Centric II) (Code: 4T4B)
Therapeutic Medical Biotechnology

Molecular Therapeutics and Drug Discovery

Unit I

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery. Gene silencing technology; siRNA- Concept, delivery and therapeutic applications in treatment of influenza and HIV/AIDS; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues

Unit II

Proteomics and drug discovery: High throughput screening for drug discovery; Identification of drug targets; Pharmacogenomics and pharamacogenetics and drug development; Toxicogenomics; Metagenomics.

Unit III

Nanobiotechnology for drug discovery, protein and peptide based compounds for cancer and diabetes, drug delivery - nanoparticle based drug delivery, lipid nanoparticles, vaccination, cell therapy, Gene therapy. Ethical, safety and regulatory issues of nanomedicine. Physicochemical characteristics of nanomaterials, Nanoparticle interaction with biological membrane, Neurotoxicology.

Unit IV

Drug Discovery & Clinical research

Introduction and importance of clinical research, Drug Development and phases of Clinical trials, Designing clinical Trials, Protocol designing, Ethical issues in clinical research, ICH-GCP Guidelines, Informed consent process, Role of CRC and CRA in clinical trials, Pharmacovigilance, Standard operating procedures, Guidelines to undertake clinical trials in India schedule Y.

Texts/References:

1. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.
3. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
4. H. Rehm, Protein Biochemistry and Proteomics, 4th Edition, Academic Press, 2006.
5. Robert A. Freitas Jr., Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience, Georgetown, TX, 1999.
6. Robert A. Freitas Jr., Nanomedicine, Volume IIA: Biocompatibility, Landes Bioscience, Georgetown, TX, 2003.
7. Kewal K. Jain, The Hand book of Nanomedicine, Humana Press, Springer 2008.
8. Nancy A. Monteiro – Riviere and C. Lang Tran, Nanotoxicology: Characterization, Dosing and Health Effects, Informa Healthcare. 2007.
9. Kumar, Challa S. S. R. (ed.) Nanomaterials - Toxicity, Health and Environmental Issues, Wiley-VCH, Weinheim, 2006.
10. Norris, Deborrah. Clinical Research Coordinator Handbook. Plexus Pub, 2009.
11. Portney, Leslie Gross, and Mary P. Watkins. Foundations of clinical research: applications to practice. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2000.
12. Stone, Judy. Conducting clinical research: A practical guide for physicians, nurses, study coordinators, and investigators. Mountainside MD Press, 2006.
13. Glasser, Stephen P., and P. Glasser. Essentials of clinical research. Springer, 2008.

Semester IV
LAB I (Code: 4P1)
Animal Biotechnology, Biostastics, Bioinformatics, Ethics & Patenting
And Industrial Biotechnology II or Environmental Biotechnology

Section I: Animal Biotechnology, Biostastics, Bioinformatics, Ethics & Patenting

1. Development of primary cell lines/maintenance of established cell lines
2. Preparation of animal cell culture media.
3. Filter sterilization and sterility test.
4. Media storage, serum inactivation.
5. Cell fusion.
6. Cell transformation by viruses.
7. Lyophilization of local germplasma.
8. Calculation of mean, mode, and median
9. Calculation of standard deviation and standard error
10. Using computer in single user and multiple user environment
11. Designing and management of databases
12. Computer aided statistical analysis
13. Computer presentation of statistical data, charts and diagrams
14. Computer aided visualization of amino acid sequence of protein and its 3D structure.
15. Retrieving metabolic pathway using internet
16. Homology searching using BLAST
17. Base sequence analysis of gene / protein sequence
18. Computer aided survey of scientific literature
19. Field layout based on statistical research designs
20. Determination of rheological constant

Section II: Section A) Industrial Biotechnology OR Section B) Environmental Biotechnology
A) Industrial Biotechnology

1. Demonstration of various bioreactor configuration, parts and integrated process control system.
2. Demonstration of addition of inoculation and sampling in CSTR
3. Determination fo volumetric mass transfer coefficient (KLa) by dynamic method and sulphite oxidation method
4. Preparation of wine from grapes.
5. Preparation and characterization of immobilized cells system
6. To perform cell disruption by ultrasonication
7. To study the settling velocity of solid particles under batch sedimentation

OR

B) Environmental Biotechnology

1. Test for the degradation of a aromatic hydrocarbons by bacteria
2. Survey of degradative plasmids in microbes growing in polluted environment
3. Effect of Sulphur dioxide on crop plants
4. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry,
5. Estimation of nitrate in drinking water.
6. Role of microorganisms in elevation of heavy metal induced stress in plants.
7. Isolation of xenobiotic degrading bacteria by selective enrichment technique
8. In vitro evaluation of medicinal plants against pathogenic microbes.
9. Effect of mycorrhizal fungi on growth promotion of plants.
10. Study of patenting procedure
11. Preparation of proposal for patenting.
12. Study of RFLP, VNTRs, SNPs

Note: At least 6 practical must be conducted within the semester.

M. Sc. Part II, Sem IV
Project (Code: 4PROJ1)

M. Sc. Part II, Sem IV
Seminar (Code: 4S1)
