DEPARTMENT OF MICROBIOLOGY

UNIVERSITY OF PUNE

M. Sc. (MICROBIOLOGY)

REVISED SYLLABUS

FOR

CREDIT BASED

POST GRADUATE COURSE IN MICROBIOLOGY

M. Sc. Part I – w. e. f. June 2009

GENERAL INSTRUCTIONS

1. Eligibility: B. Sc. with Microbiology as principal subject and performance at entrance examination.

2. A full Master's degree course in Sciences would be of 100 credits, where one credit course of theory will be of one clock hour per week, running for 15 weeks and one credit for practical course will consist of 15 clock hours of laboratory exercises

3. For M.Sc. in Microbiology a student should take admission in the Microbiology Department and complete at least 75% courses identified in the syllabus structure of Microbiology. If students so desires remaining 25% courses can be chosen from courses offered by other Departments with credit structure.

4. Course No. are designed to indicate the subject, semester, course serial number, credits assigned and the nature as theory or practicals.
   - MB indicates the subject, Microbiology
   - 1st digit indicates the semester
   - Last digit indicates the credits assigned to the course.
   - Middle number indicates the serial number. The serial number beginning with zero signifies that the course is a practical course.
     eg. MB 1.1.1 means 1st semester, 1st paper with one credit
     whereas, **MB 1.01.5** means 1st semester, 1st practical course with five credits

5. Practicals will be conducted throughout the academic year.

6. Some of the credit courses could consist of Seminars, Survey, field work, Special laboratory training in Research Laboratories etc.

7. The in semester and end semester examinations will be of 50% marks each. This will ensure that the students work regularly through the semester.

8. Question paper for each theory course will include at least one problem based on research reports (Mathematical / Data Interpretation / Comment type) related to concerned course.

9. Each course will be evaluated for 25 marks per credit of which 50 % will be based on continuous / internal evaluation.

Credit	Continuous/Internal Assessment Marks	End Assessment Marks
1	12	13
2	25	25
3	37	38
4	50	50
5	62	63

10. Results at the end of the semester will be declared using a grade point system.

11. The formula for GPA will be based on weighted average. The final GPA will not be printed unless a student passed courses equivalent to minimum 100 credit hours. Total ctredit hours means sum of credit hours of the courses which a student has passed.

12. A seven point grade system (guided by the Government of Maharashtra Resolution No. UGC-1298/[4619]/UNI. 4 dt December 11, 1999 and the University regulations) will be followed. The corresponding grade table is as indicated

Explanation of Grades and Grade Point Average (GPA)

Marks Obtained	Grade	Grade Points
100-75	O Outstanding	06
74-65	A Very Good	05
64-55	B Good	04
54-50	C Average	03
49-45	D Satisfactory	02
44-40	E Pass	01
39 and less	F Fail	00

Final Grade Points

Grade Points	Final Grade
05.00-6.00	O
04.50-4.99	A
03.50-4.49	B
02.50-3.49	C
01.50-2.49	D
00.50-1.49	E
00.00-0.49	F

Common formula for GPA:

GPA (Grade Point Average) = Total of (Grade Points Earned X Credit hours for each course) / (Total Credit Hours)

'B' Grade is equivalent to at least 55% of the marks as per GR No. UGC-1298/[4619]/UNI. 4 dt December 11, 1999

13. If the GPA is higher than the indicated upper limit in the third decimal digit, then the student be awarded higher final grade (eg a student getting GPA of 4.492 may be awarded 'A'.

14. There will be only final compilation and moderation at CGPA (Final) level done at the Department. While declaring the result, the existing relevant ordinances are applicable. There is also a provision for verification and revaluation. In case of versification the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.

15. For grade improvement minimum 30 credit courses should be taken by the student. These courses will be from the parent Department.

16. The above circular supersedes all previous circulars on the credit system being operated at Department of Microbiology, University of Pune.

M. Sc. (Microbiology) Curriculum

Semester I:

Course no.	Title	Total credits
MB 1.1.2	Systematics of Bacteria	2
MB1.2.1	Extremophiles	1
MB 1.3.2	Basic Biochemistry	2
MB 1.4.1	Protein Chemistry	1
MB 1.5.1	Carbohydrate Chemistry	1
MB 1.6.1	Nucleic Acid Chemistry	1
MB 1.7.1	Lipid Chemistry	1
MB 1.8.1	Vitamin Chemistry	1
MB 1.9.2	Biology of Yeasts and Moulds	2
MB 1.10.1	Ultra structure of Cell Membrane	1
MB 1.11.1	Cell wall of Bacteria and Fungi	1
MB 1.12 .1	Microscopy	1
MB 1.13.2	Biochemical and Molecular Biology Techniques	2
MB 1.14.2	Biostatistics	2
	Theory credits	**19**
Practicals		
MB 1.01.4	Studies on Extremophiles	4
MB 1.02.4	Biochemical techniques I	4
	Practical credits	**8**
	Total Credits	**27**

Semester II:

Course no.	Title	Total credits
MB 2.1.2	General Virology	2
MB 2.2.1	Animal Virology	1
MB 2.3.1	Plant Virology	1
MB 2.4.2	Genome structure and function	2
MB 2.5.2	Bioenergetics	2
MB 2.6.2	Enzymology	2
MB 2.7.1	Photosynthesis	1
MB 2.8.1	Respiration: Aerobic, Anaerobic	1
MB 2.9.2	Environmental Biology	2
MB 2.10.2	Mutation, repair and recombination	2
MB 2.11.2	Systematics of yeasts and molds	2
MB 2.12.1	Bioinformatics	1
MB 2.13.1	Biophysical techniques	1
MB 2.14.1	Radioisotopes in Biology	1
	Theory credits	**21**
MB 2.01.4	Experimental Enzymology	4
MB 2.02.4	Ecology and Environmental Biology	4
	Practical credits	**8**
	Total Credits	**29**

Revised Syllabus for M.Sc. I Credit Course – w.e.f. July 2009

Course no.	Title	Description	Total credits	References
		M.Sc. I Sem I Theory		
MB 1.1.2	Systematics of Bacteria	Species concept, Biological Nomenclature, theories of biological classification, structural and biochemical systematics, numerical taxonomy, chemotaxonomy. Biodiversity- characterization, generation maintenance and loss; Magnitude and distribution of Biodiversity, economic value, wild life biology, conservation strategies, cryopreservation	2	**Taxonomy** 1. Austin B and Priest F. Modern Bacterial Taxonomy. 1986. Van Nostrand Reinhold. UK. 2. Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 8th Edition, 1974. 3. Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 9th Edition, 1982. 4. Breed and Buchanan. *Bergey's Manual of Systematic Bacteriology*. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003). 5. Sykes, G. and F. A. Skinner (Eds). *Actinomycetales: Characteristics and Practical Importance*. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. 1973. **Diversity** 1. Amann R. Ludwig W. and Schleifer K. (1995). *Phylogenetic Identification and In situ detection of Individual Microbial Cells Without Cultivation*, Microbiological Reviews **59,** 143-169. 2. Cook T. (2002) *Microbial Biodiversity: Saving Bacteria to save ourselves*, Harvard Science Review, 26-28. 3. Hugenholtz P. (2002) *Exploring Prokaryotic Diversity*

Course no.	Title	Description	Total credits	References
				in the Genomic Era, Genome Biology, **3(2)**, 0003.1-0003.8. 4. Keller M. and Zengler K. (2004) *Tapping in to Microbial Diversity.* Nature Reviews **2**, 141-150. 5. Pace N. (1997) *A Molecular View of Microbial Diversity and the Biosphere*, Science, **276**, 734-740. 6. Woese C. (1987), *Bacterial Evolution*. Microbiological Reviews, 221-271.
MB1.2.1	Extremophiles	Isolation, classification and properties of extremophiles like- hyperthermophiles, psychrophiles, halophiles, acidophiles, methnogenic extremophiles etc. Adaptation mechanisms of extremophiles, biotechnological applications of extremophiles	1	Horokoshi K and Grant WD. Extremophiles- Microbial Life in Extreme Environments. 1998. Wiley Liss Pubblications
MB 1.3.2	Basic Biochemistry	1. Bonds: ionic bonding, Ion-dipole. covalent, H-bonds, Van der Wall's interaction, Hydrophobic and hydrophilic interactions. 2. Important biochemical reactions in metabolism e.g. Substitution, Addition, Elimination, Rearrangement, Oxidation, Reduction, Ring closure, Transamination, Isomerisation, epimerization, adenylation and phosphorylation Methylation, Hydrolysis, Dehydrase reaction, Tautomerisation, etc. 3. Stereochemistry: three dimensional shapes of molecules, conformation and configuration, structure and biological activity relationship. 4. Concept of weak and strong acids and bases, pH, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers.	2	**Chemical Composition of Living Systems** 1. Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry.* 6th Edition, W. H. Freeman, New York. 2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry*. 5th Edition , John Wieley and Sons, New Delhi. 3. Dawes Edwin A. (1972). *Quantitative Problems in Biochemistry*, Churchill Livingston, Edimberg. 4. Laskin A. I. and Lechevalier H. A. (1977), *CRC Handbook of Microbiology*, Vol. 1, Bacteria, CRC Press Ohio. 5. Metzler David E. (2001) *Biochemistry: The Chemical Reactions of Living Cells*, Volume 1 & 2, Academic Press California. 6. Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi
MB 1.4.1	Protein Chemistry	Structural features of amino acids, classification of amino acids, amino acids as buffers, chemical	1	7. Peberdy John F. (1980), *Developmental Microbiology*, Blackie, London.

Course no.	Title	Description	Total credits	References
		reactions of amino acids, peptide linkage: partial double bond nature, determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides), structural classification of proteins, primary, secondary, tertiary, quaternary structures of proteins.		8. Segel Irvin H. (1997). *Biochemical Calculations*. 2nd Ed. John Wiley and Sons, New York. 9. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc. 10. White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, New York.
MB 1.5.1	Carbohydrate Chemistry	Mono, di, oligosaccharides and polysaccharides, with examples, asymmetric centre in sugars, D-series, L-series, dextro, leavo-rotatory, reducing and non-reducing sugars, sugar anomers, sugar epimers, sugar derivatives such as sugar alcohols, amino sugars, sugar acids, deoxy sugars.	1	**Introduction to Bioorganic Chemistry** 1. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Press Jerry March, *Advanced Organic Chemistry*, John Wiley
MB 1.6.1	Nucleic Acid Chemistry	Structure of bases, nucleosides, nucleotides, phospho-diester linkages, 5' phosphate, 3'hydroxyl polarity of nucleic acids, tautomeric forms of bases and their implication in pairing of bases, structure of DNA (A, B and Z forms), Tm value, detailed structure of t-RNA, r-RNA, and m-RNA.	1	
MB 1.7.1	Lipid Chemistry	Classification of lipids according to chemical structure, fatty acids, saturated, unsaturated, branched, nomenclature, system structure and function of triglycerides, phospholipids, sphingolipids, terpenes, prostaglandins, waxes, steroids, detection and estimation of lipids	1	

Course no.	Title	Description	Total credits	References
MB 1.8.1	Vitamin Chemistry	Water and fat soluble vitamins: structure and function of Thiamine, Riboflavin, Nicotinic acid, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Lipoic acid, Glutathione, Vitamin B12, Ascorbic acid. Structure and function of fat soluble vitamins as vitamins A, D, E and K	1	
MB 1.9.2	Biology of Yeasts and Moulds	The vegetative cells of fungi, Growth and development of the vegetative cell, The life cycle, Asexual reproduction, Sexual reproduction, Physiology of fungi, Economic importance of fungi, Main groups of fungi	2	1. The Fungi Ed. Ainsworth , I. (1965), II (1966), III (1968), IVA (1973), IVB (1973), Academic Press. 2. Booth, C. (1971) in Methods in Microbiology vol. 4, ed. By J. R. Norris et al. , Academic Press, London. 3. Beech, F. W. and R. R. Davenport (1971) Isolation, Purification and Maintenance of Yeasts, in Methods in Microbiology vol. 4, ed. By J. R. Norris et al. , Academic Press, London, pp 153-182. 4. Rose, A. H. and J. S. Harrison ed. (1969) The Yeasts, Vols. 1, 2, & 3. Academic Press, London. 5. Barnett, H. L. and Hunter, B. B. 1960. *Illustrated Genera of Imperfect Fungi*. Burgess Publishing Co., Minnesota.
MB 1.10.1	Ultra structure of Cell Membrane	**Ultra structure and Organization of Eukaryotic Cell** Structural organization of: Cytoskeleton (structural proteins – microfilaments, actins, etc.); nucleus, Mitochondria and chloroplasts and their genetic organization, Endoplasmic Reticulum, Golgi apparatus, Protein trafficking; Events in cell cycle, Regulation of cell cycle **Membrane Transport:** The composition and architecture of membranes, Membrane dynamics, Solute transport across membranes: Passive diffusion, active transport using P and F type ATPases, Ion mediated transport, transport of ions across membranes (ion pumps),	1	**Ultrastructure and Organization of Eukaryotic Cell** 1. Alberts Bruce (1985) *Molecular Biology of Cell.* Garland Pub. 2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry Edition* , John Wieley and Sons, New Delhi. 3. De Robertis E. D. P. and De Robertis E. M. F. (1987), Cellular and Molecular Biology Lea and Febiger, Philadelphia. 4. Schlegel Hans G. (1995) General Microbiology, Edition 7, CUP, Cambridge. 5. Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) *General Microbiology*, 4th edition, Mac Millan Press, London.

Course no.	Title	Description	Total credits	References
		Biochemical shuttles across mitochondrial membranes, Model membranes; Liposomes		6. Stephen W. Paddock, *Confocal Microscopy*, from Methods and Protocols Vol. 122, Methods in Molecular Biology, Humana Press, Press Inc., Totowa, NJ **Membrane Transport:** 1. Nelson D. L. and Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York. 2. Voet Donald and Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley and sons New York. 3. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc. 4. White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, New York. 5. Zubay Geoffrey (1998) *Biochemistry*, 4th Ed., W. C. Brown, New York. 6. Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry* 4th Ed, W. H. Freeman, New York. 7. Moat Albert G. and Foster John W. (1988) *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.
MB 1.11.1	Cell wall of Bacteria and Fungi	Definition, important chemical features of the cell wall, structure, function and assembly in bacteria and archae, typical model of cell wall of bacteria and archae, chemical differentiation of fungal cell wall	1	1. Ruiz-Herrera J, (1991) Fungal cell walls. CRC Press ISBN:0849366720 2. Guntram Seltmann, Otto Holst (2001) Bacterial cell walls. Springer ISBN:3540426086
MB 1.12 .1	Microscopy	Principles and application of fluorescence, scanning, transmission electron and confocal microscopy; cytophotometry and flow cytometry. Localization of macromolecules using electron microscopy, Immuno-electron microscopy, Confocal microscopy	1	
MB 1.13.2	Biochemical and Molecular Biology Techniques	A. Principles and applications of gel filtration, ion exchange and affinity chromatography, thin layer and gas chromatography, high pressure liquid chromatography (HPLC), electrophoresis and electrofocussing, ultra centrifugation (velocity	2	**Instrumentation** 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry.* 6th Edition. Freeman, New York. 2. Cotterill, R. M. J. (2002) *Biophysics: An Introduction.* John Wiley & Sons, England.

Course no.	Title	Description	Total credits	References
		and buoyant density B. Principles and techniques of nucleic acid hybridization and Cot curves; Sequencing of Proteins and nucleic acids ; Southern, Northern and South-Western blotting techniques ; Polymerase chain reaction; Methods for measuring nucleic acid & protein interactions		3. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, Publishing Company, California. 4. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold Spring Harbor Laboratory Press, New York. 5. Nölting, B. (2006) *Methods in modern biophysics.* Second Edition. Springer, Germany. 6. Pattabhi, V. and Gautham, N. (2002) *Biophysics*. Kluwer Academic Publishers, New York & Narosa Publishing House, Delhi. 7. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York. **Molecular Biophysics** 1. Daune M. & W. J. Duffin (1999) *Molecular Biophysics: Structures in Motion*, Oxford University Press. 2. Nalting B. & B. Nalting (2003) *Methods in Modern Biophysics* Springer Verlag 3. Voit E. O. (2000) *Computational Analysis of Biochemical Systems* Cambridge University Press. **Other books:** 1. Narayanan, P. (2000) *Essentials of Biophysics*. New Age International Publication, New Delhi 2. Stephenson, F. H. (2003) *Calculations in molecular biology and biotechnology: A guide to mathematics in the laboratory*. Academic Press, Elsevier Science, London. (For numerical problems in instrumentation)
MB 1.14.2	Biostatistics	a. Quantitative methods in biology, sampling methods, scales and variables, data organization, tabulation, graphical representation b. Concepts, examples and problems for each of the following:	2	1. Brown D. and Rothery P. 1993. Models in Ecology, Wiley. 2. Cochran W. G. – Sampling Techniques, Wiley estern Ltd, New Delhi. 3. Fellller W. Introduction to probability theory and its

Course no.	Title	Description	Total credits	References
		i. Descriptive statistics: Frequency and probability distributions, graphical representation of distributions, measures of central tendency, measures of dispersion, skew-ness, kurtosis. Introduction to Normal, Binomial and Poisson distributions and their applications. Distribution of sample means, standard error and confidence interval. ii. Regression and correlation, curve fitting and choice of models. iii. Introduction to multivariate analysis: multiple regressions, ordination, principal component analysis. iv. Survey design v. Factorial design, ANOVA and F test. vi. Probability: Laws of probability, independence and randomness. vii. Hypothesis testing: Comparison of two sample means: t-tests, non-parametric tests. The concepts of null hypothesis, significance level, type I and type II errors, one tailed and two tailed tests. Categorical data and proportion data: Chi square test and test for goodness of fit.		applications, Asia Publishing House, Mumbai. 1. Glover T. and Mitchell K. 2002. An introduction to Biostatistics. McGraw-Hill , N.Y. 2. Goon, Gupta and Dasgupta- Fundamentals of statistics. World Press, Kolkota. 3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad. 4. Montgomery D. C. Design and analysis of experiments, John Wiley and Sons. 5. Murthy M.N. Sampling methods, Indian Statistical Institute, Kolkota. 6. Wayne Daniel 2007. Biostatistics, a foundation for analysis in the health Sciences, Edn. 7, Wiley-Indian Edn.
		Theory Credits	**21**	
M.Sc. I Sem I Practicals				
MB 1.01.4	Studies on Extremophiles	1. Isolation and characterization of anaerobic microorganisms 2. Isolation and characterization of thermophilic microorganisms 3. Isolation and characterization of Psychrophilic microorganisms 4. Isolation and characterization of Alkalophilic microorganisms	4	

Course no.	Title	Description	Total credits	References
		5. Isolation and characterization of Acidophilic microorganisms 6. Isolation and characterization of Halopphilic microorganisms		
MB 1.02.4	Biochemical techniques I	**A) Basic Biochemistry** 1. Buffer: Determination of pKa of a monoprotic weak organic acid; Preparation of buffers using KH_2PO_4 and K_2HPO_4, acetic acid and sodium acetate, K_2HPO_4 and H_3PO_4 2. Preparation of DNA and RNA from Eukaryotic and/ or Prokaryotic Cells 3. Colorimetry and spectrophotometry: Estimation of sugar and total carbohydrate, estimation of protein and nucleic acids (DNSA, phenol-sulphuric acid method, Lowry, Bradford and UV Spectrophotometry, Diphenyl amine and orcinol method) 4. Determination of saponification value and iodine number of fat 5. Chromatography: Separation of sugar and amino acids by paper and thin layer chromatography 6. Electrophoresis: Agarose gel electrophoresis, PAGE and SDS-PAGE of proteins 7. Molecular weight determination by Molecular sieve chromatography **B) Cell Disruption and separation of cell components using Sucrose/ Ficoll Density Gradient(yeast)**	4	1. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
		Practical Credits	**8**	
		Total Credits	**29**	

Course no.	Title	Description	Total credits	References
M.Sc. I Sem II Theory				
MB 2.1.2	General Virology	1) Distinctive properties of viruses: size, acellular (non cellular) organization, nature of viral genome, etc. 2) Morphology and ultra structure of viruses: Capsids; icosahedral, helical, envelope, glycoprotein, matrix proteins and lipids, Viral genome (double stranded viral DNA / RNA, single stranded viral DNA / RNA, etc); virus related agents (viroids, prions). 3) Cultivation of viruses: Growth of viruses in embryonated egg, in experimental animals and in cell cultures-primary and secondary cell lines, suspension cell cultures and monolayer cell cultures. 4) Assay of viruses: Physical and chemical methods of assay, (protein, nucleic acid, radioactivity tracers, electron microscopy, etc); Infectivity assay of animal viruses (plaque method, pock counting, end point method) and infectivity assay of plant viruses**.** 5) Morphology and ultra-structure of bacteriophages, one step growth curve(latent period, Eclipse period, burst size), life cycle and other details with special reference to T (odd and even).	2	7. Straus J. H. and Straus E.S. (1998) *Evolution of RNA Viruses* Ann. Rev. Microbiol. **42**: 657 – 83 8. Luria S. E. et.al. (1978) *General virology*, 3rd Ed, New York. John Wiley and Sons. 9. Fields B.N.; Knipe D. M. Chanock R.M. Hirsch M. J. (Eds) *Fields Virology*, 2nd Ed. New York, Raven Press. (1996)
MB 2.2.1	Animal Virology	1) Classification and nomenclature of viruses: ICTV recommendations 2) Life cycles and other details : DNA viruses with special reference to herpes, pox, adeno, SV40; RNA viruses with special reference to measles, rabies, polio, influenza, retroviruses; Oncoviruses	1	1. Stephens B. and Compons R. W. (1998) *Assembly of animal viruses at the cellular membrane* Ann. Rev. Microbiol.**42**:489-519 2. Reisner D. & Gross H.J. (1985) *Viroids* Ann. Rev. Biochem.**54**:531-64 3. Prusiner S. B. (1995) *The Prion Diseases*, Scientific

Course no.	Title	Description	Total credits	References
		and Lentiviruses (HIV). 3) Miscellaneous: Interferon, antiviral agents, slow and persistent viruses; Mechanism of virus host interaction / Mechanism of virus persistence.		American (1):48-57 4. Sherkar A. H. & Marion P.L. (1991) *Hepo DNA viruses and Hepatocellular Carcinomas.* Ann. Rev. Microbiol.**45**:475-508 *5.* Davis and Dulbacco *Medical Microbiology*
MB 2.3.1	Plant Virology	1) Classification and nomenclature. 2) Effects of viruses on plants: appearance of plants, histology, physiology and cytology of plants. 3) Diagnostic techniques to detect viruses: In seeds, seed stocks, and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescence microscopy.) 4) Behavior of viruses in plants: Early stages of infection, biochemistry of virus replication, cellular sites of virus replication and assembly and accumulation of virus particles. 5) Transmission of plant viruses: With vectors (insects, nematodes, fungi, etc.) without vectors (contact, seed and pollens). 6) Prevention of crop losses due to virus infection: virus free planting material, vector control, disease forecasting. 7) Life cycle and other details of few plant viruses: With special reference to TMV, Cauliflower mosaic virus etc.	1	Gibbs Adrian & Bryan Harrison ( ) *Plant Virology -The Principles*. Edward Arnold Press
MB 2.4.2	Genome structure and function	**Eukaryotic Genome:** Structure of Chromatin, chromosome, centromere, telomere, nucleosome. Genome organization, Chromatin remodeling. Types of Histones, Histone modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, C value paradox and genome size, repetitive and non-repetitive DNA sequence, Cot1/2 Pseudogenes,	2	1. Benjamin Lewin. (2004) *Genes VIII* Pearson Education Inc. NJ 2. James D. Watson. (1987) *Molecular Biology of the Gene,* 4th Ed. The Benjamin Cummings Publishing Company Inc. 3. Werner Braun ( ) *Bacterial Genetics*, 2nd Ed. S. B. Saunders Company London. 4. R.W. Old & S. B. Primrose ( ) *Principles of Gene Manipulation: An Introduction to Genetic Engineering.*

Course no.	Title	Description	Total credits	References
		organeller genome.		
MB 2.5.2	Bioenergetics	Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions.	2	
MB 2.6.2	Enzymology	Purifications of enzyme, purification chart, kinetics of single substrate enzyme catalyzed reaction. Kinetics of reversible inhibitions enzyme catalyzed reactions, King Altman approach to derive – two substrate enzyme catalyzed reactions, types of two substrate enzyme catalyzed reactions, concept of allosterism, positive and negative co-operativity, models of allosteric enzymes (Monad, Wyamann and Changuax and Koshland, Nemethy and Filmer model), kinetics of allosteric enzyme, Hill plot, examples of allosteric enzymes and their significance in regulation.	2	1. Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry* 4th Ed, W. H. Freeman, New York. 2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry* 5th Ed , John Wiley and Sons, New Delhi. 3. Dawes Edwin A. (1972) *Quantitative Problems in Biochemistry*, Churchill Livingston, Edinburgh. 4. Hall D. D. & Rao K. K. (1996) *Photosynthesis* 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London. 6. Metzler David (2001) *Biochemistry: The chemical Reactions of Living Cells*, Vol 1&2, Academic Press California. 7. Moat Albert G. & Foster John W. (1988) *Microbial Physiology* 2nd Ed. John Wiley and Sons New York. 8. Nelson D. L. & Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, 4th edition, W. H. Freeman & Co. NY 9. Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology & Clinical chemistry*, Horwood Pub. Co., England. 10. Segel Irvin H. (1997) *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York. 11. Voet Donald & Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley & sons New York.

Course no.	Title	Description	Total credits	References
				12. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edn 6, Tata Mc-Graw Hill Companies, Inc. 13. White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, NY. 14. Zubay Geoffrey (1998) *Biochemistry*, 4th Ed., W.C. Brown, New York.
MB 2.7.1	Photosynthesis	Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photosystem I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water. Bacterial photosynthesis: scope, electron carriers, Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria.	1	
MB 2.8.1	Respiration: Aerobic, Anaerobic	**Aerobic Respiration:** Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation, Atkinson's energy charge, phosphorylation potential and its significance, Energy generation in all groups of chemolithotrophs. **Anaerobic Respiration:** Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenes	1	

Course no.	Title	Description	Total credits	References
MB 2.9.2	Environmental Biology	A. Interactions between environment and biota ; Concept of habitat and ecological niches; Limiting factor ; Energy flow, food chain, food web and tropic levels ; Ecological pyramids and recycling, biotic community – concept, structure, dominance, fluctuation and succession; N, P, C and S cycles in nature. B. Ecosystem dynamics and management; Stability and complexity of ecosystems; Speciation and extinctions; Environmental impact assessment, Principles of conservation; Conservation strategies; Sustainable development.	2	1. Dash, M.C. (1993). Fundamentals of Ecology. Tata McGrw Hill Publishing Hill Co. Ltd., New Delhi 2. Macan, T. T. (1974). Freshwater Ecology. Longman Group Ltd., London 3. Meadows, P. S. and Campbell. (1978). An introduction to Marine Science. Blackie and Sons Ltd., Glasgow. 4. Richards, B. N. (1987). Microbiology of Terrestrial Ecosystems. Longman Scientific and Technical, N.Y. 5. Techobanoglous G. and F. L. Burton (1991). Wastewater Engineering, Treatment, Disposal and Reuse. 3rd Ed., Metccalf and Eddy (Eds) Tata McGraw Hill Publishing Co. Ltd., New Delhi.
MB 2.10.2	Mutation ,repair and recombination	1) Mutation rate and control of mutations by proof reading, repairs in DNA: photolyase, methyl quinine methyl transferase, glycosidase, proof reading by DNA polymerase, A P endonuclease, recombination repair, SOS, mismatch repair, and post transcriptional repair/mutations. 2) Synopsis of homologous duplex, breakage and reunion, heteroduplex DNA, Rec, Ruv proteins and their role in recombination. 3) Site directed mutagenesis, Random mutagenesis and protein engineering, Alanine scanning mutagenesis and other methods. 1) Antisense technology and its applications. 2) Protein Interaction Technologies: Two hybrid and other two component systems, protein-protein interaction, curing GFP.	2	1. Benjamin Lewin. (2004) *Genes VIII* Pearson 2. Education Inc. NJ 3. James D. Watson. (1987) *Molecular Biology of the Gene*, 4th Ed. The Benjamin Cummings Publishing Company Inc. 4. Werner Braun ( ) *Bacterial Genetics*, 2nd Ed. S. B. Saunders Company London. 5. R.W. Old & S. B. Primrose ( ) *Principles of Gene Manipulation: An Introduction to Genetic Engineering*.
MB 2.11.2	Systematics of yeasts and molds	Taxonomy, (classification, nomenclature and identification) and systematics of fungi Classification of yeasts and Molds: Characteristics as	2	1. Ainsworth, G. C.(1971) Dictionary of Fungi, CMI, Surrey. 2. The Fungi Ed. Ainsworth , I. (1965), II (1966), III (1968), IVA (1973), IVB (1973), Academic Press. 3. Barnett, J. A. , R. W. Payne, and D. Yarrow (1979) A guide

Course no.	Title	Description	Total credits	References
		criteria for classification, , A system of yeast classification, 18S rDNA nucleotide sequencing based classification of fungi, A system of classification of molds, Systematics of fungi		to identifying and classifying yeasts, Cambridge Univ. Press, Cambridge. 4. Campbell, I. (1974) Methods of Numerical Taxonomy for various genra of Yeasts, in Advances in Applied Microbiology, ed. By D. Perlman, A.P., N.Y., 17: 135-156. 5. Hawksworth, D. L. (1974). Mycologist's Handbook, CMI
MB 2.12.1	Bioinformatics	1. **Introduction and biological data bases** Nucleic acid, proteins, genomes—structure data bases, search engines, sequence data forms and submission tools, scoring matrices for sequence alignments, algorithms—pairwise sequence alignments, database similarity searches—BLAST, FASTA 2. **Methods for sequence analysis** - Multiple sequence alignment, phylogenetic analysis and tree building methods, motif searches, epitope prediction, data mining tools and applications, promoter and gene prediction, comparative analysis 3. **Structure based approaches-** Protein secondary structure prediction, threading approaches, homology based methods for protein tertiary structure prediction, visualization tools, structure evaluation and validation, antigen-antibody interactions	1	1. Baldi, P. and Brunak, S. (2001) *Bioinformatics: The machine learning approach.* Bradford Book, MIT Press, Cambridge. 2. Baxevanis, A. D. and Ouellette, B. F. F. (2002) *Bioinformatics: A practical guide to the analysis of genes and proteins.* 2nd Edition. John Wiley & Sons, New York. 3. BAXEVANIS, A.D., DAVISON, D.B., PAGE, R.D.M. & PETSKO, G.A.: Current protocols in bioinformatics. 2004. John Wiley & Sons, Inc. Publications, New York. 4. Ewens Warren J. and Gregory R. Grant. (2004) *Statistical Methods in Bioinformatics, An Introduction,* Springer, New York. 5. Lacroix, Z. and Critchlow, T. (Eds.) 2003. *Bioinformatics. Managing Scientific Data*. Morgan Kaufmann Publishers. 6. Misener, S. and Krawetz, S. A. (Eds.). 2000. *Methods in Molecular Biology*, Volume 132. Bioinformatics: Methods & Protocols. Humana Press, New Jersey. 7. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold Spring Harbor Laboratory Press, NY. 8. ORENGO, C., JONES, D. & THORNTON, J.: Bioinformatics: genes, proteins and computers. 2003. Bios Scientific Publishers, Ltd. Oxford. 9. Zoe L. & Terence C. (2004) *Bioinformatics: Managing Scientific Data*, Morgan Kaufmann Publishers, New Delhi.

Course no.	Title	Description	Total credits	References
MB 2.13.1	Biophysical techniques	Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, UV, GRO, CO, Visible, NMR and ESR spectroscopy ; Hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.	1	**Instrumentation** 1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry.* 6th Edition. Freeman, New York. 2. Cotterill, R. M. J. (2002) *Biophysics: An Introduction.* John Wiley & Sons, England. 3. Drenth, J. (2007) *Principles of protein X-ray crystallography.* 3rd Ed. Springer, Germany. 4. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry.* 3rd Ed. Brooks/Cole, Publishing Company, California. 5. Keeler, J. (2002) *Understanding NMR Spectroscopy.* John Wiley & Sons, England. 6. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold Spring Harbor Laboratory Press, New York. 7. Nölting, B. (2006) *Methods in modern biophysics.* Second Edition. Springer, Germany. 8. Pattabhi, V. and Gautham, N. (2002) *Biophysics.* Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi. 9. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
MB 2.14.1	Radioisotopes in Biology	Principles and applications of tracer techniques in biology ; Radiation dosimetry ; Radioactive isotopes and half life of isotopes ; Effect of radiation on biological system ; Autoradiography ; Cerenkoy radiation ; Liquid spectrometry.	1	**Molecular Biophysics** 1. Cavanagh John *et.al.* (1995) *Proteins NMR Spectroscopy: Principles and Practice*, Academic Press 2. Daune M. & W. J. Duffin (1999) *Molecular Biophysics: Structures in Motion*, Oxford University Press. 3. Nalting B. & B. Nalting (2003) *Methods in Modern Biophysics* Springer Verlag 4. Voit E. O. (2000) *Computational Analysis of Biochemical Systems* Cambridge University Press. **Other books:** 1. Narayanan, P. (2000) *Essentials of Biophysics.* New Age

Course no.	Title	Description	Total credits	References
				International Publication, New Delhi Stephenson, F. H. (2003) *Calculations in molecular biology and biotechnology: A guide to mathematics in the laboratory.* Academic Press, Elsevier Science, London. (For numerical problems in instrumentation)
		Theory Credits	**21**	
M.Sc. I Sem II Practicals				
MB 2.01.4	Experimental Enzymology	Studies on invertase and amylase 1. Purification of enzyme from culture supernatant/ culture 2. Determination of Km and Vm values of enzyme 3. Determination of enzyme activity in presence of activators and inhibitors. 4. Determination of enzyme activity from immobilized cells.	4	1) Methods in Enzymology Vol. I and II by S.P. Colowick and N.O.Kaplan eds. 2) Basic Biochemical Methods 2nd ed by R.R. Alexander and J.M.Griffith. 3) Hawk's Physiological Chemistry ed. by Bernard L Oser. 4) A Textbook of Practical Biochemistry by David Plummer. 5) Laboratory Mannual in Biochemistry by S. Jayaraman. 6) Practical Biochemistry by Clarke and Switzer 7) Methods in Enzymatic analysis by Bergmeyer, Vol I – III
MB 2.02.4	Ecology and Environmental Biology	1. Isolation, of cellulose degraders 2. Isolation of chitinase degraders 3. Isolation of pesticide degraders. 4. Isolation of Aflatoxin producing organism 5. Detection of Aflatoxin in food / culture 6. Screening and assay of bioemulsifier/ biosurfactant producers	4	
		Practical Credits	**8**	
		Total Credits	**29**	