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

Candidates opting for this course are advised to go through the direction relating to the course "DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)" which is available on R. T. M. Nagpur University website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

Appendix-I

Scheme of Teaching under choice based credit system for M.Sc. Program in Molecular Biology and Genetic Engineering

S.No.	Semester	Course Code/Paper	Title of the Paper	Course/ Paper	Teaching Scheme		
					Theory [Hours]	Practical [Hours]	Number of Credits
1	One	1T1	CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)	I	04	04	04
2	One	1T2	BASIC BIOCHEMISTRY	II	04	04	04
3	One	1T3	MOLECULAR BIOLOGY I	III	04	04	04
4	One	1T4	MOLECULAR BIOLOGY II	IV	04	04	04
5	One	1P1	BASED ON COURSE : I & II	Prac.I			04
6	One	1P2	BASED ON COURSE : I III & IV	Prac. II			04
7	One	1S1	Seminar				01
8	Two	2T1	BIOPHYSICAL ANALYTICAL TECHNIQUES	I	04	04	04
9	Two	2T2	ENZYME TECHNOLOGY & IMMUNOLOGY	II	04	04	04
10	Two	2T3	IPR, BIOSAFETY,BIOETHICS AND ENTERPRENEURSHIP	III	04	04	04
11	Two	2T4	BIOINFORMATICS AND DATA MINING & LAB. MANAGEMENT & SAFETY	IV	04	04	04
12	Two	2P1	BASED ON COURSE V&VI	Prac.I			04

13	Two	2P2	BASED ON COURSE VII &VIII	Prac. II			04
14	Two	2S1	Seminar				01
15	Three	3T1	INDUSTRIAL APPLICATIONS OF GENETIC ENGINEERING	I	04	04	04
16	Three	3T2	RECOMBINANT DNA TECHNOLOGY I	II	04	04	04
17	Three	3T3	ELECTIVE I	III	04	04	04
18	Three	3T4	FOUNDATION COURSE I	IV	04		04
19	Three	3P1	Based on COURSE IX – X	Prac.I			04
20	Three	3P2	Based on COURSE XI	Prac. II			04
21	Three	3S1	Seminar				01
22	Four	4T1	PLANT & ANIMAL GENETIC ENGINEERING	I	04	04	04
23	Four	4T2	RECOMBINANT DNA TECHNOLOGY II	II	04	04	04
24	Four	4T3	ELECTIVE II	III	04	04	04
25	Four	4T4	FOUNDATION	IV	04		04
26	Four	4P1	Based on COURSE XIII – XV	Prac.I			04
27	Four	4P2	Project	Prac. II			04
28	Four	4S1	Seminar				01

1. In each semester student will have to give seminar on any topic relevant to the syllabus encompassing the recent trends and development in the field. The topic of the seminar will be decided at the beginning of the semester in consultation with the supervising teacher. Seminar will be open to all the teachers of the department invitees and students.
2. The students will have to carry out the research based project work in lieu of practical in the fourth semester in the department or depending on the availability of placement;; he/she will be attached to any of the national/regional/private research institute for the duration of fourth semester. The student will be randomly allotted the priority umber for the selection of the supervisor in the third semester. The student in consultation with supervisor will finalize the topic of the project work at the third semester.
3. The course can be taught by person having post graduate qualification in relevant/ equivalent subjects/ or having teaching/ research experience in that particular field.

Course structure of M.Sc. syllabus to be implemented from 2017-18

Course code No.	Title o the course	Credits allotted
Semester I		**25 Credits**
MBGE I I T1	CELL BIOLOGY (PROKARYOTES AND EUKARYOTES)	4
MBGE II IT2	BASIC BIOCHEMISTRY	4
MBGE III 1T3	MOLECULAR BIOLOGY I	4
MBGE IV 1T4	MOLECULAR BIOLOGY II	4
MBGE I P1	PRACTICAL I : BASED ON COURSE : I & II	4
MBGE I P2	PRACTICAL II : BASED ON COURSE : III & IV	4
1S1	SEMINAR	1
Semester II		**25 Credits**
MBGE V 2T1	BIOPHYSICAL ANALYTICAL TECHNIQUES	4
MBGE VI 2T2	ENZYME TECHNOLOGY & IMMUNOLOGY	4
MBGE VII 2T3	IPR, BIOSAFETY, BIOETHICS AND ENTERPRENEURSHIP	4
MBGE VIII 2T4	BIOINFORMATICS AND DATA MINING & LAB. MANAGEMENT & SAFETY	4
MBGE III 2P1	PRACTICAL III – V & VI	4
MBGR IV 2P2	PRACTICAL IV – VII & VIII	4
2S1	SEMINAR	1
Semester III		**25 Credits**
MBGE IX 3T1	INDUSTRIAL APPLICATIONS OF GENETIC ENGINEERING	4
MBGE X 3T2	RECOMBINANT DNA TECHNOLOGY I	4
MBGE XI 3T3	ELECTIVE I	4
MBGE XII 3T4	SUBJECT CENTRIC I / FOUNDATION COURSE I	4
MBGE V 3P1	PRACTICAL V: COURSE IX – X	4
MBGE VI 3P2	PRACTICAL VI : COURSE XI	4
3S1	SEMINAR	1
Semester IV		**25Credits**
MBGE XIII 4T1	PLANT & ANIMAL GENETIC ENGINEERING	4
MBGE XIV 4T2	RECOMBINANT DNA TECHNOLOGY II	4
MBGE XV 4T3	ELECTIVE II	4
MBGE XVI 4T4	SUBJECT CENTRIC II / FOUNDATION COURSE II	4
MBGE VII 4P1	PRACTICAL VII: COURSE XIII – XV	4
MBGE VIII 4P2	PROJECT	4
4S1	SEMINAR	1

ELECTIVE PAPERS – 1) PLANT GENETIC ENGINEERING I & II or
2) MOLECULAR DIAGNOSTICS FOR GENETIC DISORDERS/DISEASES I & II or
3) BIOINFORMATICS I & II

Foundation course : For other than Mol. Bio.& Gen. Eng students

PAPER I: MOLECULAR BIOLOGY

Paper II: RECOMIBINANT DNA TECHNOLOGY and PLANT GENETIC ENGINEERING

M.Sc. Molecular Biology and Genetic Engineering

Semester I

Course code/name:

MBGE I (1T1) : 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, 15 L
chemical composition of viruses, Nomenclature and classification of viruses
(8^{th} report of ICTV). Genetic classification of viruses, Life cycle of T4 phage,
Lambda (λ) phage, Retroviruses (HIV), TMV, and SV40, Methods of cultivation
of viruses, Importance of viruses in biotechnology.

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, Lews, J., Raff, M., Roberts, K and Watson, J.D. 1991 3rd 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 5thedn. (2005)
8. General Microbiology – R. Y. Stanier, J. L. Ingraham, M. L. Wheelis, Page R Painter;
9. MacMillan Press ltd; 5th edn (1986)
10. Microbiology, Tortora, Funke and Chase, Benzamin & Cummings
11. Manual of microbiology: Tools and Techniques 2nd Edn., Kanika Sharma, Ane Books Ltd.

Course code/name: MBGE II (1T2): 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, 1^0, 2^0, 3^0, 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 pigements

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, VanBrergen, 4th edn. Oxford & IBH, 1966.
7. Biochemistry- Champe, P., 3rd Edn., Lippincott Willams & Wilkins, 2005.
8. Biochemistry-Zubay, G., 3rd 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. 2nd Edition, Sadasivam *et al*. New Age International.
13. Practical Biochemistry 3rd Edition, David Plummer. Tata McGraw Hill.
14. Short Protocals in cell Biology. Borifacino ehale, Jon Wiley Plublishing House.
15. Das, H. K. Text book of Biotechnology, wiley dream tech India pvt ltd. 2005.

Course code/name: MBGE III (1T3): 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, 3rd edn. (1995) W.H.H. Lodish, A. Berk, and C. A. Kaiser, Freeman & Co Ltd.
2. Molecular Biology of the Gene, 5th 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 (2nd Edn.) Harper Collins Coll. Publisher, New York, USA.
7. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd 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 (1T4) : MOLECULAR BIOLOGY II
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module 1: 15L

Biosynthesis of purines and pyramidine 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 interfence (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 (2T1): 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, Isotachophoresis, 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 Morality, Normality and its Standardization by titration methods.
3. Separation and Identification of Biomolecules by TLC,/ gel filtration/ iox 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, 6th Ed. Wilson Keith and Walker John (2005) Cambridge University Press, NewYork.

Course code/name:

MBGE VI (2T2) : 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, Linewaever-Burke plot, Eadie-Hofstee plot, Competitive, uncompetitive and non-competitive inhibition

Module 2: 15L

Concept of ribozyme and catalytic antibiodies 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, innune 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. Sandwitch 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 agglutation 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, 5th edn. (2003)
2. Essential Immunology - Ivan M. Roitt, Peter J. Delves Blackwell Science Ltd., 10th Edn. (2001)
3. An Introduction to Immunology - C.V. Rao; Narosa Publishing House,1st Edi.(2004)
4. Instant Notes in Immunology - P.M. Lydyard, A. Whelan, M.W. Fanger BIOS Scientific Publ. Ltd, 1st 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, 2nd 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 2nd edn.
13. C. Brown publishers.
14. Immunology - D. M. Weir and J. Steward 7th Edn.

Course code/name:

MBGE VII (2T3) : 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, 15L
codes, policies and Procedures, recognition, friendship, personal gains
Professional ethics – professional conduct
Ethical decision making, ethical dilemmas
Teaching ethical vaues to scientists, good laboratory practices, good manufacturing practices, laboratory acModuleation
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: Catagena 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 trails, 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 Dutfield, 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 Mosses V, Cape RE,2nd 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

2) Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. www.ipmatters.net/features/000707_gibbs.html

Course code/name:

MBGE VIII (2T4) : 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:

Basic concepts of sequence, similarity, identity and homology, definitions of 15L 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:

Standards for analysis & Quality management 15L

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 AcModuleation, AcModuleation Boards, NABL guidelines for AcModuleation in India

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

Module 4:

Laboratory Management & Safety : 15L

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 2nd 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 3rd Edi., PHI Learning Pvt. Ltd..

www.wormbook.org
www.ceolas.org/VL/mo/
www.nih.gov/science/models/arabidopsis/index.html

Practicals (10 credits)
MBGE III (2P1) Practical III – V& VI (5 Credits)
MBGR IV (2P2) Practical IV – VII & VIII (5 Credits)

SEMESTER III

Course code/name:

MBGE IX (3T1) : 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:

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. 15L
Whole cell Immobilization and their Industrial Applications.
Microbial applications for mineral beneficiation (bioleaching) and oil recovery.

Module 3:

Environment: Basic concepts and global issues. 15L
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:

Environmental Biotechnology, Environment-friendly technologies- biobleaching. 15L
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 2nd Edn. Mc Graw Hill, New Delhi.
4. Malik, V. S. and Sridhar, P. 1992 Industrial Biotechnoogy, 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 Biotechnolgy
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 Muhkerjee V. Publication House
22. Pollution Biology: Hynes
23. Environmetal Biology by Biswarup Muhkerjee Tata Mcgraw Hill
24. Modern Concepts of Ecology by H.D.Kumar
25. Cunning, P. (1995). Official Methods of Analysis, Vol. I and II, 16th Edn, Arlington,Virginia,
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
29. Water and Waste Water, 20th 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 (3T2): 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 transncription –
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, 3rd Edn., Farell, R. Elsevier 2005
2) Molecular Cell Biology-Lodish , Berk, 5th Edn. Freeman 2003
3) Molecular Biology of the Cell, 5th edn, Alberts 2008, Grandland science
4) Cells-Levin, 1st Ed. Jones & Bartlett Publisher 2006
5) The cell – A molecular Approach 4th Edu. Geoffrey M. Cooper, Rober E. Hausman
6) Genes IX - Lewin B. 2004, Prentice Hall
7) Biochemistry – Voet D. Voet J. G. 3rd 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, Elservier, 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) Sambrrok, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd 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 (3T3): 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 phenoilpropanoid 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 (3T3) : 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 (3T3): 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 Biostatics:

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 Biometery" 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: Subject Centric paper I
MBGE (T): XII: Cytology and Genetics
(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module I

Cell theory; cell division (mitosis and meiosis)

Structure and Molecular organization of chromosomes; special chromosomes (lampbrush chromosomes, polytene chromosomes, B-chromosomes); Karyotype and its evolution

Variations in chromosome: Numerical variations (heteroploidy), aneuploids and euploids- their occurrence, inheritance, subtypes and significance; structural variations- their occurrence, inheritance, subtypes and significance

Module II

History of genetics; Mendelism: Mendel's work on pea, laws of inheritance; deviations from Mendel's findings: incomplete dominance, codominance, multiple alleles, isoalleles, modifier genes, suppressor genes, pleiotropic genes

Chromosome theory of inheritance

Gene interaction: Non-epistatic and epistatic (9:7, 9:3:4, 13:3, 12:3:1, 15:1)

Lethal genes: Penetrance and expressivity, Dominant and recessive lethals, balanced lethal system

Module III

Non-Mendelian inheritance: Maternal effect; Cytoplasmic inheritance

Linkage and crossing over; genetic and cytological mapping; tetrad analysis

Polygenic inheritance: Multiple gene hypothesis; examples- skin colour in humans and flower length of tobacco, Pure lines of Johannsen and multiple factor hypothesis; simple and complex quantitative traits

Sex determination: Sex-linked, sex-influenced and sex-limited characters; mechanism of sex determination- Chromosomal, genic and environmental

Module IV

Chemical nature of gene: Nucleic acid as genetic material; Prions; structure of nucleic acids

Fine structure of gene; position effect; pseudoalleles

Overlapping genes; pseudogenes; Retrogenes; cryptic genes

Epigenetics: Paramutations; Callipygh sheep; Histone code; DNA methylation; genomic imprinting; epigentics and Lamarckism

Suggested reading

Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.

Khush G S 1973 Cytogentics of Aneuploids.Academic press, New York.

Pierce B A 2012 Genetics- A conceptual approach. WH Freeman and Company, New York

Snustad D P and Simmons M J 2000 Principles of Genetics (2 ed.) John Wiley and Son Inc., USA.

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]

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 pyramidine 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:

2. 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

Semester IV

Course code/name:

MBGE XIII (4T1) 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

<u>Animal Tissue Culture</u>

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

<u>Animal improvement</u>

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. Cylnes; 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, 4th edn.
12. H. K. Das, Text book of Biotechnology, Wiley dream tech India pvt.ltd.,2005
13.S. Sasidhara animal Biotechnology, MJP Pub. Chennai
14. S.S. Tomar Text book of Animal breeding Kalyani Pub. Kolkata

Course code/name: MBGE XIV (4T2):

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 (4T3): 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 (4T4) : 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 Dermetophytoses, Candidiosis and Aspergillosis; caused by protozoa's such as *Amoebiosis, Malaria, Trypnosomiosis, 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, Gonorrhea and others

MODULE 3: 15L

Genetic disorders: Sickle cell anaemia, Thalassemias, 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.

Neurogeneti 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 (4T4)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. & Ouellettee, 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 Algorithims. 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
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36. http://wiki.bioinformatics.org/Computational_Biology_%28Wunschiers%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 II: 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. (σ) (*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 (χ^2 *test*) and its use in Genetics;
   b) Application or Role of χ^2 *test*... in Contingency (row and column) Tables [for Trials permitting more than two possible outcomes (*r* X *c* table)];
   c) Application or Role of χ^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

Course Code: Subject Centric paper II

MBGE (T): XVI: Applied Genetics

(Total CREDITS 4, 1 CREDIT FOR EACH MODULE)

Module I

Population genetics: Gene pool and gene frequencies; Hardy-Weinberg's law; factors affecting Hardy-Weinberg's equilibrium- mutation, migration, genetic drift and selection; Random drift and Wright-Fisher model; molecular population genetics- AMOVA; genetic distance; genetic relatedness and identity; detection of selection events; coalescent theory

Behavioural genetics: History; evidences for genetic basis of behavior; methods for genetic analysis of behavior; Examples- Courtship in *Drosophila*, temperament in mammals, emotional stability and schizophrenia; effect of environment on behavior; ethical and social issues

Module II

Evolutionary genetics: Theories of organic evolution; mutation theory; original synthetic theory; evolution at molecular level; processes of creating variation; genotype and phenotype spaces; genetics of speciation- species and races, concept of species; isolating mechanisms; adaptive landscapes and speciation; models of speciation; molecular genetics of speciation; speciation revolution

Developmental genetics: Introduction; Pattern formation in *Drosophila*- development, egg-polarity genes, segmentation genes, homeotic genes, epigenetic changes; flower anatomy and genetic control of flower development

Module III

Plant breeding: Genetic basis of plant breeding; Methods of breeding sexually (self- and cross-pollinated) and vegetatively propagated crops; Genetic basis of inbreeding depression and heterosis; Self-incompatibility; male sterility- types and its use in plant breeding; Molecular plant breeding; Crop genetic resources; seed production and certification

Module IV

Eugenetics: Human karyotype- Chromosome number and morphology, banding, FISH, McFISH; Genetic disorders- Turner's syndrome, Klinefelter's syndrome, Down's syndrome, Patau syndrome, superfemale; Dizygotic and monozygotic twins; Chromosome mapping in humans- linkage maps, molecular maps, transcript map; Use of human genetics in medical science- Chromosome or DNA tests

References

Chopra V L 2000 Plant breeding theory and practice 2e. Oxford and IBH, New Delhi.

Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Hexter W and Yost Jr. H T 1977 The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.

Hartl D L and Jones E W 1998 Genetics: Principles and Analysis (4thed.). Jones and Barflett Publishers, USA.

Pierce B A 2012 Genetics- A conceptual approach. WH Freeman and Company, New York

Snustad D P and Simmons M J 2000 Principles of Genetics (2 ed.) John Wiley and Son Inc., USA.

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

Course code/name: MBGE(T): RECOMIBINANT 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, electrophoration 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: phosphoinothricin, glyphosate, sufonyl urea, 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, 5th 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 (2nd Edn.) Harper Collins Coll. Publisher, New York, USA.

6. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd 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.

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

COURSE PAPER. The theme: Slang and its role in literary text. Written by: Matisakova Guzal.Â The practical importance of the course paper is that one can compile a handbook on Stylistics and Comparative study of language on the base examples. The course paper consists of Introduction, main part, Conclusion and Bibliography. Introduction deals with the main purpose, methods and theoretical, practical importance of the work. Also, here was given information about the structure and brief plot of the course paper. Main part deals with general ideas on Slang, characteristic features of Slang and the Dictionary types, Youth speak and analysis of some youth slang. Conclusion is about the ach Discover 4 main components of a research paper with the PapersOwl Guide. Look at an example of a correct paper structure in APA and MLA style.Â The structure of a research paper outline is a part of the process that requires maximum attention and scrupulosity, and it has a lot of helpful functions that not only assist during writing but also define the writer as a scientist. The structure has the following functions. Expository function. This preview shows page 12 - 14 out of 15 pages. Duration of Theory Paper: 3 Hours 4 - 2 Min 35 25 25 25 110 Course Objectives: To familiarize with the fundamentals of design and implementation of system Software.Â Prerequisite(s): Computer Programming COURSE OF CONTENTS Unit I Introduction to Object Oriented Programming: Object Oriented Concepts, Merits of Object Oriented Technology. Abstraction, Encapsulation, Information Hiding. Object Model: definition, State, behavior, Identity and messages. The theme of our course paper is "Comparison of nouns in English and Russian languages". The aim of investigation is to give more understandable and interesting information about the nouns in English and Russian languages and to find out similarities and differences between them. Object: the category of case and number of nouns in English and Russian.Â In theoretical part of our course work we investigated two main questions: classification of nouns in English and morphological characteristics of nouns. We had found that nouns are classified into: (A) proper nouns; (B) common nouns.There are different groups of common nouns: class nouns, collective nouns, nouns of material and abstract nouns.