Revised Scheme and Syllabus of M.Sc. Biotechnology

1st & 2nd Semester w. e. f. 2014-15
3rd and 4th Semester w. e. f. 2015-16

Department of Bio and Nano Technology
Guru Jambheshwar University of Science & Technology, Hisar-125 001, Haryana

REVISED SCHEME OF EXAMINATION M.Sc. BIOTECHNOLOGY (2014)

FIRST SEMESTER

Sr. No.	Course No.	Title	Type	L	P	Credit
1.	MBL-511	Introductory Biotechnology	PC	5	0	5
2.	MBL-512	Biomolecules and Metabolism	PC	5	0	5
3.	MBL-513	Cell Biology	PC	5	0	5
4.	MBL-514	General & Applied Microbiology	PC	5	0	5
5.	MBP-515	Lab I (Biochemistry)	PC	0	6	3
6.	MBP-516	Lab II (General Microbiology)	PC	0	6	3
		TOTAL		**20**	**12**	**26**

SECOND SEMESTER

Sr. No	Course No.	Title	Type	L	P	Credit
1	MBL-521	Theory & Applications of Biotechniques	PC	4	0	4
2	MBL-522	Molecular Biology	PC	4	0	4
3	MBL-523	Fundamentals of Immunology	PC	4	0	4
4	MBL-524	Plant Cell, Tissue and Organ Culture	PC	4	0	4
5	MBL-525	Fermentation Technology	PC	4	0	4
6	MBP-526	Lab V (Immunology & Fermentation Technology)	PC	0	6	3
7	MBP-527	Lab VI (Plant Cell, Tissue and Organ Culture & Biophysical Techniques)	PC	0	6	3
		TOTAL		**20**	**12**	**26**

THIRD SEMESTER

Sr. No.	Course No.	Title	Type	L	P	Credit
1.	MBL-531	Genetic Engineering	PC	4	0	4
2.	MBL-532	Enzymology & Enzyme Technology	PC	4	0	4
3.	MBL-533	Molecular Genetics	PC	4	0	4
4.	MBL-534	Introductory Bioinformatics	PC	4	0	4
5.	MBL-535	Principles of Nanobiotechnology	PC	4	0	4
6.	MBP-536	Lab VII (Genetic Engineering)	PC	0	6	3
7.	MBP-537	Lab VIII (Bioinformatics/ Nanobiotechnology)	PC	0	6	3
	MBS-590	Credit seminar	PC	1	0	1
	MBD-595	In Plant/Summer Training	PC	0	6	3
		TOTAL		**21**	**18**	**30**

FOURTH SEMESTER

Sr. No.	Course No.	Title	Type	L	P	Credit
1.	MBL-542	Agriculture Biotechnology & IPR	PC	4	0	4
2.	MBL-543-546	Program Elective-I	PE	4	0	4
5.	MBD 600	Investigation Problem	PC	0	16	16
		TOTAL		8	16	**24**

Program Elective-I
MBL-543 Environmental Biotechnology
MBL-544 Food Biotechnology
MBL- 545 Medical Biotechnology
MBL- 546 Genomics and Proteomics

Semester	Credit
1st	26
2nd	26
3rd	30
4th	24
TOTAL	106

Program core (PC)	Program Elective (PE)	Total Credit
102	4	106

1. The minimum credit requirement for the M.Sc. degree in Biotechnology is 106 credits inclusive of the 04 credits for Program Elective courses.
2. Among the Program Electives Courses the student is required to opt for only one from each of the course.
3. No Program Elective Course will run unless a number of students registered for the Program Elective Course is less than five.
4. For theory courses, one hour per week per semester is assigned as one credit. For practical courses six hours per week accounts for 3 credits. One hour per week per semester is assigned as half credit.
5. Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.
6. After the completion of second semester the students are required to undertake an In-Plant Training /Summer Training MBD-595 comprising of 4-6 weeks in any industry/research organization/institute and shall be required to submit an In-Plant/Summer Training Report for which viva-voce and evaluation examination will be conducted internally.
7. In the fourth semester the students are required to undertake Investigation Problem MBD-600 comprising of 14-16 weeks and shall be required to submit an Investigation Report in the form of Thesis for which seminar, presentation and viva-voce examination will be conducted.
8. In the third semester, each student has to deliver one credit seminar of 1 credit and it will be evaluated internally by the seminar incharge.

MBL 511: INTRODUCTORY BIOTECHNOLOGY **MM: 70**
(Credits: 5+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Biotechnology: An overview-definition, scope and importance of Biotechnology, Concept of Recombinant DNA technology and Gene Cloning.

Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering.

Animal Biotechnology: *In-vitro* fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Diagnostic, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy.

Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

Nano Science & Technology: An Overview, Insights and intervention into the Nano world, Important Developments, Societal implications & Ethical issues in Nanotechnology, Applications of Nanobiotechnology in different areas.

Bioinformatics: (A brief account) Importance, Scope of Bioinformatics, world wide web as a tool, Bioinformatics institutes and databases, Bioinformatics training & limitations.

Bio-business and Bio-safety, Biotechnology for developing countries and IPR

Recommended Books:

1. Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
2. Natesh S., Chopra V.L. and Ramachandran S. (1987), Biotechnology in Agriculture Oxford & IBH, New Delhi.
3. Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
4. Tizard I.R. (2013) Immunology- An introduction, 5th Edition, Philadelphia Saunders College press.
5. Bhushan, Bharat (Ed.) 2012 Encyclopedia of Nanotechnology. Springer.
6. Bhushan, Bharat (Ed.) 2010 Handbook of Nanotechnology. Springer.
7. Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
8. Singh B.D. (2010), Biotechnology, 4th edition, Kalyani Publication.
9. Black J.G (2008) Microbiology- Principles and Explorations, 7th edition, John Wiley & Sons.

MBL 512: BIOMOLECULES AND METABOLISM **MM: 70**
(Credits: 5+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Biomolecules: An introduction, General structure of biomolecules, Fundamental principles governing structure of biomolecules, Importance of covalent and non covalent bonds.

Carbohydrates: Structure and function of biologically important mono, di and poly-saccharides, glycoproteins & glycolipids. Metabolism of carbohydrates-Glycolysis, Feeder pathways, Citric acid cycle, Gluconeogenesis, Glyoxylate and Pentose phosphate pathways and their regulations.

Proteins: Structure of amino acids, non-protein and rare amino acids. A brief account of amino acid biosynthesis and degradation, Urea cycle. Structural organization of proteins, Reverse turns and Ramachandran plot, Supra-molecular complexes of proteins. Chemical synthesis of peptides and small proteins. Protein sequencing.

Lipids: Structure of fatty acids, Classification of lipids, Structure and functions of major lipid subclasses- Acylglycerols, Phospholipids, Glycolipids, Sphingholipids, Waxes, Terpenes and Sterols. Fatty acids biosynthesis, degradation and their regulations, Ketone bodies synthesis. Biosynthesis of TAG, Cholesterol, Phospholipids and Glycolipids.

Nucleic Acids: Structure and properties of nucleic acid bases, nucleosides and nucleotides. Biosynthesis and degradation of purines and pyrimidines, Salvage pathway.

Vitamins: Structure and biochemical roles of fat and water-soluble vitamins and their co-enzymes.

Recommended Books:

1. Nelson, D.L. and Cox, M.M. (2013), Lehninger Principles of Biochemistry, 6th Edition Freeman and Company, New York.
2. Conn E.E., Stumpf P.K., Bruening G. and Doi R.H. (1997,) Outlines of Biochemistry. John Willey and Sons Inc. New York and Toronto.
3. Voet D., Voet J.G. and Pratt C.W. (2013), Principles of Biochemistry, 4th Edition John Wiley and Sons Inc., New York.
4. Elliott W.H. and Elliott D.C. (1997), Biochemistry and Molecular Biology. Oxford University Press Inc. New York.
5. Metzler D.E. (2001), Biochemistry (Vol I and II) Academic Press, London and New York.
6. Berg J.M., Tymoczko J.L. and Stryer L (2012), Biochemistry, 7th Edition W.H. Freeman Publishers, New York.
7. Garret R.H. and Grisham C.M (2010) Biochemistry, 4th Edition. Brooks/Cole, Boston.

MBL 513: CELL BIOLOGY **MM: 70**
(Credits: 5+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure &function of cytoskeleton and its role in motility.

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways

Cellular communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. Neurotransmission and its regulation.

Cancer Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Photosynthesis and Respiration: Photosynthetic apparatus, light reaction, cyclic and noncyclic photoinduced electron flow, C3 and C4 cycle and their regulation and CAM pathway, Photorespiration, dark phase of photosynthesis.

Recommended Books:

1. Alberts B.*et al* (2002), Molecular Biology of cells, 4th Edition, Taylor & Francis
2. Lodish *et al* (2013), Molecular Cell Biology, 7th Edition, W.H. Freeman Company, USA.
3. Gilbert S F (2002), Developmental Biology, SF Sinauer Associates Inc.
4. Karp G. (2012), Cell and Molecular Biology: Concept and Experiments. John Willy, New York**.**
5. Freedman L.P. (1998), Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhuser.
6. Nelson, D.L. and Cox, M.M. (2013), Lehninger Principles of Biochemistry, Freeman and company, New York.
7. Hardin J., Bertoni G. and Kleinsmith, L.J (2012). Becker's world of Cell. 8th Edition, Pearson.

MBL 514: GENERAL AND APPLIED MICROBIOLOGY **MM: 70**
(Credits: 5+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction to Microbiology: Historical background and scope of Microbiology. Ubiquitous nature of microorganisms. Impact of microbes on human affairs. Structure of prokaryotic and eukaryotic cell. Differences between Eubacteria, Archaebacteria and Eukaryotes. Salient features of different groups of microorganisms such as bacteria, fungi, protozoa and algae including their morphological features, mode of reproduction and cell cycle.

Nutrition and Classification: Principles of microbial nutrition- Chemoautotrophs, chemoheterotrophs, photoautotrophs and photoheterotrophs. Basic principles and techniques used in bacterial classification. Phylogenetic and numerical taxonomy. New approaches of bacterial classification including DNA hybridization, ribosomal RNA sequencing and characteristics of primary domains. Major groups of bacteria based on latest edition of Bergey's manual.

Viruses: General characteristics, structure, and classification of plant, animal and bacterial viruses, Replication of viruses. Lytic and lysogenic cycle in bacteriophages. A Brief account of Retroviruses, Viroid's, Prions and emerging viruses such as HIV, Avian and swine flu viruses.

Microbial Growth: The definition of microbial growth. Growth in batch culture. Mathematical representation of bacterial growth, Bacterial generation time. Specific growth rate. Monoauxic, Diauxic and synchronized growth curves. Measurement of microbial growth. Factors affecting microbial growth. Brief account of growth in fungi. Culture collection and maintenance of microbial cultures.

Control of Microorganism: Control of Microorganism by physical and chemical agents. Antiseptics and disinfectants. Narrow and broad spectrum antibiotics. Antifungal antibiotics, Mode of action of antimicrobial agents. Antibiotic resistance mechanisms.

Microbial Ecology: Microbial flora of soil, Interaction among microorganisms in environment. Symbiotic associations- types, functions and establishment of symbiosis. Brief account of biological nitrogen fixation.

Recommended Books:

1. Madigan, M.T., Martinko, J.M., Bender, K., and Buckley, D. (2011) Brock Biology of Microorganisms, 13th Edn., Pearson Education, USA
2. Tauro, P., Kapoor, K.K. and Yadav, K.S. (1996). Introduction to Microbiology, New Age Pub., New Delhi
3. Pelczar, M.J. *et. al* (2001), Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
4. Black, J.G. (2012), Microbiology: Principles and Explorations, 8th Edition, John Wiley and Sons, USA.
5. Willey, J.M., Sherwood, L., and Woolverton, C. (2013) Prescott's Microbiology 9th Revised edition, McGraw Hill Higher Education, New York
6. Pommerville, J.C. (2009) Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.
7. Tortora, G.J., Funke, B.R., Case, C.L. (2012) Microbiology -An Introduction, 11th Edition, Pearson education Pvt. Ltd. Singapore.

MBL 521: THEORY & APPLICATIONS OF BIOTECHNIQUES **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Microscopic Techniques: Principles and applications of light, Phase contrast, Fluorescence microscopy, Scanning and Transmission Electron Microscopy, Confocal Microscopy. Flow Cytometry.

Centrifugation: Preparative and analytical Centrifuges, Sedimentation analysis, RCF, Density Gradient Centrifugation.

Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC.

Electrophoresis Techniques: Theory and Application of PAGE, Agarose Gel Electrophoresis, Iso-electric Focusing, Blotting techniques- Southern, Northern and Western Blotting.

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, FTIR Spectroscopy, MS, NMR, Atomic Absorption Spectroscopy, X- ray diffraction, Raman Spectroscopy.

Radio-isotopic Techniques: Introduction to Radioisotopes and their biological applications, Radioactive Decay – Types and Measurement. Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, Radiation Dosimetry.

Other Techniques: Particle Size Analyzer, Circular Dichroism.

Recommended Books:

1. Freifelder D. (1982), Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freemen and Company, San Fransisco.

2. Rietdorf, J. (2010) Microscopy Techniques, Springer, Berlin

3. Walker J. and Wilson K (2010), Principles and Techniques-Practical Biochemistry, 7th Edition, Cambridge University Press, London.

4. Robyt, J.F. and White, B.J. (1987) Biochemical Techniques: Theory and Practice, Waveland Press

5. Skoog, D.A.; Crouch, S.R. and Holler, F.J. (2006) Principles of Instrumental Analysis, 6thEdn. Brooks/Cole, USA

6. Slater R.J. (1990), Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.

7. Boyer, R.F. (2006) Modern Experimental Biochemistry, Pearson, New Delhi.

MBL 522: MOLECULAR BIOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

DNA Structure: DNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Different forms of DNA, Forces stabilizing nucleic acid structure, Super coiled DNA, Properties of DNA, Renaturation and denaturation of DNA. Tm and Cot curves, Structure of RNA.

DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, Models of replication, Prokaryotic and eukaryotic replication mechanism. Replication in phages, Reverse transcription

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5' capping, 3' polyadenylation and splicing), RNA as an enzyme- Ribozyme.

Translation: Genetic code, General features, Deciphering of genetic code, Code in mitochondria. Translational mechanism in prokaryotes and eukaryotes. Post transnational modification and transport, Protein targeting (signalling), Non ribosomal polypeptide synthesis, Antibiotic inhibitors and translation.

Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, lac, trp and arb operon, Regulation of gene expression in eukaryotes (a brief account), Anti-sense RNA, RNAi.

Recommended Books:

1. Adams R.L.P. *et al.* (1992) The Biochemistry of Nucleic Acids, 11th Edition, Chapman and Hall, New York.
2. Lewin B. (2004) Gene VIII, Pearson Prentice and Hall, New Delhi.
3. Karp G. (2010), Cell and Molecular Biology-Concept and Experiments, 5th Edition, John Wiley, New York.
4. Lodish *et al* (2013), Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
5. Malacinski, G.M. and Freifelder D. (1998), Essentials of Molecular Biology, 3rd Edition, John and Bartlett Publishers.
6. Buchanan B.B. *et.al* (2000), Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologist, Rockville, Maryland, USA.
7. Watson *et.al* (2009), Molecular Biology of gene, 5th Edition, Pearson Education, New Delhi.
8. Klug, W.S., Cummings, M.R, Spencer C.A and Palladino, M.A. (2012), Concept of Genetics, 10th Edition, Pearson Education, Singapore.

MBL-523: FUNDAMENTALS OF IMMUNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Immunology- fundamental concepts and anatomy of the immune system
Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT & CALT); Mucosal Immunity; Antigens - immunogens, haptens; Complement system.

Immune responses generated by B and T lymphocytes
Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, Hybridoma technology and its application, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Basis of self, non-self-discrimination; Kinetics of immune response, memory; Generation of antibody diversity.

Processing and presentation of antigen: Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens, Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Antigen-antibody interactions
Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immune electron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

Clinical Immunology
Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); 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; Cytokines-properties, receptors and therapeutic uses; Vaccines

Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency Primary immune deficiencies, Acquired or secondary immune deficiencies.

Texts/References

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 8th Edition, Freeman, 2012.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 8th Edition, Current Biology publications, 2012.
4. Paul, Fundamental of Immunology, 4th edition, Lippincott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.

MBL-524: PLANT CELL, TISSUE AND ORGAN CULTURE **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction: Historical background**,** Concepts and basic techniques in tissue culture, Media preparation, Cell, Tissue and organ culture, Organogenesis.

Callus Culture: Induction, Maintenance, Growth characteristics, Suspension cultures.

Micropropagation: Techniques, Clonal propagation of elite germplasm, Factors affecting morphogenesis and proliferation rate, Technical problem in micropropagation, Meristem culture for the production of pathogen free plants, Applications of micropropagation.

Protoplast Culture: Protoplast isolation, Fusion and culture, Somatic hydridization, Selection systems for hybrids, Asymmetric hybrids, Production of hybrids and organellic recombinants, Role of protoplast culture and somatic hybridization in the improvement of crop plants.

Haploid Production: Haploid production and its significance, Anther and pollen culture, Monoploid production through chromosome elimination, Production of triploids through endosperm culture, Role of haploids, Monoploids and triploids in agriculture.

Cytodifferentiation: Cytodifferentiation in cell and tissue cultures, Origin of nuclear variations, Factors affecting variations, Ploidy levels and variations in plants from Anther culture, Control of regeneration.

Variability in Plant Systems: Somaclonal variations and *in-vitro* selection for biotic and abiotic stresses, Isolation of useful mutants at cellular level (disease resistant, herbicide resistant and salt tolerant) Practical applications of variability in tissue cultures.

Cryopreservation and Germplasm Storage: Cryopreservation and germplasm conservation, Production of synthetic and artificial seeds, Cryobiology of plant cell cultures and establishment of plant banks, Freeze preservation technology, Factors affecting revival of frozen cells, Future prospects.

Practical Application of Plant Tissue Culture: Role of tissue culture in the improvement of crop plants, Plant cell culture for the production of useful secondary metabolites- pigments, perfumes, flavours and pharmacologically important compounds. Automation in plant tissue culture for its commercial application.

Recommended Books:

1. Gamborg O.L.(2004), Plant Cell Tissue & Organ Culture,
2. Bhojwani S.S. and Rajdan M.K. (2004), Plant Tissue Culture: Theory and Practice A Revised Edition, Reed Elsevier, India New Delhi.
3. Bhojwani S.S. (2003), Agrobiotechnology & Plant Tissue Culture,
4. Smith R.H. (2000), Plant Tissue Culture, Academic Press.
5. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.

MBL 525: FERMENTATION TECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction to Fermentation Technology: Fermentation overview, Introduction to fermentation processes, industrially important microorganisms-Isolation, screening, and preservation of industrially important microorganisms.

Strain Improvement: Natural selection, mutation and screening of improved cultures, random and strategic screening methods, Use of recombinant DNA technology, protoplast fusion etc. **Principles of overproduction of primary and secondary metabolites with relevant examples.**

Fermentation Systems: Batch and Continuous system, Fed batch culture, Multistage systems, Feedback systems, Solid substrate fermentation. Instrumentation and control of fermentation processes.

Production and Recovery of Primary and Secondary Metabolites: Industrial Alcohol, Beer, Wine, Citric Acid, Acetic acid, lactic acid, Acetone- Butanol fermentation, Amino acids- Lysine & Glutamic acid production, Industrial enzymes, Antibiotics- Penicillin and Tetracycline, Bioinsecticides, Biopolymers, vitamins and steroids.

Fermentation raw materials: Media for industrial fermentation, Criteria used in media formulation, sterilization, raw materials and process control. Downstream processing- Separation processes and recovery methods for fermentation products.

Fermenter Design: Bioreactor configuration, design features, Criteria in Fermenter design, Requirement for aeration and mixing, Energy Transfer .Other fermenter designs- Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors.

Waste Treatment: Waste Treatment systems, Aerobic and anaerobic waste treatment systems for waste treatment in fermentation industry.

Recommended Books:

1. Stanbury, P.F., Hall, S., Whitaker, A. (1998), Principles of Fermentation Technology, 2nd edn. Butterworth-Heinemann Ltd
2. Ward O.P., (1999), Fermentation Biotechnology – Principles, Process and Products. Prentice Hall Publishing, New Jersey.
3. Rehm, H.J., Reed, G.B., Puehler, A. and Stadler (1993), Biotechnology, Vol. 1-8, VCH Publication.
4. Prescott, S.C.and Dunn,G.C (1992), Industrial Microbiology, 4th Edition CBS Publication, New Delhi.
5. Demain, A. I. and Davies, J. E. (1999) Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press, Washington D.C.
6. Glazer and Nikaido (1998) Microbial Biotechnology By WH Freeman & Company, New York.
7. Cruger,W. and Kruger. (2002), Biotechnology –A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi.

MBL 531: GENETIC ENGINEERING **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction: Historical background, Restriction enzymes and modifying enzymes, Restriction mapping, Construction of chimeric DNA- staggered cleavage, Addition of poly dA and dT tails, Blunt end ligation, Gene cloning.

Cloning and Expression Vectors: Vehicles for gene cloning, Plasmids, Bacteriophages, Cosmids and Phagemids as vectors, P1 vectors, F- factor based vectors, Plant and animal viruses as vector, Artificial chromosomes as vectors (YAC, BAC, PAC and MAC vectors), Expression vectors- use of promoters and expression cassettes, Bacculoviruses as expression vectors, Virus expression vectors, Binary and shuttle vectors.

Isolation Sequencing and Synthesis of Genes: Methods of gene isolation, Construction and screening of genomic and cDNA libraries, Chromosome walking, Chromosome jumping, Transposone tagging, Map based cloning, DNA sequencing Techniques (Maxam Gilbert's chemical degradation methods and Sanger's dideoxy chain termination method), Automated DNA sequencing, Organochemical gene synthesis.

Molecular Probes and PCR: Molecular probes**,** Labeling of probes, Radioactive vs Non-radioactive labeling, Uses of molecular probes. Polymerase Chain Reaction- basic principle, Modified PCR (Inverse PCR, Anchored PCR, PCR for mutagenesis, asymmetric PCR, RT PCR, PCR walking), Gene cloning Vs. Polymerase chain reaction, Applications of PCR in biotechnology, Ligase chain reaction.

Molecular Markers and DNA Chip Technology: Molecular Markers- types and applications, Construction of molecular maps (genetic and physical maps), DNA chip Technology & Microarrays (a brief account).

Genomics and Proteomics: Whole genome sequencing and functional genomics (a brief account), Applications of genomics and Proteomics with special reference to Arabidopsis and Rice.

Recommended Books

1. Brown T.A. (2010), Gene Cloning & DNA Analysis, 6nd Edition, Wiley-Blackwell, New York.
2. Watson J.D. (2009), A Passion for DNA: Genes, Genomes & Society, Cold Spring Harbor Laboratory press (CSHL)
3. Glover D.M. and B.D. Hames (1995), DNA cloning: A Practical Approach, IRL Press, Oxford.
4. Primrose (2009), Principles of Gene Manipulation & Genomics, Blackwell's Publishers, 7th Edition.
5. S.M. Kingsman and A.J. Kingsman (1998), Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eucaryotes, Blackwell Scientific Publications, Oxford,.
6. Sambrook J. E.F. Fritech and T. Maniatis (2000), Molecular cloning: A laboratory Manual, Cold Spring Harbor Laboratory Press, New York
7. Hill W.E. (2000), Genetic Engineering: A Primer, Taylor and Francis.

MBL 532: ENZYMOLOGY AND ENZYME TECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction: Historical background, Enzymes vs Chemical catalyst, Enzyme nomenclature and classification, Units of activity, Methods for enzyme assays, Extraction and purification of enzymes, Cofactors and coenzymes.

Enzyme Specificity: Substrate and reaction specificity, Lock & key hypothesis, Induced Fit hypothesis, Wrong way binding hypothesis, Three point attachment hypothesis, Mechanism of action of selected enzymes i.e. chymotrypsin, trypsin, papain, Iysozyme, ribonuclease.

Enzyme Kinetics: Factors affecting velocity of enzyme catalyzed reactions, Michaelis-Menten hypothesis, Transformation of Michaelis- Menten equation and determination of Km and Vmax, Haldane relationship, Multireactant enzymes, Enzymes inhibition i.e., reversible and irreversible inhibition, Competitive, Non-competitive and uncompetitive inhibition.

Regulatory Enzymes: Allosteric enzymes, Sequential and symmetry models, covalently regulated enzymes.

Enzyme Technology: Large scale production of enzymes, Uses of isolated enzymes in food and chemical industries, Therapeutic & medicinal use of enzymes.

Protein Engineering: Concept and Methods, Site directed mutagenesis, Active site mapping, Nature of the active site, Identification of functional groups at the active site, Immobilized enzymes–methods and applications.

Recommended Books:

1. Palmer T. (2001) Enzymes Biochemistry, Biotechnology and Clinical Chemistry, 5th Edition, Howood Publishing Chishester, England.
2. Marangoni A.G. (2003), Enzyme Kinetics-A Modern Approach,
3. Price N.C. and Stevens L. (1999), Fundamentals of Enzymology 3rd Edition Oxford University Press, New York.
4. Dixon M. and Webb E.C. (1979), Enzyme, 3rd Edition, Academic Press, New York.
5. Uhlig H (1998), Industrial Enzymes and Their Applications, Jone Wiley, New York.

MBL 533: MOLECULAR GENETICS **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Inheritance: Historical background, Extra chromosomal inheritance, Inheritance of quantitative traits, Sex linked, Sex influenced and sex limited traits.

Molecular Organizations of Chromosomes: Viral and bacterial chromosomes, Nucleosome and chromatin structure, Structure of centromere and telomere, Euchromatin and heterochromatin, Polytene and lamp brush chromosomes, Genome complexity.

Linkage, Crossing over and Gene mapping in Eukaryotes: Linkage and recombination of gene, Gene mapping by three point test cross, Tetrad analysis, Positive and negative interference, Molecular mechanism of recombination, Post-meiotic segregation, Mapping through somatic cell hybridization.

Mutation: Molecular mechanism of spontaneous mutations, Molecular mechanism of mutations induced by known chemical mutagens, Types of DNA repair, Molecular mechanism of suppression, Somatic mutations.

Gene Concept: Classical concept, Fine structure of the gene, Molecular concept of the gene, Pseudogenes, Overlapping genes, Oncogenes, Repeated genes, Gene amplification.

Bacterial and Viral Genetics: Transformation, Conjugation and Transduction, Molecular mechanism of recombination in bacteria, IS and Tn elements in bacteria, *E.coli* recombination system, Bacterial plasmids, Lytic cascade and lysogenic repression.

Recommended Books:

1. Gardener *et.al*. (2001), Principles of Genetics, 8th Edition, John Wiley, New York
2. Brooker R.J. (1999), Genetics – Analysis and Principles. Addison Wesley Longman Inc. California.
3. Maloy S.R., Cronan Jr. J.R. and Freifelder D. (1994), Microbial Genetics 2nd Edition, Jones and Barlett Publishers, London.
4. Hartl, D.L. (2012), Essential of Genetics, 8th Edition, Jones and Bartlett Publishers, London.
5. Klug, W.S., Cummings, M.R, Spencer C.A and Palladino, M.A. (2012), Concept of Genetics, 10th Edition, Pearson Education, Singapore.
6. Miglani, G.S. (2002), Advanced Genetics, Narosa Publishing House, New Delhi.
7. Snustad, Peter. D and M.J. Summons. (2012) Genetics, 6th Edition, Wiley John & Sons.

MBL 534: INTRODUCTORY BIOINFORMATICS **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction to Bioinformatics: Definition, role, scope and limitation of bioinformatics. Different branches of bioinformatics. Terminologies: Internet browser, software, hardware, database, Network, NicNet, Inflibnet, EMBnet, Operating System, algorithm.

Biological Data Banks: An introduction to data mining and data security, Data warehousing, Data capture, Data Analysis, Data Banks, Gene banks, EMBL nucleotide sequence data bank, Sequence data bank, rRNA data Bank, Peptide data bank., Data Bank similarity searches (BLAST, FASTA, PSI-BLAST algorithms multiple), Structural Data Bank (Cambridge small molecules crystal structure data Bank), Calculation of conformational energy of Bio-molecules.

Biodiversity Data Bases: Organizing Biological SPP information, Data sets in Biodiversity informatics (Spp 2000, Tree of life, ATCC, NCBI Spp analyst collaboration. (ICTV, Animal virus information system) a brief account.

Sequence Analysis: Computational methods and significance, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function. Phylogenetic analysis: Introduction and importance, phylogenetic tree, methods of phylogenetic analysis.

Application of Bioinformatics and Scientific Documentation: Virtual library searching-Medline, Science citation indexes, Electronic Journals, Grants and finding information. Research documentation- preparation of research report, settling up of a laboratory, seminar, paper preparation and presentation. How to write dissertation? Guidelines for writing of literature, materials and method, result, discussion, Presentation and references

Recommended Books:

1. Agarwal, B.L. (2003). Basic Statistics. New Age, New Delhi
2. Gupta, S.P. (2004). Statistical Methods., S. Chand & Sons, New Delhi
3. Dutta, N.K. (2002). Fundamentals of Bio-Statistics., Kanishka Publ., New Delhi
4. Przytycka, T.M. and Sagot, M.F. (2011) Algorithms in Bioinformatics, Springer My Copy, UK
5. Mount, D.W (2002), Bioinformatics: Sequence & Genome Analysis, Cold Spring Harbor Laboratory Press.
6. Lesk, A.M. (2013), Introduction to Bioinformatics, 4thEdn. Oxford University Press, Oxford.
7. Day, R.A. (1996), How to Write and Publish a Scientific Paper, 4th Edition, Cambridge University Press, Cambridge
8. Krane, D.E. (2005), Fundamental Concept of Bioinformatics, Dorling Kindersley Pvt. Ltd.
9. Brown S.M. (2000), A Biologist Guide to Bio-computing and the Internet, A Bio-Techniques Books Publication, Eaton Publishing, USA.

MBL-535 PRINCIPLES OF NANOBIOTECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction & Background: Introduction to Nanotechnology, recent advances and future aspects, Applications of Nanotechnology in different fields- Agriculture, medical applications, Space, Defence, Food processing, Cosmetics etc, Safety, environmental and Societal implications in Nanotechnology.

Instrumentation Techniques for Nanotechnology: Thermal analysis, Scanning Probe Microscopy-principle of operation, instrumentation and probes, XRD (Powder/Single crystal), AFM, Scanning Tunneling Microscopy (STM), Particle size analyzer and Zeta Sizer.

Nanomaterials- Properties, synthesis and applications; Carbon Nanotubes applications in biotechnology and biomedicine; Nanowires- synthesis methods, physical properties, applications, Smart materials.

Micro/Nanofabrication Techniques- MEMS and NEMS**,** Fabrication techniques and applications of Micro and Nanodevices.

Micro fluidics and their Applications: Micro fluidics devices, Material aspects for Micro fluidic devices, active and smart passive Micro fluidics devices, Lab-on-a-chip for Biochemical analysis, Nanomedicine and Drug Delivery, Nanotechnology in Cancer Therapy and Detection.

Books/ References:

1. Kulkarni, S, K. 2009. Nanotechnology- Principles and Practices. Capital Publishing Company.
2. Ajayan, P., Schadler, L.S. & Braun, P.V., 2003. Nanocomposite Science and Technology. Wiley-VCH Verlag.
3. Rao, CNR, Muller,A., Cheetham, A.K., 2004. The Chemistry of Nanomaterials, Volume 1&2, Wiley-VCH Verlag.
4. Balzani, V., Credi, A. & Verturi, M. 2003. Molecular Devices and Machines- A Journey into Nanoworld. Wiley-VCH Verlag.
5. Poole Jr., C.P., Owens, F.J. (2003) "Introduction to Nanotechnology", Wiley.
6. Wolfson, J.R.: 2003, 'Social and Ethical Issues in Nanotechnology: Lessons from Biotechnology and Other High Technologies', *Biotechnology Law Report*, **22**, no 4, 376-96.
7. Bhushan, Bharat. 2004. Handbook of Nanotechnology. Springer.
8. Cao, G. 2004. Nanostructures and Nanomaterials. Imperial College Press.

MBL 542: AGRICULTURAL BIOTECHNOLOGY & IPR **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Agricultural Biotechnology: An overview, Concept of Sustainable Agriculture, Role of biofertilizers and bio-pesticides in sustainable agriculture.

Biological N_2 Fixation: Diazotrophic microorganism, Free living and symbiotic nitrogen fixing microbes, Structure, function and regulation of nitrogenase enzyme, Molecular basis of legume *Rhizobium* symbiosis.

Intellectual Property Rights and Protection: The GATT & TRIPs, Concept of Patents, Copyrights, Trademarks; Patenting – need for patents. Patenting of biological materials, Patenting of life forms−plant, animals, microbes, gene, process and products, Regulatory issues and challenges to food products. Patent process, protection of knowledge, knowledge consortia and databases. Procedure for patent application, International harmonization of patent laws. Implications of intellectual property rights on the commercialization of biotechnology products.

Plant Variety Protection Act: TRIPS and WTO. Plant breeders' rights, and farmers' rights. International conventions on biological diversity.

Agricultural Biotechnology and the Society. Transgenic plants, commercial status and public acceptance. Bio-safety guidelines for research involving GMO's, Benefits and risks, Socio-economic impact and ecological considerations of GMO's. Gene flow. ; National biosafety policies and law, WTO and other international agreements related to biosafety, cross border movement of germplasm; risk management issues – containment, transgenic animals, Aquaculture, Sericulture and transgenic fish.

Regulatory Practices: Financing R&D capital and market outlook, IP, BP, SP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective.

General Principles for the Laboratory and Environmental Biosafety: Health aspects; toxicology, allergenicity, Sources of gene escape, creation of superbugs etc. Quality Assurance and validation**.** Good Manufacturing Practices (GMP) and Good laboratory practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization). Design and layout of sterile product manufacturing unit, (Designing of Microbiology laboratory), Safety in microbiology laboratory.

Recommended Books:

1 Shrivastava P.S., Narula A. and Shrivastava S.S (2004), Plant Biotechnology and Molecular Markers, Anamaya Publisher, New Delhi.
2 Altman A. (1998), Agricultural Biotechnology, Marcel Dekker.
3 Maria *et al.* (2002) Plant Biotechnology and Transgenic Plants, Marcel Dekker.
4 Adrianstater *et.al.* (2004), Plant Biotechnology: The Genetic Manupulation of Plants, Oxford University Press.
5 Brian C. (2004), Legal Aspect of Gene Technology, Thomson Severt Maxwell.
6 Sarad R.P. (2004), The GMO Hand Book: Genetically Modified Animals, Microbes and Plants, Humana Press, New Jersey.
7 Valpuseta V. (2004), Food and Vegetable Biotechnology, CRC Press, New Delhi.

MBL 543: ENVIRONMENTAL BIOTECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Environmental Biotechnology: An overview, Concepts and dynamics of Ecosystem, Food chain and energy flow.

Pollution: Basic concept and issues, Types of pollution, Sources, Chemistry and monitoring of air and water pollution, Methods of pollution measurement.

Concepts of Global Warning and Ozone Depletion, Eco-farming, Organic forming, Green house effect and acid rains, Biotechnological approaches for management (a brief account).

Waste Water Treatment: Microbiology of waste water treatments, Aerobic process, Anaerobic process, Treatment scheme of dairy, distillery, paper, pulp, sugar and antibiotic industries, Solid waste management, Conventional and modern fuels and their environmental impact, Biofuels.

Bioremediation: Concept, Use of bacteria in bioremediation, Bio-pesticide for reducing environmental impact of synthetic pesticides, Biotechnology in forestry and wasteland development, Phyto-remediation, Role of Biosensors for detection of pollutants.

Biodegradation of Xenobiotic Compounds: Organism involved in degradation of chlorinated hydrocarbons, Aromatic compounds, Microbial treatment of oil spills, Treatment of hazardous wastes.

Biomineralization: Organic matter decomposition- C-cycle, N-cycle, S-cycle, Bioconversion of cellulose, Hemicellulose, Lignin (lignocellulose), Bioleaching of ores, Recovery of metals.

Biotechnological Approaches for Preserving Biodiversity: Gene banks, Germ plasma banks and their management.

Recommended Books:

1. Agarwal S.K. (1998), Environmental Biotechnology, APH Publishing Corporation, New Delhi.
2. David S. (1997), Bioremediation Protocols, Humana Press, New Jersey.
3. Stankey E. M. (1997), Environmental Science and Technology, Lewis Publishers, New York.
4. Glazer and Nikaido (1998), Microbial Biotechnology, WH Freeman & Company, New York.
5. Singh A. and Ward O.P. (2004), Biodegradation and Bioremediation: Soil Biology, Springer.

MBL 544: FOOD BIOTECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Food Biotechnology - An overview, importance and scope.

Prokaryotic and Eukaryotic based Products: Fermented meats, Fermented milk products- kefir, koumiss, acidophilus milk, yoghurt, cheese, Fermented cereals and vegetable products - sauerkraut, soy sauce, tempeh, miso, olive, kimchi, Baker's yeast production, Single cell protein, Wine, Beer.

Biotechnology and Food Safety: Impact of Biotechnology on microbial testing of foods- current/traditional methodology and new approaches, Use of gene probes, Recombinant DNA techniques, Bioluminescence, PCR based methods, BAX system, Riboprinter and Real Time PCR based approaches; Safety evaluation of genetically engineered enzyme/novel food products/ transgenic organisms used in food industry.

Natural Control of Microorganisms and Preservation: Bacteriocins of lactic acid bacteria, Applications of bacteriocins in foods, Aflatoxin-production, Control and molecular reduction strategy, Preservation technique (a brief account), Permitted food preservative.

Biotechnology and Food Ingredients: Biogums, Bio-colours, Citric acid, Fumaric acid and malic acids, Sweeteners, Enzymes, Fat substitutes, Natural and modified starches, Fats and oils.

Protein Engineering in Food Technology: Methods, Targets and applications in foods,

Biosensors & Biological monitoring of foods; Waste management and food processing; HACCP and Hurdle Technology.

Recommended Books:

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrant., Reinhold, New York.
4. Hui Y.H. (1995), Food Biotechnology: Micro-organism, VCH Publisher.
5. Doyle M.P. (1997), Food Microbiology: Fundamentals and Frontiers, ASM Press Washington.
6. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.
7. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.

MBL 545: MEDICAL BIOTECHNOLOGY **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Medical Biotechnology: An introduction and scope.

Biopharmaceuticals: Pharmaceutical applications of plant, animal and microbial origin, Relevance of medicinal plant, Therapeutic use of recombinant proteins, Proteins drug manufacturing, Design and engineering of proteins as therapeutic agents, Protein drug delivery.

Gene Therapy: Human diseases targeted, delivery systems and targets, Gene therapy of genetic and acquired diseases, Biosensors and Nano-technology for drug targetting, Future and ethical issues, Genetic counseling.

Diagnostics: Use of nucleic acid probes and antibodies in clinical diagnosis, Mapping of human genome, Molecular diagnosis of genetic diseases.

Diseases: Parkinson's disease, AIDS, Alzheimer's disease, Prion diseases, Molecular basis of cancer, Proto-oncogenes, Oncogenes and tumor suppressor genes.

Drugs Produced through Biotechnology: Humulin, Activase, Humatrope.

Biotechnological Innovations in Vaccines Development: DNA vaccines, Edible Vaccines, Development of malarial vaccine and Tuberculosis vaccine.

Pharmacogenetics: Pharmacogenomics and Personalized medicine - a brief Account.

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Recommended books:

1. Wu S. Pong and Rojanasakul. Y. (1999) Biopharmaceutical Drug Design and Development. Humana Press, New Jersey.
2. Gary Walsh. (1998) Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, New York.
3. Vyas S.P. and Dixit. V.K. (2001). Pharmaceutical Biotechnology, CBS Publisher and Distributor, New Delhi.
4. Gupta P.K. (2004) Molecular Biology and Genetic Engineering, Rastogi Publication Meerut.

MBL 546 GENOMICS & PROTEOMICS **MM: 70**
(Credits: 4+0) **Internal: 30**
Time: 3 Hours

The student shall attempt any five out of eight questions. Each question shall carry equal marks.

Introduction to -omes and –omics

Genomics

Organization of genomes: main features of bacterial and eukaryotic genome organization. Strategies for genome sequencing: Chain termination method, automated sequencing, Next Generation Sequencing, 454 pyrosequencing, Illumina Sequencing, Sequence assembly - Clone contig and shotgun approaches. Model plant genome project and its applications. Locating the genes: ORF scanning, homology searches.

Functional Genomics

Functions analysis of genes, candidate gene identification in crop plants, deciphering the function of gene in plant secondary metabolism, gene inactivation (knock-out, anti-sense and RNA (interference) and gene over expression. Approaches to analyze global gene expression: transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging, Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications

Proteomics

Introduction to proteomics, Analysis of proteome-2D PAGE, Mass Spectrometry based methods for protein identification: De novo sequencing using Mass spectrometric data, use of MALDI TOF and related methods for protein mass determination, protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

Metabolomics

Techniques in metabolomics (HPLC, GC-MS, LC-MS), Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics. Application of metabolomics in elucidating metabolic pathways, metabolic pathways resources: KEGG, Biocarta etc., Nutrigenomics and metabolic health

Books:

1. Leister D. (2005) Plant Functional Genomics , Taylor & Francis
2. Weckwerth W. (2006) Metabolomics :Methods and Protocols , Humana Press
3. Lodish H. Berk A. *et al (2013)* Molecular Cell Biology , W.H. Freeman and Company, New York
4. Primrose S.B. and Twyman R. (2009) Principles of Genome Analysis and Genomics. John Willey and Sons Ltd
5. Dubitzky W., Granzow M., Berrar D.P. (2007) Fundamentals of Data Mining in Genomics and Proteomics. Springer Science- Business Media.
6. Lovric J. (2011) Introducing Proteomics: From concepts to sample separation, mass spectroscopy and data analysis. John Willey and Sons Ltd.
7. Mine Y., Miyashita K., Shahidi F. (2009) Nutrigenomics and Proteomics in Health and Disease: Food Factors and Gene Interaction. Wiley Blackwell