



Veer Narmad South Gujarat University,
Surat

M.Sc. (Microbiology) Syllabus

(Effective from June, 2017 to April 2020)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. MICROBIOLOGY

Teaching & Evaluation Scheme

Semester – I

Paper No.	Paper Title	Theory	Practical	External	Internal	Total	Credit
		(Hrs/Wk)					
MB-101	Taxonomy, Virology & Cytology	4	-	70	30	100	4
MB-102	Molecular Biology & rDNA Technology	4	-	70	30	100	4
MB-103	Bioanalytical techniques and Instrumentation	4	-	70	30	100	4
MB-104	Advances In Environmental Microbiology	4	-	70	30	100	4
Practicals		-	16	140	60	200	8
Total		16	16	420	180	600	24

Semester – II

Paper No.	Paper Title	Theory	Practical	External	Internal	Total	Credit
		(Hrs/Wk)					
MB-201	Microbial Physiology	4	-	70	30	100	4
MB-202	Bioinformatics & Other “OMICS”	4	-	70	30	100	4
MB-203	Enzyme Kinetics & Technology	4	-	70	30	100	4
MB-204	Research methodology, Biostatistics and IPR	4	-	70	30	100	4
Practicals		-	16	140	60	200	8
Total		16	16	420	180	600	24

Semester – III

Paper No.	Paper Title	Theory	Practical	External	Internal	Total	Credit
		(Hrs/Wk)					
MB-301	Fermentation Technology & Bioprocess Engineering	4	-	70	30	100	4
MB-302	Industrial Microbiology	4	-	70	30	100	4
MB-303	Immunology & Pathogenesis	4	-	70	30	100	4
MB-304	Advances in Pharmaceutical Microbiology	4	-	70	30	100	4
Practicals		-	16	140	60	200	8
Total		16	16	420	180	600	24

Semester – IV

Paper No.	Paper Title	Theory	Practical	External	Internal	Total	Credit
		(Hrs/Wk)					
MB-401	Seminar Presentation	6	-	70	30	100	4
MB-402	Report on Industrial / Conference / Symposium visit	4	-	-	50	50	4
MB-403	Review Article	6	-	-	100	100	4
MB-404	PROJECT/DISSERTATION	-	16	250	100	350	12
Total		16	16	320	280	600	24
Total credit of the course							96

M.Sc. Semester - I

MB 101: TAXONOMY, VIROLOGY AND CYTOLOGY

OBJECTIVE: The main aspects of this paper includes Taxonomy and Classification of Bacteria & Virus, Fundamentals of Virology along with concepts of new emergent virus, it also includes molecular aspects of phage and different organelle studies.

Unit-1	Taxonomy and classification of bacteria and virus		
	Ref: Bergey's manual, 2 edition, vol 1	Teaching Duration:	Lectures: 9
1.1	Taxonomy and classification of bacteria		
1.2	Procaryotic domains		
1.3	Classification of Procaryotic organisms and the concept of bacterial species		
1.4	Identification of procaryotes		
1.5	Polyphasic Taxonomy		
1.6	Bacterial nomenclature		
1.7	Culture Collections		
1.8	Virus taxonomy		(Ref. Fields)
1.9	The Baltimore scheme of virus classification		(Ref. Wagner)
1.10	Banking diverse data in ICTVdB		(Ref. Murray)

Unit-2	Fundamentals of virology		
	Ref: Shors	Teaching Duration:	Lectures: 7
2.1	Virus properties, structure and morphology		
2.2	Viruses that challenge the definition of a virus		
2.3	One step growth curve		
2.4	Key steps of virus replication cycles		
2.5	New Viruses and Viruses that are reemerging		
2.6	Prions and viroids		

Unit-3	Bacteriophages		
	Ref: Fields	Teaching Duration:	Lectures: 8
3.1	Virulent Phages		
	3.1.1 Phage T4		
	3.1.2 Ø x174		
	3.1.3 MS2		
3.2	Temperate phages		
	3.2.1 Phage λ.		
	3.2.2 Phage Mu-1 as a Model Transposon.		
	3.2.3 Phage P 1 as a Model plasmid		
3.3	Evolution and natural biology of Phages		
3.4	Bacteriophage creates pathogenic bacteria in nature		

(Shors)

Unit-4	Cytology		
	Ref: Campbell and Reece	Teaching Duration:	Lectures: 8
4.1	Eucaryotic cell structure		
4.2	The Nucleus		
4.3	Ribosomes		
4.4	Endoplasmic reticulum		
4.5	Golgi apparatus		
4.6	Lysosomes		
4.7	Vacuoles		
4.8	Mitochondria		
4.9	Chloroplast		
4.10	Peroxisomes		
4.11	Cytoskeleton		
4.12	Cell wall		
4.13	Extracellular matrix and intercellular junctions		

REFERENCES:

1. *Bergey's manual of systematic bacteriology*, 2nd Edition, Vol.1, Springer, ISBN:0-387-98771-1
2. Murray, Barron, Jorgenson, Pfaller, Tenover, Tenover. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press: ISBN: 1-55581-255-4.
3. Wagner, Hewlett, Bloom & Camerini, (2008). *Basic virology*, 3rd Edition, Blackwell publishers, ISBN-13:978-1-4051-4715-6.
4. Alan. J. Cann, (2005). *Principles of molecular virology*, 4th Edition. Elsevier academic press, ISBN: 0-12-088787-8.
5. David. M. Knipe, Peter M. Howley, (2007). *Fields virology*, 5th Edition Vol. 1, LWW, ISBN-13: 978-0-7817-6060-7.
6. Geoffrey M. Cooper, Robert E. Hausman, (2007). *The cell*, 4th edition, ASM press, ISBN-13:978-0-87893-220-7.
7. Moselio Schaechter, (2004). *Desk encyclopedia of microbiology*, Elsevier Academic Press, ISBN 0-12-621361-5.
8. Shors, T., (2013). *Understanding viruses*, 2nd edition, Jones and Bartlett, ISBN: 978-1-4496-4892-3.
9. Campbell, J. et al., (2015). *Biology: A Global Approach*, 10th edition, Pearson Education Pvt. Ltd.

MB 102: MOLECULAR BIOLOGY & rDNA technology

OBJECTIVE: The paper intends to deal basic reactions of molecular biology at its most advanced level.

Unit-1	GENOME ORGANIZATION, REPLICATION		
	Ref: Watson	Teaching Duration:	Lectures: 8
1.1 1.2 1.3 1.4 1.5 1.6	The Structures of DNA Nucleosome DNA topology The structure of RNA The replicon DNA replication		(Ref.Lewin)

Unit-2	GENE EXPRESSION		
	Ref: Watson and Baker	Teaching Duration:	Lectures: 8
2.1 2.2 2.3 2.4 2.5 2.6	Transcription 2.1.1 RNA Polymerase 2.1.2 Features of Prokaryotic promoters 2.1.3 Assembly synthesis and processing of prokaryotic transcripts 2.1.4 Regulation of transcription in prokaryotes Translation 2.2.1 Structure and role of tRNA 2.2.2 Ribosome structure 2.2.3 Genetic code 2.2.4 Translation in prokaryotes DNA topology The structure of RNA The replicon DNA replication		(Ref.Lewin)

Unit-3	TOOLS OF RECOMBINANT DNA TECHNOLOGY		
	Ref: Watson and Baker	Teaching Duration:	Lectures: 8
3.1 3.2 3.3	Enzymes and vectors 3.1.1 Restriction enzymes 3.1.2 DNA ligase 3.1.3 Vectors: plasmids, bacteriophage, M13 based vectors, phagemids, cosmids, YAC, BAC, HAC/ MAC Polymerase Chain Reaction Genomic and chromosome libraries		(Murray) (Russel)

Unit-4	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY		
	Ref: Primrose	Teaching Duration:	Lectures: 8
4.1	DNA Fingerprinting & DNA Forensics		(Watson)
4.2	Gene Therapy		
	4.2.1 Human Gene Therapy		(Glick)
	4.2.2 DNA Vaccines		
	4.2.3 Gene Augmentation		
	4.2.4 Gene therapy for Cancer Cells		
4.3	Recombinant products: hormones and vaccines		(Rastogi)
4.4	Regulation of gene action by RNAi		(Watson)
4.5	Transgenesis in plants		
	4.5.1 Gene transfer to plants		
	4.5.2 Plants as bioreactor		
4.6	Transgenesis animals		(Glick)
	4.6.1 Retroviral vector method		
	4.6.2 Cre-lox P recombination system		

REFERENCES:

1. Lewin, B., (2004). *Genes VIII*. Pearson.
2. Watson, J. D. *et al* (2008). *Molecular Biology of the Gene*. 5th Edition, Pearson
3. Murray, Barron, Jorgenson, Pfaller, Tenover, Tenover. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press, ISBN: 1-55581-255-4.
4. Primrose, S. and Twyman, R. (2006). *Principles of gene manipulation & genomics*, 7th edition. Black well publishing, Malden.
5. Glick, B. R., Pasternak, J. J. and Patten C. L., (2010), *Molecular Biotechnology: Principles and Applications Recombinant DNA*, 4th edition, ASM Press.
6. Rastogi, S. and Pathak, N. (2009), *Genetic Engineering*, Oxford Uni. Press.

MB 103: BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION

OBJECTIVE: The objective of the course is to introduce the students to the concepts of physical principles of detection and measurement systems. Emphasis will also be given to understand the principles of major experimental techniques applied to understand these physical problems. The course will cover theoretical aspects and applications of modern analytical techniques in Modern Biology.

Unit-1	Molecular techniques		
	Ref: Murray	Teaching Duration:	Lectures: 7
1.1	Non amplified nucleic acid probes		
1.2	Amplified nucleic acid technique		
1.3	Target Amplification technique		
1.4	Probe Amplification technique		
1.5	Post amplification detection and Analysis		
1.6	Current Application		
1.7	RFLP, RAPD, VNTR, STR and SNP analysis		

Unit-2	Chromatographic techniques		
	Ref: Wilson	Teaching Duration:	Lectures: 8
2.1	Principle and classification of chromatography		
	2.1.1 Partition chromatography		
	2.1.2 Adsorption chromatography		
	2.1.3 Thin layer chromatography		
	2.1.4 Gel permeation chromatography		
	2.1.5 Ion exchange chromatography		
	2.1.6 Affinity chromatography		
	2.1.7 High-Performance Liquid chromatography		
	2.1.8 Gas chromatography		
	2.1.8.1 GC-MS		
	2.1.8.2 LC-MS		

Unit-3	Spectroscopic and X-ray diffraction techniques		
	Ref: Khandpur	Teaching Duration:	Lectures: 9
3.1	Principles, Instrumentation and applications in biological sciences		
	3.1.1 UV-VIS spectroscopy		
	3.1.2 Infrared spectroscopy		
	3.1.3 Nuclear Magnetic Resonance spectroscopy.		
	3.1.4 Mass spectrometer		
	3.1.4.1 Basic mass spectrometer		
	3.1.4.2 Principle of operation		
	3.1.4.3 Types of mass spectrometers		

3.2	3.1.4.4 Components of a mass spectrometer 3.1.4.5 Application of mass spectrometry X-ray Diffraction 3.2.1 Principle & applications of Debye Scherrer camera
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Unit-4	Electrophoretic techniques		
	Ref: Walker	Teaching Duration:	Lectures: 8
4.1	General principles		
4.2	Support media		
4.3	Electrophoresis of proteins		
4.4	Electrophoresis of nucleic acids		
4.5	Capillary electrophoresis		
4.6	Microchip electrophoresis		

Reference:

1. Wilson, K. and Walker, J., (2010). *Principles and Techniques of Biochemistry and Molecular Biology*, 7th edition, Cambridge University Press (Low price edition), New York.
2. Khandpur, R. S., (2008). *Handbook of analytical instruments*. 2nd edition, Tata McGraw-Hill Publishing Company Limited (New Delhi).
3. Webster J. G., (2009). *Bioinstrumentation*, Student edition, Wiley India (P) Ltd. New Delhi.
4. Upadhyay, A., Upadhyay, K and Nath, N., (2003). *Biophysical Chemistry (Principles and Techniques)*, 8th edition, Himalaya Publishing House.
5. Khopkar, S. M., (2008). *Basic concepts of Analytical Chemistry*, 3rd edition, New age international publishers (New Delhi).
6. Sharma, B. K., (2005). *Instrumental methods of chemical analysis*, 24th edition, GOEL publishing house, Meerut.
7. Murray, Barron, Jorgenson, Pfaller, Tenenbaum. *Manual of clinical microbiology*, 8th Edition, Vol. 2, ASM Press, ISBN: 1-55581-255-4.

MB 104: ADVANCES IN ENVIRONMENTAL MICROBIOLOGY

OBJECTIVE: The paper focuses on several aspects of waste water engineering and also on the application of microbes to solve several environmental problems. The paper also makes the students familiar with current research in making the environment safe and healthy. It also exploits the principles of environmental microbiology and applies this understanding for economic purpose.

Unit-1	Characteristics of waste water		
	Ref: Metcalf & Eddy	Teaching Duration:	Lectures: 8
1.1	Waste water constituents.		
1.2	Sampling and analytical procedures		
1.3	Physical characteristics		
1.4	Inorganic non-metallic constituents.		
1.5	Metallic constituents.		
1.6	Aggregate organic constituents.		
1.7	Microbial growth kinetics		

Unit-2	Bioremediation		
	Ref: Doble & Anilkumar	Teaching Duration:	Lectures: 8
2.1	Bioremediation technologies		
2.2	Biotreatment of waste		
	2.2.1 Textile effluent		
	2.2.2 Food and Dairy industry		
	2.2.3 Sugar and Distillery waste		
	2.2.4 Pharmaceuticals		
	2.2.5 Hospital waste		
	2.2.6 Waste from nuclear plants		
2.3	Biodesulfurization		

Unit-3	Biodegradation		
	Ref: M. Alexander	Teaching Duration:	Lectures: 8
3.1	Fundamentals of Biodegradation		
	3.1.1 Growth linked biodegradation		
	3.1.2 Acclimation		
	3.1.3 Detoxication		
	3.1.4 Activation		
	3.1.5 Bioavailability		
	3.1.6 Cometabolism		
	3.1.7 Inoculation		
3.2	Biodegradation of pesticides		(Doble&Anilkumar)

3.3	Biodegradation of polymers	(Doble&Anilkumar)
3.4	Biodegradation of dyes	(Doble&Anilkumar)

Unit-4	Microbial ecology and Environmental Biotechnology		
	Ref:	Teaching Duration:	Lectures: 8
4.1	Microbial ecology – New Directions, new importance (BMSB Ed. 2 Vol 1)		
4.2	Nucleic acid probes and their application in environmental microbiology (BMSB Ed. 2 Vol 1)		
4.3	Metagenomic libraries from uncultured microorganisms		(Osborn)
4.4	Microbial transformation of heavy metals		(Mohapatra)
4.5	Microbial transformations of Pesticides		(Mohapatra)
4.6	Bioprospecting		(Sumit Ray)
4.7	Investigative Biodeterioration		(Allsopp)
4.8	The control of Biodeterioration		(Allsopp)

References:

- Hawksworth, D. L., (1995). *Biodiversity: Measurement and Estimation*, 1st edition, Chapman & Hall - The royal society.
- Garrity, G. M. and Boone, D. R., (2001). *Bergey's Manual of Systematic Bacteriology Volume 1: The Archaea and the Deeply Branching and Phototrophic Bacteria*; 2nd edition, Springer.
- Metcalf & Eddy Inc., (2002). *Wastewater Engineering: Treatment and Reuse*, 4th edition, McGraw Hill Higher Education.
- Doble, M. & Anil kumar., (2005). *Biotreatment of Industrial Effluents*. Butterworth-Heinemann – An imprint of Elsevier.
- Alexander, M., (1999). *Biodegradation and Bioremediation*, 2nd edition, Academic Press.
- Osborn, A.& Smith, C., (2005). *Molecular Microbial Ecology (Advanced methods)*, 1st edition. BIOS Scientific Publisher, Taylor & Francis group.
- Hurst, C., (2007). *Manual of Environmental Microbiology*, 3rd edition, ASM Press.
- Allsopp, D. *et al.*, (2004). *Introduction to Biodeterioration*, 2nd edition, Cambridge University Press.
- Mohapatra P. K., (2010). *Environment Biotechnology*, I K International.
- Ray S & Ray A K (2010) *Biodiversity & Biotechnology*, New Central Book Agency, London (ISBN: 81-7381-505-4)

LIST OF PRACTICALS SEMESTER 1

1. One-step growth curve.
2. Digesting DNA with Restriction Endonuclease.
3. Ligation of DNA fragments.
4. Amplification of gene by PCR.
5. To study RFLP.
6. Extraction of total RNA from Yeast
7. DNA isolation from filamentous fungi.
8. Demonstration HPLC and GC
9. Thin layer chromatography of sugars, amino acids.
10. Extraction of plasmid DNA from bacterial cell
11. Proteins quantification by SDS-PAGE.
12. Analysis of domestic water and waste water
 - 12.1 Physical
 - Acidity
 - Alkalinity
 - Hardness –EDTA titrimetric method
 - Chlorine demand
 - Solids : TDS and TSS
 - 12.2 Inorganic non-metallic constituents
 - Chloride
 - 12.3 Aggregate organic constituents
 - Biological oxygen demand
 - Chemical oxygen demand

M.Sc. Semester – II

MB: 201 MICROBIAL PHYSIOLOGY

Objective: This paper deals with the understanding of the processes of life of microorganisms as mediated by its structures and chemical components operating together to accomplish the common tasks of life. The paper introduces inter-relatedness of microbiology, biochemistry and genetics in context of the functioning of bacterial cell

Unit-1	MOLECULAR TOOLS FOR MICROBIAL PHSIOLOGY:		
	Ref.: Moat	Teaching Duration:	Lectures: 08
1.1	Mutant Hunts		
1.2	Blotting procedures:		
1.3	3.1.1 Southern Blotting		[Primrose]
	3.1.2 Northern Blotting		[Primrose]
	3.1.3 Western Blotting		[Primrose]
	3.1.4 South western blots		(A.G.Moat)
1.4	Reporter genes		
1.5	DNA Mobility Shifts		
1.6	Primer Extension		
1.7	Two Hybrid Analysis		
1.8	FISH		

Unit-2	MOLECULAR ADAPTATION PHYSIOLOGY:		
	Ref.: U. N. Streips, Moat, Desk Encyclopedia & David White	Teaching Duration:	Lectures: 09
2.1	Prototypical Two Component Signalling		
2.2	Regulation of Signal Transduction		
2.3	Spectrum of Functions		
	2.3.1 Osmolarity Changes and Porin Regulation		
	2.3.2 Quoram Sensing and Staphylococcal Virulence		
	2.3.3 Chemotaxis and Atypical Output Response		
	2.3.4 The Phosphorelay and Sporulation Initiation in Bacillus subtilis		
2.4	Physiology, Biochemistry & Genetic Aspects of:		
	2.4.1 Oxidative Stress Response and Regulation		
	2.4.2 Heat Shock Response		
	2.4.3 Nutritional Stress and Starvation Stress Response		

	2.4.4 pH Stress and Acid Tolerance
2.5	Biochemistry and Physiology of Radiation Resistant Microorganisms

Unit-3	INORGANIC METABOLISM & ENERGY PRODUCTION:		
	Ref.: David White:	Teaching Duration:	Lectures: 08
3.1	Assimilation of Nitrate and Sulphate		
3.2	Dissimilation of Nitrate and Sulphate		
3.3	Nitrogen Fixation		
3.4	Catabolism of Aliphatic Hydrocarbons		
	Growth on C ₁ compounds other than CO ₂ – The Methyloprophs		

Unit-4	PHOTOSYNTHESIS & BIOSYNTHESIS:		
	Ref.: David White & Moat	Teaching Duration:	Lectures: 08
4.1	Phototrophic Prokaryotes		
4.2	Purple Photosynthetic Bacteria		
4.3	Green Sulphur Bacteria		
4.4	Cyanobacteria and Chloroplast		
4.5	The Structure of Photosynthetic Membranes in Bacteria		
4.6	Cell wall and Capsule Biosynthesis		
	4.6.1 Peptidoglycan Structure and Synthesis		
	4.6.2 Lipopolysaccharide Structure and Synthesis		
	4.6.3 Extracellular Polysaccharide, Synthesis and Export in Gram negative Bacteria		

References:

1. The Physiology and Biochemistry of Prokaryotes, 2nd Edition, David White, Oxford University Press 2003, ISBN: 0-19-512579-7
2. Microbial Physiology, 4th Edition, 2009, Albert G. Moat, John W. Foster, Michael P. Spector, Wiley, ISBN: 978-81-265-2106-7.
3. Streips U.N. and Yasbin R.E. (2002). *Modern Microbial Genetics*. Second edition. Wiley-Liss, A John Wiley and sons Inc., publication, New York.
4. Schaechter M. (2004). *The Desk Encyclopedia of Microbiology*. Elsevier Academic Press, California USA.

MB 202: BIOINFORMATICS & OTHER “OMICS”

OBJECTIVES: The basic objective is to give students an introduction to the basic techniques of bioinformatics. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems. The students will become familiar with the use of a wide variety of internet applications, biological database and will be able to apply these methods to research problems. This paper describe a rapidly growing branches of highthroughput, large scale biology & maturing scientific discipline like Genomics, Proteomics, Transcriptomics.

Unit-1	GENOME AND GENOMICS		
	Ref: Primrose	Teaching Duration:	Lectures: 07
1.1	Introduction to Genomics: Structural, Functional and Comparative		
1.2	Comparative Genomics of Prokaryotes, Eukaryotes and Organelles		
1.3	Genome Mapping: RFLPs, SNPs, AFLPs		
1.4	Next generation sequencing method		
1.5	Genome assembling Ref: Xiong		
1.6	Genome Annotation Ref: Xiong		

Unit-2	PROTEOMICS AND OTHER “OMICS”		
	Ref: R.M. Twyman:	Teaching Duration:	Lectures: 09
2.1	Interaction Proteomics: Methods of Protein-Protein Interaction		
2.2	Expression proteomics		
	2.2.1 Basic techniques and approaches (2-D Differential gel electrophoresis)		
2.3	Functional Proteomics		
	2.3.1 Protein Microarray and its Application, 2.3.2 Types and Manufacture of protein chip		
2.4	Application of Proteomics: In the field of Medical, Pharmaceutical and Plant Biotechnology		
2.5	Transcriptomics: RNA level Gene Expression: DNA Micro array Technology and its Application, Printing Technologies Ref: Primrose		
2.6	Metagenomics: Ref: The Science of Metagenomics		
	2.6.1 Metagenomics offer a way forward and Contribution in various fields.		
	2.6.2 Designing a Metagenomics Project: Sequence based and Function based analysis.		

Unit-3	DATABASES: IN SILICO RESOURCE FOR THE INFORMATION.		
	Ref: Ghosh	Teaching Duration:	Lectures: 09
3.1	Biological Database and database design.		
3.2	Nucleotide sequence database: EMBL, gene bank, DDBJ		
3.3	Protein Database:		
	3.3.1 Protein sequence database: PIR, Swiss-Prot		
	3.3.2 Structure database: PDB, MMDB		

3.4	Classification database: CATH, SCOPE
3.5	Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST
3.6	Metabolic pathway Database: KEGG

Unit-4	APPLIED BIOINFORMATICS:		
	Ref: Ghosh	Teaching Duration:	Lectures: 09
4.1	Pairwise Sequence Alignment Ref: Xiong		
	4.1.1	Sequence Homology versus Sequence Similarity	
	4.1.2	Sequence Similarity versus Sequence Identity	
	4.1.3	Methods: Global and Local	
	4.1.4	Scoring Matrices: PAM and BLOSUM	
4.2	Multiple Sequence Alignment Ref: Xiong		
	4.2.1	Scoring Function	
	4.2.2	Exhaustive Algorithms	
	4.2.3	Heuristic Algorithms	
4.3	Markov Model And Hidden Markov Model Ref: Xiong		
4.4	Phylogeny: Statistical methods to obtain phylogenetic tree, Software for phylogenetic analysis		
4.5	Secondary structure prediction: Computation methods for secondary structure prediction: Chou Fasman, GOR and Softwares for Secondary structure prediction		
4.6	Protein Modeling: methods of Protein Modeling, Homology Modeling; fold recognition and threading approaches, and Ab-initio structure prediction methods.		

REFERANCES:

1. Twyman R. (2008). Principles of Proteomics. Taylor & Francis Publisher, Oxon.
2. Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden.
3. Xiong, J., (2009). *Essential Bioinformatics*, Cambridge University press.
4. Board on Life Sciences. (2007). The Science of Metagenomics. Division of Earth and Life sciences, The National Academies Press, Washington DC.
5. Zhumar Ghosh and Bibekanand Mallick (2008) Principles and Applications OUP India

MB-203 Enzyme Kinetics & technology

Objective: This paper will give insight on kinetics of enzymes and enzyme inhibition. Students will learn about the general methodology of enzyme extraction & purification along with its applications. A recent trends in enzymology focus on modification of enzymes for its efficient applicability, an approach covered in enzyme engineering.

Unit-1	ENZYME KINETICS:		
	Ref: T. Palmer	Teaching Duration:	Lectures:09
1.1	Kinetics of uncatalyzed chemical reaction		
1.2	Kinetics of Enzyme catalyzed reactions		
1.3	Methods use for investigating kinetics of enzyme catalyzed reaction:		
	1.3.1 Initial velocity studies		
	1.3.2 Rapid enzyme catalysis		
1.4	Kinetics of single substrate enzyme catalyzed reaction:		
	1.4.1 Michaelis-Menten equation, its modification and its importance		
	1.4.2 V_{max} and K_m		
	1.4.3 Lineweaver-Burk plot, Eadie-Hofstee plot, Hans plot, Dixon plots		
1.5	Enzyme inhibition kinetics:		
	1.5.1 Reversible inhibition:		
	1.5.2 Competitive inhibition		
	1.5.3 Non Competitive inhibition		
	1.5.4 Un Competitive inhibition		
	1.5.5 Allosteric inhibition		
	1.5.6 Substrate inhibition		
	1.5.7 Partial inhibition		
	1.5.8 Irreversible inhibition		
1.6	Kinetics of multi-substrate enzyme catalyzed reaction:		
	4.6.1 Ping-pong reaction		
	4.6.2 Random-order reactions		
	4.6.3 Compulsory order reactions		

Unit-2	Enzyme Extraction, Isolation and Purification		
	[Ref. Shanmugam]	Teaching Duration:	Lectures: 08
2.1	Enzyme extraction and isolation		
2.2	Purification of enzymes		

Unit-3	Enzyme Engineering of industrial enzymes		
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	Ref: Ashok Pandey	Teaching Duration:	Lectures: 07
3.1	Introduction		
3.2	Targets and results for industrial enzymes		
	3.2.1 Detergent enzymes		
	3.2.2 Starch hydrolysis and fructose manufacturing		
	3.2.3 Animal feed enzymes		
	3.2.4 Xylanase in pulp bleaching		
	3.2.5 Chemoenzymatic synthesis		
3.4	Rational Design methods		
	3.4.1 Site directed mutagenesis		
	3.4.2 Chemical modifications and unnatural amino acids		
3.5	Random methods		
	3.5.1 Sequence space		
	3.5.2 Methods for mutagenesis		
	3.5.3 Methods for recombination		
	3.5.4 Sequence homology independent recombination		
	3.5.5 Screening and selection		

Unit-4	Applications of enzyme		
	Ref. Shanmugam	Teaching Duration:	Lectures: 07
4.1	Large scale applications of enzymes		
4.2	Role of enzymes in detergent industries		
4.3	Enzymes in starch industries		
4.4	Applications of enzymes in baking industries		
4.5	Applications of enzymes in dairy industries		
4.6	Applications of enzymes in animal feed biotechnology		
4.7	Applications of enzymes in textile, paper and pulp industries		
4.8	Diagnostic and therapeutic enzymes		

REFERENCES:

1. Palmer T (2004): *Enzymology*. East-West Press Pvt. Ltd., New Delhi.
2. Price N C and Stevens L (1999) *Fundamental of Enzymology* , 3rd Ed. Oxford
3. Shanmugam S and Sathishkumar T, (2009), *Enzyme technology*, 1st ed., I. K. Int. pub. House

MB-204 RESEARCH METHODOLOGY, BIOSTATISTICS AND IPR

Objectives: The learning objective of the paper will enrich the students with basic principle of research methodology which help the students to learn essential steps involved in research. It also increase the understanding in use of biostatistics in analysis and interpretation of data. This paper also provide opportunity to learn importance of IPR in the todays knoeledge based industry and role of international organization in protection of IPR.

UNIT 1	RESEARCH METHODOLOGY		
	Reference: Gurumani, Ranjit Kumar	Teaching Duration	Lectures: 08
1.1	Research: What does it means? (Ranjit Kumar)		
1.2	Types of research. (Ranjit Kumar)		
1.3	The research process: A quick glance(Ranjit Kumar)		
1.4	Formulating a research problem (Ranjit Kumar)		
1.5	Constructing hypothesis (Ranjit Kumar)		
1.6	Selecting a study design(Ranjit Kumar)		
1.7	Contents of research proposal - outline(Ranjit Kumar)		
1.8	Literature citation (Gurumani)		
1.9	Research report (Gurumani)		
1.10	Research report- Tables (Gurumani)		
1.11	Research report- Figures (Gurumani)		
1.12	Research report- Formatting & Typing. (Gurumani)		

UNIT 2	FUNDAMENTALS OF BIOSTATISTICS		
	Reference: Arora	Teaching Duration	Lectures: 09
2.1	Introduction to Biostatistics		
	2.1.1 Defination, Development & Application of Biostatistics		
	2.1.2 Role of Biostatistics		
	2.1.3Data and its collection		
	2.1.4Classification of Data		
2.2	2.1.3 Importance and usefulness of Statistics		
	Preliminary Concepts		
	2.2.1 Variables and constants		
	2.2.2 Populations and Samples		
	2.2.3 Random Samples		
	2.2.4 Discrete and Continuous Variables		
	2.2.5 Relationship and Prediction		
2.3	2.2.6 Variables in biology		
2.4	Sampling Techniques (Khan)		
2.5	Diagramatic and Graphical Representation of Data (Khan)		
	Frequency Distribution (Gurumani)		

UNIT 3	METHODS OF DATA ANALYSIS		
	Reference: Khan	Teaching Duration	Lectures: 10
3.1	Measures of Central Tendency 3.1.1 Arithmetic Mean 3.1.2 Median 3.1.3 Mode 3.1.4 Geometric Mean 3.1.5 Harmonic Mean 3.1.6 Illustrative Problems		
3.2	Student t-test	Ref: Gurumani	
	3.2.1 Introduction 3.2.2 Student's t-Distribution 3.2.3 Application of t-Distribution		
3.3	Analysis of Variance (ANOVA)	Ref: Gurumani	
	3.3.1 Principle of Anova 3.3.2 Partitioning of Anova 3.3.3 Comparison of pairs of Means 3.3.4 Assumption Underlying Anova 3.3.5 Application of Anova		

UNIT 4	Intellectual Property Right (IPR)		
	Reference: Sateesh M.K.	Teaching Duration	Lectures:06
4.1	Introduction		
4.2	Forms of intellectual property		
4.3	International and regional agreement/treaties in IPR		
4.4	IPR related legislation in india		
4.5	International organization and IPR		
4.5.1	World Trade Organization (WTO)		
4.5.2	WTO treaties		
4.5.3	Genenal Agreement on tariffs and trade (GATT)		
4.5.4	Trade – Related Aspects Of IPR (TRIPS)		
4.5.5	World Intellectual Property Organization (WIPO)		

REFERENCES:

1. Sateesh M.K. (2008) Bioethics and Biosafety, I.K.International Publishing House Pvt. Ltd.
2. Gurumani N. (2011) Research Methodology For Biological Sciences, MJP Publishers, Chennai (ISBN: 978-81-8094-016-0)
3. Arora, P. N. (2007). *Biostatistics*. Himalaya Publishing House.
4. Kumar, R. (2005). *A Step-by-step Guide for Beginners*. Sage Publications.
5. Khan I. A. & Khanum A **Fundamentals of Biostatistics**, Ukaaz Publications, Hyderabad. (ISBN: 9788190044103)

LIST OF PRACTICALS SEMESTER 2

1. Find out the cellulase activity by using CMC as substrate.
2. To determine K_m & V_{max} of alpha amylase.
3. To study the effect of pH, temperature on alpha amylase activity.
4. To study the effect of activators and inhibitors on alpha amylase activity.
5. Immobilization studies: Preparation of urease/Amylase entrapped in alginate beads and determination of percent entrapment
6. Ultraviolet irradiation survival curve.
7. Perform chemical mutagenesis.
8. Isolation of mutants: Respiratory deficient.
9. Sequence retrieval systems for Nucleic acid and Proteins
10. To Study the protein Structure database (PDB)
11. Sequence based search analysis by BLAST
12. Any two EMBOSS applications for nucleotide and protein sequence analysis.
13. Sequence analysis by Multiple sequences alignment.
14. Computer assisted oligonucleotide primer designing.
15. Rasmol application for protein structure visualization. (Demonstration)
16. Protein Secondary structure prediction
17. Homology modeling: SwissModel

M.Sc. Semester – III

MB-301: Fermentation Technology & Bioprocess Engineering

Objective: This course is designed to impart the knowledge of basic principle of fermentation process. Which help students to design, develop and operate industrial level fermentation process along with the engineering aspects of bioprocess with rheological behavior of fluids and mass transfer.

UNIT 1	Microbial growth kinetics & Fermentor control systems		
	Reference: Stanbury	Teaching Duration	Lectures: 08
1.1	Batch culture		
1.2	Continuous culture		
1.3	Multistage & Feedback systems		
1.4	Fed-batch culture.		
1.5	Methods of measuring process variables		
1.6	On-line analysis of other chemical factors.		
1.7	Control systems		

UNIT 2	Strain improvement & Recovery of fermentation product		
	Reference: Stanbury	Teaching Duration	Lectures: 08
2.1	Strain improvement (Nduka Okafor)		
2.2	Removal of microbial cells and other solid matter.		
2.3	Cell disruption		
2.4	Liquid-liquid extraction		
2.5	Solvent recovery		
2.6	Two phase solvent extraction		
2.7	Chromatography		
2.8	Membrane processes		
2.9	Drying		
2.10	Crystalization		
2.11	Whole broth processing		

UNIT 3	Fluid flows and mixing		
	Reference: Doran	Teaching Duration	Lectures: 08
3.1	Classification of fluids.		
3.2	Fluids in motion		
3.3	Viscosity.		
3.4	Momentum transfer		
3.5	non-newtonian fluids		
3.6	viscosity measurement		
3.7	Rheological properties of fermentation broth.		

3.8	Factors affecting broth viscosity.
3.9	Mixing.
3.10	Power requirement for mixing.
3.11	Scale-up of mixing system.

UNIT 4	Mass transfer		
	Reference: Doran	Teaching Duration	Lectures: 07
4.1	Molecular diffusion.		
4.2	Role of diffusion in bioprocessing.		
4.3	Convection mass transfer.		
4.4	Oxygen uptake in cell culture.		
4.5	Mass transfer correlation.		
4.6	Measurement of $K_L a$.		

Reference:

1. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology*. 2nd ED, Aditya books(P) Ltd, New Delhi.
2. Okafor N. (2007) *Modern industrial microbiology and biotechnology*, Science publishers, USA.
3. Doran P.M. (2008) *Bioprocess engineering principles*, Academic press, California.

Further Reading:

1. Shuler M. L. and Kargi F. (2003) *Bioprocess engineering Basic concepts*, 2nd ED, Pearson education Pvt Ltd, India.
2. Bailey J. S. and Bhatia S.C. (2009) *Biochemical engineering*. CBS publishers & distributors, India.
3. Moo-Young M. (2004) *Comprehensive biotechnology*, Vol- 1 to 4, Pergamon press Ltd, England.

302: Industrial Microbiology

Objective: Industrial microbiology is a branch of applied microbiology in which microorganisms are used in industrial processes; for example, in the production of high-value products such as drugs, chemicals, fuels and food product. This paper explains production and processes of various microbial metabolites at industrial scale by use of microbes.

UNIT 1	Industrial production of Biomolecules		
	Reference: Flickinger	Teaching Duration	Lectures: 08
1.1	Antibiotics: Cephalosporin and Streptomycin		
1.2	Organic acids: Citric acid and Lactic acid Ref: Ratledge		
1.3	Amino acids: Glutamic acid and L-Lysine		
1.4	Enzymes: Amylase and Protease		
1.5	Hormones: Erythropoietin and Human Insulin		
1.6	Immuno therapeutic: Monoclonal Antibody production and Recovery		
1.7	Anticancer agent: Anthracyclines		

UNIT 2	Modern trends in microbial production -1		
	Reference: Flickinger	Teaching Duration	Lectures: 08
2.1	PHA: Sseparation, purification, and manufacturing Methods		
2.2	Food grade pigments Ref: Dufossé L		
2.3	Biosurfactant Ref: Lederberg J.		
2.4	1, 2 pentane diols (Optically active 1,2 diols)		
2.5	Nitrile Hydratase (Acrylamide)		

UNIT 3	Modern trends in microbial production-2		
	Reference: Nduka Okafor	Teaching Duration	Lectures: 08
3.1	Biocatalyst: Immobilized enzymes and immobilized cells		
3.2	Production of microbial insecticides		
3.3	Manufacture of <i>Rhizobium</i> inoculants		
3.4	Techniques and technology to produce biomass of cyanobacteria and Microalgae Ref; Rhem and Reed		
3.5	Cyanobacteria and Microalgae exploitation Ref; Rhem and Reed, Vol 10		

UNIT 4	Microbial production of Food and Beverages		
	Reference: Prescott & Dunn	Teaching Duration	Lectures: 07
4.1	Fermented Milk Products		
4.1.1	Cheese		
4.1.2	Yogurt		
4.1.3	Kefir		
4.2	Fermented Soy Products Ref: Flickinger		
4.2.1	Soy sauce		
4.2.2	Soy paste		
4.2.3	Tempeh		
4.2.4	Natto		
4.2.5	Tofu		
4.3	Wine and Brandy Ref; Rhem and Reed, Vol 9		

References:

1. Moo-Young, M. *et al* (1985) *Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products*. Pergamon.
2. Flickinger, M. & Drew, S.(1999) *Encyclopedia of Bioprocess Technology*,(Volumes 1 - 5) Wiley-Interscience.
3. Ratledge, C. & Kristiansen, B.(2006) *Basic Biotechnology 3Ed*. New Delhi: Cambridge University Press.
4. Lederberg, J. (2000) *Encyclopedia of Microbiology, 2Ed (Volumes 1 to 4)*.Academic Press.
5. Reed, G.(1981) *Prescott and Dunn's Industrial Microbiology*. Chapman & Hall.
6. Dufossé, L.(2006): *Food Grade Pigments*. Food Technol. Biotechnol. 44 (3) 313–321.
7. Nduka Okafor, (2007): *Modern Industrial Microbiology and Biotechnology*. Science pulishers, Enfield, NH, USA
8. H.J. Rehm and G.Reed (2010) *Biotechnology*. (Vol 9) Wiley India Pvt. Ltd.
9. H.J. Rehm and G.Reed (2010) *Biotechnology*. (Vol 10) Wiley India Pvt. Ltd.

MB-303: Molecular Pathogenesis and Immunology

Objective: This paper focuses on principles of immunology, molecular pathogenesis, immunotechnology and uses in immunotherapy. It also throws light on understanding and studying molecular pathogenesis of the disease causing organisms which lends helping hands to therapy, control of transmission, vaccine development and to the science of immunology. This paper is planned to acknowledge the students regarding advances in immunology, immunotechnology and immunotherapy.

UNIT 1	Receptor Biology		
	Reference: Abbas	Teaching Duration	Lectures: 08
1.1	The Major Histocompatibility Complex		
1.1.1	Structure of MHC molecules		
1.1.2	Genomic organization of MHC		
1.1.3	Antigen processing & presentation MHC I & II molecules.		
1.2	T-cell receptor		
1.2.1	T cell receptor complex: TCR-CD and accessory membrane molecules		
1.2.2	T cell activation		
1.3	B-cell receptor		
1.3.1	The B cell receptor and co-receptor complex		
1.3.2	Signal transduction by BCR		
1.3.3	Second signals for B cells provided by complement receptors		
1.3.4	Presentation of protein antigens by B lymphocytes to helper T cells		
1.3.5	Helper Tcell mediated activation of B lymphocytes		

UNIT 2	Immunotherapy		
	Reference: Paul	Teaching Duration	Lectures: 08
2.1	A major goal for immunotherapy - Immunotolerance.		
2.2	Cellular therapeutics		
2.3	Antibody therapeutics		
2.4	Engineered antibodies for therapy		
2.5	Engineering antibodies for cancer therapy		
2.6	Immunomodulators and their application in cancer (Paul 5 th ed.)		
2.7	Cytokines and their application in cancer (Paul 5 th ed.)		
2.8	Immunoconjugates and their application.		

Unit-3	Molecular Pathogenesis		
	Reference: MIMS	Teaching Duration	Lectures: 08
3.1	Attachment and Entry of microorganisms in to the body		
3.1.1	Enteropathogenic <i>E. coli</i>		
3.1.2	Phagocytosis in polymorhonuclear leucocytes		
3.1.3	Phagocytosis in macrophages		
3.1.4	Consequences of defects in the phagocytic cell		
3.2	The spread of microbes through the body		
3.2.1	Microbial factors promoting spread		
3.2.2	Spread via lymphatics		
3.2.3	Spread via the blood		
3.3	Antigenic variation		
3.4	Mechanisms of tissue and cell damage		
3.4.1	Microbial toxins		
3.5	Host and Microbial factors Influencing Susceptibility		
3.5.1	Genetic Factors in the Microorganisms		
3.5.2	Genetic Factors in the Host		
3.5.3	Pathogenesis of animal virus (Hepatitis)		

UNIT 4	Molecular Plant Pathology		
	Reference: Mehrotra and Agarios	Teaching Duration	Lectures: 07
4.1	Host pathogen interaction Ref. Mehrotra and Agarios		
4.2	Genetics of virulence in pathogens and of resistance in host plant.		
4.3	Horizontal and vertical resistance, Disease Escape		
4.4	Examples of molecular genetics of selected plant diseases : Powdery mildew		
4.5	and Rice blast		
4.6	Compatible and incompatible reactions		
4.7	Recognition of host and gene for gene concept Ref. Flor and Agarios		
4.8	Resistance genes of plants, Signal transduction between pathogenicity and resistance genes, Signaling and regulation of programmed cell death		
4.9	Pathogenesis of plant virus (TMV)		

References:

1. Murray, P. (2003). *Manual of Clinical Microbiology Vol-1*, 8th Ed. ASM Press.
2. Mims, C. A. *et al* (2000). *MIMS' Molecular pathogenesis of Infectious Disease*, 5th Ed. Academic Press.
3. Pa005) *Plant Pathology: Pathogen and Plant disease*, S. Chand & Company Ltd. New Delhi. ehrotra, R. S. and Aggarwal, A. (2007) *Plant Pathology*, 2nd Ed., Tata McGraw-Hill Publishing Company Limited New Delhi.
5. Agarios, G. N. (2005). *Plant Pathology*, 5th ed. Elsevier.

6. Flor, H. H. (1971). Current status of the gene-for-gene concept. *Ann. Rev. Phytopath.*, 9:275-296.
7. Mitra, S. (2007). *Genetic Engineering-Principles and Practise*. Macmillan India Ltd, New Delhi.
8. Kindt, T; Osborne, B.& Goldsby, R.(2006) *Kuby Immunology 6Ed*. W. H. Freeman.
9. Janeway, C. *et al.* (2004) *Immunobiology 6 Ed*. Garland Science.
- 10.Lichtman, A. & Abbas, A.(2003) *Cellular and Molecular Immunology 5Ed*.Saunders.
- 11.Paul, W. (1999) *Fundamental Immunology 4Ed*. Lippincott Williams & Wilkins.

MB-304: ADVANCES IN PHARMACEUTICAL MICROBIOLOGY

Objective: This paper gives insight of microbiological analysis and quality control in pharmaceutical industries. It includes the learning of good manufacturing practices and its monitoring in pharmaceutical companies.

UNIT 1	MICROBIOLOGICAL ASSAY FOR PHARMACEUTICAL ANALYSIS		
	Reference: Ref: W. Hewitt	Teaching Duration	Lectures: 08
1.1	Microbiological assay		
1.2	The agar diffusion assay: Its quantitative basis		
1.3	The theory and practice of Tube assays for growth promoting substances		
1.4	The theory and practice of Tube assays for growth inhibiting substances		
1.5	Standard reference materials		

UNIT 2	MONITORING MICROBIOLOGICAL QUALITY		
	Reference: Denyer, S.P	Teaching Duration	Lectures: 08
2.1	Good manufacturing practice and good industrial large scale practice		Ref: Flickinger
2.2	Monitoring microbiological quality – Conventional testing methods		
2.3	Monitoring microbiological quality – Application of rapid methods		

UNIT 3	MICROBIAL ASPECTS OF PHARMACEUTICAL PROCESSING		
	Reference: Hugo and Russell's	Teaching Duration	Lectures: 08
3.1	Microbial spoilage and preservation of pharmaceutical products		
3.2	Sterilization control and sterility assurance		
3.3	The quality assurance and quality control of pharmaceutical products		

UNIT 4	PHARMACEUTICAL MICROBIOLOGY		
	Reference: Denyer, Walsh, Gad	Teaching Duration	Lectures: 07
4.1	Pharmaceuticals, biologists and biopharmaceuticals ref: G. Walsh		
4.2	Bioinformatics and Pharmacogenomics for developing information – Based medicine and pharmacotyping in health care management Ref: Gad		
4.3	Microbiological auditing Ref: Denyer, S.P.		

Reference:

- Denyer, S. P. and Baird, R. M. (2008). *Guide to microbiological control in pharmaceuticals*

- and medical devices*. 2nd Edition, CRC Press, Boca Raton.
2. Flickinger, M. C. and Drew, S. W. (1999). *Encyclopedia of Bioprocess Technology*. Wiley-Interscience, New Jersey.
 3. Barredo, J. L. (2005). *Microbial Processes and Products*. Humana Press, New Jersey.
 4. Gad, S. C. (2007). *Handbook of Pharmaceutical Biotechnology*. Wiley-Interscience, New Jersey.
 5. Hugo and Russell's(2007). *Pharmaceutical Microbiology*, Blackwell Publishing.
 6. Walsh, G. (2007). *Pharmaceutical Biotechnology- Concepts and Applications*, Wiley.
 7. Hewitt, W.(2004). *Microbiological Assays for Pharmaceutical Analysis-A rational approach*, Indian Edition, CRC.

LIST OF PRACTICALS SEMESTER 3

1. Screening of citric acid and lactic acid producing microorganisms.
2. Screening of cellulase, amylase and protease producing microorganisms.
3. Production of fungal amylase by solid state or submerged fermentation.
4. Partial purification of amylase by ammonium sulphate precipitation and dialysis/column chromatography and calculation of specific activity & fold purification.
5. Determination of *KLa* of laboratory fermenter.
6. Sterility testing of pharmaceutical products by direct inoculation & membrane filtration methods as per Indian Pharmacopoeia (IP).
7. Cell disruption by sonication and estimation of intra cellular protein.
8. Comparison of ethanol production using pure carbohydrate and agro industrial waste.
 - a) Determination of pH, TSS (OBrix).
 - b) Determination of alcohol (ethanol) percentage.
 - c) Determination of phenol content.
 - d) Estimation of reducing & total sugar.
9. Microbial production of dextran by *Leuconostoc mesenteroides*. (Estimation of reducing & total sugar, Dextranase activity, extraction of dextran, pH, Characterization by TLC and viscosity)
10. ELISA detection of anti-HIV sera.
11. ELISA detection of HBsAg.

M.Sc. Semester - IV

MB-401	Seminar Presentation
	<ul style="list-style-type: none"> ➤ Students have to individually deliver a seminar on the advance or novel topic other than that mentioned in the curriculum. ➤ Topic should not be related to his/her dissertation. ➤ Maximum number of presentation slide should not exceed 25. ➤ A topic should be explained within 12 minutes, followed by counter questions from the examiners for 3 minutes. ➤ Students have to submit one copy of colour printed handouts (4 slides /page) of his/her presentation to the examiner.
MB-402	Report on Industrial Visit OR participation in Conference OR Symposium
	<ul style="list-style-type: none"> ➤ Students have to individually submit a printed copy of the report on Industrial visits and their participation in Conference/Symposium as per the prescribed format given below: ➤ Industrial Visit: <ul style="list-style-type: none"> • Profile of industry and including its management. • Product profile. • Flow sheet diagram of the entire process under taken. • List of instruments & process observed along with their significance. • Summary. • Proof of visit (Photographs/Images) ➤ Conference / Symposium: <ul style="list-style-type: none"> • Details of the Organizer & the Sponsor. • Scope of the conference. • List of resource person. • Abstract of topics delivered by them. • Category of theme covered in conference along with number of participants. • Knowledge enrichment and value addition from the proceedings. • Type of involvement/role of the student participant.
MB-403	Review Article
	<ul style="list-style-type: none"> ➤ Review Article <ul style="list-style-type: none"> • Students will be individually allotted a research paper for review. • The selected paper should be from a reputed peer reviewed journal having ISSN. • Selected Research paper should have been published during the last five years. • The research paper should not exceed 15 pages including

	<p>references.</p> <ul style="list-style-type: none"> • Students have to answer the questionnaire as per the attached format and submit it to the department.
MB-404	Project/Dissertation
	<ul style="list-style-type: none"> ➤ Project work should be done individually on any topic of importance related to the subject. ➤ Project may be done in-house or at a recognized institution outside the campus as specified in the guidelines. ➤ The concerned candidates have to submit their Project/Dissertation in a standard Hard-Bound thesis format. ➤ The Thesis will be evaluated by an external examiner. ➤ The Project/Dissertation must be presented in a Power-Point Presentation by the concerned candidates within 15 minutes during their Dissertation Viva

QUESTIONNAIRE FOR REVIEW OF PAPER

INTRODUCTION

1. Is the information provided in the 'Introduction' section helps to understand the problem?
2. State the reasons for performing this study.
3. Define the objectives/hypothesis of the research.

METHODS

4. Can you suggest other samples, if applicable, that can be taken for the prescribe study to get the similar results?
5. Find other methods, if applicable, that can be appropriately used to fulfill the aim of the study.
6. Have you understood the rationale for the selection of technique(s) /method(s) in the given study?
7. Can you suggest alternate technique(s) /method(s), if applicable, that can be use to perform same analysis with its pros and cons?
8. Has sufficient information been provided to carry out the experiment? Do you think of any further information?
9. Can you think of additional experiments for this paper?

RESULTS AND DISCUSSION

10. Is all the essential data represented in form of figures and tables?
11. Is there any duplication/repetition of work in the form of tables or graphs?
12. What are the limitations of the study carried out?

CONCLUSION

13. Report the conclusion of the study supported by appropriate evidence from ‘Literature Review’.
14. Can you suggest the name of any other journal for this type of publication?
15. Suggest a ‘Future Line of Investigation’ for this type of research.

Guidelines and Rules for Dissertation

Standard Format / Style of Submission of Manuscripts

Submission of all manuscripts/thesis should be in a single MS Word file strictly adhering to the following parameters:

1. Thesis is to be printed in Times New Roman typing.
2. Font size to be kept 12.
3. Line Spacing should be 1.5
4. Thesis should contain:
 - a) Title page with the name(s) of the candidate, their Examination Seat Number, Name of the supervising teacher and the Name of the institute.
 - b) Authentication certificate of the institute.
 - c) Declaration
 - d) Acknowledgement.
 - e) Chapter wise Index with Sub-heads and page numbers.
 - f) Introduction (Maximum 05 Page).
 - g) Review of Literature. (Maximum 15 Page)
 - h) Aim & Objectives
 - i) Materials and Methods.
 - j) Results and Discussion.
 - k) Conclusion
 - l) Future line of investigation
 - m) Appendix
 - n) References.
5. All tables, charts, images should be at their appropriate places.

Figures & Tables: Each figure/table Should be numbered, titled. The position of figure or table should be placed at an appropriate place within the article only.

Project may be carried out in-house, or the student, after due sanction from the supervising teacher and institute, can opt for pursuing dissertation at following recognized institutions or industries like:

1. Any UGC recognized University PG departments.

2. Any Agriculture University.
3. All National and State level research institute.
4. ISO or FDA/USFDA industry or research center having R & D and Q.C. facilities.
