UNIVERSITY OF RAJASTHAN, JAIPUR

~~M.A.~~/M.SC./~~M.COM~~

(BIOTECHNOLOGY)

2013-2014 (PREVIOUS)-I/II SEMESTER

2014-2015 (FINAL)- III/IV SEMESTER

Prepared by 16/9

Checked by 24/9

UNIVERSITY OF RAJASTHAN
JAIPUR

M. Sc. BIOTECHNOLOGY
SYLLABUS SEMESTER SCHEME

Sessions 2012-2014

Session-2012-2014

M. Sc. Biotechnology Semester Scheme ~~2011-13~~

First Semester

Paper	Title of the Paper	Max. Marks
I	Cell Biology	100
II	Genetics	100
III	Microbiology	100
IV	Biotechniques	100
Practical I	Based on theory papers I & II	100
Practical II	Based on theory papers III & IV	100

Second Semester

V	Molecular Biology	100
VI	Genetic Engineering	100
VII	Computer applications, Biostatistics & Bioinformatics	100
VIII	Biological macromolecules & Enzymology	100
Practical III	Based on theory papers V & VI	100
Practical IV	Based on theory papers VII & VIII	100

Third Semester

IX	Animal cell science & Technology	100
X	Plant Biotechnology	100
XI	Bioprocess engineering	100
XII	Environmental Biotechnology	100
Practical V	Based on theory papers IX & X	100
Practical VI	Based on theory papers XI & XII	100

Fourth Semester

XIII	Industrial Biotechnology & Bio safety	100
XIV	Pathogenesis & Immunology	100
XV	Intellectual property rights, Entrepreneurship, Ethics and Research	100
Practical VII	Based on theory papers XIII & XIV	100
XVI	Elective Paper (Seminar)	100
XVII Project work	Dissertation, Industrial training, Industry visit, Seminars	100
Total Marks		**2400**

FIRST – SEMESTER

S. No.	Subject Code	Course title	Course category	Credit	CONTACT PER HOUR			EoSE DURATION (HRS)	
					L	T	P	THY	P
1.	BTH 101	Cell Biology	CCC	6	6	0	0	3	0
2.	BTH 102	Genetics	CCC	6	6	0	0	3	0
3.	BTH 103	Microbiology	CCC	6	6	0	0	3	0
4.	BTH 104	Biotechniques	CCC	6	6	0	0	3	0
5.	BTH 111	PRACTICAL – I (BTH – 101, BTH – 102)	CCC	6	0	0	9	0	4
6.	BTH 112	PRACTICAL-II (BTH-103, BTH-104)	CCC	6	0	0	9	0	4
7.	**TOTAL CREDITS IN SEMESTER**			**36**	-	-			

SECOND – SEMESTER

S. No.	Subject Code	Course title	Course category	Credit	CONTRACT PER HOUR			EoSE DURATION (HRS)	
					L	T	P	THY	P
1.	BTH 201	Molecular biology	CCC	6	6	0	0	3	0
2.	BTH 202	Genetic engineering	CCC	6	6	0	0	3	0
3.	BTH 203	Computer applications, Biostatistics & Bioinformatics	CCC	6	6	0	0	3	0
4.	BTH 204	Biological macromolecules & Enzymology	CCC	6	6	0	0	3	0
5.	BTH 211	PRACTICAL –III (BTH – 201, BTH –202)	CCC	6	0	0	9	0	4
6.	BTH 212	PRACTICAL-IV (BTH-203, BTH-204)	CCC	6	0	0	9	0	4
7.	**Total credits in the semester**		-	**36**					

THIRD – SEMESTER

S. No.	Subject Code	Course title	Course category	Credit	CONTRACT PER HOUR			EoSE DURATION (HRS)	
					L	T	P	THY	P
1.	BTH 301	Animal cell science & Technology	CCC	6	6	0	0	3	0
2.	BTH 302	Plant Biotechnology	CCC	6	6	0	0	3	0
3.	BTH 303	Bioprocess engineering	CCC	6	6	0	0	3	0
4.	BTH 304	Environmental Biotechnology	CCC	6	6	0	0	3	0
5.	BTH 311	PRACTICAL – V (BTH – 301, BTH – 302)	CCC	6	0	0	9	0	4
6.	BTH 312	PRACTICAL-VI (BTH-303, BTH-304)	CCC	6	0	0	9	0	4
7		**Total credits in the Semester**	-	**36**					

FOURTH – SEMESTER

S. No.	Subject Code	Course title	Course category	Credit	CONTRACT PER HOUR			EoSE DURATION (HRS)	
					L	T	P	THY	P
1.	BTH 401	Industrial Biotechnology & Bio safety	CCC	6	6	0	0	3	0
2.	BTH 402	Pathogenesis & immunology	CCC	6	6	0	0	3	0
3.	BTH 403	Intellectual property rights, Entrepreneurship, Ethics and Research	CCC	6	6	0	0	3	0
5.	BTH 411	PRACTICAL –VII (BTH – 401, BTH – 402)	CCC	6	0	0	9	0	4
7.	BTH 412	Elective Paper (SEMINAR)	SEM	4	0	0	4	0	1
8.	BTH 413	Dissertation		8	0	0	8	0	1
8.	**Total credits in the Semester**		-	**36**					

M.Sc. Biotechnology: Scheme of examination (2011-2013)

Note:

1. The course of M. Sc. (Biotechnology), semester scheme will be spread over two academic years consisting of four semesters, two semesters each in M. Sc. Previous (Semester I and Semester II) and M. Sc. Final (Semester III and Semester IV).The PG course (M. Sc. Biotechnology) of all the four semesters shall be of 144 credits i.e., each semester of PG course shall offer 36 credits. The candidate is required to earn a minimum of 120 credits.
2. Each semester will have continuous assessment which will include internal assessment in theory and practical by internal examination/ seminar/ oral examination- viva voce etc. and the maximum marks will be 30. This will not be included for main University examination.
3. In theory, 15 hrs of theory teaching will be equivalent to one credit.
4. In practical and dissertation, 45 hrs of laboratory work will be equivalent to 2 credits.
5. Each theory paper shall carry 100 marks and will be of 3 hrs duration.
6. The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.
7. Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.
8. Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).
9. The Elective paper in the M.Sc. IV Semester will be based on detailed review report on one of the courses listed in the syllabus. The student will make a complete report in about 100 pages that shall be evaluated by the course coordinator and one internal teacher. The marks will be awarded internally.
10. The project work will involve in depth practical work on a problem suggested by the supervisor of the candidate. The evaluation of the dissertation will be done by the external examiner and carry 100 marks. The dissertation submitted by the candidate shall be evaluated by one external expert, Head of the department and supervisor of the candidate. The seminars, in-plant training and industrial visit reports will also be submitted by the candidate to the Head of the Department who will submit these to the external examiner. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under:

Dissertation	75 marks
Viva voce	25 marks
Total	**100 marks**

I Semester –Paper I
Cell Biology (BTH 101)

Time: 3 hrs.

Max Marks: 100
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

The Dynamics of cell, shape and motility: Structural organization of the plant cell, biochemical energetics. Cytoskeleton, microtubules and microfilaments, motor and flagellar movements.

Cell wall, plasma membrane and plasmodesmata: Structure and functions, growth models and functions, sites for ATPases, ion carriers, channels and pumps, receptors. Role in movement of molecules and macromolecules, comparison with gap junctions. Transport across membranes.

Introduction to cytogenetics, cytological methods, pretreatments, chemical fixatives, fixation, stains and mechanism of staining.

Chloroplast and mitochondria: Structure, Organization and function of mitochondrial and chloroplast genomes, diversity and evolution of organelle genomes.

Other Cellular organelles: Structure and functions of micro-bodies, Golgi apparatus, ribosomes, lysosomes, endoplasmic reticulum.

Plant vacuole: Structure and function

Nucleus: Structure, nuclear pores, nucleosome organization, nucleolous.

Chromatin organization : Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, euchromatin and heterochromatin, specialized types of chromosomes, polytene, lampbrush, B-chromosomes , supernumerary chromosomes, molecular basis of chromosome pairing.

Cell Death: Introduction to Necrosis, Senescence, Apoptosis – Programmed cell death, Mechanism of apoptosis, Apoptosis triggered by internal signals, Apoptosis triggered by external signals, Apoptosis inducing factor, Apoptosis in cancer, immune system, organ transplants, Apoptosis in plants.

Cell communication and Signal transduction: Overview of extra cellular signaling Basic characteristics of cell synthatase system- Paracrine, endocrine, autocrine synthatase. Tight junctions and Gap junctions, signal molecules- hormones, neurotransmeter proteins, environmental factors

Second messengers and their role in signal transduction, Second messengers Camp, lipid derived second messenger (phosphatidyl inositol derived second messenger) & IP3 Role of calcium as second messenger

Cell surface receptors in signal transduction, G-protein coupled receptor – structure and function, Ion channel receptors, Tyrosine kinase linked receptors, Receptors with intrinsic enzyme activity (RTK)

Interaction and regulation of cell signaling pathways- bacterial and plant two component signaling system, bacterial chemotaxis and quorum sensing.

Mechanics of cell division: Cell cycle, Components in cell cycle control – Cyclin , CDKs Check points in cell cycle. The events of m phase, CDK & cyclin B leading to Metaphase the check points. The spindle assembly check points leading to Anaphase. DNA damage check point controlled by P 53 protein. Ras and Map (mitogen activated protein kinases).

Different stages of mitosis: Cohesins and condensins in chromosome segregation, Microtubles in spindle assembly, Structure of kinetochore, centrosome and its functions, Sister Chromatid separation. Cytokinesis actin & myosin in the generation of contractile ring, somatic metaphase.

Meiosis– Significance, Chiasma formation- Synaptonemal complex, Recombination during meiosis- Recombination nodules.

Abnormalities in Cell Cycle- Cancer

Suggested Laboratory Exercises:

1. EM study of cell organelles
2. Study of stages in cell cycle
3. Mitosis and Meiosis
4. Histochemical localization of protein, carbohydrate, fats, starch, lignin, DNA, RNA etc
5. Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
6. Demonstration of SEM and TEM.
7. Karyotype analysis, banding patterns
8. Polytene, lampbrush, B-chromosomes and sex chromosomes,
9. Linear differentiation of chromosomes through banding techniques, such as G banding, C-banding and Q-banding.
10. Silver banding for staining nucleolus-organizing region, where 18S and 28S rDNA are transcribed.
11. Orcein and Feulgen staining of the salivary gland chromosomes of Chironomas and Drosophila.
12. Characteristics and behavior of B chromosomes using maize or any other appropriate material.
13. Any other practical based on theory syllabus.

Suggested readings:

1. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
2. De, D.N: 2000. Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
3. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
4. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.

5. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
6. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers. Boston, Massachusetts.
7. Karp, G. 1999. Cells and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc., U.S.A.
8. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.

I Semester –Paper II
Genetics (BTH 102)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

Mendelian and non- Mendalian inheritance, Gene interaction (12:3:1; 9:3:4; 9:7 ratios), Epistasis, hypostasis,co-dominance, Lethal Genes, Linkage and chromosome mapping in eukaryotes, Polygenic inheritance

Extra nuclear inheritance, Cytoplasmic male sterility, inheritance of mitochondrial and chromosomal plant genes, Hardy-Weinberg Law. Gene frequency and genotype frequency

Cancer: Proto- oncogenes, oncogenes and tumor suppressor genes.

Human genetics: Pedigree analyses, lod score for linkage testing, karyotypes and genetic disorders.

General account of inherited human diseases

Gene mapping : Molecular and Physical maps, Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, QTL mapping, Development of mapping population in plants.

Recombination: Homologous and non-homologous recombination, molecular mechanism of recombination, Holiday junction. Transposition, Site specific recombination; Gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination; Role of Rec A and Rec BCD enzymes and other recombinations.

Gene structure and expression: Genetic fine structure, cis-trans test, fine structure analysis of eukaryotes, introns and their significance, RNA splicing, regulation of gene expression in prokaryotes and eukaryotes.

Structural and numerical alterations in chromosomes : Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes, Origin, occurrence, production and meiosis of haploids, aneuploids and euploids, origin and production, of autopolyploids, chromosome and chromatid segregation, allopolyploids, types, genome constitution and analysis, evolution of major crop plants, induction and characterization of trisomics and monosomics.

Mutation, Mutagenesis and types of DNA damage: Mutagens and their effects – Physical(Radiations) and Chemical (Base analogues, Intercalating agents, Alkylating agents and others), Types of mutation- lethal, conditional, biochemical, loss of function, gain of function, base substitution, frame-shift mutation, germinal verses somatic mutants. Mutations induced by transposons. Insertional mutagenesis, in vitro mutagenesis and deletion techniques, Ames test for mutagenesis. Ploidy and their genetic implications.

Repair mechanisms of mutational DNA damages- Direct reversal of damages (Photoreactivation and Dealkylation), Excision Repair mechanisms (NER and BER), Post-replication repair mechanisms (Mismatch repair and Recombination repair), SOS repair.

Suggested Laboratory Exercises:

1. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
2. Silver banding for staining nucleolus-organizing region, where 18S and 28S rDNA are transcribed.
3. Working out the effect of mono- and trisomy on plant phenotype, fertility and meiotic behaviour.
4. Induction of polyploidy using colchicines, different methods of the application of Colchicines.
5. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
6. Effect of translocation heterozygosity on plant phenotype. chromosome pairing and chromosome disjunction and pollen and seed fertility.
7. Meiosis of comp1ex translocation heterozygotes.
8. Isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens.
9. Working out the effect of mono- and trisomy on plant phenotype, fertility and meiotic behavior..
10. Analysis of morphological and molecular diversity in different cultivars/varieties of a crop plant.
11. Any other practical based on theory syllabus.

Suggested Readings:

1. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
2. Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
3. Busch, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus rDNA Part A. Academic Press.
4. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
5. Khush,G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
6. Lewis, R. 1997. Human Genetics: Concepts and Applications (2nd editions). WCB McGraw Hill, USA.

7. Russel, P.J. 1998. Genetics (5th edition). The Benjamin/Cummings Publishing Company INd., USA.
8. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd edition). John Wiley & Sons Inc., USA.
9. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: laboratory Methods. CRC Press, Boca ratan, Florida.
10. Sharma, A.K. and Sharma, A. 1999. Plant Chromosome Analysis, Manipulation and Engineering. Hoarwood Academic Publisher, Australia.
11. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd.USA.

I Semester –Paper III
Microbiology (BTH 103)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

History and Development of Microbiology, Microbial evolution, systematic and taxonomy-Evolution of earth and earliest life forms; primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Nomenclature and Bergey's Manual.

Prokaryotic and eukaryotic diversity: Prokaryotic Cells: Structure and Function-Cell wall composition of Gram+ve & -ve bacteria; Cell wall and cell membrane

synthesis; Flagella and motility; cell inclusions like endospores, gas vesicales. Bacteria: Purple and green bacterial, Cyanobacteria; budding bacteria, Spirochaetes; Sheathed bacteria, Endospore forming rods and cocci; Mycobacteria; Rickettsias, Chlamydias and Mycoplasms, Archaea: Archaea as earliest life forms; Halophiles, Methanogens; Hyperthermophilic archaea and Thermoplasma. Eukarya: Algae, Fungi, Slime molds and Protozoa.

Microbial Diseases-Disease reservoirs; Epidemiologial terminologies; infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases; Disease transmitted by animals(rabies),insects and ticks(rickettsias, malaria),Food and water borne diseases; Public health and water quality; Emerging and resurgent infectious diseases. Plant diseases caused by microbes.

Microbial Growth: Pure culture technique; and auxotrophs. Microbial Growth-The definition of growth, mathematical expression of growth, growth cure, measurement of growth and growth yields, Synchronous growth, Continuous, Batch and Fed Batch Culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection maintenance and preservation.

Bacterial genetic system (recombination, transformation, conjugation, transduction) Bacterial genetic map with reference to *E. coli*. Genetic system of yeast and *Neurospora*

Physiology and Metabolic Diversity among Microorganisms-Nutritional classification of microorganisms- chemoautotrophs, chemotheterotrophs and photosnthetic microorganisms. Photosynthesis in microorganisms; Chemolithotrophy; Hydrogen, Iron, Nitrate and oxidizing bacteria; Nitrate and sulfate reduction; Syntrophy; Role of anoxic decomposition; Nitrogen metabolism; Nitrogen fixation, Hydrocarbon transformation.

Chemotherapy and Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and Cephalosporins; Broad-Spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Suggested Laboratory Exercises:

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms.
3. Isolation of pure cultures from soil and water.
4. Growth; Growth curve, Measurement of bacterial population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen source on growth.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
6. Study of mutations by Ames test.
7. Analysis of water for potability and determination of MPN.
8. Biochemical characterization of selected microbes.
9. Other practical based on theory syllabus.
10. Any other practical based on theory syllabus.

Suggested Readings:

1. General Microbiology, Stainer,R.Y.,Ingraham,J.L,Whelis,M.L and Painter,P.R. The Macmillan Press Ltd.
2. Brock Biology Microorganism,Madigan,M.T.,Martinko,J.M. and Parker,J.Printice-Hall.
3. Microbiology,Pelczar,M.J.Jr.,Chan,E.C.S. and Kreig,N.R.,Tata McGraw HIll.
4. Microbial Genetics,Maloy,S.R.,Cronan,J.E.Jr. andFreifelder,D.Jones,Bartlett Publishers.
5. Microbiology-a Laboratory Manual,Cappuccino,J.G and Sherman,N.Addison Wesley.
6. Microbiological Applications,(A Laboratory Manual in General Microbiology)Benson,H.J.WCG;Wm C.Brown Publishers.
7. Microbiology:Fundamentals and Applications,S.S. Purohit,Published by Agrobios, India.
8. Industrial Microbiology, A.H. Patel.

I Semester –Paper IV

Biotechniques (BTH 104)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

General techniques: Microscopy- SEM, TEM, Confocal microscopy. Staining techniques. Micrometry, measurement of dimensions, counting of cells by haemocytometer. Histochemical techniques-Localization of nucleic acids ,proteins, lipids, carbohydrates and enzymes.

Chromatography-Paper chromatography, TLC,GC/GLC,HPLC, Ion Exchange chromatography, Affinity chromatography, Adsorption chromatography, Spectrophotometry, Electrophoresis (Paper, Gel, Immunodiffusion etc.)

Preparation of buffers, Evaluation of PKa's, Enzyme immobilization technique.

Spectroscopy, GCMS, NMR.

Proteins: Isolation of proteins, Estimation of proteins by Lowry and Bradford's methods. Thermal unfolding and stability of proteins, Reduction of disulphide bonds of proteins.

Carbohydrates: Estimation of glucose by Glucose oxidase (Trinder's reagent), Estimation of reducing sugars by Nelson Somogi's method, Effect of temperature, time and substrate concentration on α-amylase activity.

Genetics and Molecular Biology: Genetic recombination, Techniques and screening of recombinants, Insertion mutation of a cloned gene, Isolation of plasmids and their curing, Restriction analysis of plasmids to locate position of inserts,

Restriction mapping of the plasmid, Isolation of gene (antibiotic resistant) from the plasmid, Cloning of restriction fragment containing neomycin phosphotransferase gene, Expression of β-gal under different promoters, with wild type *E.coli* as control.

Immunology: Purification of Immunoglobin from serum, Double diffusion, Generation of antibody in mouse, Conjugation of antibody in mouse, Conjugation of antibody with enzyme, ELISA (i) Capture ELISA,(ii) Direct ELISA , Western blot, Affinity column and purification of antigen, Cell fusion for generation of Hybridoma.

DNA and RNA: Isolation of DNA and RNA, Estimation of DNA and RNA by chemical means, wavelength scan of DNA and RNA, Melting studies of Calf thymus DNA.

Suggested Laboratory Exercises:

Practicals based on theory syllabus.

Suggested Reading (for Laboratory Exercises)

1. Butenko, R.G. 2000. Plant Cell Culture, University Press of Pacific.
2. Collin, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
3. Dixon, R.A. (Ed.) 1987. Plant Cell Culture :Practical Approach. IRL Press, Oxford.
4. Gelvin, S.B. and Schilperoort, R.A. (eds.) 1994. Planl Molecular Biology Manual. 2nd edition, Kluwer Academic Publishers, Dordrecht. The Netherlands.
5. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd., Edington, UK.
6. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 2. In Practice 2nd edition. Exegetics Ltd., Edington, UK.
7. Glick B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
8. Glover, D.M. and Hames, B.D. (Eds.) 1995. DNA Cloning 1 : A Practical Approach, Core Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
9. Hackett, P.B., Fuchs, J.A. and Meesing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co., Inc. Menlo Park, California.

10. Hall, R.D. (Ed.) 1999. Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.
11. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
12. Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. Academic press, New York.

II Semester –Paper V
Molecular Biology (BTH 201)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

DNA Replication: Prokaryotic and eukaryotic DNA replication. Unit of replicon, enzymes involved, mechanisms of DNA replication, origin and replication fork, fidelity of replication, accessory proteins involved in DNA replication, extra chromosomal replicon. Structure and function of different types of RNA's- m-RNA, t- RNA,r-RNA,sn-RNA; small nuclear proteins, ribosome- sub units and its molecular structure and function, genetic code- nuclear and organelle codes.

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, Biochemistry of Ribozymes –Hammerhead, hairpin and other ribozymes, applications of antisense and ribozyme technology.

Transcription-Prokaryotic, Eukaryotic transcription, transcriptional factors and machinery, RNA polymerases, Regulatory elements and mechanisms of transcription regulation- formation of initiation complex, transcription activators and repressors, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, RNA transport, nuclear export of m- RNA, m-RNA stability.
Translation-Prokaryotic and eukaryotic translation, the translation machinery. Formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, aminoacylation of t –RNA, aminoacyl tRNA synthetase, termination of translation, regulation of translation.

Protein Localization. Synthesis of Secretory and membrane proteins, intracellular protein traffic-import into nucleus, mitochondria, chloroplast and peroxismes, Receptor mediated endocytosis.
Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulation gene expression .
Molecular biology methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods, analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels.

Suggested Laboratory Exercises:

1. Isolation of genomic DNA. And its quantification
2. Southern blotting.
3. RFLP analysis
4. Isolation of RNA.
5. Isolation of polyA+RNA.
6. Northern blotting.
7. Preparation of probes.
8. *In vitro* transcription
9. *In vitro* translation.
10. Metabolic labellling of proteins and immunoprecipitation.
11. Any other practical based on theory syllabus.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual, J.Sambrook,E.F.Fritsch and I. Maniatis, Cold Spring harbor Laboratory Press, New York,2000.
2. Introduction to Practical Molecular Biology,P.D.Dabre, John Wiley & sons Ltd.,Yourk,1988.
3. Molecular Biology LabFax. T.A. Brown (Ed.), bios Scientific Publishers Ltd, Oxford,1991.
4. Molecular biology of the Gene (4th Edition),J.D. Watson,N.H. Hopkins,J.W. Roberts,J.A. Steitz and A.M.
5. Molecular Cell biology (2nd Edition) J.Darnell,H.Lodish and D.Baltimore,Scientific American Books,USA,1994.
6. Molecular Biology of the Cell (2nd Edition)B.Alberts,D.Bray,J.Lewis,M.Raff,K.Roberts,and J.D. Watson, Garland publishing. Inc., New York,1994.
7. Gene VI(6th Edition)Benjamin Lewin.Oxford University Press.U.K.,1998.
8. Molecular Biology and biotechnology.A comprehensive desk reference.R.A. Meyers(Ed.) VCH Publishers,Inc.,New York,1995.
9. Genomes,T.S.Brown

II Semester –Paper VI

Genetic Engineering (BTH 202)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

Genetic engineering tools and their applications: PCR and its applications, Restriction enzymes, modification enzymes(methylases and other enzymes needed

in genetic engineering),DNA and RNA markers. Nucleic Acid Purification, Yield Analysis. **Nucleic Acid Amplification and its Applications.** Gene Cloning Vectors Plasmids, bacteriophages, phagemids, cosmids. Artificial chromosome vectors (YAC,BAC),CHEF analysis, animal virus derived vectors-SV40 and retroviral vectors, Restriction Mapping of DNA fragments and Map Construction. Nucleic Acid Sequencing.

cDNA Synthesis and Cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening. Alternative Strategies of Gene Cloning-Cloning interacting genes. Two and three hybrid systems, cloning differentially expressed genes. Nucleic acid microarray arrays.

Site-directed Mutagenesis and Protein Engineering: How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension,SI mapping, RNase protection assays, Reporter assays.

Northern and Western blotting, DNA fingerprinting, Chromosome walking, Southern and Fluorescence *in situ* hybridization.

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 regulation and silencing.

Application of genetic engineering: Transgenic plants and animals, production of recombinant pharmaceuticals, disease diagnoses. Proteomics, genomics, metabolomics and nanotechnology.

Suggested Laboratory Exercises

1. Growth characteristics of *E. coli* using plating and turbidimetric methods.
2. Isolation of plasmid from *E. coli* by alkaline lysis method and its quantitation spectrophotometrically.

3. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
4. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.
5. Demonstration of DNA sequencing by Sanger's di-deoxy method.
6. Isolation of protoplasts from various plant tissues and testing their viability.
7. Effect of physical (e.g. temperature) and chemical (e.g. osmoticum) factors on protoplast yield.
8. Demonstration of protoplast fusion employing PEG.
9. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
10. Demonstration of androgenesis in Datura.
11. Electroporation of protoplasts and checking of transient expression of the reporter gene.
12. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.
13. Any other practical based on theory syllabus.

Suggested Reading:

1. Butenko, R.G. 2000. Plant Cell Culture, University Press of Pacific.
2. Collin, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
3. Dixon, R.A. (Ed.) 1987. Plant Cell Culture :Practical Approach. IRL Press, Oxford.
4. Gelvin, S.B. and Schilperoort, R.A. (eds.) 1994. Planl Molecular Biology Manual. 2nd edition, Kluwer Academic Publishers, Dordrecht. The Netherlands.
5. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd., Edington, UK.
6. George, E.F. 1993. Plant Propagation by Tissue Culture. Part 2. In Practice 2nd edition. Exegetics Ltd., Edington, UK.
7. Glick B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.

8. Glover, D.M. and Hames, B.D. (Eds.) 1995. DNA Cloning 1 : A Practical Approach, Core Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
9. Hackett, P.B., Fuchs, J.A. and Meesing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co., Inc. Menlo Park, California.
10. Hall, R.D. (Ed.) 1999. Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.
11. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
12. Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. academic press, New York.

II Semester –Paper VII

Computer applications, Biostatistics & Bioinformatics (BTH 203)

Time: 3 hrs. **Max Marks: 100**
Min. Marks: 36

- *Each theory paper shall carry 100 marks and will be of 3 hrs duration.*
- *The theory question paper will be divided into two parts A and B. Part A of question paper shall contain 10 (ten) very short answer type questions. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 5 questions. Question1 will have 6 (six) parts, out of which 4 (four) questions are required to be answered, each carrying 5 marks. Maximum word limit for each part is 50-70 words. The other 4 questions will have 100% internal choice. Each question will carry 15 marks, with a total of 60 marks.*
- *Each Practical examination will be of four hour duration and involve laboratory experiments/ exercises, and viva- voce examination in ratio of 75: 25 (i.e. 15% for record and 10% for viva).*

Introduction to computer: Basic components and their functions, hardware and software, input- output devices. Basic concepts about data and information, Representation of data in computers in binary, bits and bytes. Computers words coding (ASCII and EBCDIC), Numeric data. Introduction to programming languages, C. Perl. Conceptual understanding of assemblers, compilers, operating system.