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.

Brief description, classification and tabulation of data and its graphical representation. Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, variance, idea of two types of errors and level of significance, test of significance (F test, T test, Z test and chi- square Test);. Probability distributions (Binomial, Poisson and normal); sampling distribution; simple linear regression and correlation. Application of computers in Biostatical problems.

Information retrieval: LAN, WAN, introduction to internet, WWW. NICNET, ERNET, VSNL, ISDN, E-mail, Publication on worldwide web, on line publishing ventures e.g., Biomed, online international database access. Motif analysis and power point presentation.

Biological database: primary sequence database (Protein and DNA database), secondary database, composite databases. Sequences alignment and Database searching: Evolutionary basis of sequence alignment, optimal alignment methods, substitution scores and Gap penalties. Statistical significance of alignment, Database similarity searching; FASTA, BLAST. Paintise database searching: EMBOSS, multiple sequence alignment; CLUSTAL W, BTIS, and Network in India.

Suggested Laboratory Exercises:

1. Dot-matrix comparison – understanding sliding window – window size (word size) and stringency
2. Pairwise alignment
3. Multiple sequence alignment
4. Searching DNA databases with FASTA and BLAST
5. Searching protein sequence databases with FASTA and BLAST
6. Making Patterns (prosite syntax) and consensus sequence from multiple sequence alignments
7. Compositional analysis of DNA – GC/AT content - codon usage - codon bias
8. Understanding ORF and gene prediction
9. Protein structure visualization
10. Secondary structure prediction online

11. Understanding the bioinformatics behind human, rice, yeast and *E.coli* genome projects
12. Test of significance (F test, T test, Z test and chi- square Test)
13. Analysis of data and calculation of standard deviation and variance
13. Any other practical based on theory syllabus

Suggested Readings:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

II Semester –Paper VIII
Biological macromolecules & Enzymology (BTH 204)

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).*

Macromolecules and supra molecular assemblies- Types of macromolecules in biological systems. Molecular assemblies: membrane system, ribosomes, extracellular matrix, chromosomes in the light of macro molecules. High energy compounds: their synthesis and utilization with special reference to ATP.

Amino acids: Structure, classification, chemical and physical, Biosynthesis of amino acid (Reductive amination, Transamination, GS-GOGAT system).

Proteins: Classification, structural configuration. Ramachandran map properties of proteins .Biological importance of proteins, Protein sequencing. Glycopotein, Lipoproteins- structure & function.

Nucleotides: Biosynthesis of purines & pyrimidene. Pathways by denavo and salvage pathway.

Carbohydrate: Classification, structure and function of monosaccharides, polysaccharides.

Lipids: Classification, structure, biosynthesis and functions.

Enzymes: Structure and properties, substrate specificity, classification, mechanism of enzyme action and regulation, Michalis Menten Equation,Km value. Allosteric enzymes. Mnemonical enzymes , kinetics of enzyme inhibitors, Ribozymes and catalytic antibodies, Functional proteins- structure and drug target (enzyme and receptors).

Secondary metabolites: General introduction and significance, Difference from primary metabolites. Alkaloids, Flavonoids & Steroids.

Protein and nucleic acid data bases: Structural comparison at secondary and tertiary levels .Computer aided drug designing. Computational techniques in structural analysis: Nanoparticals

Suggested Laboratory Exercises:

1. Reactions of amino acids, sugars and lipids.
2. Isolation,purity determination and quantitation of cholesterol,DNA and RNA
3. Electrophoresis of Proteins-native and under denaturing conditions.
4. N-and C-terminal analysis of proteins.
5. Peptide mapping.
6. Quantitation of Proteins and Sugars.
7. Analysis of oils-iodine number,saponification value,acid number.
8. UV. Visible,Fluroence and IR Spectroscopy.Absorption spectra.
9. Separation techniques-Centrifugation,Chromatography (Gepermeation, Ion exchange.TLC etc.)and Electrophoresis.
10. Separation techniques(HPLC,GPC,FPLC)
11. Enzyme:Purification and Kinetic analysis.
12. Electrophoresis of DNA-linear,circular and super coiled.
13. Hybridoma technology
14. Any other practical based on theory syllabus

Suggested Readings:

1. Biochemistry,D.Voet and J.G.Voet,John Wiley & Sons.
2. Biochemical Calculations,Irwin H.segel,John wiley and sons inc.
3. General Chemistry,Linus Pauling,W.H.Freeman & Company.
4. Organic Chemistry,DJ Cram and GS Hammond,McGraw Hill.
5. Biochemistry, D Voot and JG Vet,J Wiley and Sons.
6. Physical biochemistry,D Frefilder,W.H. Freeman & company.
7. Laboratory Techniques in Biochemistry and Molecular Biology,Work and work.
8. Understanding Chemistry,CNR Rao,Universities press,Hydrabad 1999.
9. A Biologist's Guide to principles and Techniques of practical biochemistry,K.Wilson & KH goulding,ELBS Edition 1986.
10. Tools of Biochemistry by T.G. cooper.
11. Essentials of Molecular Biology, David friefilser.jones and Barllett publications.
12. Proteins-Structure and Molecular properties.TE creighton,WH freeman and company.
13. Genes VII,B.Lewin.Oxford university press.

14. Introduction to protein structure.c.Branden and J.Tooze,Garland publishing,New York.
15. Encyclopaedia of Molecular Biology,J.Kendrew,Blackwell scientific publications,oxford.
16. Physical chemistry of Macromolecules,taford,C.,John Wiley and Sons.
17. Introduction to Biophysical Chemistry.RB Martin,McGraw Hill,New York.
18. Biophysical chemistry,Cantor,WH Freeman.
19. Protein Structure,by Max Perut Perutz.

III Semester- Paper IX
Animal cell science & Technology (BTH 301)

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).*

Structure and organization of animal cell, Cell physiology. Equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balance salt solutions and simple growth medium.

Brief account on the chemical, physical and metabolic functions of different constituents of culture medium. Biology and characterization of the cultured cells and measuring their growth. Basic techniques of mammalian cell culture *in vitro*.

Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements.

Serum & protein free defined media and their application. measurement of viability and cytotoxicity. Biology and characterization of cultured cells, measuring parameters of growth.

Basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation. Scaling-up of animal cell culture,

Cell synchronization. Cell cloning, micromanipulation and types of cloning. Cell transformation. Application of animal cell culture.

Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines. Somatic cell genetics. Organ and histotypic cultures.

Measurement of cell death. Apoptosis. Three dimensional culture and tissue engineering. Applications of animal cell culture.

Suggested Laboratory Exercises:

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC,and measurement of pathogencity activity.
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
7. Measurement of doubling time.
8. Role of serum in cell culture.
9. Preparation metaphage chromosome from cultured cells.
10. Isolation of and demonstration of apoptosis of DNA laddering.

11. MTT assay for cell viability and growth.
12. Cell fusion with PEG.
13. Any other practical based on theory syllabus

Suggested Readings:

1. Culture of Animal Cells,(3rd Edition),R.Ian Froshney,Wiley-Liss.
2. Animal Cell Culture-Practical Approach,Ed.john R.W.Mesters,Oxford.
3. Cell Growth and Division:A Practical Approach,Ed,R.Basega,IRL Press.
4. Cell Culture Lab Fax.Eds.M.Butler & M.Dawson,Bios Scientific Publications Ltd. Oxford.
5. Animal Cell Culture Techniques. Ed.Martin Clynes,Springer.
6. Methods in Cell Biology,Vol.57,Animal Cell Culture Methods. Ed.Jenni P Mathur and David Barnes. Academic Press.

III Semester- Paper X
Plant Biotechnology (BTH 302)

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).*

Concept of totipotency, history of development of plant tissue culture, Different PTC media and their nutritional components. PTC laboratory facilities, operation and management, media preparation and sterile techniques. Plant tissue culture as a technique to produce novel plants, somaclonal variations, suspension culture, single cell clone.

Protoplast isolation, culture, fusion, selection of cybids and regeneration.
differentiation, organogenesis, Micropropagation (up to field transfer), production of virus free plants,
Anther, pollen and ovary culture for production of haploid plants.
Production of synthetic seeds,

Cryopreservation and slow growth for germ plasm preservation, transgenic approaches to crop improvement: resistant against biotic (virus, fungi, bacteria, nematode, insect, weed) and abiotic stress (salinity, drought, herbicide, cold, metals), longer shelf life. Nutritional quality improvement - golden rice and other developments. Extension of flower life, pigmentation and fragrance.

Manufacture of valuable products: antigens, antibodies, edible vaccines, enzymes, proteins.

Plant transformation technology: The basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of T-DNA transfer and role of virulence gene.
Use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter genes with introns.
Methods of nuclear transformation, viral vectors and their applications. Multiple gene transfer , vectorless and direct DNA transfer. Particle bombardment, electroporation, micro injection. Transgenic gene stability and gene silencing. Molecular markers: RFLP, RAPD, SCAR, SSCP, AFLP, applications of molecular markers.

Suggested Laboratory Exercises:

1. Preparation of media.
2. Surface sterilization
3. Organ culture.
4. Callus propagation, organogenesis, transfer of plants to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of Haploids.
7. Cytological examination of regenerated plants.
8. Agrobacterium culture,selection of transformants,reporter gene(GUS)assays.
9. Developing RFLP and RAPD maps.
10. Any other practical based on theory syllabus

Suggested Readings:

1. J.Hammond,P.McGarvey and V.Yusibov(Eds.):Plant Biotechnology.Springer Verlag,2000.
2. T-J.Fu,G.Singh,and W.R.Curtis(Eds):Plant Cell and Tissue Culture for the Production of Food ingredients.Kluwer Academic/Plenum Press.1999.
3. H.S.Chawla: Biotechnology in Crop improvement. International Book Distributing Company,1998.
4. R.J.Henry:Practical Application of plant Molecular Biology. Chapman and hall.1997.
5. P.K.Gupta: Elements of Biotechnology. Rastogi and Co.Meerut,1996.

III Semester- Paper XI
Bioprocess Engineering (BTH 303)

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 Bioprocess Engineering. Measurement and control of Bioprocess parameters. Classification of Bioreactor types.
Types of fermentation processes: Batch, fed batch and continuous bioreactions, biotransformation. Downstream Processing.

Metabolic engineering: control mechanisms and manipulation of metabolic pathways. Isolation, maintenance and preservation of industrial microorganisms, microbial growth and death kinetics. Media for industrial fermentation.

Industrial production of chemicals, utilizing wastes: Alcohol (ethanol), Acids (citric, acetic, and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid). Single cell protein.

Introduction to food technology; principles of food processing. Elementary idea of canning and packing, sterilization and pasteurization of food products, technology of typical food products (Bread, cheese, idly) food preservation.

Suggested Laboratory Exercises:

1. Isolation and preservation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. Comparative studies of Ethanol production using different substrates.
4. Production and estimation of Alkaline Protease.
5. Use of alginate for cell immobilization.
6. Microbial production of single cell protein.
7. Any other practical based on theory syllabus

Suggested Readings:

1. Biochemical Engineering Aiba,S.,Humphrey,A.E. and Millis,N.F.Univ.of Tokyo Press,Tokyo.
2. Biochemical Reactors,Atkinson,B.,Pion Ltd.London.
3. Biochemical Engineering fundamentals,Baily,J.E. and Oils,D.F.,McGrow Hill Book Co.,New York.
4. Bioprocess Technology:Fundamentals and Applications,KTH,Stockholm.
5. Process Engineering in Biotechnology,Jackson,A.T.,Prentice Hall,Engelwood cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler,M.L. and Kargi, F.,Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F.and Whitaker, A., Pergamon Press, Oxford.
8. Bioreaction Engineering Principles,Nielson,J. and Vissadsen,J.,Plenum Press.
9. Chemical Engineering Problems in Biotechnology,Shuler,M.L.(Ed.),AICHE.
10. Biochemical Engineering,Lee,J.M.Prentice Hall Inc.
11. Bioprocess Engeering-Kinetics,mass Transport,Reactors and Gene Expression,Vieth,W.F.,John V.& sons,Inc.

III Semester – Paper XII

BIORESOURCE AND ENVIRONMENTAL BIOTECHNOLOGY (BTH 304)

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).*

Water : Natural resource and its management, Sources of water pollution and biological treatment processes and their microbiology: Aerobic Processes-Oxidation ponds, Trickling filter, Activated sludge process, rotating discs, rotating drums; Anaerobic processes-Anaerobic digestion, anaerobic filters, Upflow anaerobic sludge blanket reactors.

Microbiology of degradation of xenobiotics in Environment - Oil pollution, surfactants, pesticides. Solid wastes: Sources and management (composting, vermiculture and methane production), bioremediation of contaminated soils and waste-land and groundwater.

Global environmental problems: Green house effect and acid rain, their effects and biotechnological approaches for management. Biofuels, Methodology of environmental management-the problem solving approach, its limitations. Biodiversity and its conservation; Plant germplasm collection including of wild species, intraspecific variations in crop plants, molecular characterization of variations.

Human population growth and global food prospects, food security and availability of food, Molecular basis of genetic modification and crop improvement programmes, GM food crops, plant as chemical and pharmaceutical factories, biosafety and GM food crops, biotechnology in controlling crop diseases, weeds, insects and pests. Biopesticides in integrated pest management. Seed- seed banks, terminator gene technology and implications, International and local regulations.

Suggested Laboratory Exercises:

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water.
3. Determination of dissolved oxygen concentration of water sample.
4. Determination of biological oxygen demand(BOD)of a sewage sample.
5. Determination of chemical oxygen demand(COD)of sewage sample.
6. Determine the efficiency of removal of air pollutant using fibrous air filter.

7. Isolation of xenobiont degrading bacteria by selective enrichment technique.
8. Test for the degradation of a aromatic hydrocarbons by bacteria.
9. Survey of degradative plasmids in microbes growing in polluted environment.
10. Effect of Sulphur dioxide on crop plants.
11. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry.
12. Estimation of nitrate in drinking water.
13. Study on biogenic methane production in different habitats.
14. Any other practical based on theory syllabus

Suggested Readings:

1. Plant,Gene and Crop Bitechnol,M.J.chrispeel and D.E.Sadava ASPB 2003.
2. Economic Botany, S.L. Kocher.
3. Wastewater Engineering-Treatment,Disposal and Reuse,Metcall and Eddy, Inc.,Tata McGraw Hill, Delhi.
4. Comprehensive biotechnology,vol.4,M. Moo-Yound (Ed-in-chief),Pergamon Press, Oxford.
5. Environmental Chemistry,A.K.De,Willey Eastern Ltd.,New Delhi.
6. Introduction to Biodeterioration.D.Allsopp and K.J.Seal,ELBS/Edward Arnold.
7. Cookson,J.T.1995.Bioremediation Engineering: design and Application. McGraw-Hill,Inc.
8. Cheremisinoff, Nicholas P. Biotechnology for waste and wastewater treatment.

IV semester Paper XIII
Industrial Biotechnology and Bio safety (BTH 401)

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).*

Selection of industrial microorganisms: industrial cultures- bacteria, algae, fungi and actinomycetes. Primary and secondary screening of microorganisms for industrial products. Isolation and preservation of microorganisms for industrial products. Strain development- mutation, selection and recombination. Mushroom cultivation technology. Biofertilizers and their application. Immobilisation of microbial cells and their application.

Fermentation process: design- overview of aerobic and anaerobic fermentation process. Fermentor systems- types. Fermentation process and factors affecting fermentation process. Design of fermentation media. Substrates used as carbon and nitrogen sources.

Production of microbial products: Organic acids (lactic acid, acetic acid & gluconic acid) Amino acid (Aspartic acids) Alcohol and beverages (acetone- butanol, beer, wine) Enzymes (proteases, amylases, lipases, cellulases & pectinases).

Health care products and food additives: Antibiotics- penicillin, streptomycin and erythromycin. Vaccines- BCG, hepatitis- B & recombinant vaccines. Vitamins- B_{12}, D & C. dairy products- cheese, yoghurt and other products.

Biosensors- application in industry, health care and environment.

Bioplastics and biopolymers.

Unit-IV

Biosafety; security measures, laboratory information management system (LIMS). Laboratory safety- safety policies. Operation hazardous compounds, chemicals, solvents, poisons, isotopes, explosives and biological strains (bacterial, fungal etc.). Storage of hazardous material and disposal of biological and radioisotope wastes.

Suggested Laboratory Exercises:

1. Isolation of industrially important microorganisms for microbial processes.
2. Comparative studies of Ethanol production using different substrates.
3. Microbial production of citric acid using *Aspergillus niger*.
4. Microbial production of antibiotics (Penicillin).
5. Cultivation techniques of mushrooms
6. Selection of efficient PGPR and mycorrhizae and their affect on growth
7. Preparation of a list of the hazardous chemicals and their biosafty measures.
8. Any other practical based on theory syllabus

Suggested Readings:

1. Biochemical Engineering Aiba,S.,Humphrey,A.E. and Millis,N.F.Univ.of Tokyo Press, Tokyo.
2. Biochemical Reactors,Atkinson,B.,Pion Ltd.London.
3. Biochemical Engineering fundamentals,Baily,J.E. and Oils,D.F.,McGrow Hill Book Co.,New York.
4. Bioprocess Technology:Fundamentals and Applications,KTH,Stockholm.
5. Process Engineering in Biotechnology,Jackson,A.T.,Prentice Hall,Engelwood cliffs.
6. Bioprocess Engineering:Basic Concepts,Shuler,M.L. and Kargi,F.,Prentice Hall,Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury,P.F. and Whitaker,A., Pergamon Press,Oxford.
8. Bioreaction Engineering Principles,Nielson,J. and Vissadsen,J.,Plenum Press.
9. Chemical Engineering Problems in Biotechnology,Shuler,M.L.(Ed.),AICHE.
10. Biochemical Engineering,Lee,J.M.Prentice Hall Inc.
11. Bioprocess Engeering-Kinetics,mass Transport,Reactors and Gene Expression,Vieth,W.F.,John V.& Sons,Inc.

IV semester Paper XIV

Pathogenesis & Immunology (BTH 402)

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 and history of disease development: Early discovery of pathogenic microorganisms; Classification of important micro organisms; parasitism & pathogenicity, host range, stages in the development of diseases.

Host parasite relationships- Normal microflora of skin, oral cavity, gastrointestinal tract; entry of pathogens into host; colonization and factors predisposing to infections, types of toxins (exotoxin, endotoxin and entrotoxin) and their structure; mode of actions, Biochemical, physiological. Nonspecific and specific defence mechanisms. Mechanism of pathogenesis, host factors influencing resistance to infection, vaccination.

Establishment of pathogen, spreading, tissue damage and anti-phagocytic factors; mechanisms of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts.

Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium Bacillus, Clostridium*, Non-sporing Anaerobes, Organisms belonging to . Enterobacteria , Vibrios,

Non fermenting gram negative bacilli , *Yersinia; Haemophilus; Bordetella, Brucella;* Mycobacteria, Spirochaetes, Actiomycetes; Rickettsia and Chlamydia .

Establishment, spreading, tissue damage and anti- phagocytic factors; mechanism of fungal adhesion, colonization and invasion of fungal spores.

Nomenclature and classification of viruses; distinctive properties of viruses; morphology and ultrastructure; capsid and their arrangements; their types and structures;

Animal human *viruses; epidemiology*, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses Picorna, Orthomyxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40, Hepatitis viruses.

Effect of viruses on plants; appearance of plants, histopathology, physiology, pathogenicity,; common viral diseases of plants, transmission of plant viruses by vectors (insects, nematode, fungi) and without vectors(contacts, seeds and pollen). Brief account of diagnostic techniques in plants; infectivity assay of plant viruses, indicator plants, vector control.

Brief history of Immunology; innate responses, innate and acquired immunity, organization and structure of lymphoid organs. Nature, biology and types of antigens and super antigens. Antibodies-structure, types; theories of antibody production. Antigen antibody interactions, Hybridoma technology and monoclonal antibodies, Major Histocopatibility complex, cells of immune system, regulation of immune response- antigen processing and presentation, generation of humoral responses, Hypersensivity, Autoimmunity. immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, Immuno techniques.

Suggested Laboratory Exercises:

1. Study of various symptoms produced in plants due to virus infection.
2. Study of viral diseases of plants/animals/human (Specimen/photographs)
3. Different type of viruses (Photographs/sketches).
4. Raising virus free plants through apical meristem culture.
5. Blood film preparation and identification of cells.
6. Lymphoid organs and their microscopic organization.
7. Immunization, Collection of Serum.

8. Double diffusion and Immuno-electrophoresis.
9. Radial Immuno diffusion.
10. Purification of IgG from serum.
11. Separation of mononuclear cells by Ficoll-Hypaque.
12. Con-A induced proliferation of thymocytes (by MTT method).
13. Western-blotting.
14. ELISA.
15. Hapten Conjugation and quantitation.
16. Immunodiagnostics (demonstration using commercial kits).
17. Any other practical based on theory syllabus.

Suggested Readings:

1. Morag C and Timbury M.C.(1994) Medical virology-X Edition. Churchill Livingstone,London.
2. Dimmock Nj,Primrose SB(1994).Introduction to Modern Virology,IV Edition,Blackwell Scientific Publications,Oxford.
3. Conrat HF,Kimball PC and Levy JA(1994)virology-III Edition Prentice Hall,Englewood cliff,New jersey.
4. Matews,RE.,(1992)Functionals of plant virology,Academic press,San Diego.
5. Topley and Wilson's(1995)Text Book on principles of Bacteriology,virology and Immunology,Edward Arnold,London.
6. Lennetter,(1984)Diagnostic procedures for viral and Rickettsial diseases.american public Health association, NY.
7. William Hayes(1985)The genetics of Bacteria and their viruses.Blackwell Scientific Publishers,London.
8. Ronald M.Atlas.(1995)-Principles of microbiology-MosbyYear Book,Inc.Missouri 63146.
9. Kenneth M.Smith-plant viruses.Universal Book Stall,New Delhi.
10. Mark H.Adams-Bacteriophages-inter science publishers,Inc.New York.
11. D.G.A Walkey(1985)-Applied Virology.International Books & Periodicals supply service.New Delhi.
12. Karl.Maramarosch.-Plant Deseases of viral,viroid,Mycoplasma & uncertain etiology.Oxford & IBH Publishing Vo.Pvt.Ltd.New Delhi,Bombay, Calcutta.

13. Powar & Daginawala.General Microbiology Vol.II.Himalaya Publishing House.
14. An Introduction to Viruses.Vikas Publishing House.
15. Agrios,G.N.(1997)Plant Pathology,Academic Press.
16. Kuby Immunology,4th Edition-R.A. Goldsby, Thomas J.Kindr.Barbara, A.Osbarne,(Freeman) & Co.New York.
17. Immunology-A short course,4th Edition-Eli Benjamini,Richard Coico,Geoffrey Sunshine,(Wiley-Liss).
18. Fundamentals of Immunology,William paul.
19. Immunology, By Roitt and others.
20. Roitt, .M.(1998) Essentials of Immunology, ELBS, Blackwell Scientific publishers, London.
21. Immunology by Abbas.
22. Microbiology by Abbas
23. Microbiology by Pelczar,Chan and Krieg.TMH.

IV SEMESTER: Paper XV

Intellectual Property Rights, Entrepreneurship, Ethics and Research Methodology (BTH 403)

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).*

Intellectual property rights: Meaning, Evolution- classification and forms. Importance of IPR's in the field of science and technology. Patents- concepts and

principles of patenting, patentable subject matter. Procedure of obtaining patents, rights of patents, infringement of patent rights, remedies for infringement of patent rights- patentability and emerging issues.

Entrepreneurship: 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.

Ethical issues: introduction- causes of unethical acts, ignorance of laws, codes, policies and procedures, recognition, friendship, personal gains. Professional ethics- professional conduct. Ethical decision making, ethical dilemmas. Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory accreditation.

Research Methodology: introduction- Basic research, applied research, need based research. Identification of the problem, defining the problem. Research project planning. Literature search- information sources, library resources-books, journals, abstracts hand books, procedure manuals, encyclopedias, annual reports, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.

Design of the experimental programme- variables in the experiments, materials and methods, evolution of methods, application of methods.

Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications, impact factor of journals.

Suggested Readings:

1. Álvaro Cuervo, Domingo Ribeiro and Salvador Roig, 2007, Entrepreneurship Concepts, Theory and Perspective. Part II, 155-170

2. Francis T. Hannafey, 2004. Entrepreneurship and Ethics: A Literature Review.J. of Bussiness Ethics, Volume 46, Number 2, 99-110
3. Emmanuel Hassan, Ohid Yaqub, Stephanie Diepeveen, 2010. Intellectual Property and Developing Countries: A review of the literature, the RAND Corporation, 1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
4. Krattiger et al 2007 "Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices", Managing Innovation for a Better World
5. Hahn, Robert W., *Intellectual Property Rights in Frontier Industries: Software and Biotechnology*, AEI Press, March 2005.
6. Miller, Arthur Raphael, and Michael H. Davis. *Intellectual Property: Patents, Trademarks, and Copyright.* 3rd ed. New York: West/Wadsworth, 2000.
7. Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, California: Sage Publications.
8. Creswell, J. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, California: Sage Publications.
9. John W. Creswell, 2009, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Third Edition, www.sagepub.com, ISBN: 978-1-4129-6557-6
10. Dahlia K. Remler, Gregg G., Van Ryzin, R.,2011 Research Methods in Practice, Strategies for Description and Causation. , www.sagepub.com, ISBN: 978-1-4129-6467-
11. Glenn, Linda MacDonald 2011.Ethical Issues in Genetic Engineering and Transgenics
12. "Primer on Ethics and Human Cloning" by Glenn McGee http://www.actionbioscience.org/biotech/mcgee.html
13. "Primer on Ethics and Crossing Species Boundaries "http://www.actionbioscience.org/biotech/baylis_robert.html
14. "Genetic Engineering and Xenotransplantation" by Shane T. Grey http://www.actionbioscience.org/biotech/grey.html
15. "The Dangerous Promise of Gene Therapy" by Sophia M. Kolehmainen http://www.actionbioscience.org/biotech/kolehmainen.html

16. Richard Sherlock, John D. Morrey - 2002 -Ethical issues in biotechnology, Rowman & Littlefield Publishers, Inc., Maryland.
17. Paul B. Thompson - 2007 Food biotechnology in ethical perspective, The Springer, 2nd Ed., The Netherlands.
18. Krishna R. Dronamraju 2008 Emerging consequences of biotechnology: biodiversity loss and IPR issues. World Sc. Publ. Co. Pvt. Ltd., Singapore.

IV SEMESTER: Paper XVI

ELECTIVE PAPER (SEMINAR) (BTH 412)

INTERNAL EVALUATION **Max Marks: 100**
Min. Marks: 36

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. ***The topic of seminar should be different and independently allocated to each candidate.***

IV SEMESTER: Paper XVII
PROJECT WORK: DISSERTATION

Max Marks: 100
Min. Marks: 36

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 visit 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**

Note: The candidates shall start preparation for their dissertation (Industrial training and visit) soon after the Second Semester. The dissertation so prepared be submitted in the Fourth Semester. ***The topic of dissertation should be different and independently allocated to each candidate.***

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M.Sc. Biotechnology Semester Scheme 2011-13

Scheme of Practical exams

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).

At least 75% laboratory experiments/ exercises must be performed by the students as mentioned in the syllabus in each paper.

Time: 4 hrs

Max Marks: 100
Min. Marks: 36

(Note Q. no. 1 shall be based on the first paper and Q. no. 2 based on the second paper of theory in a semester)

Q. no. 1	(a) Major Exercise	15
	(b) Minor Exercise	10
	(c) Minor Exercise	5
Q. no. 2	(a) Major Exercise	15
	(b) Minor Exercise	10
	(c) Minor Exercise	5
Q. no. 3	Comment upon the spots (5 spots)	15
Q. no. 4	Practical Record	15
Q. no. 5	Viva	10