SYLLABUS FOR

MASTER OF SCIENCE

IN

BIOTECHNOLOGY

(Two years/Four semesters)

2016-17

Eligibility for M.Sc. in Biotechnology:

Pass with 50% aggregate marks in Bachelor's degree (Medical and allied Medical Sciences / Bio Sciences) or equivalent or relevant higher qualification.

Semester-wise marks distribution/course hours:

S.No.	Semester	Marks	Course Hours
1.	I	600	27
2.	II	600	27
3.	III	550	28
4.	IV	450	27
	Grand Total	2200	109

M. Sc in Biotechnology – Semester-I

S. No.	Code	Title of Course	Marks		Total Marks	Periods/week		Total Periods /week	Course Hours
			Theory (80 + 20*)	Practical (20 +5*)		Theory	Practical		
1	MBT101	Introductory Biomathematics and Biostatistics	100	-	100	4	-	4	3
2	MBT102	Cell Biology	100	25	125	4	4	8	6
3	MBT103	Molecular Biology	100	25	125	4	4	8	6
4	MBT104	Biochemistry	100	25	125	4	4	8	6
5	MBT105	General Microbiology, Microbial Physiology & Biotechnology	100	25	125	4	4	8	6
				Total Marks	**600**	**Total Periods**		**36**	**-**
						Course Hours		**-**	**27**

M. Sc in Biotechnology – Semester-II

S. No.	Code	Title of Course	Marks		Total Marks	Periods/week		Total Periods /week	Course Hours
			Theory (80 + 20*)	Practical (20 +5*)		Theory	Practical		
1	MBT201	Environmental Biotechnology	100	-	100	4	0	4	3
2	MBT202	Immunology	100	25	125	4	4	8	6
3	MBT203	Biophysical and Biochemical Techniques	100	25	125	4	4	8	6
4	MBT204	Genetic Engineering	100	25	125	4	4	8	6
5	MBT205	Computer Applications	100	25	125	4	4	8	6
				Total Marks	**600**	**Total Periods**		**36**	**-**
						Course Hours		**-**	**27**

***** denotes Internal Assessment

M. Sc in Biotechnology – Semester-III

S. No.	Code	Title of Course	Marks		Total Marks	Periods/week		Total Periods /week	Course Hours
			Theory (80 + 20*)	Practical (20 +5*)		Theory	Practical		
1	MBT301	Animal Tissue Culture & Animal Biotechnology	100	25	125	4	4	8	6
2	MBT302	Plant Tissue Culture & Plant Biotechnology	100	25	125	4	4	8	6
3	MBT303	Enzymology and Enzyme Technology	100	25	125	4	4	8	6
4	MBT304	Bioprocess Engineering and Technology	100	25	125	4	4	8	6
5	MBT305	Seminar/Journal club/Assignment	50	-	50	6	-	6	4
				Total Marks	**550**	**Total Periods**		**38**	**-**
						Course Hours		**-**	**28**

M. Sc in Biotechnology – Semester-IV

S. No.	Code	Title of Course	Marks		Total Marks	Periods/week		Total Periods /week	Course Hours
			Theory (80 + 20*)	Practical (20 +5*)		Theory	Practical		
1	MBT401A Or MBT401B	Genomics and Proteomics Or Introduction to Bioinformatics	100	-	100	4	-	4	3
2	MBT402A Or MBT402B Or MBT402C	Medical Biotechnology Or Intellectual property Rights Or Microbial Biotechnology	100	-	100	4	-	4	3
3	MBT403	Educational Tour/Industrial Visit	50	-	50	-	-	-	-
4	MBT404	Research Project	Thesis: Presentation/Viva:		200	-	28	28	21
				Total Marks	**450**	**Total Periods**		**36**	**-**
						Course Hours		**-**	**27**

***** denotes Internal Assessment

M. Sc. Biotechnology (Semester-I)

Introductory Biomathematics and Biostatistics

MBT 101

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates

The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION -A

Binomial Theorem, Pascal rule and Pascal triangle.
Scientific notation, significant digits, rounding off. Scientific notation, Sampling, problem identification, desing of experiment, factorial designs: full factorial design, fractional factorial design, concept of population and sample, random sampling, Data collection.

SECTION -B

Measures of central tendency, mean, arithmetic mean, geometric mean & harmonic mean, medium, mode, quartile, decile, percentile, dispersion, mean deviation, standard deviation, geometric standard deviation, standard error, coefficient of variation, variance, coefficient of determinant and coefficient of non-determinant, moments, distribution of data, normal distribution, skewness and kurtosis

SECTION -C

Pearson's correlation coefficient, linear correlation and regression, correlation and regression analysis of exponential curve. Power function, log function, logarithmic regression, Dose response curve, coefficient of determination, Reciprocal regression analysis, double reciprocal regression analysis, logistic regression analysis, monomolecular regression, Gompertz growth function and Gompertz decay function and its analysis.

SECTION -D

Probability, Testing of hypothesis, Null and alternative hypothesis, Type-I and Type-II errors, level of significance, two tailed and one tailed tests, Z-score, chi-square (X_2) test, student 't' test, 'F' test, Probability distribution function, standard normal distribution, Poisson distribution function, binomial distribution, student 't' distribution, chi square (X_2) distribution, Analysis of variance, ANOVA-one way ANOVA and two way ANOVA. Non parametric statistics : Wilcoxon test : Wilcoson signed rank test, wilcoxon rank sum test, Spearman rank coefficient, Kruskal-Wallis test, Kendall's coefficient of Concordance (w)

Books Recommended:

1. Kothari, C.R. (2004) Research Methodology Methods and Techniques, New Age International Publications, New Delhi

2. P.S.S. Sundar Rao, P.H. Richard, An Introduction to Biostatistics, Prentice Hall of India (P.) Ltd. New Delhi 2003.

1) 3. Jerrold H. Zar, Biostatistical Analysis, Tan Prints (I) Pvt. Ltd., New Delhi, 2003.P.S.S. Sundar Rao, P.H. Richard, An introduction to Biostatistics, Prentico Hall of India (P.)Ltd. New Delhi 2003
2) Jerrold H. Zar, Bio statistical analysis, Tan Prints (I) Pvt. Ltd. New Delhi 2003
3) Bernard A. Rosner (2011). Fundamentals of Biostatistics, Cengage Learning, pp 888

M. Sc. Biotechnology (Semester-I)
Cell Biology (Theory)
MBT 102

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION -A

History of cell biology: Development of cell theory, First cell, evolution of metabolism, Present day Prokaryotes and Eukaryotic Cells
Diversity of cell size and shape: General organization of prokaryotic and eukaryotic cells, Development of multicellular organisms
Structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems

SECTION -B

Cell biology techniques: Microscopy-light, phase-contrast, fluorescence, confocal, scanning electron microscopy. Use of radioisotopes, cell culture, fractionation of cells contents.
Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle, Growth and characteristics of cell division.
Regulators of cell cycle progression: MPF, families of cyclins and cyclin dependent kinases,
Growth factors, cell cycle inhibitors.

SECTION -C

Cell motility: Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism.
Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

SECTION -D

Cell transport across membranes: Simple Diffusion, Facilitated diffusion, Active transport, Energetics of transport, Mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Books Recommended:

1) Smith, C.A. and Wood, E.J. (1993). Cell Biology: Molecular and Cell Biochemistry. Chapman & Hall, London.
2) Karp, G. (1999). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons Inc., New York.
3) Pollard, T.D. and Ernshaw, W.C. (2002). Cell Biology. Elsevier Science (USA)
4) Becker, W.M., Kleinsmith, L.J. and Hardin, J. (2000). The World of the Cell. The Benjamin/Cummings Publishing Company.
5) Cooper, G.M. (2000). The Cell – A Molecular Approach. ASM Press, Washington, D.C.
6) Rastogi, S.C. (2005) Cell Biology, New Age International, pp. 532
7) Alberts, B., Bray, D., Hopkin, K., Johnson, A.D., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P (2009) Essential Cell Biology, Garland Science, pp 860

M. Sc. Biotechnology (Semester-I)
Cell Biology (Practical)
MBT 102

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Microscopic examination of bacteria, yeast and plant cell
2. Preparation of permanent slides of eukaryotic and prokaryotic cell.
3. Study of different stages of mitosis and meiosis.
4. Staining and visualization of different cell organelles.
5. Instrumental methods for cell biology-centrifugation, chromatography.
6. Histochemical techniques.

M. Sc. Biotechnology (Semester-I)
Molecular Biology (Theory)
MBT103

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

DNA: the vehicle of inheritance, chemical structure & base composition of nucleic acids, A, Band Z-DNA, double helical structures, forces stabilizing nucleic acid structure, super coiled
DNA, properties of DNA, nucleic acid hybridization – cot curves.
DNA replication, Repair and Recombination: Replication initiation, elongation and termination in prokaryotes & eukaryotes, enzymes and accessory proteins involved in DNA replication,Fidelity; DNA repair- photoreactivation, nucleotide and base excision repair, mismatch repair, SOS response, gene amplification, mobile genetic elements.

SECTION –B

Prokaryotic transcription; transcription unit, promoters: constitutive and inducible, initiation, termination- rho dependent and independent. Eukaryotic transcription, promoters for RNA polymerase I, II and III, transcription factors, regulatory elements & mechanism of transcription regulation, post-transcriptional modifications: processing of hnRNA, rRNA & tRNA; 5'cap formation, 3'-end processing, polyadenylation and splicing.

SECTION –C

Genetic code, prokaryotic & eukaryotic translation, the translation machinery, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation & termination, ribosome recycling factor, tm RNA, regulation of translation, co & post translation modification of proteins and intracellular protein targeting import into nucleus, mitochondria and peroxiome, non-ribosomal polypeptide synthesis, prions.

SECTION –D

Regulation of gene expression in prokaryotes and eukaryotes; (operon concept; lac, trp and ara operons), RNA interference, Viral & cellular oncogenes, tumor suppressor genes from humans, structure, function & mechanism of action of p53 tumor suppressor proteins, Molecular mechanism of antisense molecules, ribozymes, applications of antisense & ribozyme technologies.

Books Recommended:
1. Rawn, J. D. (1989). Biochemistry, 2nd edition, Neil Patterson Publications, U. S. A. , North Carolina,
2. Damal, J., Lodish, H., and Baltimore, D. (1990). Molecular Cell Biology, 2nd ed., Scientific American Books, Distributed by W. H. Freeman and Co., New York.
3. Adams, R. L. P., Knowler, J. T., and Leader, D. P. (1992). The Biochemistry of Nucleic acids, 11th ed., Champman and Hall, The New York/London/Tokyo/Melbourne/Madras.
4. Stryer, L. (1995). Biochemistry, 4th ed., W. H. Freeman and Co., New York.

5. Nelson, D. L. & Cox, M. M. (2005). Lehninger Principles of Biochemistry, 4th ed., Worth Publishers, New York.
6. Watson J., Baker T., Bell S., Gann A, Levine M and Loscik R. (2008). Molecular Biology of the Gene. 6th Ed. Pearson Education.
7. Krebs J.E., Goldstein E.S. and Kilpatrick ST (2009), Lewin's Genes, Jones and Bartlett Publishers, U.K.
8. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set Cold Spring Harbor Laboratory Press
9.James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene (7th Edition) Benjamin Cummings, Publishers.

M. Sc. Biotechnology (Semester-I)
Molecular Biology (Practical)
MBT103

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Isolation of genomic DNA from plant tissues.
2. Isolation of genomic DNA from *E. coli* cells.
3. Spectrophotometric analysis of DNA.
4. Restriction digestion of DNA.
5. Separation of digested fragments by agarose gel electrophoresis.
6. Transfer of resolved DNA fragments from agarose gel to nylon/nitrocellulose membrane.
7. Hybridization of nylon/nitrocellulose blots.

Books Recommended:

1. Practical handbook of biochemistry and molecular biology (1989) by Gerald D. Fasman (CRC Press, Taylor and Francis Group).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press, New York).
3. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set Cold Spring Harbor Laboratory Press, New York.

M. Sc. Biotechnology (Semester-I)
Biochemistry (Theory)
MBT104

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Carbohydrates: Classification, characteristics and functions of monosaccharides, disaccharides-polysaccharides. Epimers, isomers, anomers, chiral carbon atom, chair and boat form, glucopyranose and fructopyranose.

SECTION –B

Amino acids & peptides: Classification, chemical reactions and physical properties
Proteins: Classification of proteins. Primary, Secondary (Alpha helix and beta pleated structure), Tertiary and Quaternary structures of proteins. Disulphide bridges, Ramachandran plot.

SECTION –C

Lipids: Definition and classification of lipids. Fatty acids- General formula, nomenclature and chemical properties structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins.
Beta oxidation - Pathway and regulation. Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid - Structure and composition of fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides. Ketone bodies - Formation and utilization.

SECTION –D

Nucleic Acids: Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, T_m and its relation to GC content.
Overview of metabolite pathways: Glycolysis, citric acid cycle, oxidative phosphorylation, pentose phosphate pathway and gluconeogenesis and their regulation; photosynthesis.

Books Recommended:

1. Stryer, L. (2012). Biochemistry: 7th Edition, W.H. Freeman and Company, New York
2. Lehninger, A.L., Nelson, D.L. and Lox, M.M. (2012). Principles of Biochemistry 6th Ed., W.H. Freeman and Company, New York
3. Moran, Horton, Scrimgeour & Perry (2011)Principles of Biochemistry, Prentice Hall.
4. Zubay, G.L., Parson. W.W. and Vance, D.E. (1995). Principles of Biochemistry: Student Study Art Notebook, Wm. C. Brown Publishers.
5. Rawn, J.D. (1989). Biochemistry, Neil Patterson Publishers.
6. Bucke C., (1999)), Carbohydrate Biotechnology Protocols, Humara Press.

M. Sc. Biotechnology (Semester-I)
Biochemistry (Practical)
MBT104

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Theory & Application of Buffers & pH
2. Preparation of buffers: Phosphate buffer and Tris buffer
3. Quantitation of sugars: Anthrone method and Bradford method
4. Protein estimation: Lowry's method
5. Determination of saponification and acid value of fat.
6. Determination of Iodine number of fat.
7. Separation of amino acids by TLC.

Books Recommended:

1. Singh, S.P. (2006) Practical manual of Biochemistry. 6th Edition, CBS publication.
2. Sawhney, S.K. and Randhir Singh (2001). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
3. Plummer D.T. (1998). An Introduction of Practical Biochemistry, 3rd Ed. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
4. Bansal, D.D., Khardori, R. & Gupta, M.M. (1985). Practical Biochemistry. Standard Publication, Chandigarh.

M. Sc. Biotechnology (Semester-I)
General Microbiology, Microbial Physiology & Biotechnology (Theory)
MBT 105

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

Section – A

Principles of Microbiology: Principles and applications of bright field, dark field, phase contrast, fluorescence and scanning tunnelling microscopy.
Methods in Microbiology; pure culture techniques, theory and practice of sterilization, principles of microbial nutrition, microbial culture media, enrichment culture techniques, culture collection, culture purification and preservation methods.

Section-B

Prokaryotic cells: Organelle of microbes and their structure and functions. Cell wall types of Gram-positive and Gram-negative bacteria, capsules, Pili, Fimbriae, flagella. Classification of microorganisms based on their nutritional requirements. Sporulation and regeneration in bacteria. Brief comparison of archaea and eubacteria.

Section – C

Microbial Growth: Definition of growth, mathematical expression of growth, growth curve, diauxic and synchronous growth, effect of temperature, pH (acidity, basicity), oxygen and water availability on growth.
Virology: General characteristics , classicfication, ultrastructure of virus, viroids. Methods of isolation and purification of virus (T4,Mu, X174, M13 only). Lytic and lysogenic life cycles of virus.

Section- D

Bacterial Genetics: Recombination in bacteria, transformation, transduction, conjugation, plasmids; drug resistance in bacteria, transposons.
Bacterial classification: Bacterial classification according to Bergey's manual, 16S rRNA, % GC ratio, DNA-DNA homology, fatty acid analysis methods of classification.

Books Recommended:

1. Damal. J, Lodish, H. and Baltimore, D. (2007). Molecular Cell Biology, 6th edition, Scientific American Books, Distributed by W.H. Freeman and Co., New York.
2. Lewin, B. (2007). Gene IX, 9th edition, Jones and Bartlett Publishers.
3. Lehninger, Nelson, D. L. & Cox, M. M. (2005). Lehninger Principles of Biochemistry, 4th ed., Worth Publishers, New York.
4. Freifelder, D. (2000). Microbial Genetics, Narosa Publishing House.
5. Watson,J.D., Baker,T.A, Bell,S.P., Gann,A., Levine,M., Losick,R. (2004). Molecular biology of the gene (5^{th} Ed.). Pearson Education (Singapore) Pvt. Ltd.
6. Chander,M, Puri, P. (2008). A Concise course in Microbiology. Krishna Publishing House. Pvt. Ltd.

7. Presscott, L.M., Harley, J.P. and Klein,D.A. (2011). Microbiology (6th Edition). McGraw Hill Inc.
8. Ronald, A.M. (1995). Principles of Microbiology. Mosby Year Book Inc. Missouri.
9. Pelczar, M.J., Chan, E.C.S., Kreig, N.R. (2010). Microbiology: Concepts and Applications. McGraw Hill, NY.
10. Tortora, G.J., Funke, B.R., Case, C.L. (2012). Microbiology an Introduction (11th edition), Benzamin Cummins.

M. Sc. Biotechnology (Semester-I)
General Microbiology, Microbial Physiology & Biotechnology (Practical)
MBT105

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. To study the morphology and structural characteristics of different bacteria and fungi using light microscope.
2. To perform serial dilution of the soil sample to isolate bacterial and fungal CFU.
3. To perform the Gram staining of given bacterial samples isolated in above experiment.
4. To evaluate the microbiological quality of potable water by MPN/MTFT method.
5. To isolate bacterial or fungal DNA and purify it by gel electrophoresis.
6. To test for the antibiotic sensitivity of the bacterial sample.
7. To perform the MIC test for antibiotic sensitivity of a bacterial strain against a specific antibiotic.
8. Preservation/cryopreservation of a microbial strain.

Books Recommended:

1. Claus, W.G. and Claus, G.W. (1991). Understanding microbes: Laboratory Text Book for Microbiology, W.H. Freeman Company.
2. Benson, H.J. (1994). Microbiological Applications, 6th ed., Win, C. Brown Publishers, England.
3. Cappucino, J.G. (1999). Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.

M. Sc. Biotechnology (Semester-II)
Environmental Biotechnology
MBT201

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Environmental Pollution and management: Types of pollution including electronic pollution, methods for the measurement of pollution, Air pollution and its control through Biotechnology; sources of water pollution, waste water treatment: physical, chemical and biological treatment processes. Microbiology of waste water treatments, aerobic and anaerobic process. Thin film techniques for waste water treatment using aquatic plants. Role of nanotechnology in environmental pollution control.

SECTION –B

Solid waste management with vermicomposting: Organic waste processing, composting, anaerobic digestion, vermiculture and vermicomposting, essential precautionary steps in vermicomposting, vermiculturing, vermiwash, overall benefits, economics and marketing.
Biomass production and Biofuels: Introduction, plant biomass, sources of biomass, forest biomass, crop residues (cereals, leguminous crops, sugar cane etc.) aquatic biomass, wastes as a source of energy, composition of plant biomass (cellulose, hemicellulose and lignins), biomass conversion, biological and non- biological processes, useful products biomass (ethyl alcohol, methanol, methane), Application and future prospects, Recent trends in biofuel research.

SECTION –C

Biological nitrogen fixation and biofertilizer:The range of nitrogen fixing organisms, biochemistry of nitrogenase, genetics of nitrogen fixation, regulation of *nif* gene expression, symbiotic nitrogen fixation, genetic analysis of *Rhizobium* bacteria, regulation of nod gene expression, transfer of *nif* genes from *Klebsiella pneumoniae* to other organisms, application and future prospects. green manuring, the blue green algae, algalization,*Azolla*, present status and improvements.

SECTION –D

Bioremediation: Types of bioremediation, use of fungi, algae and bacteria in biosorption, ecological considerations, biodegradation of oil spills, surfactants, TNT wastes, dye stuff wastes, insecticides, herbicides, antibiotics. plastic menace, biodegradable plastics, volatile toxic gases and biofiltration.

Books Recommended:

1. Manahan, S. E. (2000), Environmental Science and Technology, Lewis Publishers, New York.
2. Anderson, D. & Conning, D.M. (1984). Experimental Toxicology, Royal Society of Chemistry.

3. Abbasi, S.A., and Ramasami, E. (1999). Biotechnological Methods of Pollution Control. Universities Press, Hyderabad.
4. Alexander, M.(1999). Biodegradation and Bioremediation. Acadamic Press, San Diego.
5. David, T.G. (1984). Microbial Degradation of Organic Compounds, Marcel Dekkar Inc., New York.
6. Omenn, G.E. (1987). Environmental Biotechnology, Plenum Press, New York.
7. Rittmann, D.E., McCarty, P.L. (2001). Environmental Biotechnology: Principles and Applications. McGraw Hill, New York.

M. Sc. Biotechnology (Semester-II)
Immunology (Theory)
MBT202

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction: Phylogeny of immune System, Innate and acquired immunity, Clonal nature of immune response, Organization and structure of lymphoid organs, Nature and biology of antigens and super antigens, Antibody structure and function, Antigen-Antibody interactions.

SECTION –B

Major histocompatibility complex, BCR & TCR, generation of diversity, Complement system. Cells of the Immune system: Heamtopoiesis and differentiation, lymphocytes trafficking, B-lymphocytes, T- lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cell, eosinophils, neutrophils and mast Cells. Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses, Activation of B- and T-lymphocytes, Cytokines and their role in immune regulation, T- cell regulation, MHC restriction, Immunological tolerance.

SECTION –C

Cell- mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity. Hypersensitivity. Autoimmunity.

SECTION –D

Transplantation, Immunity to infectious agents (intercellular parasites, helminthes & viruses), Tumor immunology, AIDS and other immunodeficiencies, Hybridoma Technology and Monoclonal antibodies.

Books Recommended:

1. Kuby, J. (2004), Immunology, 5th Edition. W.H. Freeman and Company, New York
2. Roitt, I.M., Brostoff, J., Male, D.K., & Roth, D. (2006). Immunology (7th ed.). The C.V. Mosby Company. St. Louis
3. Murphy, K.M. (2011). Janeway's Immunobiology, 8th Edition (Immunobiology: The Immune System (Janeway)) Garland Science. Taylor and Francis Group.
4. Kanfmann, S.H.E., Sher A., Ahmed, R. (2002). Immunology of Infections Diseases, ASM Press, Washington
5. Strites D.P., Terr. A.I. & Parslow T.G. (1997), Medical Immunology, 9th Ed., PHI, Cambridge.

6. Paul, W./E. (1995), Fundamental Immunology, 3rd Ed., Raven Press, New York
7. Austyn, J.M. and Wood K.J. (1993), Principles of Cellular and molecular Immunology, Oxford University Press Inc. New York.
8. Britch, J.R. and Lennox, E.S. (1995), Monoclonal Antibodies Principles and Application,Wiley Liss.

M. Sc. Biotechnology (Semester-II)
Immunology (Practical)
MBT202

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Blood film preparation and identification of cells.
2. R.B.C. Counting.
3. Total leukocyte count & Differential leukocyte count
4. A.B,O Blood group testing
5. Direct and indirect haemagglutination assays.
6. Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method
7. Separation of serum / plasma from blood
8. Double immunodiffusion test
9. Dot Immuno blot assay (DIBA).

Books Recommended:

1. Stevans, C.D. (2009). Clinical Immunology and Serology : A Laboratory Perspective F.A. Davis Company, Philadelphia
2. . Hay, F.C. Westwood O.M.R. (2002). Practical Immunology, 4th Ed., Blackwell Science, U.K.
3. Celis, K.E. (1998). Cell Biology: A laboratory handbook. Vol-I Academic Press, U.K.

M. Sc. Biotechnology (Semester-II)
Biophysical and Biochemical Techniques (Theory)
MBT 203

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Principles and application of light, phase contrast, fluorescence scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.
Centrifugation: Types of centrifuges and centrifugation, rotors and applications, ultracentrifuge-Analytical and preparative.

SECTION –B

Principles and techniques of nucleic acid: hybridisation and Cot curves; Sequencing of proteins and nucleic acids; Southern, Northern and South Western blotting techniques; Polymerase chain reaction. Principles and applications of gel filteration, ion-exchange and affinity chromatography, thin layer and gas chromatography, high pressure liquid (HPLC) chromatography

SECTION –C

Principles of biophysical methods used for analysis of biopolymeric structure, X-ray diffraction fluorescence UV/CD, visible NMR and ESR spectroscopy, hydrodynamic methods, Atomic absorption and plasma emission spectroscopy. Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

SECTION –D

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques

Books Recommended:

1) Wilson K. and Walker J. (Eds.) (1995). Practical Biochemistry : Principles and Techniques, Cambridge University Press, U.K.
2) Riley, T. and Tomilson, C. (1987). Principles of Electroanalytical Methods. John Wiley and Sons Ltd. , Chichester, England.
3) Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wiley and Sons Ltd. , Chichester, England.
4) Cooper, T.G (1977). The Tools of Biochemistry, John Wiley & Sons, N.Y.
5) Freifelder, D. (1982). Physical Biochemistry. Applications to Biochemistry & Molecular Biology, W.H. Freeman & Co.

6) Sadasivam, S. and Manickam, A. (1992). Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi.
7) Sawhney, S.K. and Singh, R. (2001). Introductory Practical Biochemistry. Narosa Pub.House, New Delhi.
8) Plummer, D.T. (1990). An Introduction to Practical Biochemistry 3rd ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
9) Rana, S.V.S (2008) Bio-Techniques, Rastogi publications

M. Sc. Biotechnology (Semester-II)
Biophysical and Biochemical Techniques (Practical)
MBT 203

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Isolation of DNA and protein from biological samples.
2. Estimation of DNA and protein by Spectrophotometer
3. Preparation of standard curve of protein by Bradford method.
4. Electrophoresis of proteins-Native and denaturing PAGE.
5. Ion exchange chromatography of proteins.
6. Affinity chromatography of proteins
7. Thin layer chromatography of biomolecules.
8. Gel permeation chromatogrphy

M. Sc. Biotechnology (Semester-II)
Genetic Engineering (Theory)
MBT204

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes,

SECTION –B

Plasmids; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Yeast vectors, Shuttle vectors, siRNA technology.

SECTION –C

Expression strategies for heterologous genes: vector engineering, codon optimization, host engineering, in vitro transcription & *in vitro* translation, expression in bacteria, expression in yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies.
Linkers; Adaptors; Homopolymeric tailing, strategies for cDNA libraries; Transformation; Northern, Southern and Colony hybridization,Southwestern and Far-western cloning; Phage display

SECTION –D

Cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay; DNaseI footprinting)

PCR and Its Applications
Primer design; Fidelity of thermostable enzymes (Taq & Pfu polymerases); DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in gene recombination; SOEing; Site specific mutagenesis; deletion; addition;

Books Recommended:
1. RW old and SB Primrose (2004). Principles of gene manipulation. Black Well Publication.
2. Molecular Cloning; a laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2001, 3rd Edition, reprint 2007.
3. DNA Cloning: A Practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
4. Gene cloning and DNA analysis : An introduction by TA brown (5th ed.) 2006 Blackwell Sci. Ltd.
5. Principles of gene manipulations and genomics Primrose & Twyman 2006, Blackwell Sci. Ltd.
6. Molecular Biotechnology (2nd Edn.) S.B. Primrose, Blackwell, Scientific Publishers.Oxford.
7. Hugo A. Barrera-Saldaña (2012) Genetic Engineering - Basics, New Applications and Responsibilities, Publisher: InTech

8. Gene Cloning and DNA Analysis: An Introduction by T. A. Brown (April, 2013) John Wiley & Sons

M. Sc. Biotechnology (Semester-II)
Genetic Engineering (Practical)
MBT204

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Isolation of plasmid.
2. Making competent cells of *E.coli*.
3. Transformation of competent *E.coli* cells.
4. Cloning of foreign DNA insert in plasmid (PET Vector).
5. Isolation of total RNA.
6. Expression of fusion protein (His-tagged/MBD-tagged)
7. PCR.

Books Recommended:

1. Practical handbook of biochemistry and molecular biology (1989) by Gerald D. Fasman (CRC Press, Taylor and Francis Group).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press, New York).
3. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual (Fourth Edition): Three-volume set Cold Spring Harbor Laboratory Press, New York.

M. Sc. Biotechnology (Semester-III)
Computer Applications (Theory)
MBT 305

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction to digital computers: organization; low-level and high-level languages, the binary number system. Programming techniques. Introduction to internet and its applications.
Introduction to MS-Excel, use of worksheet to enter data, edit data, copy data, move data, Use of in-built statistical functions for computations of mean, S.D., Correlation, regression coefficient etc.. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to various statistical software packages.

SECTION –B

Introduction to programming in C: Overview, Character set, C Tokens, Keywords, Identifiers, Variables, Constant, Data Types, Comments, Structure of a C. Program Operators & Expressions: Types of operators, Precedence and Associativity, Expression, Statement and types of statements Built-in functions: printf( ), scanf( ), getch( ), getchar, putchar( ), header files, Preprocessor directives : #include, #define Control Statements : If, If-else, Nested If – else, Switch, While, Do-while, for, Nested for loop, break continue etc.

SECTION –C

Arrays, One Dimensional arrays, Two Dimensional Arrays, storing data into arrays, Searching and Sorting, Functions, calling a function, passing arguments, Call by Reference, Call by Value, Storing and Displaying Strings, Structure & Union.

SECTION –D

Introduction, Characteristics of Data base approach, Database users, Schemas and Instances, DBMS Architecture and data independence, database languages, Introduction to SQL. History, Basic Structure, DDL Commands (Create, Alter, Drop) , DML Commands (Select, Insert, Update, Delete), Simple Queries, Aggregate Functions, clauses (WHERE, JOIN, DISTINCT, ORDER BY, GROUP BY, HAVING, and UNION).

Books Recommended:
1. Sinha, P.K. (1992). Computer Fundamentals.
2. Norton, P. (2000). Introduction to Computers. Mc Millan, New York.
3. Taxali, R.K. (2002). PC software made simple, TMH.
4. Kanetkar, Y.P. (2004). Let us C, BPB Publications.
5. Sood S., Kumar S. and Maalti (2010). Programming Using C, Jyoti Book Depot Pvt. Ltd.
6. Gupta, S.C. (2004). Fundamentals of Statistics, Himalaya Publishing House.

M. Sc. Biotechnology (Semester-II)
Computer Applications (Practical)
MBT205

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Write programmes to demonstrate using conditional statements using C languages.
2. Write programme to manipulate matrices.
3. To demonstrate array function.
4. To perform mail merge.
5. Use of Excel and PowerPoint.

Books Recommended:

1. Compute fundamentals (2002) by P.K. Sinha (BPB Publications).
2. "Pragramming with C" (1997) by Venugopal K R and Sudeep R Prasad (Tata McGraw Hill).
3. "The C Programming Language" (2007) by Brain W. Kernighan and Dennis M. Ritchie (Prentice Hall of India).

M. Sc. Biotechnology (Semester-III)
Animal Tissue Culture & Animal Biotechnology (Theory)
MBT301

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION -A

Concept of aseptic techniques in ATC; design and layout of ATC lab, Equipment for ATC lab. Laboratory safety and Biohazards, balanced salt solution and tissue culture media.
Detection of contamination, preservation, storage and shipment of cells. Growth of cells in the serum free hormone(s) supplemented medium, Role of CO_2 in culture medium.

SECTION -B

Dispersion and disruption of tissue, monolayer and suspension culture techniques, measurement of growth and viability of cells in culture, maintenance of cultured cell line, primary and established cell line cultures, cell separation.

SECTION -C

Cell culture characteristics, scale up methods for propagation of anchorage dependent and suspension cell culture, concept of Bioreactors for mass culture of mammalian cells, microcarrier culture. Three dimensional culture system and tissue engineering.

SECTION -D

Cell synchronization, cell transformation, cell immobilization techniques, Cell cloning and micromanipulation, animal cloning.

Books Recommended:

1. Spier, R. R. and Griffiths, J. B. (1990). Animal Cell Biotechnology, Academic Press, London.
2. Gareth, E. J. (1996). Human Cell Culture Protocols, Humana Press.
3. Julio, E., Celis (1998). Cell Biology-A Laboratory Hand Book, Vol. I-IV, 2nd Ed., Academic Press, New York.
4. Butler, M. (2004). Animal Cell Technology, 2nd Ed., BIOS Scientific Publishers, U.K.
5. John M. Davis (2011) Animal Cell Culture: Essential Methods: Publishers Wiley
6. R. Ian Freshney (2012) : A Manual of Basic Technique and Specialized Applications, 6th Edition, John Wiley and Sons, New York.

M. Sc. Biotechnology (Semester-III)
Animal Biotechnology (Practical)
MBT301

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen.
3. Cell counting and cell viability.
4. To obtain monolayers of peritoneal macrophages
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
7. Determination of cell doubling time of a given cell line.
8. Cytotoxicity assay method for a given cell line

Books Recommended:

1. Culture of Animal Cells, (3rd Edition), R. Ian Freshney. Wiley-Liss.
2. Animal Cell Culture – Practical Approach, Ed. John R.W. Masters, 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 Mather and David Barnes. Academic Press.
7. R. Ian Freshney (2012) : A Manual of Basic Technique and Specialized Applications, 6th Edition, John Wiley and Sons, New York.

M. Sc. Biotechnology (Semester-III)
Plant Tissue Culture &Plant Biotechnology (Theory)
MBT 302

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION -A

Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids**,** History of plant cell culture, Culture media types, Media composition, Plant growth regulators, Gelling agents, Cellular totipotency, Dedifferention and Redifferentiation, Callus and cell culture, Organogenesis and embryogenesis.

SECTION -B

Micropropagation methods, stages of micropropagation, types, applications and limitations. Somatic embryogenesis types, protocol, media requirements, embryogenic callus, EDCs, advantages and disadvantages. Application of propagation techniques in crop improvement.. Acclimatization of micropropagated plantlets, Technical problems in PTC. Axillary bud, shoot tip and meristem culture. Embryo culture technique and rescuing hybrid embryos.

SECTION -C

Production of synthetic seed and their applications. Virus free plant production by PTC. Anther and microspore culture, Development of haploid plants, diploidization, applications. Protoplast isolation, culture and fusion, Somatic hybridization, Methods of somatic cell fusion, selection of somatic hybrids, cybrids and their applications. Somaclonal variations, isolation of useful variants at cellular level, Production of disease resistance, herbicide resistance and salt tolerance plants. Cryopreservation: factors influencing revival of frozen cells, applications and future prospects of freeze preservation.

SECTION –D

Secondary metabolites production: methods, applications and limitations. Prospects of genetic engineering of plants. Genetic colonization of plants by Agrobacterium infection and tumour growth, Ti – plasmids, neoplastic transformation of plant cells. Techniques for the production of transgenic plants. Crop improvement through transgenics, benefits and risk of producing transgenic plants, commercialization of transgenic plants.

Books Recommended:

1) Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Springer Verlang, Berlin.
2) Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990). Hand Book of Plant Cell Culture, Vols. 1 – 5. McGraw Hill Publishing Company, New York.
3) Shaw C.H. (1988), Plant Molecular Biology – A Practical Approach IRL Press Oxford.
4) Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.
5) Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, ButterWorths, London.

6) Bhojwani, S.S. and M.K. Razdan (1983), Plant Tissue Culture. Theory and Practice Elsevier science publications Amsterdam.
7) Draper J.R. Scott, P. Armitage, R. Walden, (1988). Plant Genetic Transformation and Gene Expression – A Laboratory Manual. Blackwell Scientific Publications, Oxford.
8) Grierson, D. and Covey, S.N. (1984). Plant Molecular Biology, Black Publishers, New York
9) Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
10) Hopkins W.G. (2006) Plant Biotechnology, Infobase Publishing, pp 153

M. Sc. Biotechnology (Semester-III)
Plant Tissue Culture &Plant Biotechnology (Practical)
MBT 302

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1) Methods of sterilization.
2) Preparation of media-MS (full strength, half strength).
3) Filter sterilization of thermo labile components
4) Micropropagation.
5) Effect of various growth hormones on cell division and cell proliferation
6) Callus induction & sub culturing, organogenesis.
7) Anther culture technique.
8) Acclimatization of tissue culture raised plantlets.

M. Sc. Biotechnology (Semester-III)
Enzymology and Enzyme Technology (Theory)
MBT 303

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION -A

Classification and nomenclature of enzymes, enzyme properties and denaturation; Energetics of enzyme catalyzed reactions, transition state; Mechanism of enzyme action; Regulation of enzyme activity;
Isoenzymes, co-factors and co-enzyme, Concept of active centre, binding sites, stereospecificity and ES complex formation, activation energy and transition state theory.
Effect of temperature, pH and substrate concentration on reaction rate. Extraction, assay and purification of enzymes.

SECTION -B

Basic aspects of Enzyme Kinetics: Pre-steady state kinetics. Michaelis-Menten, Line Weaver-Burke, Eadie-Hofstee and Hanes-Woolf equations and Km value.
Enzyme inhibitors: Types of inhibitors–Reversible and irreversible, their mode of action and experimental determination.
Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.

SECTION -C

Regulation of enzyme activity and concentration: Brief account of enzyme induction and repression, covalent modification, isoenzymes and allostery, ribozymes and abzyme.
Enzyme specificity. Evidences for enzyme substrate complex. Nueleophilic and electrophilic attack. Role of metal ions in enzyme catalysis.
Mechanism of enzyme action e.g. Lysozyme, chymotrypsin, DNA polymerase etc. zymogens and enzyme activation.

SECTION -D

Allosteric interactions and product inhibition: Complex kinetics and analysis.
Membrane bound enzymes- Extraction, assay, lipid-protein interaction and effect of fluidity on enzyme activity.
Enzymic bioconversions e.g. Starch and sugar conversion processes etc. Immobilization of Enzymes and their industrial applications.

Books Recommended:

1) Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox. 1993. Worth Publishers, New York.
2) Palmer, T. (2001). Enzymes. Horwood Publishing, Chichester
3) Methods in enzymology Vol.185 (1990) Gene Expression technology edited by D.V. Goeddel (Academic Press Inc. San Diego).
4) Enzymes: biochemistry, biotechnology and clinical chemistry (2001) by Trevor Palmer (Horwood).

5) Fundamentals of enzymology: The cell and molecular biology of catalytic proteins (2003) by Nicholas C. Price, Lewis Stevens, Lewis Stevens published (Oxford University Press, USA).
6) Principles and reactions of protein extraction, purification, and characterization (2004) edited by Hafiz Ahmed PhD (CRC, Taylor Francis Group).
7) Shultz, A.R. (1994). Enzyme Kinetics, Cambridge Press.
8) Trevor, P. (1995). Understanding Enzymes, 4th ed. Prentice Hall/Ellis Horwood, England.
9) Engel, P.C. (1996). Enzymology Labfax, Bios Scientific Publisher, Academic Press, U.K.
10) Price, N.C. and Strevens, L. (1999). Fundamentals of Enzymology, 3rd ed., Oxford University Press.
11) Bisswanger, H. (2013) Practical Enzymology, Willey BlackWell

M. Sc. Biotechnology (Semester-III)
Enzymology and Enzyme Technology (Practical)
MBT 303

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Extraction and purification of enzymes.
2. Effect of pH on enzyme activity and stability.
3. Effect of temperature on enzyme activity and stability.
4. Effect of metal ions on enzyme activity.
5. The effect of enzyme concentration on the rate of enzyme catalyzed reaction.
6. Effect of substrate concentration on enzyme activity and demonstration of the Km and Vmax of the reaction.
7. Effect of inhibitors on enzyme activity.
8. Immobilization of enzymes.

M. Sc. Biotechnology (Semester-III)
Bioprocess Engineering & Technology (Theory)
MBT304

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction: Historical development from Petri-plate, shake flask, Lab level bioprocess, pilot level to industrial level bioprocess engineering. Scale up of bioprocesses parameters. Growth parameters, growth rate, specific growth rate and biomass doubling, degree of multiplication, growth yield,Ydx/ds, Ydx/do2, metabolic quotient, effect of substrate concentration on growth rate, Monod growth relation, saturation constants and its importance, biomass estimation.

SECTION –B

Bioreactors type: Introduction, Basic function of a bioreactor, microbial, animal and plant bioreactors. Aspectic operation and contamination. Sterilization of bioreactors, Body construction, Temperature control and measurement. Aeration and agitation, impellers, Stirrer, glands and bearings, packed gland seal, mechanical seal, magnetic drives, Baffles, different types of spargers, different ports, temperature probes. Dissolve oxygen probe. Valves and stream traps : Gate valves, globe valves. Piston valves, needle valves, plug valves, ball valves, butterfly valves, pinch valve, Diaphragm valves, check valves, pressure control valves, pressure reduction and retaining valves, safety valves, steam traps.
Bioreactor vessels, Wald hof-type acetators and cavitators, tower bioreactor, cylindroconical vessels, air lift bioreators, deep jet bioreactor, cyclone column, packed tower, rotating disc bioreactor.

SECTION –C

Mass and Gas transfer in Microbial systems: Introduction, The oxygen requirement for industrial bioreactors, oxygen demand and supply and balance between them, volumetric oxygen transfer, determination of KLa values, sulphite oxidation techniques, gassing out techniques: static method and dynamic method, oxygen balance method. Fluid rheology: Bingham plastic, pseudo plastic, Dilatants, Casson body. Factors affecting KLa values in bioreactors, the effect of medium rheology on KLa values, scale up and scale down of airation and agitation

SECTION –D

Sterilization
Introduction, medium sterilization, design of batch sterilization process, del factor, sterilization cycle, Richards rapid method for design of sterilization cycles, batch sterilization, scale up of batch sterilization, continuous sterilization, sterilization of feed, sterilization of wastes. Filter sterilization, filter sterilization of media and air, Depth filters design and theory.

Books Recommended:

1. Stansbury, P.F., Whittaker, A. Hall, S.J. Principles of Fermentation Technology 3 Edition. Pergamon Press. 2008.
2. Bailey, J.E., and Olis, D.R. Biochemical Engineering Fundamentals. McGraw Hill.
3 Moo-Young, M. Comprehensive Biotechnology. Vol 1-4.
4. Doran, P.M. Bioprocess Engineering Principles. Academic Press 2011.
5. Michael, L. Shuler and Kargi, F. Bioprocess Engineering: Basic Concepts. Pearson- Prentice Hall. 2009.
6. Crueger, W. and Crueger, A. Biotechnology: a Textbook of Industrial Microbiology. Panima Publishing Corporation.
7. McNeil, B and Harvey, L.M. Fermentation a practical approach. IRL Press (Oxford University Press). 2007.
8. Shijie Liu. Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design. Elsevier Sci. Publishers. 2012.
9. Kim Gail Clarke. Bioprocess Engineering: An Introductory Engineering and Life Science Approach. Woodhead Publishing Ltd. 2013.
10. B. Atkinson Biochemical Engineering and Biotechnology Hand Book. MacMillan Press 2009.
11. J.M. Lee. Biochemical Engineering Prentice Hall 2008.

M. Sc. Biotechnology (Semester-III)
Bioprocess Engineering & Technology (Practical)
MBT304

Practical : 20 marks
Int. assessment: 05 marks
Total : 25 marks
Time : 3 hours

1. Determination of TDS, pH and conductivity of given wastewater sample after standardization of given probes/instruments.
2. Screening and Isolation of cellulose degrading microbes.
3. Bioremediation of dyes using different fungal/bacterial strain isolated from soil at shake flask level.
4. To study the parts of a bioreactor working and functioning of any bioreactor studied in theory paper by bioreactors assembling and dismantling.
5. Sterilization of fermenter and fermentation media.
6. To characterize and isolate the effluent decolourisation product by TLC/GLC.
7. Determinations of thermal death point (TDP) and thermal death time (TDT) of microbes for designing of sterilization.
8. Study the effect agitation on aeration and determination of KLa volumetric oxygen transfer rate in the bioreactor by dynamic gassing out technique.

M. Sc. Biotechnology (Semester-III)
Seminar/Journal club/Assignment

MBT305

To make the students conversant with latest happening in the field of Biotechnology and to improve their communicational skill, seminars covering latest topics in Biotechnology have been included in the curriculum. Each candidate will deliver seminar on recent developments in Biotechnology or on important recent scientific discovery published in prestigious scientific journals. Presentation of Seminars will carry 25 marks. An objective type common paper of 25 marks on all the seminars will be taken at the end of the session. The question paper will be set and evaluated by a board of three internal examiners.

M. Sc. Biotechnology (Semester-IV)
Genomics and Proteomics
MBT401A

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries, comparative genomes (Arabidopsis, rice and panda)
DNA sequencing: conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes.

SECTION –B

FISH, Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping).
DNA Microarrays: Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips.
Gene Identification and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.

SECTION –C

Proteome analysis: Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays, differential display proteomics, yeast 2-hybrid system, FRET, bimolecular fluorescence complementation assay.

SECTION –D

Advantages and disadvantages of DNA and protein microarrays. Total expression vs functional proteomics, oligosaccharide microarrays for glycomics, pharmacogenomics, introduction to metabolomics.

Books Recommended:

1. Peruski, L.F. Jr. and Peruski, A.H. (1997). The Internet and New Biology: Tools for Genomic and Molecular Research ASM.
2. Schena, M.ed. (1999). DNA Microarrays: A practical approach. Oxford University Press.
3. Hunt, S. and Livesey, F. ed. (2000). Functional Genomics: A practical approach. Oxford University Press.
4. Josip Lovric. (2011). Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis. Wiley
5. R. Varshney. (2013). Translational Genomics for Crop Breeding. Wiley-Blackwell Ltd.
6. Sandy B. Primrose, Richard Twyman (2009). Principles of Gene Manipulation and Genomics, 7th Edition. Wiley.

7. Genomics: Essential Methods (2010). by Mike Starkey (Editor), Ramnath Elaswarapu (Editor). Wiley.
8. Nawin C. Mishra, Günter Blobel (2010). Introduction to Proteomics: Principles and Applications. Wiley
9. Jonathan Pevsner. (2009). Bioinformatics and Functional Genomics, 2nd Edition. Wiley Blackwell.
10. Molecular Analysis and Genome Discovery, 2nd Edition (2011). Ralph Rapley (Editor), Stuart Harbron (Editor). Wiley Sci Publishers.
11. Introduction to Proteomics. (2008). Agnieszka Kraj (Editor), Jerzy Silberring (Editor). Wiley Publishers.

M. Sc. Biotechnology (Semester-IV)
Introduction to Bioinformatics
MBT401B

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction to Bioinformatics: History of Bioinformatics, milestones, Genome sequencing Projects, Human Genome Project, objectives and applications of Bioinformatics.
Introduction to databases: Type and kind of databases, e.g. PUBMED, MEDLINE
Nucleic acid and protein databases: GenBank, EMBL, DDBJ, SWISS PROT, INTERPRO, UNIPROT. Genome project TIGR database, SGD, PLASMODB Data format

SECTION –B

Sequence alignment: Scoring matrices, PAM, BLOSUM, Local and global alignment concepts; Dot matrix sequence comparison; Dynamic programming; Needleman-Wunch algorithm, SmithWaterman algorithm;

SECTION –C

Database searches for homologous sequences, FASTA and BLAST, PSSM searching, PSIBLAST and PHI-BLAST, Multiple sequence alignment; Phyllogenetic analysis Motifs and Pattern Databases: PROSITE, Pfam, BLOCKS, PRINTS

SECTION –D

Protein sequence analysis tools, secondary structure prediction, tertiary structure prediction homology modelling, fold recognition, ab initio methods structure visiualization and analysis tools, rasmol chimera spdviwer, Structure analysis Structural databases: PDB, PDBsum, NDB etc. SCOP, CATH

Books:

• Cynthia Gibas & Per Jamesbeck, (2000). " Developing Bioinformatics Computer Skills," O' Rilley & Associates.
• Campbell and Heyer, Discovering Genomics, Proteomics & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
• Bourhe P. E. and Weissig H. (2003). Structural Bioinformatics (Methods of structural Analysis). Wiley-Liss.
• Mount D. W. (2004). Bioinformatics & Genome Analysis. Cold Spring Harbor Laboratory Press.
• Wayne W. Danile(2004), Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition Wiley.

M. Sc. Biotechnology (Semester-IV)
Medical Biotechnology
MBT402A

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Genetically engineered stem cells in cancer treatment, Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues

SECTION –B

Immunotherapy: Cancer immunotherapy; Role of cytokine therapy in cancers; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Clinical transplantation and immunosuppressive therapy; Vaccine development; recombinant vaccines and clinical applications.

SECTION –C

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors

SECTION –D

Genetic markers-Biomarkers in early drug development; Biomarkers in Clinical development; Biomarkers for molecular Diagnostics- example of cancer biomarkers; IVET
Drugs; Types of Drugs - examples of latest drugs; steps in drug designing, HTS, In silico drug designing, structure based drug designing, methods of docking concept of ADME metabolism & Drug Excretion; QSAR; Drug Legislation & safety.

Books Recommended:

1) Spier, R.R. and Grifftths, J.B. (1994). Animal Cell biotechnology, 6th Ed., Academic Press, London.
2) Krogsgaard-larsen P. , Liljefors T., Madsen U. and Larsen K, Liljefors T. Madsen U. (2002).
3) Text Book of Drug Design and Discovery, Taylor and Francis Publications, Washington D.C. Palson, O.B. and Bhatia, N.S. (2009). Tissue Engineering. Dorling Kindersley (India) Pvt.Ltd.

4) Robert L. and other (2009) .Essentials of Stem Cell Biology. 2nd Ed. Academic Press, London.
5) Khan, F.A. (2013) Medical Biotechnology, Academic Press, pp 368

M. Sc. Biotechnology (Semester-IV)
Intellectual Property Rights
MBT402B

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction to intellectual property rights and its different forms.
Ownership of Tangible and Intellectual Property, Farmers Rights, Animal and Plant breeders rights, Brief history of IPR system in India.

SECTION –B

Development of patent system in India. Introduction to Indian Patent law, Basic requirements of patentability, patentable subject matter, Non obviousness, Compulsory licensing, Patent infringements and revocation,

SECTION –C

World Trade Organisation and its related intellectual property provisions, TRIPS agreement, Patent Cooperation treaty, Budapest treaty.
Patent Litigation: Substantive Aspects of Patent Litigation, Procedural Aspects of Patent Litigation

SECTION –D

Recent Development in Patent System and Patentability of Biotechnology invention Special issues in Biotechnology Patents: Disclosure Requirements, Collaborative and competitive research, Challenges for the Indian Biotechnological research and industries.

Reference Books:

Intellectual Property rights in the WTO and Developing countries (2001) by Watal, J. Oxford University Press, New Delhi.

Law Relating to Intellectual Property Rights, 1st Edition(2007) by Ahuja, V.K

Patent law and Entrepreneurship, 3rd Edition, Kalyani publishers (2010) by Singh, I. and Kaur, B

New developments in biotechnology: Patenting life-special report (1990) Office of Technology Assessment (OTA), US Congress (Washington D.C. Dekker).

Draft manual of patent practice and procedure (2008) Patent Office, India.

Intellectual Property Bulletin.

M. Sc. Biotechnology (Semester-IV)
Microbial Biotechnology
MBT402C

Theory : 80 marks
Int. assessment: 20 marks
Total : 100 marks
Time : 3 hours

Instructions for paper setters and candidates
The question paper will consist of five sections A, B, C, D and E. Section - A, B, C and D will have two questions from the respective sections of the syllabus and carry 15 marks each. Section - E will consist of 10 short answer type questions which will cover the entire syllabus uniformly and will carry 20 marks in all. Candidates are required to attempt one question each from sections A, B, C and D of the question paper and the entire section E.

SECTION –A

Introduction to microbial technoloogy, Microbial metabolites : Primary & Seondary, microbial applications in food and health care industries.
Introduction to microbial genomes, phylogenetic relationships between various genera of microbes- 16SrRNA sequencing and Ribosomal Database project

SECTION –B

Prokaryotic genome organization, chromids, Bacterial and viral metagenomics, synthetic genomics, microbial sequencing projects, comparative genomics of relevant organisms such as pathogens and non-pathogens, human microbiome project.

SECTION–C

Microbial biofilms, polyketide synthase, antibiotic resistance, extremophiles and extremophilic biocatalysts, lantibiotics, biosynthesis of nanomaterials, probiotics, microbial degradation of xenobiotics, viral enzymes in modern biotechnology and clinical applications.

SECTION –D

Microbial bio-products : penicillin G, Microbial Enzymes : amylases, cellulases, cellobiohydrolase, endoglucanase, cellobiase, β-glucosidase, proteases. Microbial cultures, microbial product recovery.
Alcohol biotechnology : Beer, Whisky, and Wine. Microbial culture, fermentation media, microbial bio-processes and product recovery for beer, whisky and wine.

M. Sc. Biotechnology (Semester-IV)
Educational Tour/Industrial Visit
MBT403

To enrich students' learning experiences and to help them to acquire practical knowledge about the subject, industrial visits will be arranged by the Department. The students are required to submit written report about the visit at the end of semester. Viva voce will be conducted.

M. Sc. Biotechnology (Semester-IV)
Research Project
MBT404

To give the students sufficient experience and proficiency in the research methodology and to enable them to carry out independent research, projects will be assigned to the students as per individual interest and availability of specialized faculty. The project report will be submitted in the form of dissertation. The project will be presented for evaluation at the end of semester and viva voce examination will be conducted.