

**SYLLABUS for M. Sc. Molecular Biology and Genetic Engineering**  
**Choice Based Credit System (Semester Pattern)**  
**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**  
**Effective from 2015-2016**

**Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Molecular Biology and Genetic Engineering**

<b>M. Sc. Molecular Biology and Genetic Engineering Semester I</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
Core 1	Paper 1: Cell Biology (Prokaryotes And Eukaryotes)	4	-	4	4	3	80	20	100	40		
Core 2	Paper 2: Basic Biochemistry	4	-	4	4	3	80	20	100	40		
Core 3	Paper 3: Molecular Biology I	4	-	4	4	3	80	20	100	40		
Core 4	Paper 4: Molecular Biology II	4	-	4	4	3	80	20	100	40		
Pract. Core 1 & 2	Practical 1: Based on Course: I & II	-	6	6	4	2-6*	100*	-	100		40	
Pract. Core 3 & 4	Practical 2: Based on Course: III & IV	-	6	6	4	2-6*	100*	-	100		40	
Seminar 1	Seminar 1	2	-	2	1			25	25	10		
<b>TOTAL</b>		<b>18</b>	<b>12</b>	<b>30</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Molecular Biology and Genetic Engineering Semester II</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
Core 5	Paper 5: <b>Biophysical Analytical Techniques</b>	4	-	4	4	3	80	20	100	40		
Core 6	Paper 6: <b>Enzyme Technology &amp; Immunology</b>	4	-	4	4	3	80	20	100	40		
Core 7	Paper 7: <b>IPR, Biosafety, Bioethics And Enterpreneur-ship</b>	4	-	4	4	3	80	20	100	40		
Core 8	Paper 8: <b>Bioinformatics And Data Mining &amp; Lab. Management</b>	4	-	4	4	3	80	20	100	40		
Pract. Core 5 & 6	Practical 3: <b>Based On Course: V &amp; VI</b>	-	6	6	4	2-6*	100*	-	100		40	
Pract. Core 7 & 8	Practical 4: <b>Based On Course: VII &amp; VIII</b>	-	6	6	4	2-6*	100*	-	100		40	
Seminar 2	Seminar 2	2	-	2	1			25	25	10		
	<b>TOTAL</b>	<b>18</b>	<b>12</b>	<b>30</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Molecular Biology and Genetic Engineering Semester III</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
Core 9	Paper 9: <b>Industrial Applications Of Genetic Engineering</b>	4	-	4	4	3	80	20	100	40		
Core 10	Paper 10: <b>Recombinant DNA Technology I</b>	4	-	4	4	3	80	20	100	40		
Core Elective 1	Paper 11: A) <b>Plant Genetic Engineering I</b> OR B) <b>Molecular Diagnostics Methods</b> C) <b>Bioinformatics and Data mining I</b>	4	-	4	4	3	80	20	100	40		
Foundation Course 1	Paper 12: <b>Biostatistics I/ French I/ German I/ Communication Skills I/ Personality Development Through Fine Arts I</b>	4	-	4	4	3	80	20	100	40		
Pract. Core 9 & 10	Practical 5: <b>Based On Course: IX &amp; X</b>	-	6	6	4	2-6*	100*	-	100		40	
Pract. Core Elective 1	Practical 6: <b>A) Based On Course XI</b>	-	6	6	4	2-6*	100*	-	100		40	
Seminar 3	Seminar 3	2	-	2	1			25	25	10		
	<b>TOTAL</b>	<b>18</b>	<b>12</b>	<b>30</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

<b>M. Sc. Molecular Biology and Genetic Engineering Semester IV</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in hrs.		Max. Marks		Total Marks	Minimum Passing Marks		
							External Marks	Internal Ass		Th	Pract	
Core 11	Paper 13: <b>Plant &amp; Animal Genetic Engineering</b>	4	-	4	4	3	80	20	100	40		
Core 12	Paper 14: <b>Recombinant DNA Technology II</b>	4	-	4	4	3	80	20	100	40		
Core Elective 2	Paper 15: A) <b>Plant Genetic Engineering II</b> OR B) <b>Molecular Diagnostics</b> C) <b>Bioinformatics and Data mining II</b>	4	-	4	4	3	80	20	100	40		
Foundation Course 2 (NOTE: Only for students of other M. Sc. Subjects)	Paper 16: <b>Biostatistics II/ French II/ German II/ Communication Skills II/ Personality Development Through Fine Arts II</b>	4	-	4	4	3	80	20	100	40		
Pract. Core 11, 12 & Elective 2	Practical 7: <b>Based On Course: XIII - XV</b>	-	6	6	4	2-6*	100*	-	100		40	
Project	Project	-	6	6	4	2-6*	100*	-	100		40	
Seminar 4	Seminar 4	2	-	2	1			25	25	10		
	<b>TOTAL</b>	<b>18</b>	<b>12</b>	<b>30</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>	

## Course structure of M.Sc. syllabus to be implemented from 2015-16

Course code No.	Title o the course	Credits allotted
<b>Semester I</b>		
<b>25 Credits</b>		
MBGE I (T)	CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)	100marks/ 4 credits
MBGE II (T)	BASIC BIOCHEMISTRY	100marks/ 4 credits
MBGE III (T)	MOLECULAR BIOLOGY I	100marks/ 4 credits
MBGE IV(T)	MOLECULAR BIOLOGY II	100marks/ 4 credits
MBGE I (P)	PRACTICAL I : BASED ON COURSE : I & II	100marks/ 4 credits
MBGE II (P)	PRACTICAL II : BASED ON COURSE : III & IV	100marks/ 4 credits
	SEMINAR	25 marks/ 1credit
<b>Semester II</b>		
<b>25 Credits</b>		
MBGE V (T)	BIOPHYSICAL ANALYTICAL TECHNIQUES	100marks/ 4 credits
MBGE VI (T)	ENZYME TECHNOLOGY & IMMUNOLOGY	100marks/ 4 credits
MBGE VII (T)	IPR, BIOSAFETY, BIOETHICS AND ENTERPRENEURSHIP	100marks/ 4 credits
MBGE VIII (T)	BIOINFORMATICS AND DATA MINING & LAB. MANAGEMENT & SAFETY	100marks/ 4 credits
MBGE III (P)	PRACTICAL III – V & VI	100marks/ 4 credits
MBGR IV (P)	PRACTICAL IV – VII & VIII	100marks/ 4 credits
	SEMINAR	25 marks/ 1credit
<b>Semester III</b>		
<b>25 Credits</b>		
MBGE IX (T)	INDUSTRIAL APPLICATIONS OF GENETIC ENGINEERING	100marks/ 4 credits
MBGE X (T)	RECOMBINANT DNA TECHNOLOGY I	100marks/ 4 credits
MBGE XI (T)	ELECTIVE I	100marks/ 4 credits
MBGE XII (T)	FOUNDATION COURSE I	100marks/ 4 credits
MBGE V (P)	PRACTICAL V: COURSE IX – X	100marks/ 4 credits
MBGE VI (P)	PRACTICAL VI : COURSE XI	100marks/ 4 credits
	SEMINAR	25 marks/ 1credit
<b>Semester IV</b>		
<b>25Credits</b>		
MBGE XIII (T)	PLANT & ANIMAL GENETIC ENGINEERING	100marks/ 4 credits
MBGE XIV (T)	RECOMBINANT DNA TECHNOLOGY II	100marks/ 4 credits
MBGE XV (T)	ELECTIVE II	100marks/ 4 credits
MBGE XVI (T)	FOUNDATION COURSE II	100marks/ 4 credits
MBGE VII (P)	PRACTICAL VII: COURSE XIII – XV	100marks/ 4 credits
MBGE VIII (P)	PROJECT	100marks/ 4 credits
	SEMINAR	5 marks/ 1credit

## M.Sc. Molecular Biology and Genetic Engineering

### Semester I

**Course code/name:**

**MBGE I (T) : CELL BIOLOGY (PROKARYOTES AND EUKARYOTES) (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1:** **15L**

Ultra-structure of prokaryotic and eukaryotic (plant & animal) cells  
 Plasma membrane, cell wall their structural organization.  
 Cellular organelles –: Mitochondria, chloroplast; Nucleus, Golgi apparatus.  
 other organelles and their organization,  
 Transport of nutrients, ions and macromolecules across membranes.

**Module 2:** **15L**

Cell cycle- Different phases of cell cycle, Controls and Check points, cyclins and cdks – types and their role. Molecular, events and model systems, Apoptosis, Cytoskeleton and Cell motility  
 Cell communication: General principles of signaling – endocrine, exocrine & synaptic signaling, surface and intracellular receptors, G proteins and generation of secondary messenger, mode of action of cAMP and  $Ca^{++}$  calmodulin, Target cell adaptation, cellular responses to environmental signals in plants and animals - mechanisms of signal transduction

**Module 3:** **15L**

General characters of microorganisms: Historical developments in Microbial Biotechnology, The concept of Microbial origin of Fermentation, Microscopy and microscopic observation of Microorganisms, Structure and general characters of Bacteria, Archaea, Fungi and Algae, Classification of Bacteria, Fungi and Algae

**Module 4:**

Viruses: General characters of viruses, Morphology and structure of viruses, chemical composition of viruses, Nomenclature and classification of viruses (8<sup>th</sup> report of ICTV). Genetic classification of viruses, Life cycle of T4 phage, Lambda ( $\lambda$ ) phage, Retroviruses (HIV), TMV, and SV40, Methods of cultivation of viruses, Importance of viruses in biotechnology. **15 L**

Practicals :

1. Morphological study of mitotic & meiotic chromosomes
2. Cell fractionation
3. Sterilization methods (Autoclaving, Hot air oven, radiation and filtration)
4. Preparation of routine microbiological media
5. Microscopic observation, Staining and identification of bacteria, fungi and algae
6. Culturing & preservation of microorganisms: Tube culture (slant/broth), plate culture, flask culture & preservation
7. Isolation of bacteria, fungi, algae and bacteriophages
8. Measurement of microbial growth (Viable count and turbidometry)
9. Study for bacterial growth curve

**Books Recommended:**

1. Cell & Molecular Biology . E.D.D De Robertis & E.M.F De Robertis, waverly publication.
2. Molecular Biology of the cell. Alberts, B; Bray, D, Lewis, J., Raff, M., Roberts, K and Watson, J.D. 1991 3<sup>rd</sup> edn. Garland publishers, Oxford
3. Microbiology - M. J. Pelzar, E. S. N. Cfan and N.R. Kreig, McGraw Hill Publ.
4. Introductory Microbiology - J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge Univ. Press.
5. General Microbiology - H.G. Schlegel Cambridge University Press.
6. Microbiology – concepts and Application. John Wiley and Sons, New York, 1988.
7. Microbiology- L. M. Prescott, J. P. Harley, D. A. Klein; McGraw Hills 5<sup>th</sup>edn. (2005)
8. General Microbiology – R. Y. Stanier, J. L. Ingraham, M. L. Wheelis, Page R Painter;
9. MacMillan Press ltd; 5<sup>th</sup> edn (1986)
10. Microbiology, Tortora, Funke and Chase, Benzamin & Cummings
11. Manual of microbiology: Tools and Techniques 2<sup>nd</sup> Edn., Kanika Sharma, Ane Books Ltd.

**Course code/name: MBGE II (T): BASIC BIOCHEMISTRY**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1: 15L**

Carbohydrates –Brief introduction (Structure & classification of simple sugars and Polysaccharides)

Carbohydrate Metabolism Embden, Meyerhoff and Parnass EMP)

Pathway & its regulation, Krebs cycle and its regulation, Krebs Kornberg Cycle, glycogenolysis, glycogenesis, gluconeogenesis Pentose Phosphate pathway and its regulation, Glucuronate-Xylulose pathway, Oxidative phosphorylation.

**Module 2: 15L**

Amino acids and Proteins – classification, chemical reactions and physical properties, criteria of homogeneity, end group analysis, 3 D structure of proteins, hierarchy in structure, 1<sup>o</sup>, 2<sup>o</sup>, 3<sup>o</sup>, quaternary structure, domain structure, Structure of the Peptide bond, Ramachandran plot, Biosynthesis and degradation of individual amino acids, Urea Cycle.

**Module 3: 15L**

Lipids–classification, physicochemical properties, structure and functions

Lipid Metabolism: Beta Oxidation of Fatty acids, fatty acid biosynthesis

Biosynthesis of simple fat, phospholipids, cholesterol, sulfolipids and their possible regulation.

**Module 4: 15L**

Structure and functions of Heme and chlorophyll and antibiotics (penicillin, streptomycin, chloromphenical)

Hormones: Types (Plant and animal), chemistry, physiological role and Regulation. Endocrinopathies

Vitamins – Types (water and fat soluble), chemistry, sources, RDA, physiological role, deficiency manifestations.

**Practicals:**

1. Quantitative determination of proteins by Biuret and Lowry's methods or Ninhydrin test
2. Quantitative Estimation of lipids & / Fatty acids profiling in various plant materials by GC
3. Determination of acid number, iodine value in fats.
4. Study of activity of decarboxylase enzyme
5. Determination of sugars by anthrone method
6. Isolation of plant pigments

**Books Recommended:**

1. Biochemistry-Stryer, Berg, 6th Edition, W. H. Freeman and Co.,2007.
2. Lehninger' Principles of biochemistry-Nelson, Cox, 4th Edn., W.H.Freeman and Co.,2005.
3. Biochemistry –Voet, D.; Voet, J.; 3rd Edn. John Wiley and sonsInc., 2004.



4. Harper's Principles of Biochemistry-Murray, Gardener, Mayes, Rodwell, 27th Edn.
5. Biochemistry-Rawn, D., Pamina publications, 2004
6. Textbook of biochemistry-West, Todd, Mason, VanBrogen, 4<sup>th</sup> edn. Oxford & IBH, 1966.
7. Biochemistry- Champe, P., 3<sup>rd</sup> Edn., Lippincott Williams & Wilkins, 2005.
8. Biochemistry-Zubay, G., 3<sup>rd</sup> Edn., Pearson Education P.Ltd, 2003
9. Enzymes- Palmer, T. , Affiliated East West Press Pvt. Ltd., 2004
10. Cell and Molecular biology, Gerald Karp, John Wiley and sons Inc.
11. Introductory Practical Biochemistry by Sawhney and Randhir Singh., Narora Pub. House.
12. Biochemical method. 2<sup>nd</sup> Edition, Sadasivam *et al.* New Age International.
13. Practical Biochemistry 3<sup>rd</sup> Edition, David Plummer. Tata McGraw Hill.
14. Short Protocols in cell Biology. Borifacino ehale, Jon Wiley Publishing House.
15. Das, H. K. Text book of Biotechnology, wiley dream tech India pvt ltd. 2005.

**Course code/name: MBGE III (T): MOLECULAR BIOLOGY I  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1: 15L**

Gene: gene concept, unit of function, replication, recombination and mutation  
 Fine structure of gene: bar locus, complex loci, rII locus and complementation analysis  
 Gene function: one gene/one enzyme hypothesis, pathways of gene action.  
 Genome organization: Genome organization in prokaryotes and eukaryotes  
 special features of eukaryotic gene structure and organization, genome organization  
 in mitochondria and chloroplast,

**Module 2: 15L**

DNA content and C-value paradox, methods to measure DNA content variation  
 Various types of DNA sequences (simple sequences, repetitive sequences, nonsense  
 sequences, tandem gene clusters, satellites)  
 DNA Damage and repair: Spontaneous and Induced mutations – Physical and Chemical  
 mutagenesis, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift,  
 mis-sense and non-sense mutations, Photo-reactivation, Excision Repair, Mismatch  
 Repair, Post-replication Repair, SOS Repair

**Module 3: 15L**

Recombination in bacteria and viruses :Transformation: Competence factors,  
 mechanism of transformation, mapping genes by transformation,  
 Conjugation: Structure of F plasmid, Mechanism of transfer of F plasmid, Hfr,  
 mechanism of integration of F plasmid into bacterial chromosome, circularization  
 of chromosome, Conjugation mapping – different methods.  
 Transduction & Gene mapping.  
 Genome Rearrangements and Recombination: Complete and Segmental  
 Duplication of Genomes, Insertion, Deletion and Translocation of Sequences,  
 Process of Rearrangements, Homologous Recombination – rec Pathways, Site  
 specific Recombination, Non-homologous End Joining, Transposon and Repeats  
 mediated Rearrangements, Molecular mechanisms of Gene Conversion.

**Module 4: 15L**

Genetics of *Caenorhabditis alligans*, Yeast, *Drosophila*, and Human:  
*Caenorhabditis alligans* gene regulation and silencing  
 Yeast molecular genetics: genome - mutants and genetic screens  
 genetic redundancy – cell type determination – cell cycle regulation of  
 mitotic events – genetic interaction: two hybrid systems – gal pathway,  
 gene regulation

*Drosophila* molecular genetics: genome - developmental genetics – mutants and genetic screens – P element biology – directed expression in *Drosophila* – construction and use of genetic mosaics.

Human Genetics: inborn errors of metabolism, X and Y-linked genes, Viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins, Biosynthesis of glycogen in animals and its regulation.

### **Practicals :**

1. Isolation, and study of polytene chromosome in *Drosophila*
2. Study of structure chromosomal rearrangements
3. Effect of mutagenes on physiology and genetic material of suitable organism
4. Bacterial conjugation
5. Bacterial transduction
6. Bacterial transposons

### **Recommended books:**

1. Molecular Cell Biology, 3<sup>rd</sup> edn. (1995) W.H.H. Lodish, A. Berk, and C. A. Kaiser, Freeman & Co Ltd.
2. Molecular Biology of the Gene, 5<sup>th</sup> edn. (2004) J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick, Pearson Education Inc.
3. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York
4. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA
5. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
6. Kleinsmith, L. J. and Kish, V. M. 1995 Principles of Cell and Molecular Biology (2<sup>nd</sup> Edn.) Harper Collins Coll. Publisher, New York, USA.
7. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3<sup>rd</sup> Edi.) Jones and Bartiet Pub. Inc., London
8. Wolf, S. L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA

**Course code/name:****MBGE IV (T) : MOLECULAR BIOLOGY II  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1: 15L**

Biosynthesis of purines and pyrimidine nucleotides from ribose including regulation, salvage pathways

Structure, types and function of nucleic acids (DNA & RNA)

DNA Replication: Prokaryotic and eukaryotic DNA replication mechanism, enzymes and accessory proteins involved in DNA replication.

**Module 2: 15L**

Protein Synthesis: Prokaryotic transcription, eukaryotic transcription, RNA polymerases, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5' Cap formation, Transcription termination, 3'end processing and polyadenylation, nuclear export of mRNA, mRNA stability

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs, group I and group II introns, *Cis*- and *Trans*- splicing reactions, tRNA splicing, alternate splicing.

Genetic Code, Prokaryotic and eukaryotic translation - Synthesis of aminoacyl tRNA, aminoacyl synthetases, Mechanism of initiation, elongation and termination, Regulation of translation, co- and post-translational modifications of proteins, mobility shift assay, Dipeptide assay, Tripeptide assay, *In vitro* translation.

**Module 3: 15L**

Regulation of gene expression: Induction and repression, operon theory, lac operon, trp operon, ara operon, attenuation, positive and negative control, catabolite repression, regulation of transcription by cAMP and CRP, and guanosine tetraphosphate, *Run off* transcription. Britten-Davidson and Mated models of gene regulation, regulation of gene expression in eukaryotes.

**Module 4: 15L**

RNA interference: RNA silencing in cytoplasm and genome level, ds RNA mediated RNA interference (Si RNA and micro RNA), RNAi pathways (si RNA and mi RNA pathway), Functions and RNA interference (Protection against viral infections, securing genome stability, repression of protein synthesis and regulation, chromatin condensation and transcriptional suppression, RNAi as an experimental tool for suppressing gene expression, potential therapeutic use of RNAi, Molecular mechanism of antisense molecules.

Biochemistry of ribozyme; hammer – head, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

Interacellular protein transport: synthesis of secretory and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Protein targeting and protein localization signals, role of golgi

**Practicals:**

1. Study of expression of inducible genes
2. Regulation of gene expression
3. Isolation of total cellular RNA from suitable organisms (yeast, plant, animal cells)
4. Isolation of total m RNA from suitable organisms

**Recommended books:**

1. Molecular Biology of the Gene - J. D. Watson, N. H. Hopkins, J. W. Robertis, A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California - 1988
2. Genes VII. - Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
3. Molecular Biology – Freifelder, D, Narosa Publishing house New York, Delhi, 1987.
4. Molecular Cell Biology - Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel 4th edn. American Scientific Books. W.H. Freeman, New York (2000).
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology - Brown, 3rd edition.
7. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation.

**Practicals (10 Credits):**

MBGE I (P) : Practical I: (5 credits) Based on Course : I & II  
MBGE II (P): Practical II: (5 credits) Based on Course : III & IV

## Semester II

**Course code/name:**

**MBGE V (T): BIOPHYSICAL ANALYTICAL TECHNIQUES  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module I:** **15L**

Centrifugation: Differential centrifugation, Density gradient centrifugation, Ultracentrifugation.

Characterization of macromolecules using X-ray diffraction analysis

Mass spectrometry: Theory, Instrumentation and applications

Various hyphenated techniques: Theory and applications of LC-MS, GC-MS, HPTLC-MS, etc.

**Module II:** **15L**

Various types of Chromatographic Techniques:

TLC, HPTLC, GC and Column chromatography (Partition, Adsorption, Ion-exchange chromatography, Gel filtration chromatography, affinity chromatography, reverse phase chromatography, HPLC)

Electrophoresis:

Principles, Agarose, Starch, PAGE including SDS-PAGE, Pulsed Field Gel Electrophoresis,

Isoelectric focusing, Isotachopheresis, gel -documentation

**Module III:** **15L**

Spectrophotometric Techniques:

Fundamentals of Absorption and Emission spectrophotometric techniques

Theory, instrumentation & application of visible, UV, IR, AAS, NMR, ESR, CD, ORD, fluorescence and Raman spectrophotometric techniques.

**Module IV:** **15L**

Microscopy, phase contrast, fluorescence, Electron, confocal, scanning

tunneling and polarization microscopy; Cell sorter and its applications

Radio isotope technique : Radioactive decay constant, half life of an isotope,

Detection and measurement of radio activity, Geiger Muller counters,

scintillation counting, auto radiography and RIA , Application of isotopes

in biological studies.

**Practicals:**

1. Study of Laboratory Instruments :  
Electrophoresis unit, Autoclave, Water bath, Hot air oven, Laminar air flow, Light microscope, Haemocytometer and cell number determination, pH meter, Centrifuge, Spectrophotometer, HPCL / GC , balance, Pipettes
2. Preparation of various Buffers and to check its pH, preparation of solution of given Molarity, Normality and its Standardization by titration methods.
3. Separation and Identification of Biomolecules by TLC,/ gel filtration/ ion exchange/affinity chromatography
4. Separation and identification of biochemical compounds by HPLC
5. Separation of biomolecules by centrifugation
6. Study of cell viability by fluorescence microscope
7. Separation of DNA and Proteins by Electrophoresis
8. Quantification of biocompounds by spectrophotometer
9. Gel documentation of DNA, RNA and proteins

**RECOMMENDED BOOKS:**

- 1) A textbook of biophysics, R. N. Roy, New Central Publication, 1st edition.
- 2) Elementary biophysics. P. K. Srivastava Narosa Publication, 1st edition.
- 3) Biophysical Chemistry. Upadhyay & Nath, Himalaya publications 3rd edition.
- 4) Biological thermodynamics. Donald T. Haynie, Cambridge University Press, 1st edition.
- 5) Principles of Physical Biochemistry. Kensl E. van Holde, W. Curtis Johnson, P. Shing Ho, Pearson Prentice Hall, 2nd edition.
- 6) Biophysical chemistry Part I: The conformation of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition
- 7) Biophysical chemistry Part III: The behavior of biological macromolecules. Cantor and Schimmel, W. H. Freeman and Company, 10th edition
- 8) Biochemistry of nucleic acids. 1992. Adams *et. al.* Chapman and Hall.
- 9) Crystallography made crystal clear. 1993. G. Rhodes. Academic Press.
- 10) Principles of physical biochemistry. 1998. Van Holde *et. Al.* Prentice Hall.
- 11) Principles and Techniques of Biochemistry and Molecular Biology, 6<sup>th</sup> Ed. Wilson Keith and Walker John (2005) Cambridge University Press, NewYork.

**Course code/name:****MBGE VI (T) : Enzyme technology and Immunology  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1:****15L**

Enzymes : classification and nomenclature, isolation purification of enzymes, localization of enzymes, concept of apo-enzyme and holo-enzyme, isoenzymes in health and diseases. Relevance of structure function relationship of enzymes, Determination of active site of an enzyme, Mechanism of enzyme action through covalent catalysis, acid-base catalysis and or proximity induced catalysis.

Kinetics: Michaelis- Menten equation, Lineweaver-Burke plot, Eadie-Hofstee plot, Competitive, uncompetitive and non-competitive inhibition

**Module 2:****15L**

Concept of ribozyme and catalytic antibodies in enzyme technology. Multienzyme complex and its role in metabolic regulation( Fatty acid synthase complex and Pyruvate dehydrogenase complex), Allosteric enzymes as a regulatory tool in metabolism with its general features and kinetics- ATCase

Mechanism of catalysis by Lysozyme, Ribonuclease and Carboxypeptidase

**Module 3:****15L**

Introduction: Immunity, innate response, Immune system, Cells and organs of Immune system

Innate immunity, Antigens- Factors affecting antigenicity, Antibodies-Structure and isotypes

Antigen presentation by MHC class I and II, Humoral and cell mediated immunity-TCR, BCR and signal transduction , Complement system

Antigen antibody reactions: Kinetics, specificity, Immunochemical techniques- Precipitation, agglutination, Complement fixation, Immunodiffusion, RIA, ELISA

**Module 4:****15L**

Immunological tolerance, Autoimmunity, Hypersensitivity and Immune responses to pathogens (Virus, bacteria, fungi, parasites), Transplantation and Tumor immunology, Vaccinology, Antibody therapy, Monoclonal Antibodies and Superantigens

**Practicals:**



1. Study of Factors affecting Enzyme activity: Cofactors, inhibitors, substrate concentration, temperature and pH
2. Study of Isocitrate dehydrogenase in yeast- An allosteric enzyme
3. Separation of isoenzymes by native PAGE.
4. Electrophoresis of serum proteins by SDS-PAGE
5. Methods for immobilization of enzymes
6. Sandwich Enzyme-Linked Immuno-sorbent Assay (ELISA) to test antigen concentration
7. Radial immunodiffusion Assay for finding the concentration of Antigen and Ouchterlony Double Diffusion assay to compare the two antigens against an antibody.
8. Latex agglutination test for detection of antigen and antibody
9. Study of Immuno-histochemistry test for localizing antigen
10. Collection of human blood, separation of mononuclear cells and counting of viable cells

#### **Recommended Books for Enzymology:**

1. Balasubramanian, D., Bryce, C., Dharmalingam, K., Green, J. and Jayaraman, K. (1999) Concepts in Biotechnology, University Press, India.
2. Colin Ratledge and Bjorn Kristiansen (2001) Basic Biotechnology, Cambridge University Press, UK.
3. Joshi, V. K., Ashok Pandey. (1999) Biotechnology, Food fermentation (Microbiology, Biochemistry and Technology) Vol. I & II Basic, Educational Publishers and Distributors, Ernakulam.
4. Whitaker Stanbury (1998) The principles of fermentation technology, Butterworth Heineman, U.K.
5. Vedpal, S. Malik, Padma Sridhar, Sharma, M. C. and Polasa, H. (1992) Industrial Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

#### **Recommended Books for Immunology:**

1. Immunology – R. A. Goldsby, T. J. Kindt, B. A. Osborne, Janis Kuby; W.H. Freeman & Company, 5<sup>th</sup> edn. (2003)
2. Essential Immunology - Ivan M. Roitt, Peter J. Delves Blackwell Science Ltd., 10<sup>th</sup> Edn. (2001)
3. An Introduction to Immunology - C.V. Rao; Narosa Publishing House, 1st Edn. (2004)
4. Instant Notes in Immunology - P.M. Lydyard, A. Whelan, M.W. Fanger BIOS Scientific Publ. Ltd, 1<sup>st</sup> Edn. (2003)
5. Immunology: Introductory textbook; Nandini Shetty, New Age International pvt. Ltd. 1st Edn. (2003).
6. A Handbook of Practical and clinical Immunology - Short protocols in Immunology Vol 1. Talwar and S. K. Gupte, 2<sup>nd</sup> Edn. (2003) , Coliganetal John Wiley.
7. Immunology II Edn., Kuby, J. W. H., Freeman and Company, New York.
8. Immunology - Klaus D. Elgert , Wiley-Liss. NY.
9. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edn. (5 volumes)
10. Topley and Wilson's, Edward Arnold, London. The Experimental Foundations of Modern Immunology - Clark, V.R., John Willey and Sons, Incl.
11. Fundamental Immunology – W. E. Paul, Raven Press, New York.
12. Fundamentals of Immunology - R. M. Coleman, M. F. Lombord and R. E. Sicard 2<sup>nd</sup> edn.
13. C. Brown publishers.
14. Immunology - D. M. Weir and J. Steward 7<sup>th</sup> Edn.

**Course code/name:****MBGE VII (T) : IPR, BIOSAFETY, BIOETHICS AND ENTERPRENEURSHIP****(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1:**

Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting 15L  
 General agreement on trade and tariffs Indian sui-generis system for animal variety and farmer's rights protection act, PVFRA , WTO with reference to biotechnological affairs, TRIPs.  
 General Introduction: Patent claims, the legal decision – making process, ownership of tangible and intellectual property, Patent litigation.  
 Basic Requirements of Patentability: Patentable subject matter, novelty and the public domain, non obviousness .  
 Special issues in Biotechnology Patents: Disclosure requirements, Collaborative research, Competitive research.  
 Plant biotechnology Indian patents and Foreign patents, Plant variety protection act, The strategy of protecting plants.  
 Recent Developments in Patent System and Patentability of biotechnological inventions.  
 IPR issues in Indian Context Role of patent in pharmaceutical industry, computer related innovations. Case studies Rice, Turmeric, Margo, etc. and challenges ahead.

**Module 2:**

Entrepreneurship 15L  
 Concept, definition, structure and theories of entrepreneurship  
 Types of start-ups  
 Types of entrepreneurship, environment, process of entrepreneurial development, Entrepreneurial culture, entrepreneurial leadership,  
 Product planning and development  
 Project management  
 Search for business idea  
 Concept of projects  
 Project identification, formulation  
 Design and network analysis  
 Project report and project appraisal

**Module 3:**

Ethical Issues: Introduction – causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains 15L  
 Professional ethics – professional conduct  
 Ethical decision making, ethical dilemmas  
 Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory acModulation  
 Bioethics & Society (Indian context): Ethical issues on New Genetics – Human Genome Project – Gene therapy – Genetic screening – Experimentation with human subjects -National Practice of health care – Public & Private medical practice – National resource allocations.

**Module4:**

Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution 15L  
 Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad

Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance.

Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton).

Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc.

International dimensions in biosafety: Cartagena protocol on biosafety, bioterrorism and convention on biological weapons

### **Practicals:**

Report submission on Biosafety assessments, transgenic crop, Bioethics & Society, Preparation of patent application, Seeking permission to work on GM crops, IGMORIS, application for strip trials, application for BRL I and II (case studies),

### **Recommended Books :**

Intellectual Property Rights - Brigitte Anderson, Edward Elgar Publishing

Intellectual Property Rights and the Life Sciences Industries - Graham Duffield, Ashgate Pub.

WIPO Intellectual Property Handbook

Intellectual Property Rights - William Rodelph Cornish, David Clewelyn

Entrepreneurship: New Venture Creation - David H. Holt

Biotechnology-The science and the business Moses V, Cape RE, 2<sup>nd</sup> edn., CRC press 2000.

Patterns of Entrepreneurship - Jack M. Kaplan

Entrepreneurship and Small Business Management: C. B. Gupta, S. S. Khanka, Sultan Chand

Indian Patents Law, Mittal, D.P. (1999) Taxmann, Allied Services (p) Ltd.

Handbook of Indian Patent Law and Practice - Subbaram, N. R., S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

**Websites:** 1) Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com](http://www.iptoday.com)

2) Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000.

[www.ipmatters.net/features/000707\\_gibbs.html](http://www.ipmatters.net/features/000707_gibbs.html)

**Course code/name:****MBGE VIII (T) : BIOINFORMATICS AND DATA MINING & LABORATORY MANAGEMENT AND SAFETY****(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1:****15L**

Introduction to Bioinformatics, Importance of the subject in handling biological data–  
Bioinformatics data – nucleic acid sequence, protein sequence, protein structure,  
genomic, proteomic and metabolomic information

Bioinformatics databases – types (Nucleic acid sequence databases: GenBank,  
EMBL, DDBJ; Protein databases: UniProt, SWISS-PROT, TrEMBL, PIR\_PSD ;  
Genome Databases (NCBI, EBI, TIGR, SANGER ), file formats (genbank, fasta,  
gcg, msf, nbrfpir etc. ), access tools with examples

Bioinformatics tools and Resources – free online tools, downloadable free tools,  
software packages, internet, Bioinformatics books and Journals, Bioinformatics  
web- portals

**Module 2:****15L**

Basic concepts of sequence, similarity, identity and homology, definitions of  
homologues, orthologues, paralogues,

Sequence analysis methods in bioinformatics,

Dot-matrix comparison (Pairwise alignment algorithms – Needleman and Wunch algorithm,

Smith Watermann algorithm , Scoring matrices: basic concept of a scoring matrix,

Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series)

Basics of sequence alignment - match, mismatch, gaps, scoring alignments,

gap penalty, protein vs DNA alignment

Multiple sequence alignment algorithms – progressive alignment algorithms,

heuristic algorithms - Blast algorithm, FASTA algorithm.

Molecular Phylogenetics,

Multiple sequence alignment based databases searching: Consensus sequence,  
patterns, profiles.

**Module 3:****15L**

Standards for analysis & Quality management

Basic standards, Need of standards in analytical sciences

Analytical standards- Reference materials/controls (positive & negative), High purity  
substances, certified reference material

Working or secondary standards, matrix effect in standards

Biological standards , Biochemical standards , Microbial cell lines and standards

Quality Management - Quality system, Inspection and testing, Handling, Storage,

Packaging, Preservation of the material, Internal quality audits, Quality assurance.

Laboratory Accreditation, Accreditation Boards, NABL guidelines for Accreditation in India

Proficiency testing system, Internal quality control, Inter and intra laboratory testing programmes , Advantages of  
Accreditation.

**Module 4:****15L**

Laboratory Management & Safety :

Administration of Laboratories, Laboratory design, Security measures, Laboratory

Information management system (LIMS)

Laboratory safety – Safety policies

Operation Hazardous compound - chemicals, solvents, poisons, isotopes, explosives and Biological strains (Bacterial, fungal etc)

Storage of hazardous material and disposal of biological and radioisotope wastes

### Practicals:

1. Training on usage of various bioinformatics tools (online), software packages, web portals
2. Online searching of various databases (nucleic acids, proteins, organisms) using diff. Bioinformatics tools (FASTA, BLAST)
3. To find the sequences of a given protein in SWISS-Prot, Uni-Prot
4. To search biochemical pathway involved for a given trait.
5. To work out the sequence from given autoradiogram and to identify it from Gene Bank by BLAST method.
6. To generate Pair-wise and multiple sequence alignment of a given organisms
7. To generate phylogenetic tree using given sequences.
8. To predict a protein from given sequence by using online tools from NCBI.
9. To design PCR primers for isolation of given gene and to clone it in the given vector.
10. To generate the map of given plasmid and find the Reporter gene.
11. To predict N-Glycosylation site in the given protein sequence.
12. Translate the given gene sequence.
13. To find out ORF in the given gene sequence.
14. To find out the promoter in the given sequence.
15. Compositional analysis of DNA – GC/AT content - codon usage - codon bias

### Recommended Books:

1. Mount W. 2004 Bioinformatics and sequence genome analysis 2<sup>nd</sup> Edi. CBS Pub. New Delhi
2. Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter,
3. Peter c2002 Molecular Biology of the Cell New York and London: Garland Science.
4. McEntyre, J.; Ostell, J., editors Bethesda (MD) The NCBI Handbook: National Library of Medicine (US), NCBI; 2002-2005
5. Bergman, N.H Comparative Genomics\_Humana Press Inc., Part of Springer Science+Business Media; 2007
6. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
7. Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics
8. Brown T. A., Genomes, 3rd Edition. Garland Science 2006
9. Campbell A. M. & Heyer, L. J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007.
10. Primrose, S. & Twyman, R., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
11. Cynthia Gibas & Per Jambeck (2001) Developing Bioinformatics Computer Skills: -Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai
12. Des Higgins & Willie Taylor (2000) Bioinformatics: Sequence, structure and databanks. Oxford University Press
13. H. H. Rashidi & L. K. Buehler (2002) Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London
14. Misener, S. and Krawetz, S.A. (2000). Bioinformatics Methods and Protocols. Human Press, Totowa, New Jersey.
15. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
16. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals
17. Orpita Bosu & Simmeinder Kaur Thukral Bioinformatics –Databases, Tools and Algorithms Oxford Univ press, New Delhi.

18. Shuba Gopal, Rhys Price Jones, Paul Tymann and Anne Haake Bioinformatics –with fundaments of Genomics and Proteomics Tata Mc Graw Hill Education Pvt Ltd., New Delhi
19. Rastogi, S.C., Namita Mendiratta and Parag Rastogi Bioinformatics Methods and Applications 3<sup>rd</sup> Edi., PHI Learning Pvt. Ltd..

[www.wormbook.org](http://www.wormbook.org)

[www.ceolas.org/VL/mo/](http://www.ceolas.org/VL/mo/)

[www.nih.gov/science/models/arabidopsis/index.html](http://www.nih.gov/science/models/arabidopsis/index.html)

### **Practicals (10 credits)**

MBGE III (P) Practical III – V& VI ( 5 Credits)

MBGR IV (P) Practical IV – VII & VIII ( 5 Credits)

## SEMESTER III

**Course code/name:**

**MBGE IX (T) : Industrial Applications of Genetic Engineering  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1:** **15L**

Introduction to Bioprocess Engineering, Bioreactors. Types of fermentation processes: Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.), Measurement and control of bioprocess parameters. Downstream Processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization.

**Module 2:** **15L**

Industrial Production of Chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein. Whole cell Immobilization and their Industrial Applications. Microbial applications for mineral beneficiation (bioleaching) and oil recovery.

**Module 3:** **15L**

Environment: Basic concepts and global issues. Environmental Pollution: its types, measurement and control measures. Physical, chemical, biological and advance treatment processes of waste water treatment. Treatment schemes for waste water of pulp & paper mill, dairy, distillery, and tannery. Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

**Module 4:** **15L**

Environmental Biotechnology, Environment-friendly technologies- bioleaching. Bioremediation-microbial, phycoremediation, mycoremediation, phytoremediation, its mechanism, techniques & applications for reclamation of contaminated soils, waste land, water bodies and industrial effluents, advantages, disadvantages of bioremediation technology. Solid waste management (landfills, vermiculture, biotechnologies for plastic & e-waste management). Biopesticides and integrated pest management (IPM).

**Practicals:**

1. Isolation of Industrially important microorganisms from microbial processes
2. Development of laboratory scale bioreactors: know how
3. Recovery of product from fermentation broth and optimization of parameters
4. Extraction of protein from a crude bioprocess homogenate using Aqueous Two Phase System (ATPS)
5. Comparative studies of ethanol production using different substrates
6. Production of microbial biofertilizers and biopesticides
7. Determination of Biology Oxygen demand (BOD) of sewage sample
8. Determination of Chemical Oxygen demand (COD) of sewage sample
9. Testing for microbiological quality of potable water (Coli form test)
10. Microbial degradation of organic matter
11. Testing for microbial biodegradation of pesticides

**Recommended Books:**

1. P. T. Kalaichelvan and I. Arul Pandi 2007 Bioprocess Technology, MJP Pub. , Chennai.
2. Alexander, M. 1994 Biodegradation and Bioremediation, Acad. Press, San Diego, CA
3. Bailey, J. E. and Ollis, D. F. 1987 Biochemical Engineering Fundamentals 2<sup>nd</sup> Edn. Mc Graw Hill, New Delhi.
4. Malik, V. S. and Sridhar, P. 1992 Industrial Biotechnology, Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
5. Yoshida, T. and Tanner, R. D. 1993 Bioproducts and Bioprocess Vol. 2 Springer-Verlag, Berlin
6. Casida, L. E. 1994 Industrial Microbiology, Wiley Eastern Ltd., New Delhi
7. Gadd, G. M. 2001 Fungi in Bioremediation, Cambridge Univ. Press, U.K.
8. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
9. Tortora, G. J., Fernke, B. R. and Case, C. L. (2001) Microbiology – An Introduction, Benjamin Cummings.
10. Standbary P. F. A. Whitaker and Hall. 1995, Principles of Fermentation Technology. Pergaman. McNeul and Harvey. 1990.
11. Michael Shiler and Kargi, Bioprocess Engineering.
12. Mukhopadhaya S.N. ( 2001 ) Process Biotechnology Fundamentals. Viva Books Pvt. Ltd. New Delhi.
13. E.M.T. EL` Mansi & C.F.A. Bryce Fermentation Technology and Biotechnology
14. Comprehensive Biotechnology (All volumes) Ed. Young, M.Y. Pub: Pergmon Press
15. Environmental Microbiology. Grant, WD and Long PE. Publ: Blakie, Glasgow
16. Biotreatment systems Vol. 22. Ed. Wise, DL.
17. Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul
18. Laboratory Experiments in Microbiology by Gopal Reddy et al
19. Das, H. K. Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005
20. Air Pollution Vol I by A.C. Stern
21. Environmental management by Biswarup Mukherjee V. Publication House
22. Pollution Biology: Hynes
23. Environmetal Biology by Biswarup Mukherjee Tata Mcgraw Hill
24. Modern Concepts of Ecology by H.D.Kumar
25. Cunning, P. (1995). Official Methods of Analysis, Vol. I and II, 16<sup>th</sup> Edn, Arlington, Virginia, USA, AOAL.
26. USA, AOAL.
27. Burus, R. G. and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Sci. Publ.
28. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20<sup>th</sup> Edition, American Public Health Association.
29. Water and Waste Water, 20<sup>th</sup> Edition, American Public Health Association.
30. Ec Eldowney S, Hardman D. J., Waite D.J., Waite, S. (1993) Pollution: Ecology and Bio-treatment – Longman Scientific Technical.



**Course code/name:****MBGE X (T): RECOMBINANT DNA TECHNOLOGY I****(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1 :** **15L**

Scope of Recombinant DNA Technology, Milestones in Genetic Engineering  
 Isolation, purification, and quantification of DNA and RNA  
 Preparation of total cellular DNA from animal & plant, preparation of plasmid DNA, bacteriophage DNA, separation and quantization of DNA by Gel electrophoresis.  
 Total cellular RNA, cytoplasmic and nuclear RNA, poly (A+) RNA, detection & quantitation and gel electrophoresis.  
 Methods of gene transfer techniques in plants and animals (*Agrobacterium* mediated, electrophoration and particle gun, liposome, PEG).

**Module 2:** **15L**

Cutting, joining and modifying and amplifying DNA , Restriction endonucleases, Ligases, Alkaline phosphatase, polymerases. Double digest modification of restriction fragment ends. Other ways of joining DNA.  
 Amplification of DNA-PCR and cell based DNA cloning, importance of cloning, PCR : Basic features, optimization of PCR parameters, types of PCR and applications, principles of cell based DNA cloning, cloning system for producing single stranded and mutagenized DNA.

**Module 3:** **15L**

Gene Cloning Vectors: Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes.  
 Alternative Strategies of Gene Cloning: Cloning interacting genes-Two-and three hybrid systems, cloning differentially expressed genes, Nucleic acid microarray arrays.  
 cDNA Synthesis and Cloning mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors and their chemical synthesis, Library construction and screening, construction and screening of genomic libraries.

**Module 4:** **15L**

Nucleic acid hybridization: Principles and applications, preparation of probes, principles of nucleic acid hybridization, nucleic acid hybridization assays and micro-assays.  
 Tools for analyzing gene expression: Reporter genes, Analysis of gene regulation, purification & detection tags, analysis at the level of gene transcription – Northern blot, in situ hybridisation, RNase protection assay, RT-PCR analysis at the level of translation Western blot, *in situ* analysis, ELISA, protein gel electrophoresis, antibody production.

**Practicals:**

1. Isolation of DNA from suitable microorganism/ higher organism
2. DNA amplification by PCR
3. Restriction digestion of genomic or lambda DNA and size determination of the fragments
4. Determination of insert size by R.E analysis
5. Preparation of competent cells, transformation of *E.coli* and screening of transformants
6. (Blue / white screening)
7. Analysis of recombinant clone
8. Ligation of vector and insect DNA, and checking of LM
9. Western Blotting

**Recommended Books:**

- 1) RNA methodologies-A laboratory guide for isolation & characterization, 3<sup>rd</sup> Edn., Farrell, R. Elsevier 2005
- 2) Molecular Cell Biology-Lodish , Berk, 5<sup>th</sup> Edn. Freeman 2003
- 3) Molecular Biology of the Cell, 5<sup>th</sup> edn, Alberts 2008, Garland science
- 4) Cells-Levin, 1<sup>st</sup> Ed. Jones & Bartlett Publisher 2006
- 5) The cell – A molecular Approach 4<sup>th</sup> Edu. Geoffrey M. Cooper, Rober E. Hausman
- 6) Genes IX - Lewin B. 2004, Prentice Hall
- 7) Biochemistry – Voet D. Voet J. G. 3<sup>rd</sup> Edn., Johnwiley & Sons inc. 2004
- 8) Cell & Molecular & William & Wilkins 2006
- 9) DNA repair mutagenesis: Friedberg E. C. ASM press 1995.
- 10) Enzymology primer for Recombinant DNA technology Eun HM, Elsevier, 1996.
- 11) Glick, B.R. and Pasternak, J.J. (1994) Molecular Biotechnology, ASM Press.
- 12) John G. Webster. (2004) Bioinstrumentation. Univ. of Wisconsin, John Wiley & Sons, Inc.
- 13) Sambrook, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3<sup>rd</sup> edn., Vol. 1,2,3) Cold Spring Laboratory Press, New York.
- 14) Savile Pradbury (1991) Basic measurement techniques for light microscopy, Oxford Univ. Press, Royal Microscopical Society.
- 15) Surzeki, S. (2000). Basic Techniques in Molecular Biology, Springer.
- 16) Westermeier, R (1993) Electroporesis in practice – VCH – Federal Republic of Germany.
- 17) Willett, J.E. (1991) Gas Chromatography, John Wiley & Sons.
- 18) Wilson, K. and Walker (1995) Practical Biochemistry Principles and Techniques, Cambridge Univ. Press.

## **ELECTIVE PAPER I**

**Course code/name: MBGE XI (T): PLANT GENETIC ENGINEERING  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

### **MODULE I**

Plant breeding technique and domestication of plant

Historical account of plant tissue culture

Technique of plant tissue culture

Shoot tip and meristem cell culture-isolation and culture of plant stem cell for clonal propagation and disease free plant propagules multiple shoot induction.

Somatic Embryogenesis- direct and indirect .role of growth regulators ,explants types, genotype and cultural condition and somaclonal variation.

### **MODULE II**

Suspension culture and production of plant secondary metabolites

Production of haploid plants and homozygous lines and its signification in crop improvement

Protoplast isolation ,culture and fusion technique – selection and regeneration of hybrid plants, symmetric and asymmetric hybrids cybrids.embryo rescue technique. Synthetic seed technology.

### **MODULE III**

Plant transformation technology-

Basis of tumour formation ,mechanism of DNA transfer . feature of Ti and Ri plasmid and their uses as vector, role of virulence gene , binary vectors markers. Use of reporter of gene 35 S and other promoter . methods of nuclear transformation -direct and indirect.

Application of plant transformation for productivity and performance. Development of transgenic plant for herbicide,insect resistance and disease resistance

Male sterility-Bar and Barnes system.

### **MODULES IV**

Metabolic engineering and industrial production : plant secondary metabolites, control mechanism and manipulation of phenolpropanoid pathway, shikimate pathway, alkaloids, industrial enzyme, biodegradable plastics,polyhydroxybutyrate, therapeutic protein, 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 region), SSCP(single stranded conformational polymorphism)AFLP, QTL, map based cloning, molecular marker assisted selection.

### **PRACTICALS:**

1. Media Preparation
2. Meristem and axillary bud culture
3. Organogenesis & Somatic Embryogenesis
4. Embryo Rescue Technique
5. Anther /Pollen culture technique
6. Morphology and cytology of callus
7. Isolation of DNA
8. Estimation of plant DNA by agarose gel electrophoresis.

9. Spectrophotometric estimation of DNA.
10. Cell suspension culture technique.

### **FOUNDATION COURSE I:**

**Practicals:** (Total 10 Credits)

MBGE V (P): Practical V (5 Credits): course IX - X

MBGE VI (P): Practical VI (5 credits) : course XI

**Course code/name: Elective Paper I:  
MBGE X I (T) : MOLECULAR DIAGNOSTICS METHODS  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**MODULE 1:**

Introduction to Molecular diagnostics and its significance in post genomic era in health care industry; Gene and signal amplification techniques for diagnostics; Molecular diagnosis of pathogen (Bacteria, fungi, virus and protozoas) mediated diseases; immune disorders; cancer and their role in cancer management and cancer susceptibility; Molecular tools in genetic counseling; pre-symptomatic, prenatal tests and new born screening; applications in Health care and forensics; concerns in Molecular diagnostics and genetic testing; regulatory & ethical issues.

**MODULE 2:**

Principles and methods of isolation and purification of nucleic acids(DNA & RNA) from microbes, animal, human etc. Molecular cloning, labeling of nucleic acids, hybridization.

Electrophoretic methods for mutation detection: SSCP, hetero-duplex analysis, DGGE and TRFLP, Chemical Cleavage of mismatched nucleotides, Ribonuclease cleavage of mismatched DNA, RNA duplexes,

Preparation of RNA sample containing miRNA, miRNA detection methods SNP detection methods and applications.

**MODULE 3:**

Nucleic acid amplification methods: Types of PCR, Reverse transcriptase PCR, Real time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Labelling PCR, Allele specific PCR, Quantitative fluorescent PCR, Alu PCR, Hot-start, *In situ* PCR, Long PCR, PCR-ELISA, Arbitrarily primed PCR, Triplet primed PCR, Isothermal amplification (TMA, NASBA, SDA) multiple thermal amplification; Linked Linear amplification, Ligation assay, Primer extension, applications of PCR , PCR based genetic analysis.

**MODULE 4:**

DNA sequencing methods – Principles and various DNA sequencing methods; Next –generation sequencing – Massively parallel sequencing platforms, Titanium, Illumina Genome analyzer II SOLiD 3 system, paired End sequencing; Pyrosequencing- microarrays; DNA bar coding data analysis and storage.

**Practicals:**

Isolation of genomic DNA from microbe, animal and human

Isolation of Plasmid DNA

Quality and Quantitative analysis of DNA by UV spectrophotometer, agrose gel electrophoresis etc.

Isolation of RNA from prokaryote (*E.coli*) and eukaryote (*C. elegans*).

PCR amplification of Genomic DNA, plasmid DNA

Real time PCR demo

Automated DNA sequencing data observations and analysis.

**Recommended Books:**

John M Walker & Ralph Rapley Hand book of Molecular Biomethods

Michal Janitz Next Generation Genome sequencing: Towards personalized medicine

Tom Strachan, Andrew Read. Human Molecular Genetics (Taylor and Francis) 2010 ISBN: 9780815341499

Tom Strachan, Judith Goodship, Patrick Chinnery. Genetics and Genomics in Medicine 1st edition, ISBN: 9780815344803

**Course Code: Elective paper I****MBGE (T): XI: Bioinformatics and Data Mining  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)****Module 1****15L****Basic Mathematics**

Limits: Constants, Types of constants, Variables, Types of Variables, Function, Types of function, Right hand and left hand limits, working rule for finding out the limit, problems based on limits. Continuity: Define, point out discontinuity, Method of finding the continuity, Continuity from right and from left, Problem based on continuity. Differentiability: Basic concept of the derivatives of function, Definition of the derivative of function, right hand and left hand derivatives, Condition for differentiability of a function, Problem based on differentiability. The binomial theorem: Define, Binomial theorem for a positive integral index, Binomial Expansion, Finding middle term, general term, Binomial theorem for any index. Differentiation and Integration: Introduction, Basic concepts and problems related to differentiation.

**Module 2****15L****Basic Biostatistics:**

Data Representation: Types of Numerical data, Tables and Graphs. Measures of central tendency: Arithmetic Mean, Weighted arithmetic mean, Median and Mode - Geometric mean and Harmonic mean. Measures of Dispersion: Range, Interquartile range, Average deviation, Standard deviation and Coefficient of variation, Lorenz curve. Unit-IV Linear Correlation: Types of Correlation, Methods of studying Correlation: Scatter diagram, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation. Linear Regression: Regression line, Regression Equations, Regression Coefficients. Multiple regression. Unit-V Probability: The concept of probability, Sample space, Independent events, mutually exclusive events, Addition law of probability, Conditional probability, Bayes theorem. Probability Distributions: Expected value and Variance, Binomial distribution, Poisson distribution, Normal distribution, Chi squared distribution, Students t distribution. Theory of Sampling: The purpose of sampling, Principles of sampling, Methods of samplings, Techniques of non-probability sampling, Size of Sample, Sampling and NonSampling errors. Probability: Introduction, Events and types of events, Probability of events, Mutually exclusive events, favorable events, exhaustive events, independent events, addition theorem on probability, conditional probability, Multiplication theorem, Problem based on probability theorem, Baye's theorem, Problem based on Baye's theorem.

**Module 3****15L****INTRODUCTION TO COMPUTER APPLICATION, Programming and data base management**

Computer organization; Softwar - System software and Application software. Networking fundamentals, types of networking, network topology; File Transfer Protocol (FTP), Telnet, Simple Mail Transfer Protocol (SMTP). Internet basics; Hyper Text Markup Language (HTML). Web designing; Web servers. Techniques of problem solving, Algorithm development, Flowcharting, Stepwise refinement. Structured programming; Object oriented programming, classes, objects, Abstract data types, Data types, Operators (Arithmetic, Logical and Comparison) and expressions. Branching and iteration, Arrays, Object/Message paradigm. Data encapsulation- modules and interfaces; Polymorphism - Static and dynamic binding, Inheritance: class and object

inheritance. Object oriented software design; Generic and reusable classes, Debugging and testing of programs. Database system - Operational Data, Characteristics of database approach, architecture. Overview of DBMS; Data associations - Entities, Attributes and Associations, Relationship among Entities, Representation of Associations and Relationship, Data Model classification. Entity Relationship model; Relational Data Structure- Relations, Domains and Attributes, Relational Algebra and Operations, Retrieval Operations. Relational Database Design - Anomalies in a Database, Normalization Theory, and Normal forms; Query processing and optimization; Security, backup and recovery. Distributed Databases- concepts, architecture, design; Object Oriented databases; Structured Query Language (SQL) - Data Definition Language (DDL), Data Manipulation Language (DML), Query by example. PL/SQL - Stored procedure, Database triggers; Relational Data Base Management Package.

#### **Module 4**

**15L**

##### **Introduction to Bioinformatics**

Basic molecular biology; introduction to the basic principles of structure/function analysis of biological molecules; genome analysis; different types and classification of genome databases (e.g. HTGS, DNA, Protein, EST, STS, SNPs, Unigenes etc.). Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principal component analysis, Principal coordinate analysis, Multidimensional scaling; Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jackknifing; Markov Models. Hidden Markov Models, Bayesian estimation and Gibbs sampling. DNA sequence retrieval system, various DNA and protein sequence file formats, Basic concepts of similarity searching and sequence alignments, pair wise and multiple sequence alignments, DNA sequence analysis, different gene prediction models and gene annotation tools. Protein sequence analysis and structure prediction, comparative genome analysis, phylogenetic analysis, gene expression analysis tools, programming languages and their applications in bioinformatics.

##### **Practicals:**

1. Introduction to Bioinformatics database
2. Statistical Test like MANOVA, Cluster analysis, Discriminant analysis, PCA etc with R package.
3. Protein structure visualization
4. Homology model of a protein
5. Phylogeny analysis

##### **Suggested Readings**

Addison-Wesley Professional. Michael Y. Galperin and Eugene V. Koonin. (Eds.) 2003. *Frontiers in Computational Genomics*. Caister Academic Press.

Animesh K. Datta (2007) "Basic Biostatistics and it's application" First Edition, New Central Book Agency, Ltd, Kolkata.

Arnold, Ken and Gosling, James 1996. *The Java Programming Language*. The Java Series. Addison Wesley.

Balaguruswamy, E. 1998. *Programming with ANSI C*. Tata McGraw Hill, New Delhi.



- Balaguruswamy, E. 2001. Programming with Object Oriented Programming using C++. Tata McGraw Hill, New Delhi.
- Batschelet E. (1992), "Introduction to Mathematics for Life Sciences", 3rd Edition, Springer-Verlag
- Bergin, J. 1994. Data Abstraction: The Object-Oriented Approach Using C++. McGraw Hill.
- Bishop M.J., Rawlings C.J. (Eds.). 1997. DNA and Protein Sequence Analysis. A Practical Approach. IRL Press, Oxford.
- Buyens, Jim. 2002. Microsoft FrontPage -Inside Out. Microsoft Press.
- Cox, V., Wermers L. and Reding E. E. 2006. HTML Illustrated Complete. Course Technology.
- Date, C. J. 2000. Introduction to Database System. Addison Wesley.
- Desai, B. C. 2000. Introduction to Database Systems. Galgotia Publications, New Delhi.
- Elmasri and Navathe. 2006. Fundamentals of Database Systems. Addison Wesley.
- Garcia-Molina, H., Ullman, J. D. and Widom J. 2002. Database Systems: The Complete Book.
- H. Nell and D. quading. Pure Mathematics (Advance level Mathematics), Vol. 1, 2, 3 Cambridge University Press, 2002.
- Hooman Rashidi, Lukas K. Buehler. 2005. Bioinformatics Basics: Applications in Biological Science and Medicine. Taylor & Francis /b S Publication.
- Jeffrey Augen. 2004. Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine.
- Narayanan, S. and Manicavachaagam Pillai, T.S. (1993) "Calculus, Vol. I and II"; Vishwanathan Printers and Publishers.
- Nell H. (2002), "Pure Mathematics (Advance level Mathematics)", Vol. 1, 2, 3 Cambridge University Press
- Niederst, J. 2001. Web Design in a Nutshell. O'Reilly Media, Inc.
- Parihar and Parihar (2007) "Biostatistics and Biometry" First Edition, Student Edition, Jodhpur
- Prentice Hall. Rob, P. and Coronel, C. 2006. Database Systems: Design, Implementation and Management.
- Sethi, R. 1996. Programming Language Concepts. Addison Wesley.
- Stroustrup, B. 1997. The C++ Programming Language. Addison Wesley.
- Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition, Prestographik, Vellore, India.
- Tanenbaum, A.S. 2003. Computer Networks. Prentice Hall of India, New Delhi. Thomson Learning.
- Silberschartz, A., Korth, H. F. and Sudarshan, S. 1997. Database Systems Concepts. Tata McGraw Hill, India.
- Warren, J; Gregory, E; Grant, R (2004), "Statistical Methods in Bioinformatics", 1st edition, Springer.
- Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition.

**Course code/name:**

**Foundation Course I: BIOSTATISTICS I  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**MODULE I : INTRODUCTION AND DATA**

**15 Hrs**

- A) INTRODUCTION TO STATISTICS AND BIOSTATISTICS :
- a) Definition, History, Meaning and Scope of Statistics and Biostatistics;
- B) TYPES OF DATA :
- Measurements and Counts; Biological data; Quantitative and Qualitative data; Biological Data Types...Measurement and Measurement Scale: Data on Nominal scale, Ordinal scale, Interval scale and Ratio scale;
- C) PRESENTATION OF DATA:
- a) Raw Data and Treated Data;
  - b) Presentation of Data in Table form... Simple Tables, An Ordered Array; Frequency Table/Distribution.....Preparation of Frequency table for Data at various scales; Modifications of frequency distribution; Two-way Classification; Presentation of Data in Graphical form... Line diagram, Bar Graph and its various modifications, Histogram, Frequency Polygon, Cumulative Frequency distribution and Ogive, Pie chart, Pictogram, Stem and Leaf Display.

**MODULE II : ANALYSIS OF QUANTITATIVE DATA**

**15 Hrs**

MEASURES OF LOCATION (CENTRAL TENDENCY):

- a) Essential Features of a good Measure of Central Tendency;
- b) Types of Measures of Central tendency in different Situations (For numerical data, Discrete and Continuous data, Frequency distribution Arithmetic Mean, The Median (also for Tied Data), and The Mode (and Unimodal, Bimodal distribution etc.);
- c) Other Quantiles e.g., Quartiles, Octiles, Percentiles;
- d) Other Measures of Central Tendency e.g., Weighted Mean, Grand Mean, Geometric Mean, Harmonic Mean etc.(all basic concepts);
- e) The Effect of Coding Data... Coding by Subtraction and Coding by Division
- f) Merits and Demerits of Important Measures of Central Tendency and their applications;
- g) Interrelationship between Mean, Mode and Median

**MODULE III : MEASURES OF DISPERSION OR VARIABILITY 15 Hrs]**

Types of Measures of Dispersion In different Situations (For numerical data, Discrete and Continuous data, Frequency distribution etc., Use of different Formulae; The Range Interquartile range, The Mean Deviation (M.D.); The Variance;The Standard Deviation (S.D.) [in case of simple data, continuous and discontinuous data, large data etc.]; The Coefficient of Variation (COV); The Indices of Diversity...Concept of Homogeneity or relative Diversity; The Effect of Coding Data on Sample Statistics

**MODULE IV : Random variables and probability distribution**

**15 Hrs**

Discrete and continuous random variables, binomial distribution, poisson distribution and their properties.

NORMAL DISTRIBUTION:

- a) Continuous distribution;
- b) The Concept of Normal distribution;

- c) Concept of Symmetry and skewness and kurtosis
- d) properties of A Normal Distribution
- e) The distribution of Means...Concept, Importance of Standard Error of Mean and Normal Deviate (Z score);

**[Note: Students Can Be Taught Writing Statistical Equations Using Microsoft Word Program... Equations and Symbols]**

## Semester IV

### Course code/name:

### MBGE XIII (T) PLANT AND ANIMAL TISSUE CULTURE (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

#### Module I 15L

Conventional Plant breeding technique.  
History of tissue culture technique.  
Plant tissue system and importance of macro and micro elements.  
Role of photoperiod, humidity and temperature on plants and in-vitro culture.  
Nutrient media composition of commonly used nutrient culture media like MS (1962), White (1953), B5 (1970), SH (1965), methods of sterilization.  
Laboratory organization and requirements of Plant tissue culture lab.  
Totipotency of plant cell, De-differentiation and Re-differentiation.

#### Module II 15L

Explant isolation technique, In-vitro culture, Initiation and maintenance of callus, suspension culture, growth curve.  
Micropropagation shoot tip culture, Rapid clonal propagation and Production of virus free Plant.  
Embryo culture and embryo rescue technique.  
Anther and ovary culture. Germplasm conservation, cryopreservation, slow growth, DNA banking, Protoplast isolation and culture technique.

#### Module III : 15L

##### Animal Tissue Culture

Media for cultured cells & tissues – natural & defined media.  
Preparation of various tissue culture media, sterilization and sterility testing.  
Setting up of primary cultures of Fibroblast cells from neonatal rat skin for establishment of continuous cell lines.  
Maintenance of continuous cell lines in the laboratory.  
Cell hybridization, use of hybridoma cell lines for the production of monoclonal antibodies.  
Cryopreservation of cells, embryos, ova and semen.  
Embryonic Stem cells – isolation, culture and preservation.

#### Module IV: 15L

##### Animal improvement

Conventional methods of animal Improvement – Selective Breeding and Cross breeding.  
Embryo Biotechniques for augmentation of replication efficiency and faster multiplication of superior germplasm, Super ovulation, Oestrus synchronizaion, embryo collection and transfer.  
*In vitro* culture of oocytes, *in vitro* fertilization, embryo culture and preservation.  
Micromanipulation and cloning, Somatic cell cloning, Embryo sexing.  
Identification and isolation of genes of economic importance.  
Production of animals as bioreactors for proteins of pharmaceutical value.  
Gene mapping in farm animals.  
Marker assisted selection and genetic improvement of live stocks.

##### **Practical :**

1. Media Preparation
2. Meristem and axillary bud culture
3. Organogenesis & SE
4. Embryo Rescue Technique

5. Anther /Pollen culture technique

**Animal tissue culture based practicals**

6. Preparation of Tissue culture medium & membrane filtration.
7. Cell counting and cell viability.
8. Cryopreservation and thawing.
9. Role of serum in cell culture.
10. Isolation of DNA from cell culture.

**Books Recommended:**

1. Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture - Akio Fujiwara
3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe
4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux
5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

**Recommended Books:**

1. C. Helgasson; Basic cell culture protocols, 3rd edition, Human press
2. E. D. Rang, H.P. Dale, M.M. Ritter; Pharmacology, 5th edition
3. J. Mather and d. Barnes; Animal cell culture methods, Elsevier, vol 57
4. J. R. W. Masters; Animal Cell Culture-A practical approach, Oxford university press
5. J. Paul Basic Protocols in cell and tissue culture
6. M. Butler; Animal cell technology-Principles and products, Open University press
7. M. Butler and M. Dawson, Cell culture lab. fax, Bios scientific Pvt. Ltd.
8. M. Cynes; Animal cell culture techniques, Springer Verlag
9. M. M. Young; Animal Biotechnology, Pergamon press, Oxford
10. N. Jenkins; Animal cell biotechnology-Methods and protocols, Human Press
11. R. I. Freshney; Culture of animal cells:A manual of basic techniques, John Wiley & sons, 4<sup>th</sup> edn.
12. H. K. Das, Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005

**Course code/name: MBGE XIV (T):**  
**RECOMBINANT DNA TECHNOLOGY II**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1:** **15L**

DNA synthesis, Nucleic Acid Sequencing methods, separation, cloning, Molecular Tools and Their Applications: Restriction enzymes, modification enzymes, DNA, and RNA markers, Restriction mapping of DNA Fragments and map construction. Formation of Point mutations and molecular mechanism

**Module 2:** **15L**

Molecular Mapping of genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, chromosome micro-dissection and micro-cloning, molecular markers (PCR and non-PCR based) in genome analysis, molecular markers linked to disease resistance genes.

**Module 3:** **15L**

Site-directed Mutagenesis and Protein Engineering

How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays.

Expression Strategies for Heterologous Genes Vector engineering and codon optimization, host engineering, *In vitro* transcription and translation, expression in bacteria, Yeast, insects and insect cells, mammalian cells, and in plants.

Processing of Recombinant Proteins: Purification and refolding, characterization and stabilization

**Module 4:** **15L**

Phage Display , T-DNA and Transposon Tagging: Role of gene tagging in gene analysis,

T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon.

Transgenic and Gene Knockout Technologies, Targeted gene replacement, Chromosome engineering.

Gene Therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

**Practicals:**

1. Isolation of DNA and its quantification (plant, animal, bacterial)
2. Isolation, purification, quantification and separation of plasmid DNA
3. RAPD, RFLP analysis from microbe genome.
4. DNA sequencing
5. Gel electrophoresis of DNA
6. Extraction of DNA from Gel
7. Detection of transposon through bacterial conjugation

**Recommended Books:**

1. Molecular Biology of the gene - J. Watson
2. Genes VI, VII and VIII - Benjamin Lewin
3. Molecular Biotechnology Principles and application of recombinant DNA
4. Molecular Biology - Robert F. Weaver
5. Recombinant DNA: A short course - J. Watson, Tooze and Kurtz
6. Molecular Biology - J. Watson
7. Plant Molecular Biology: A practical approach. - C.H. Shaw (2006), Panima Pub. Corp.
8. Methods in plants Molecular biology - Schuler, Raymond. E Zielinski (2005), Acad. Press.
9. Current protocols in molecular biology - Ausbel *et. al.*, 2000.
10. Molecular cloning Vol. 1-3. Sambrook and Russel. 2001. CSH press.
11. Principles of gene manipulation. 1994. Old and Primrose, Blackwell Scientific Publ.
12. Genome analysis. Four volumes. 2000. CSH Press.
13. Principles and techniques of biochemistry and molecular biology, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, New York.
14. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, R.L. Press, Oxford, 1995
15. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
16. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
17. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
18. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
19. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992
20. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
21. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998

## ELECTIVE PAPER II

### Course code/name: MBGE XV (T): PLANT GENETIC ENGINEERING II (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

#### Module I

Cloning: Isolation of single cells, culturing of single cell - Different methods, viability test of cultured cells, role of hormones in morphogenesis.

Somatic embryogenesis: Physical and chemical factors responsible for induction of somatic embryos, molecular basis of somatic embryogenesis, genotype specificity of somatic embryogenesis.

In-vitro pollination and fertilization, overcoming barriers to wide hybridization, production of dihaploids and their application in genetics and plant breeding, polyploids through endosperm culture and their application in plant breeding.

#### Module II

Genetic resources, germplasm conservation, gene bank – some case studies on success stories on commercial application of plant tissue culture, abiotic stress resistant: isolation and culture of salt tolerant cell lines.

Production of secondary metabolites through cell culture technique in some important medicinal plants, factors affecting production, biotransformation, elicitors induced production, hairy root culture and production of secondary metabolites.

#### Module III

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency.

Genetic engineering for abiotic stress like drought, flooding, salt and temperature.

Genetic engineering for quality improvement of protein, lipids, carbohydrates, vitamins and mineral nutrients. RNAi approach

Chloroplast transformation – advantages, vectors and success.

#### Modul IV

Molecular characterization of transgenics for gene integration – PCR, Southern blot, gene expression, Western blot, ELISA, marker free methodologies, gene stability, gene silencing, gene staking,

Conained green house trial , field trial of transgenic plants, selection of promising events, point of integration, RCGM, GEAC.

### Practicals:

1. Induction of shoots from shoot tip in MS medium containing growth regulators
2. Induction of callus and somatic embryogenesis in monocot plants
3. Anther culture and production of haploid callus
4. Induction of callus and isolation of salt tolerant cell line
5. Induction of hairy roots and production of secondary metabolites
6. Transformation of gus gene in plants through Agro-bacterium
7. Amplification of transgene from plant by PCR
8. Cell suspension culture
9. Endosperm culture

#### Books Recommended:

1. Plant Tissue Culture and its Biotechnological Applications - W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture - Akio Fujiwara
3. Frontiers of Plant Tissue Culture - Trevor A. Thorpe
4. In Vitro Haploid Production of Higher Plants - S. Mohan Jain, S.K. Sopory, R.E. Veilleux



5. Plant Tissue Culture : Theory and Practice - S.S. Bhojwani and A. Razdan

6. Plant Cell, Tissue and Organ Culture - Applied AND Fundamental Aspects - Y.P.S. Bajaj and A. Reinhard

**Course code/name: Elective Paper II:  
MBGE XV (T) : MOLECULAR DIAGNOSTICS  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**MODULE 1:** 15L

Infection mode of transmission of diseases caused by fungi, protozoa's, helminthes; types of infectious diseases.

Diagnosis of infections caused by fungi such as Dermotophytoses, Candidiosis and Aspergillosis; caused by protozoa's such as *Amoebiosis*, *Malaria*, *Trypanosomiosis*, *Leishmaniasis*; caused by helminthes such as *Fasciola hepatica*, *Ascaris lumbricoides*, *Filariasis* and *Schistosomiasis*;

**MODULE 2:** 15L

Infections caused by bacteria such as *Streptococcus*, *Coliforms*, *Salmonella*, *Shigella*, *Vibrio* and *Mycobacterium*; caused by viruses such as adenoviruses, Rhabdo viruses, Hepatitis virus and retroviruses caused by nematodes/cestodes such as taeniasis and H.nana infection, bacterial food poisoning, cholera, *E.coli* diarrhea.

Sexually Transmitted Diseases such as HIV, AIDS, Syphilis, Gonorrhoea and others

**MODULE 3:** 15L

Genetic disorders: Sickle cell anaemia, Thalassemys, Hemophilias

Duchenne muscular dystrophy and Becker Muscular dystrophy, Cystic Fibrosis, spinomuscular atrophy, neurofibromatosis I

Colourblindness, Retinitis pigmentosae, Glaucoma and Cataracts

Retinoblastoma, Colorectal cancer, Breast cancer, Factor V Leiden mutation.

Neonatal and Prenatal disease diagnostics, Male infertility based on Y genes, Mitochondrial DNA for maternal inherited diseases.

**MODULE 4:** 15L

Metabolic genetic disorders (mono- & polygenic): Phenylketonuria, Galactosemia, Mucopolysaccharidosis, diabetes mellitus, Tay Sach's Syndrome & Marfan Syndrome.

Neurogenetic disorders: Alzheimer disease & syndromes due to triplet nucleotide expansion like Huntington disease, spinocerebellar ataxia.

**Practicals:**

PCR for 16S RNA from bacteria

PCR RFLP for Factor V Leiden mutation

PCR RFLP for Sickle cell anemia

Mutation analysis by sequencing for Thalassemia-Demo

Mutation analysis by Genotyping for Huntington disease-Demo

DNA Fingerprinting-Demo

Genetic basis of male infertility in humans.

**Recommended Books:**

1. Wayne, W. , Grody, Robert M. Nakamura, Charles M. Strom and Frederick L. Kiechle Molecular Diagnostics: Techniques and application for the clinical laboratory.
2. William B. Coleman and Gregory J. Tsongalis Molecular Diagnostics: For the clinical laboratories.
3. Editors: Tang, Yi-Wei, Stratton, Charles W. (Eds.) Advanced Techniques in Diagnostic Microbiology ISBN 978-1-4614-3970-7

**Course Code: Elective paper II**  
**MBGE (T)XI: Bioinformatics and Data Mining-Advanced**  
**Course**

**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1**

**BIOLOGICAL DATABASES AND DATA ANALYSIS:**

Nature of biological data; Overview of available Bioinformatics resources on the web; NCBI/ EBI/EXPASY etc; Biological Databases: Nucleic acid sequence databases; GenBank/EMBL/ DDBJ; Biological Databases: Protein sequence databases; PIR-PSD; SwissProt, UniProtKB; Database search engines: Entrez, SRS. Overview/concepts in sequence analysis; Pairwise sequence alignment algorithms: Needleman & Wunsch, Smith & waterman ; Scoring matrices for Nucleic acids and proteins: MDM, BLOSUM, PAM, CSW; Database Similarity Searches: BLAST, FASTA; Multiple sequence alignment: PRAS, CLUSTALW; Biological databases: Genome & genetic disorders; Genome databases: Human, model organisms, microbes & viral: OMIM; Biological databases: structural databases: PDB, NDB, CCSD; Derived databases: Prosite, BLOCKS, Pfam/Prodom.

**Module 2**

**RNA/PROTEIN STRUCTURE PREDICTION AND MOLECULAR MODELING:**

Structural data, databases and structure analysis: Exploring the Database searches on PDB and CSD, WHATIF Molecular visualization tools; Visualization of tertiary structures, quaternary structures, architectures and topologies of proteins and DNA using molecular visualization softwares such as RasMol, Cn3D, SPDBV, Chime, Mol4D etc. Structure prediction tools and homology modeling: Prediction of secondary structures of proteins using different methods with analysis and interpretation of the results; Comparison of the performance of the different methods for various classes of proteins. (Fasman method, Garnier Osguthorpe Robson (GOR), Neural Network based; methods); NLP approach for secondary structure prediction of RNA; Introduction to mfold and Vienna packages; Prediction of tertiary structures of proteins using Homology Modeling approach: SWISSMODEL, SWISS-PDB Viewer; Prediction of tertiary structures of proteins different methods for fold recognition along with analysis and interpretation of results (Threading techniques; Homology Modeling and abinitio methods). Molecular dynamics simulation and docking: Basic principles of theoretical modeling, Empirical force fields for biomolecular simulations, Energy minimization, Molecular dynamics, Monte Carlo simulation Peptide building (PYMOL / DStools ).

**Module 3**

**Advanced Bioinformatics:**

Genomic databases and analysis of high-throughput data sets, Analysis of DNA sequence, Sequence annotation, ESTs, SNPs. BLAST and related sequence comparison methods. EM algorithm and other statistical methods to discover common motifs in biosequences. Multiple alignment and database search using

motif models, ClustalW and others. Concepts in phylogeny. Gene prediction based on codons, Decision trees, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models. Computational analysis of protein sequence, structure and function. Modeling protein families. Expression profiling by microarray/gene chip, proteomics etc., Multiple alignment of protein sequences, Modeling and prediction of structure of proteins, Designer proteins, Drug designing. Markov chains (MC with no absorbing states; Higher order Markov dependence; patterns in sequences; Markov chain Monte Carlo – Hastings-Metropolis algorithm, Simulated Annealing, MC with absorbing States), Bayesian techniques and use of Gibbs Sampling, Advanced topics in design and Analysis of DNA microarray experiments. Computationally intensive methods (Classical estimation methods, Bootstrap estimation and Confidence Intervals, Hypothesis testing, Multiple Hypothesis testing), Evolutionary models (Models of Nucleotide substitution), Phylogenetic tree estimation (Distances: Tree reconstruction – Ultrametric and Neighbor-Joining cases, Surrogate distances, Tree reconstruction, Parsimony and Maximum Likelihood, Modeling, Estimation and Hypothesis Testing), Neural Networks (Universal Approximation Properties, Priors and Likelihoods, Learning Algorithms – Back propagation, Sequence encoding and output interpretation, Prediction of Protein Secondary Structure, Prediction of Signal Peptides and their cleavage sites, Application for DNA and RNA Nucleotide Sequences), Analysis of SNPs and Haplotypes.

#### **Module 4**

##### **TOOLS AND TECHNIQUES FOR BIOLOGICAL DATA MINING:**

Quality of Biological Data & Data Accuracy; General issues regarding Biological Databases: Representation of errors due to (machines, 3D structural and sequence data of proteins and nucleic acid, Proteomics and Micro array data). UNIT II Optimization Techniques: Steepest Descent, Conjugate Gradient, Newton-Raphson, Simulated annealing in Biomolecular Structure Optimization; Genetic Algorithms: Ab initio methods for structure prediction; Lattice, SOM, etc., Information theory, entropy and relative entropy, Stochastic Grammars & natural languages processing techniques. Clustering and Classification Algorithms: Hierarchical and non-hierarchical Clustering, K-Means clustering, Grid based clustering, Analysis of MD trajectories, Protein Array data Analysis. Dynamic Programming and application in bioinformatics: Sequence Alignments, Structure Alignments; Foundations for Machine learning Techniques: Hidden Markov Model, Neural 356 Network, Bayesian modeling, The Cox-Jaynes Axiomes; Support Vector machine & Ant colony optimization: Multiple Sequence Alignments, Biomolecular Structure Prediction; Fuzzy logic system & application in bioinformatics; Introduction to WEKA package; Clustering and classifications, Protein Array data Analysis.

##### **Practicals:**

Nucleic acid sequence databases, Protein sequence databases, Database search engines, Database Similarity Searches, Multiple sequence alignment, Genome databases, Structural databases, Derived databases  
Structural data, databases and structure analysis, Molecular visualization tools, Structure prediction tools and homology modeling, Molecular dynamics simulation and docking

Genomic databases and analysis of high-throughput data sets, BLAST and related sequence comparison methods, Statistical methods to discover common motifs in biosequences, Multiple alignment and database search using motif models, ClustalW, Classificatory analysis, Neural Networks, Genetic algorithms, Pattern recognition, Hidden Markov models, Computational analysis of protein sequence, Expression profiling by microarray/gene chip, proteomics, Modelling and prediction of structure of proteins, Bayesian techniques and use of Gibbs Sampling, Analysis of DNA microarray experiments, Analysis of one DNA sequence, Analysis of multiple DNA or protein sequences, Computationally intensive methods, Multiple Hypothesis testing, Phylogenetic tree estimation, Analysis of SNPs and Haplotypes. 354

### **Suggested Readings**

1. Amaratunga, D. & Cabrera, J. 2004. Exploration and Analysis of DNA Microarray and Protein Array. John Wiley.
2. Attwood, T. K. & Parry-Smith, D. J. 2001. Introduction to Bioinformatics. Delhi Pearson Education (Singapore) Pvt. Ltd.
3. Baldi, P. and Brunak, S. 2001. Bioinformatics: The Machine Learning Approach. MIT Press.
4. Baxevanis, A. D. & Ouellette, B., F. F. 2002. Bioinformatics: A Practical Guide to the analysis of Genes and Proteins (2nd Ed.). New York, John Wiley & Sons, Inc. Publications.
5. Baxevanis, A.D. and Francis Ouellette, B.F. 2004. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
6. Baxevanis, A.D. and Francis, B.F. 2004. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
7. Baxevanis, A.D., Davison, D.B., Page, R. D. M. & Petsko, G.A. 2004. Current Protocols in Bioinformatics. John Wiley & Sons Inc. New York.
8. Benjamin / Cummings. Krawetz, S.A. and Womble, D.D. 2003. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana Press.
9. Ewens, W.J. and Grant, G.R. 2001. Statistical Methods in Bioinformatics. Springer.
10. Graur, D. and Li, W-H. 2000. Fundamentals of Molecular Evolution.
11. Gupta, G. K. 2006. Introduction to Data Mining with Case Studies. Prentice Hall of India, New Delhi.
12. Han, J. and Kamber, M. 2006. Data Mining: Concepts and Techniques. Morgan Kaufman.
13. Hand, D., H. Mannila, P. Smyth. 2001. Principles of Data Mining. Prentice Hall of India, New Delhi.
14. John Wiley. Duda, R.O., Hart, P.E. and Stork, D.G. 1999. Pattern Classification. John Wiley.
15. Jones, N.C. and Pevzner, P.A. 2004. Introduction to Bioinformatics Algorithms. The MIT Press.
16. Klir, G. J. and Yuan Bo. 2002. Fuzzy sets and Fuzzy logic: Theory and Applications Prentice Hall of India, New Delhi.

17. Koskinen, T. 2001. Hidden Markov Models for Bioinformatics. Kluwer Academic Publishers.
18. Krane, D.E. and Raymer, M.L. 2002. Fundamental Concepts of Bio-informatics.
19. Lee, K. H. 2005. First Course on Fuzzy Theory and Applications. Springer.
20. Lesk, A.M. 2002. Introduction to Bio-informatics. Oxford University Press.
21. Linder, E. and Seefeld, K. 2005. R for Bioinformatics. O'Reilly and Associates.
22. Mitra, S., Acharya, T. 2004. Data Mining: Multimedia, Soft Computing, and Bioinformatics. John Wiley
23. Mount, David. 2004. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York.
24. Percus, J.K. 2001. Mathematics of Genome Analysis. Cambridge University Press.
25. Sinauer Ass., USA. Hans Dieter & Didier Rognan. 2003. Molecular Modeling: Basic Principles and Application.
26. Sorensen, D. and Gianola, D. 2002. Likelihood, Bayesian and MCMC Methods in Genetics. Springer.
27. Tisdall, J.D. 2001. Mastering Perl for Bioinformatics. O'Reilly and Associates.
28. VCH. Webster, D. M. Ed. 2000. Protein Structure Prediction: Methods and Protocols. Totowa Humana Press.
29. Wang, J.T.L., Zaki, M.J., Toivonen, H.T.T. and Shasha, D. 2004. Data Mining in Bioinformatics. Springer.
30. Wiley VeH Gmbh and Co. KGA. Holtje, H.D. & Folkers, G., Weinheim. 1997. Molecular modeling: Basic Principles and Applications.
31. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997 Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
32. Wu, C.H. and McLarty, J.W. 2000. Neural Networks and Genome Informatics. Elsevier.
33. Wunschiers, R. 2004. Computational Biology Unix/Linux, Data Processing and Programming. Springer.
34. Yang, M.C.C. 2000. Introduction to Statistical Methods in Modern Genetics. Taylor and Francis.
35. [http://wiki.bioinformatics.org/Likelihood%2C Bayesian and MC MC Methods in Genetics %28Sorensen%29](http://wiki.bioinformatics.org/Likelihood%2C%20Bayesian%20and%20MC%20Methods%20in%20Genetics%20Sorensen%29)
36. [http://wiki.bioinformatics.org/Computational Biology %28Wunschiers%29](http://wiki.bioinformatics.org/Computational%20Biology%20Wunschiers%29).
37. Wiley. Gimona, G. Cesareni. & Yaffe, M. Sudol ( EDS. ) Aug 2004. Modular protein Domains. Wiley-vch verlag gmbh & co., 3-527-30813-X.

Course code/name:

## Foundation Course I: BIOSTATICS II

### MODULE I: PROBABILITY THEORY

15 Hrs

- A) Important Terms, Basic Concept of Probability...  
 Sample space, Events (Different Types... Null, Simple, Compound, Exhaustive (Cases), Collectively Exhaustive, Mutually Exclusive, Dependent and Independent Events, equally Likely, Equally Probable, And Favourable];  
 Concepts of Probability.... Classical Concept of Probability and its Rules, Frequency Interpretation Concept.
- B) SOME RULES OF PROBABILITIES :
- a) Probabilities and Odds;
  - b) Addition Rules/Theorem on Total Probability (and Rule for Calculating Probability of an Event);
  - c) Independent Events;
  - d) Multiplication Rules/Theorem on Compound Probability (Conditional Probability);

### MODULE II: Statistical Inference

15 Hrs

- A) ESTIMATION:
- a) Theory of Point Estimation;
  - b) Confidence Intervals for Means...
    - i) For Large Samples(Z score),
    - ii) For Small Samples with unknown population S.D. ( $\sigma$ ) ( $t$  test); Confidence Intervals for Standard Deviation
1. CONCEPTS OF TESTS OF HYPOTHESIS :
- a) Null Hypotheses (Simple and Composite, One-Sample and Two-Sample);
  - b) Significance Tests.. 1) One-tailed and 2) Two-tailed tests;
  - c) Statistics for Tests Concerning Means... Z score; Small Samples ( $t$  test);
  - d) Tests Concerning Differences among Means...
    - 1) Statistic for large-sample test concerning difference between two means (Z statistic)
    - 2) Statistic for Small-sample test concerning difference between two means ( $t$  statistic)
    - 3) Statistic for test concerning differences among means.

### MODULE III SAMPLING AND SAMPLING THEORY

15 Hrs

- A) SAMPLING THEORY AND TYPES OF SAMPLES :
- a) Concept of population and sample drawn from population, concept of random sample
  - b) Types of Sampling... Meaning, Factors, Advantages and Drawbacks  
 Probability Sampling—  
 Simple Random Sampling, Systematic (Interval) Sampling, Stratified Sampling.
  - ii) Non-Probability Sampling—
    - 1) Convenience (haphazard) Sampling, 2) Volunteer Sampling, 3) Judgment Sampling, 4) Quota Sampling

### MODULE IV ANALYSIS OF COUNT DATA AND PAIRED DATA

15 Hrs

- A) ANALYSIS OF COUNT DATA :
- a) The Estimation Of Proportions  
 Use of Z score, Maximum error of Estimate and Determination of Sample Size
- B) STATISTIC FOR TEST CONCERNING DIFFERENCES AMONG PROPORTIONS..
- a) Chi square test ( $\chi^2$  test) and its use in Genetics;
  - b) Application or Role of  $\chi^2$  test... in Contingency (row and column) Tables [for Trials permitting more than two possible outcomes ( $r \times c$  table)];
  - c) Application or Role of  $\chi^2$  test... in Goodness of Fit



- C) ANALYSIS OF PAIRED DATA :
- a) Regression and Correlation Analysis
    - i) Meaning and Comparison
    - ii) Simple Regression and Simple Correlation  
Estimation of parameters by method of least squares; test of significance of regression and coefficient;  $F$  test and ANOVA; Standard Error Of Estimate; Coefficient of Correlation ( $r$ ) and  $t$ -testing  
Regression through Origin
  - c) Correlation Analysis
    - 1) Understanding Correlation of Determination ( $r^2$ ) and Coefficient of Correlation ( $r$ ),
    - 2) Preparation of Scatter Plot,
    - 3) Finding the values of Correlation of Determination ( $r^2$ ) and Coefficient of Correlation ( $r$ ),
    - 4) Assumptions of Correlation Analysis,
    - 5) Testing the Hypothesis about the Correlation Coefficient...
      - ANOVA and  $F$  test,
      - $t$ -test

## Foundation Course

Course code/name: MBGE XII: Foreign Language : French I  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

### Module: 1. Grammar

Definite and Indefinite Articles

Parts of Speech

Verbs : Regular and Irregular

Formation of Sentences : Affirmative, Interrogative and Negative.

Imperative Mood

Tenses : Present, Future and Past.

Conjunctive and Disjunctive Objects

Demonstrative Adjectives

Direct and Indirect Objects

Partitive Articles

Prepositions and Conjunctions

### Module: 2 Conversational French

How to Greet

How to ask and answer question

How to introduce oneself

Speaking about weather

Telephone conversation

Buying things and making purchases

Table Manners

### Module: 3 Civilisation

Greetings

Ettiquetes

Some facts about France

French Culture

Climate and seasons

Food Culture

Fashion Trends in France

### Module 4: Vocabulary

Numbers

Time

Festivals

House and Furniture

Physical Features

Face and Body

Colours

Clothes

Authentic Documents

Days and Months

Shopping

Food : Vegetables, Fruits, Cheese, etc+

**Reference Book:** Neelima Raddi and Anjali Paranjpye Nouvel EnÉchanges, Oxford School Educ, Bilan 1 and 2.

**FOUNDATION COURSE**

**Course code/name: MBGE XVI: FOREIGN LANGUAGE : FRENCH II**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**Module 1:** **15L**

Grammar  
 Tenses : Recent Past, Near Future and Imperfect.  
 Comparative and Superlative  
 Past Tense with Avoir and Être  
 Indefinite Third Person Pronoun  
 Reflexive Verbs  
 Transformations from Adjective to Adverb  
 Relative Pronouns  
 Present Participle  
 Gerund  
 Possesive Pronoun  
 Conditional  
 Special Usage of Verb + Infinitive

**Module 2:** **15L**

Conversational French  
 To Express Sentiments  
 Presentation of Simple Projects  
 To Express Opinion  
 Travelling  
 Refusing Politely  
 To Give Suggestions and Express Views

**Module 3:** **15L**

Civilisation  
 French Heritage  
 Sports  
 Region  
 Religion and Holidays  
 Links Between France and India  
 Lifestyle in France  
 The Pleasure of Reading French Litterature

**Module4:** **15L**

Vocabulary  
 Genral Day to Day Useful Vocabulary  
 Travelling  
 Hotel Vocabulary  
 French Culture and Fashion  
 Directions  
 Politeness  
 Professions  
 Animals  
 Household

**Reference Book :**

Neelima Raddi and Anjali Paranjpye Nouvel En Échanges, Oxford School Education,  
 Bilan 3 and 4

**Practicals:** (Total 10 Credits)

MBGE V (P): Practical V (5 Credits): course XIII - XIV

MBGE VI (P): Practical VI (5 credits) : course XV

**OR**

**FOUNDATION COURSE**

**Course code/name: MBGE XVI: FOREIGN LANGUAGE : German I  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**MODULE 1****15 hrs**

Text and Grammar  
German Background – History,  
The Article,  
The Nominative,  
The Alphabets,  
The Numbers,  
Time

**MODULE 2****15 hrs**

The Verb,  
Pronouns,  
Preposition,  
Akkusative and  
Dative cases

**MODULE 3****15 hrs**

The Modal Verbs,  
Genetiv,  
Präteritum,  
Reflexive Pronouns,  
Perfect ,  
Times of the Year  
Lessons 1 – 10 with explanation of the above mentioned items relative to the Lessons taken

**MODULE 4****15 hrs**

Comprehension and Essay Writing  
Understanding the Language,  
Newspaper Reading,  
Essay writing related to Picnic,  
Travel,  
Birthday,  
Yearly Celebrations,  
Conversation German

**Reference Books:**

Schulz and Griessbach, Deutsche Sprachlehre für Ausländer, Max Hüber Verlag, München –  
Lessons 1 to 10 only.

**FOUNDATION COURSE**

**Course code/name: MBGE XVI: FOREIGN LANGUAGE : German II**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

**MODULE 1****15 hrs**

Text and Grammar  
 The Imperative,  
 Adjective and Adjective Declination,  
 Nebensätze

**MODULE 2****15 hrs**

Relative Pronouns,  
 Infinitive Sentences,  
 Relative Sentences,

**MODULE 3****15 hrs**

Conjunctive cases I  
 Conjunctive cases II,  
 Lessons 11 to 20 with explanation of the above mentioned items relative to the Lessons taken.

**MODULE 4****15 hrs**

Comprehension and Letter writing  
 Reading of Texts from Magazines and brochures,  
 Travel Brochures,  
 Understanding the German Countryside,  
 Map Reading of Germany,  
 Information on German ++ Post,  
 Railways,  
 Bus Routes,  
 Air Routes,  
 Landmarks in the German Nation.

**Reference Books:**

Schulz and Griessbach, Deutsche Sprachlehre für Ausländer, Max Hüber Verlag, München –  
 Lessons 11 to 20 only.

**OR**

## Foundation Course

**Course code/name: COMMUNICATION SKILLS- I**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

### **MODULE 1**

**15 hrs**

#### Communication

- Definition of Communication
- Elements of Communication (Sender, Receiver & Media)
- Communication Process/ Cycle
- Types of Communication (Verbal- Oral & Written, Non-verbal- Body Language, Sign Language & Paralanguage)
- Patterns of Communication in Organization (Internal, External, Upward, Downward, Horizontal, Diagonal, Grapevine)
- 7 C's of effective Communication
- Barriers of Communication (Physical, Mechanical, Language, Psychological, Linguistic, Cultural )

### **MODULE 2:**

**15 hrs**

#### Reading Skills

- Meaning of Reading
- Importance of Reading
- Types: Active & Passive Reading
- Skimming
- Scanning

### **MODULE 3:**

**15 hrs**

#### Writing Skills:

- Letter Writing  
 Formal Letter (Application for leave, T.C & Permission)  
 Informal letter writing (Family members, Friends & Relatives)
- Situational English
- Idea expansion
- Describing incidents/events/Experience
- Comprehension
- Precise Writing

### **MODULE 4:**

**15 hrs**

#### Grammar & Vocabulary

- Tenses
- Use of Prepositions
- Active Voice & Passive Voice
- Direct & Indirect Speech
- Common errors in English
- Synonyms

- Antonyms
- One word substitution
- Idioms & Phrases (Phrasal Verbs & Idiomatic Expressions)

**Recommended Text Books:**

- Essential Communication Skills by Shalini Aggarwal, Ane Books Pvt. Ltd, New Delhi.
- Technical Communication: Principles and Practice (2<sup>nd</sup> Edition), by Meenakshi Raman and Sangeeta Sharma, Oxford University Press, New Delhi.
- Effective Technical Communication by M. Ashraf Rizvi, McGraw Hill Education Pvt. Ltd. Delhi.
- Communication Skills for Effective Management by Anjali Ghanekar,
- English Grammar and Composition by Rajendra Pal and Prem Lata Suri, Sultan Chanda and Sons Publisher.

**Reference Books:**

- Communication Skills Handbook: How to Succeed in Written and Oral Communication by Jane Summers, Brette Smith, Wiley India Pvt.Ltd.
- Speaking Accurately by K.C. Nambiar, Cambridge University Press, New Delhi.
- Speaking Effectively by Jeremy Comfort, Pamela Rogerson, Cambridge University Press New Delhi.
- Improve your Communication Skills by Barker, Kogan Page India Pvt, Ltd.  
The Oxford Guide to Writing and Speaking by John Seely, Oxford University Press,  
New Delhi.



## Foundation Course

**Course code/name: COMMUNICATION SKILLS-II**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

### MODULE 1

**15 hrs**

#### Phonetics

- Study of Speech Organs
- List of Phonetic Alphabets
- Manner of Articulation of 44 Sounds
- Word Transcription
- Stress & Intonation

### MODULE 2

**15 hrs**

#### Speaking Skills

- Phone Call Etiquettes
- Presentation Skills
- Public Speaking
- Group Discussion
- Interview Skills (Definition, Types, Grooming and Preparation Techniques)

### MODULE 3:

**15 hrs**

#### Business Correspondence

##### Elements/ Parts of Business Letters

- Formats: Full Block, Semi Block & Modified Block
- Job Application, Letter of inquiry, Letter of Complaint, Letter of Claim & Demand Letter
- Resume: Design, Parts & Styles ( Chronological, Functional )
- E-mail: Nature, Purpose, Advantages, Characteristics of Successful E-mail messages & E-mail format
- Meeting: Notice, Agenda, Minutes & Types of Minutes
- Reports: Meaning, Significance, Essential Features of a good Report & Types of Report

### MODULE 4:

**15 hrs**

#### Behavioural Skills

- Developing Positive Attitude: Meaning, Types, Steps to improve Positive Thinking, Benefits of a Positive Attitude & Things to develop positive Attitude
- Leadership Skills
- Decision Making Skills
- Time Management
- Stress Management
- Problem Solving Skills

**Recommended Text Books:**

- Effective Technical Communication by M. Ashraf Rizvi, McGraw Hill Education Pvt. Ltd. Delhi.
- Business Communication by Sangeeta Magan, Biztantra, New Delhi.
- Essential Communication Skills by Shalini Aggarwal, Ane Books Pvt. Ltd, New Delhi.
- Soft Skills for Everyone by Jeff Butterfield, Cengage.
- Spoken English: A Manual of Speech and Phonetics by R.K. Bansal & J.B. Harrison,  
Orient Blackswan Pvt. Ltd, Hyderabad.
- Technical Communication: Principles and Practice (2<sup>nd</sup> Edition), by Meenakshi Rama and Sangeeta Sharma, Oxford University Press, New Delhi.
- Soft Skills for Managers by Dr. T. Kalyana Chakravarthi & Dr. T. Latha Chakravarthi,  
Biztantra, New Delhi.

**Reference Books:**

- Behavioural Science by Dr. Abha Singh, Wiley India Pvt. Ltd.
- Ace of Soft Skills by Gopalswami Ramesh, Mahadevan Ramesh, Pearson Publication,  
Delhi.
- Better English Pronunciation by J.D. O'Connor, Cambridge University Press  
Delhi,  
2009
- Speaking Effectively by Jeremy Comfort, Pamela Rogerson, Cambridge  
University  
Press New Delhi.
- Technical Writing and Professional Communication for Non-native Speakers of  
English by Thomas N. Huckin & Leslie A. Olsen, McGraw-Hill

**OR**

## Foundation Course

**Course code/name: Personality Development through Fine Arts I**  
**(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

### MODULE 1

**15 hrs**

#### **Personality: Understanding the concept**

- Personality and Personality Development
- Theories of Personality Development
- Personality Traits
- Personality in relation to social and cultural aspects
- Personality and Individuality
- 

### MODULE 2

**15 hrs**

#### **Fine Arts: Understanding the concept**

- Learning the Artistic sensitivity Intellectual, Emotional and Psychological aspects of Fine Arts in the context of personal development
- Understanding the theory of imitation and reasons for branches of Fine Arts in the context of dimensions of personality
  - Performing Arts: Dance, Drama, Music
  - Visual Arts: Painting and Sculpture
  - Theatre, Film and Television
  - Architecture
  - Reasons for various branches of Fine Arts- Theory of Imitation
- **Understanding the relationship between Dance, Drama and Music**
  - Dance and Drama to make the body more flexible
  - Drama and Music to understand the importance of voice culture
  - Music and Dance to understand the rhythm of the body
  - Dance and Choreography to understand the sense of composition

### MODULE 3

**15 hrs**

- **Practicing the art of acting for Effective Communication**
  - Vachik Abhinay for effective speech
  - Angik Abhinay for effective body language
  - Aharya Abhinay for effective use of given conditions
  - Sattvika Abhinay for effective emotional convincing abilities and response
  - Developing Intra personal communication through soliloquies technique
  - Developing Interpersonal communication through dialogue delivery technique
  - Developing self consciousness and awareness through acting and singing
  - Learning to develop a composed personality by using the acting technique of elimination of Jerzy Grotowsky
  - Learning to develop an attitude of remaining neutral and balanced by using the technique of alienation of Bertolt Brcht

- **Developing the Personality through building the character**
  - Understanding the purpose and anatomy of our own body and utilizing it as a tool for our own performance through art of acting
  - Actor and his own world – a self assessment
  - Understanding others through playing characters
  - Understanding the emotional world of the character
  - Perceiving the world through the Dramatic Art
  - Personal elevation through creativity and performance
  - Playing various roles to experience various kinds of personalities

#### **MODULE 4**

**15 hrs**

- **Understanding the language and the performance aspects for personal development**
  - Understanding the language of Dance, Drama and Music
  - Conditioning and learning through improvisation situations
  - Understanding the phenomena of reality, illusion of reality and the personal reality
  - Practicing, Emotion Memory, Catharsis and Relief
  - Improving leadership qualities through team work group productions
  - Personal Development through Anchoring, News Reading, Compeering and Script writing
  
- **Understanding the concept of creativity to become creative person**
  - Knowing the component part of creation
  - Knowing the technique for creation
  - Knowing the methods for creation
  - Developing the symbols for creations
  - Motivation for creation
  - Performing Arts, Creativity and Personal Development

## Foundation Course

### Course code/name: Personality Development through Fine Arts II (Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

#### MODULE 1:

15 hrs

- Understanding the concept of painting as an art form
- Understanding the color therapy and its significance in art and real life
- Understanding the aesthetics of painting and the aesthetics of personal life
- significance of individual perception in painting and individual life
- Personal Development and Creativity through artistic illustrations and designs
- Developing self consciousness and awareness through creative art process

#### MODULE 2:

15 hrs

- Understanding the concept of Sculpture as an art form to learn the multidimensional approach towards individual and social life
- Understanding the color therapy and its significance in art and real life
- Understanding the aesthetics of sculpture and the aesthetics of personal life
- Significance of individual perception in sculpture and individual life
- Visual Arts, Creativity and Personal Development
- Self realization and self motivation through visual arts

#### MODULE 3:

15 hrs

- Understanding the language of Painting and Sculpture
- Understanding the art of Painting and Sculpture for Effective Communication
- Developing the lateral and positive thinking through artistic shapes and forms
- Perceiving the world through two dimensional and three dimensional art forms
- Spiritually developing individually and meditating through painting and sculpture
- Applying the principles of Applied Art and Applied Psychology through the art of advertisement for self marketing

#### MODULE 1

15 hrs

- Conditioning and learning through sketches and drawing and developing logic through geometrical designs
- Understanding the various Personalities through simple portraits
- Understanding the phenomena of reality, illusion of reality and the personal reality through visual arts
- Practicing, Emotion Memory, Catharsis and Relief through visual arts

## Reference Books

- Abhinaya Kala by – Dr. Vinod Indurkar
- Directing and Dramaturgy by Rob Swain
- Stanislavsky and Directing (Theory Practice and Influence) – Anna Migliarasi
- The Directions Craft by Katie Michell
- Personality development a psychoanalytic perspective - Debbie Hindle, Marta Vaciago Smith – 2013
- Self Theories and their role in motivation - [Carol S. Dweck](#) – 2000
- Dance : A Creative Art Experience - [Margaret N. H'Doubler](#) – 1998
- Dance : Rituals of Experience - [Jamake Highwater](#) - 1992
- Drama as Therapy: Theatre as Living - [Phil Jones](#) - 1996
- Music Therapy and Addictions - [David Aldridge](#), [Joerg Fachner](#) - 2010
- A Psychological Interpretation of Drawings and Paintings. The SSCA Method: A ..- [Zoltán Vass](#) – 2012
- Sculpture and Enlightenment - Erika Naginski
- Communication Skills and Personality Development – AIR CMDE P.C. SHARMA
- Personality Development - R.C. Bhatia

## Books Recommended

- Gershenfeld, Neil, When things start to think, New York: Henry Holt, 1999
- Buston, Bill; Sketching User Experience: Getting The Design Right and the Right Design (Interactive Technologies), Morgan Kaufmann, 2007
- Drama Kings: The Men Who Drive Strong Women Crazy - [Dalma Heyn](#) – 2011
- Music Therapy and Mental Illness: With A Focus on Schizophrenia and the Role - [Dr. Harrison S. Mungal, PhD.](#) – 2010
- Spontaneous Painting: Creating the Symbol Journey - [Susan Bello Ph. D.](#) – 2013
- Personality Development and Communication Skills - [Sachin Gupta \(M.Com.\)](#) – 2009

## SEMESTER I

## M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

## PRACTICAL I

TIME : 12 HOURS

FULL MARKS : 100 (Ex. Ass.)

Q.1 Practical from course I	25
Q.2 . Practical from course II	25
Q.3. Comment on the spots from course I , II	10
Q. 4. Viva- Voce	20
Q. 5. Practical records	20

## SEMESTER I

## M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

## PRACTICAL II

TIME : 12 HOURS

FULL MARKS :100 (Ex. Ass.)

Q.1 One minor practical from course III	15
Q.2. One minor practical from course IV	15
Q.3. One major practical from course III or IV	20
Q.4. Comment on the 2 spots from course III, IV	10
Q. 5. Viva- Voce	20
Q. 6. Practical records	20

## SEMESTER II

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING  
PRACTICAL III

TIME : 12 HOURS	FULL MARKS :100 (Ex. Ass.)
Q.1 One minor practical from course V	15
Q.2. One minor practical from course VI	15
Q.3. One major practical from course V or VI	20
Q.4. Comment on the 2 spots from course V, VI	10
Q. 5. Viva- Voce	20
Q. 6. Practical records	20

## SEMESTER II

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING  
PRACTICAL IV

TIME : 12 HOURS	FULL MARKS : 100 (Ex. Ass.)
Q.1 Practical from course VII	20
Q.2. Practical from course VIII	20
Q.3. Minor Practical from course VIII	10
Q.4. Comment on 2 spots from course VII , VIII	10
Q. 5. Viva- Voce	20
Q. 6. Practical records	20



## SEMESTER III

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING  
PRACTICAL V

TIME : 12 HOURS	FULL MARKS : 100 (Ex. Ass.)
Q.1 One practical from course IX	20
Q.2 . One practical from course X	30
Q.3. Comment on Two spots	10
Q4. Viva- Voce	20
Q.5. Practical records	20

## SEMESTER III

M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING  
PRACTICAL VI

TIME : 12 HOURS	FULL MARKS : 100 (Ex. Ass.)
Q.1 One major Practical from course XI	30
Q.2. One minor Practical from course XI	20
Q.3. Comment on the 2 spots from course	10
Q. 4. Viva- Voce	20
Q. 5. Practical records	20

## SEMESTER IV

## M.Sc. EXAMINATION IN MOLECLAR BIOLOGY AND GENETIC ENGINEERING

## PRACTICAL VII

TIME : 12 HOURS

FULL MARKS :100 (Ex. Ass.)

Q.1 Two practicals from course XIII, XIV	20
Q. 2. One major practical from course XV	30
Q. 3. Comment on two spots	10
Q.4. Viva- Voce	20
Q. 5. Practical record	20

## Foundation course I (For students other than MOL. BIO. & GEN. ENG.)

**Course code/name: MBGE (T): MOLECULAR BIOLOGY  
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)**

### **Module 1: 15L**

**Nucleic acids:** Structure, types and function of nucleic acids (DNA & RNA)

**DNA Replication:** Prokaryotic and eukaryotic DNA replication mechanism, enzymes and accessory proteins involved in DNA replication. Biosynthesis of purines and pyrimidine nucleotides from ribose including regulation, salvage pathways.

### **Module 2: 15L**

**Genetic Code:** Triplet nature of genetic code, breaking the code, wobble hypothesis, universality of the genetic code, general features of the genetic code.

**Protein Synthesis:** Prokaryotic transcription, eukaryotic transcription, RNA polymerases, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5' Cap formation, Transcription termination, 3'end processing and polyadenylation, nuclear export of mRNA, mRNA stability

### **Module 3: 15L**

**Regulation of gene expression:** Gene expression in prokaryotes: Induction and repression, operon theory (lac operon, trp operon, ara operon), attenuation, positive and negative control  
Gene expression in eukaryotes.

### **Module 4: 15L**

**DNA Damage and repair:** Spontaneous and Induced mutations – Physical and Chemical mutagenesis, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift, mis-sense and non-sense mutations, Photo-reactivation, Excision Repair, Mismatch Repair, Post-replication Repair, SOS Repair

### **Recommended Books:**

1. Molecular Biology of the Gene - J. D. Watson, N. H. Hopkins, J. W. Robertis, A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California - 1988
2. Genes VII. - Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
3. Molecular Biology – Freifelder, D, Narosa Publishing house New York, Delhi, 1987.
4. Molecular Cell Biology - Lodish, H., Baltimore, D; Fesk, A., Zipursky S.L., Matsudaride, P. and Darnel 4th edn. American Scientific Books. W.H. Freeman, New York (2000).
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology - Brown, 3rd edition.
7. Essentials of Molecular Biology. D. Freifelder, Panima publishing corporation.
8. Principles of Genetics By Tamarin,
9. Cell Biology By De Robertis and De Robertis

## Foundation course II (For students other than MOL. BIO. & GEN. ENG.)

### Course code/name: MBGE(T): RECOMBINANT DNA TECHNOLOGY AND PLANT GENETIC ENGINEERING

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

**Module 1:** **15L**  
 Scope of Recombinant DNA Technology, Milestones in Genetic Engineering, Restriction enzymes, modification enzymes, DNA markers, Cutting, joining and modifying and amplifying DNA, Gene Cloning Vectors Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes, molecular markers in genome analysis( RFLP, RAPD and AFLP).

**Module 2:** **15L**  
 Methods of gene transfer techniques in plants and animals (*Agrobacterium* mediated, electroporation and particle gun, liposome, PEG), principles of cell based DNA cloning, importance of cloning, construction and screening of genomic libraries.  
Polymerase Chain Reaction : Basic features, optimization of PCR parameters, variations in PCR and applications.

**Module 3:** **15L**  
 Nucleic acid hybridization: Preparation of probes, principles & applications of nucleic acid hybridization, nucleic acid *in situ* hybridization assays - Southern, Northern and Western methods, Dot and Slot methods, various types of Nucleic Acid Sequencing methods.

**Module 4:** **15L**  
 Plant Transformation technology for Transgenic production: Basis of tumor formation, hairy root features of TI and RI plasmids, mechanisms of DNA transfer, Role of virulence genes, use of TI and RI as vectors, binary vectors, Application of Plant Transformation for productivity and performance: Herbicide Resistance: phosphinothricin, glyphosate, sulfonamide, atrazine; Insect resistance: Bt genes, Non-Bt like Protease Inhibitors, alpha amylase 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

#### Recommended books:

1. Molecular Biology of the Gene, 5<sup>th</sup> edn. (2004) J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick, Pearson Education Inc.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell, Garland Publishing, Inc., New York
3. Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA
4. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
5. Kleinsmith, L. J. and Kish, V. M. 1995 Principles of Cell and Molecular Biology (2<sup>nd</sup> Edn.) Harper Collins Coll. Publisher, New York, USA.
6. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3<sup>rd</sup> Edi.) Jones and Bartiet Pub. Inc., London

7. Wolf, S. L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA
8. Genes VII. - Benjamin Lewin, Oxford Univ. Press, Oxford (2000)
9. Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. Molecular Cell Biology - 4th edn.
10. American Scientific Books. W.H. Freeman, New York (2000).
11. Twyman, R.M., Advance Molecular Biology Bios Scientific publishers Oxford 1998.
12. Brown, T.A. Molecular Biology -, 3rd edition.