

# FACULTY OF LIFE SCIENCES

## Syllabus

For

### **M.Sc. MICROBIOLOGY** (Credit Based Evaluation & Grading System) (SEMESTER: I - IV)

**Examinations: 2019–20**



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## **Guru Nanak Dev University** **Amritsar**

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**M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)**  
**(Credit Based Evaluation & Grading System)**

**Program Code: MCB**

**COURSE SCHEME**

**SEMESTER-I**

Course No.	C/E/I	Course Title	Credit			Total Credits	Mid Sem. Marks	End Sem. Marks
			L	T	P			
MCL401	C	General Microbiology	3	0	0	3	20	80
MCL402	C	Bacteriology	3	0	0	3	20	80
MCL403	C	Virology	3	0	0	3	20	80
MCL404	C	Mycology and Plant Pathology	3	0	0	3	20	80
MCL453	C	Microbial Physiology & Biochemistry	3	0	0	3	20	80
MTL261	C	Biostatistics	4	0	0	4	20	80
MCP421	C	Microbiological Techniques-I	0	0	3	3	-----	100
MCP422	C	Microbiological Techniques-II	0	0	4.5	4.5	-----	100
		<b>Total Credits</b>	-	-	-	<b>26.5</b>		

**M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)  
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**SEMESTER-II**

Course No.	C/E/I	Course Title	Credit			Total Credits	Mid Sem Marks	End Sem Marks
			L	T	P			
MCL451	C	Concepts in Immunology	3	0	0	3	20	80
MCL452	C	Food Microbiology	3	0	0	3	20	80
MCL405	C	Microbial Genetics	3	0	0	3	20	80
MCL454	C	Molecular Biology and Genetic Engineering	4	0	0	4	20	80
MCL455	C	Environmental Microbiology	3	0	0	3	20	80
MCP471	C	Lab Techniques in Clinical Microbiology & Immunology	0	0	3	3	-----	100
MCP472	C	Applied Microbiology Lab	0	0	4.5	4.5	-----	100
		<b>Total Credits</b>	-	-	-	<b>23.5</b>		

**NOTE: PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1<sup>st</sup> Semester. This ID Paper is one of the total ID Papers of this course.**

**M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)  
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**Semester-III**

Course No.	C/E/I	Course Title	L	Credit		Total Credits	Mid Sem Marks	End Sem Marks
				T	P			
MCL501	C	Clinical & Medical Microbiology	3	0	0	3	20	80
MCL502	C	Environmental Biotechnology	3	0	0	3	20	80
MCL503	C	Industrial Microbiology	3	0	0	3	20	80
CSL591	C	Computer Applications	3	0	0	3	20	80
	I	Interdisciplinary Course**	4	0	0	4	20	80
MCP523	C	Food Microbiology Lab	0	0	3	3	-----	100
MCP522	C	Environmental & Industrial Microbiology Lab	0	0	4.5	4.5	-----	100
		<b>Total Credits</b>	-	-	-	<b>23.5</b>		

**M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)**  
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**Semester-IV**

Course No.	C/E/I	Course Title	Credit			Total Credits	Mid Sem Marks	End Sem Marks
			L	T	P			
MCL551	C	Recent advances in Microbiology*	4	0	0	4	20	80
MCL552	C	Advances in Industrial Microbiology	3	0	0	3	20	80
	E	Elective Course**	3	0	0	3	20	80
	I	Interdisciplinary Course***	4	0	0	4	20	80
MCP571		Research Assignment	0	0	4	4	-----	100
MCP572	C	Field Study	0	0	1	1	-----	100
MCP573	C	Advanced Practicals in Microbiology	0	0	4.5	4.5	-----	100
		<b>Total Credits</b>	-	-	-	<b>23.5</b>		

\* Based on seminars to be delivered by M.Sc. IVth semester students. Since each year the chosen topics will be different therefore no syllabus can be defined in sections. The exam of the above will be conducted internally.

**\*\* Elective courses**

MCL 581 Microbial fertilizers and Microbial pesticides  
MCL 583 Biochemical & Biophysical Techniques  
MCL 584 Waste Recycling

**\*\*\*Interdisciplinary Courses will be selected from scheme of courses of other Departments.**

**M.Sc. MICROBIOLOGY (SEMESTER-I)**  
**(Credit Based Evaluation & Grading System)**

**MCL-401: GENERAL MICROBIOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Historical developments of microbiology, scope of microbiology. Brief account of organization and classification of microorganisms. Differences between prokaryotic and eukaryotic cell. Cell cycle, mitosis, meiosis.

**SECTION-B**

Overview of bacterial cell structure, (size, shape, arrangement, membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore). Bacterial genome and its organization. Brief account of fungi, structure, physiology and classification. Brief account of viruses (bacteriophages) structure, life cycle (lytic and lysogenic).

**SECTION-C**

Reproduction and Growth: Life cycles of representative microorganisms including bacteria, fungi and viruses, population growth and its measurement, effect of environmental conditions on growth pH, temp. aeration etc, continuous culture, diauxic, synchronous growth cultures and anaerobic cultures. Control of microbes by physical and chemical agents. Antibiotics, properties and mode of action; Drug resistance and its significance. Antibiotic sensitivity test.

**SECTION-D**

Industrial uses of bacteria, yeast & molds. Microscopy: Principles and applications in microbiology, brightfield microscopy, darkfield microscopy, fluorescence and immuno fluorescence microscopy, phase contrast and electron (transmission and scanning) microscopy. Staining of microorganisms.

**Books Recommended:**

1. Stanier, R.Y. Adelberg, E.A. and Ingraham, J.L. (1984), General Microbiology, IV edn. Mac Millan Press.
2. Pelczar, M.J. Chan, E.C.S. and Krieg, N.R. (1986), Microbiology, V Ed. McGraw Hill.
3. Prescott. L.M. Harley J.P. and L. Kreig D.A. (1990). Microbiology, WCB Publishers.
4. Rosenberg, E & Cohen I.R. (1983). Microbial Biology. H.S. International Editions

**M.SC. MICROBIOLOGY (SEMESTER-I)  
(Credit Based Evaluation & Grading System)**

**MCL-402: BACTERIOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

General characteristics of bacteria. Bacterial growth, Synchronous growth, Continuous culture Measurement of growth, Cell division and reproduction.

**SECTION-B**

The Archaea and Deeply Branching Phototrophic Bacteria: Domain Archaea; Methanogens, Thermoplasmas, Extremely Thermophilic sulphur metabolizers. Domain Bacteria; The Deinococci and Nonproteobacteria Gram Negatives: Aquificales and Thermotogae, Deinococcus-Thermus, Photosynthetic Bacteria: Chloroflexi, Chlorobi, and Cyanobacteria.

**SECTION-C**

Phyla Planctomycetes, Chlamydiae, Spirochaetes and Bacteroidetes. The Proteobacteria; -proteobacteria, -proteobacteria, -proteobacteria, -proteobacteria and -proteobacteria.

**SECTION-D**

The low G+C Gram Positive Bacteria: Clostridia, Mollicutes, Bacilli. The high G+C Gram Positive Bacteria; Actinobacteria, Planctomycetes, Spirochetes, Fibrobacters, Bacteroides, Fusobacteria.

**Books Recommended:**

1. Holt, J.G., Krieg, N.R., Sneath, P.H.A., Atalay, J.T. and Williams, S.T. (Eds) Bergey's Manual of Determinative Bacteriology, 9<sup>th</sup> Edition (William R. Hensyl Ed)
2. Davis, B.D. DeLbecco, R. Eisen, H.N. Ginsberg, H.S. and Wood, W.B. Jr. Microbiology, Harper & Row, 2006
3. Stanier, R.Y., Ingraham, J.L. Wheelis, M.L. and Painter, P.R.. General Microbiology, Macmillan Press Ltd. U.K., 2005
4. Prescott, L.M., Harley, J.P. and Klein, D.A. Microbiology 6<sup>th</sup> Edition, McGraw Hill, London (2005).
5. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott's Microbiology 9<sup>th</sup> Edition, McGraw Hill Education, (2014).

**M.Sc. MICROBIOLOGY (SEMESTER-I)**  
**(Credit Based Evaluation & Grading System)**

**MCL-403: VIROLOGY**

**Time: 3 Hours**

**Credit: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

Historical account and development of virology. General characteristics, envelope, capsid, nucleic acid & classifications of animal & bacterial viruses. One step growth curve of phages, Isolation & purification of viruses. Cytopathic effects of virus infection.

**Section-B**

Assays of viruses, biophysical properties of viruses and point, thermal inactivation, dilution end point, longevity *in-vitro*, virus culture. Chloroplast agglutination, haemagglutination, serological & molecular based detection of viruses.

**Section-C**

Attachment and entry of enveloped and non-enveloped animal viruses, Replication strategies of animal viruses, Insect Transmission of plant viruses, Role of viruses in genetic engineering. Brief concept of viroids and prions.

**Section-D**

Viral diseases of plants (papaya, banana, tomato): symptoms, transmission, virus & control. Viral diseases of animals (Ranikhet disease of poultry farm, foot & mouth disease of cattle, bird flu & SARS). Clinical symptoms, pathophysiology, diagnosis and control of viral diseases in humans (Influenza, hepatitis, polio, Zika, Dengue, AIDS)

**Books Recommended:**

1. Cann, Allanj. 1997. Principles of Molecular Virology, Academic Press London.
2. Mathews REF 1998. Plant Virology, Academic Press, London.
3. Viruses & Mycoplame diseases in India, Raychandri, S.P. & Nariani, T.R. 1994. Malhotra Publishing House. New Delhi.
4. N. Dimmock, A. Earton and K. Leppard : Introduction to Modern Virology, Blackwell Publishing (2007)
5. E.K. Wagner and M.J. Hewlet. Basic virology (2<sup>nd</sup> Edn) Blackwell publishing (2004)



**M.SC. MICROBIOLOGY (SEMESTER – I)  
(Credit Based Evaluation & Grading System)**

**MCL-404: MYCOLOGY AND PLANT PATHOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Introduction, history, thallus organization, cell structure, Mode of nutrition, nutrient requirements of fungi, sexual and asexual reproduction, fungal hormones, heterothallism, parasexuality in fungi.

**SECTION-B**

Brief account of systems of classification. Distinguishing characters and general life cycles of Oomycota, Zygomycota, Ascomycota, Basidiomycota & Deuteromycota. Origin and Phylogeny of fungal kingdoms.

**SECTION-C**

Fungal diseases of plants: Symptoms, transmission and control measures (biological, chemical, regulatory, physical). Rust and loose smut of wheat, red rot of sugarcane, late blight of potato, ergot of rye. Physiological responses of plants to pathogen: effect on respiration, photosynthesis, translocation of nutrients and water, yield.

**SECTION-D**

Economic importance of fungi: Role of fungi in biodegradation, biodeterioration, medicine, food industry, enzyme production, biological control & mushroom production.

Fungi as symbionts: Mycorrhizal associations-ectomycorrhiza, endomycorrhiza & ectendotrophic mycorrhiza; Lichens.

**Books Recommended:**

1. Alexopolous, C.J. and Mims, C.W., Blackwell, M (1996). Introductory mycology. IV edn., John Wiley and Sons inc., New York.
2. Mehrotra, R.S. and K.R. Aneja. (2015). An introduction to Mycology. New Age International publishers.
3. Agriose, G.N. 2005, Plant Pathology, 5th edition Publisher: Academic Press.
4. Carlile, M.J. Watkinson, S.C. and Gooday, G.W. (2001) The Fungi. Publisher: Academic Press.
5. Singh, R.S. (2009) Plant diseases. Oxford and IBH publishing company, New Delhi.
6. Moore and Landecker. (1972) Fundamentals of the fungi. Publisher: Prentice Hall

**M. Sc (MICROBIOLOGY) SEMESTER-I**  
**(Credit Based Evaluation & Grading System)**

**MCL-453: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Scope of studies on physiology and metabolism of microorganisms. Differences in level of organization of eukaryotic and prokaryotic cells, Biochemical components of microbial cell, Structure and function of different organelles ( cell wall, cell membrane, capsule, flagella, pili/fimbriae, mitochondria, chloroplast, inclusion bodies, golgi apparatus, endoplasmic reticulum etc.).

**SECTION-B**

Modes of nutrition, classification of microorganisms on the basis of energy and carbon source requirements. Role of vitamins and growth factors. Growth of microorganisms, phases of growth, parameters for measuring growth. Factors (pH, temperature, availability of oxygen and osmolarity of medium) affecting growth of microorganisms.

Brief account of cell division in Gm-ve and Gm+ve cocci/rods,

Resting forms in microorganisms, Endospore formation and its regeneration, salient genetic and biochemical events involved in endospore formation.

**SECTION-C**

Bioenergetics, basic concepts, redox pairs in energy productions, substrate level, oxidative and photo phosphorylations, chemiosmosis and components of ETC. Intermediary metabolism of carbohydrates (Important pathways for breakdown of glucose), formation of precursors and reducing power.

Nitrogen assimilation and Control od glutamine synthetase, Nitrogen fixation; components involved and their interaction with general nitrogen regulation (Ntr system)

Biosynthesis of cell wall, nucleotides and amino acids. General account of control of branched anabolic pathways

**SECTION-D**

Groups of microorganism with C<sub>1</sub> metaboile systems, General properties of Archaeobacteria, Salient features and differences from eubacteria and eukaryotes. Brief account of physiology of thermophiles, halophiles and methanogens. Methanogenesis

**Books Recommended:**

1. Conn E.E. & Stumpf, P.K. (1988), Outline of Biochemistry John Wiley & Sons.
2. Gottschalk, E. (2006). Microbial Metabolism Springer Verlag.
3. Moat, A. and Foster, J.W. 2006 Microbial Physiology. 4<sup>th</sup> edition, Wiley-Liss.
4. Edwards, Clive, 1990. Microbiology of Extreme Environments. Mc Graw Publishing. Co.

**M. Sc (MICROBIOLOGY) SEMESTER-I  
(Credit Based Evaluation & Grading System)**

**MTL-261 BIOSTATISTICS**

**Credits: 4-0-0**

**Time: 3 Hours**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Note:-** The scope of this paper is restricted only to the applications of various statistical techniques. The mathematical derivations of various results are excluded.

**Section-A**

**Statistical Methods** — Collection of data, Frequency distribution and, Measures of Central Tendency, Dispersion.

**Correlation and Regression** — Relationship between variables, Covariance, Karl-Pearson's Correlation Coefficient, Spearman's rank Correlation Coefficient, Least square technique for regression lines (without proof), Regression Coefficients, Relationship between Correlation analysis and Regression Analysis.

**Section-B**

**Probability** — Mathematical definition of probability of an event, Use of permutations and combinations in calculations of Probability, Conditional probability, Additive and Multiplication law of Probability, Random Variables and its pmf, pdf, cdf, Mathematical expectation and variances, Theoretical Distributions: Binomial, Poisson and normal, Properties of these distributions (applications only).

**Section-C**

**Hypothesis Testing** — Sample, Population, Statistics and Parameters, Null Hypothesis, Level of significance, Definitions of Chi-square, 't' and 'F' variates and their pdfs only, Applications of these distributions in testing of hypothesis.

**Section-D**

**Large sample test-** Testing of significance of proportion in single population, Testing of equality of proportions in two populations, Testing of significance of mean in single population, Testing of equality of means in two populations.

**Analysis of Variance** — Meaning of analysis variance with linear models, Analysis of variance for one-way classified data, Analysis of variance for two-way classified data with one observation for cell.

**M. Sc (MICROBIOLOGY) SEMESTER-I  
(Credit Based Evaluation & Grading System)**

**Text Books**

1. Fowler, J., Cohen, L. and Jarvis, P. (1998). Practical Statistics for Field Biology. John Wiley and Sons, 2nd ed. [Chapters: 4,5,6,7,(7.1–7.6), 9 (9.1–9.4), 12 (12.1–12.7), 13 (13.1–13.4, 13.6,13.7), 14 (14.1–14.5, 14.7), 15 (15.3–15.8, 15.10–15.11), 16 (16.9–16.13), 17 (17–.1–17.3, 17.5,17.6,17.8)].
2. Raghavarao, D. (1983). Statistical Techniques in Agricultural and Biological Research Oxford and IBH Publishing Co. [Chapters: 2,3,4,5,7,8,9 and 10].

**Reference Books:**

1. Bland, M. (2006). An Introduction to Medical Statistics. Oxford University Press, 3rd ed.
2. Finney, D.J. (1980). Statistics for Biologists. Chapman and Hall Ltd.
3. Hoel, P.G. (1971). Elementary Statistics. John Wiley and Sons, 3<sup>rd</sup> ed.
4. Ross, S.M. (2005). Introductory Statistics. Academic Press, 2<sup>nd</sup> ed.
5. Wayne, W, Daniel (1999). Biostatistics: A Foundation for Analysis in Health Sciences. John Wiley and Sons, 7<sup>th</sup> ed.
6. Woodworth, G. (2004). Biostatistics: A Bayesian Introduction. John Wiley and Sons.

**M.Sc. MICROBIOLOGY (SEMESTER-II)  
(Credit Based Evaluation & Grading System)**

**MCL-451: CONCEPTS IN IMMUNOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Types of immunity: innate and acquired. Acute-phase response and its mechanism. Types and properties of immune cells, heterogeneity of lymphoid cells, T-cell subsets and surface markers, TCR, BCR, Null cells, Monocytes.

**SECTION-B**

Primary and secondary lymphoid organs-Thymus, spleen, lymph nodes, lymphatic system, mucosal-associated lymphoid tissue (MALT), lymphocyte traffic. Characteristic properties of antigens, adjuvants, T-dependent and T-independent antigens, recognition of antigens by T-cell and role of MHC.

**SECTION-C**

Antigen-antibody interactions, affinity and avidity, high and low affinity antibodies, immunoglobulins, classes and structure, complement fixing antibodies. Various types of immunodiffusion and immunoelectrophoretic procedure, Immunoblot, ELISA, RIA, agglutination of pathogenic bacteria, hemagglutination and hemeagglutination inhibition.

**SECTION-D**

Complement cascade. Types of hypersensitivity reactions, autoimmune disorders, their underlying molecular mechanism, etiology, diagnostic, prognostic and prophylactic aspects.

**Books Recommended:**

1. Kuby, J. (1992), Immunology, W.H. Freeman, USA.
2. Paul, W.E (1991), Immunology: Recognition and Responses W.H. Freeman, New York.
3. Playfair, J.H.L. (1992), Immunology at a Glance (5th Ed), Blackwell Scientific publication, Oxford.
4. Roitt IM, Brostoff J, Male DK (2001) Immunology, Mosby Inc, UK.
5. Janeway CA, Trevers P, Walport M, Schlomhick M (2001), Immuno Biology. The Immune System in Health and Disease, 5th Edition, Garland Publication, USA

**M.Sc. MICROBIOLOGY (SEMESTER-II)  
(Credit Based Evaluation & Grading System)**

**MCL 452: FOOD MICROBIOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Food as nutrient for micro-organisms. Extrinsic and intrinsic factors of food affecting the growth of micro-organisms. Causes of food spoilage: Microbiological and food enzymes, General principles of food preservation.

**SECTION-B**

Micro-organisms (yeast, bacterial and molds) important in food microbiology. Concept of probiotics. Processing and spoilage of fermented food products: vegetables and fruits (sauerkraut, pickles, wine, cider);

**SECTION-C**

Processing and spoilage of fermented food products: Cereal products (Soya sauce, miso, tempeh. Idli, dosa, bread); Milk and milk products: Cheese, yogurt, kefir, koumiss, fermented milks. FSSAI-brief introduction and food safety and standard regulation, 2011 (licensing and registration of food businesses, General Hygienic and Sanitary practices to be followed by Food Business Operators, packaging and labelling).

**SECTION-D**

Microbiology quality control - Hazard analysis and critical control points (HACCP). Sampling plan. Methods for microbiological examination of foods (direct examination, cultural techniques), enumeration methods. Alternate indirect methods (dye reduction, electrical, ATP), rapid methods for detection of specific organisms and toxins (immunological/molecular methods). cleaning-in-place (CIP) in food industry.

**Books Recommended:**

1. Banwart, G.J. 1989, Basic Good Microbiology. 2nd Edition. Van Nostrand Reinhold.
2. Frazier, W.C. and Westener, D.C., 1988. Food Microbiology. 5th edition. McGraw Hill Inc., New York.
3. Jay, J.M., Loessner M.J. and Golden D.A. 1986. Modern Food Microbiology 7th Edition, Springer, New York, U.S.A.
4. Hayes P.R. (1992). Food microbiology and hygiene. Elsevier Science Publishers Ltd., England.
5. Blackburn, C.W. 2006, Food Spoilage micro-organisms, CHIPS, New York, USA.
6. Doyle. M.P., Beuchat, L.R, Montville, T.J. 2001, Food Microbiology Fundamentals and Frontiers. 2nd Edition, ASM press, USA.
7. Blackburn, C.W. and McClure, P.J. 2002, Food borne pathogens hazards risk analysis and control. Wood Head Publishing, U.K.
8. Brown, M., 2002, Microbiological risk assessment in food processing, Wood Head Publishing, U.K.
9. <http://fda.up.nic.in/2011.htm>

**M. Sc (Microbiology) SEMESTER-II  
(Credit Based Evaluation & Grading System)**

**MCL-405: MICROBIAL GENETICS**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Organization of prokaryotic and eukaryotic genome: Chromatin and chromosomes, nucleosomes.

Basic concept of epigenetics and its significance,

Generalized recombination: Molecular mechanism and proteins involved in recombination

**SECTION -B**

Mutants and their role in microbial genetics, types of mutants, fluctuation test, genetic analysis with mutants and gene mapping, linkage and multifactor crosses and complementation, Reversion and suppression.

Transposable elements: types and mechanism of transposition, significance. Phage Mu.

**SECTION -C**

Transformation: competence factors and DNA uptake, significance.

Transduction: generalised and specialized transduction, and their mechanism.

Phage : gene organization, lytic and lysogenic phase.

**SECTION -D**

Conjugation: F-factor , Hfr strain and interrupted mating

Bacterial plasmids; types, control of copy number and incompatibility, fertility factors,

Resistance factor

**Books Recommended:**

- Friefelder, D., Maloy, S.R. and Cronan, J.E. 1994. Microbial Genetics, IInd Edition. Jones and Barlett Publishers.
- Genes IX, Lewin, Benjamin 2007, CBS Publishers and Distributors
- Malacinski, G.M. & Friefelder, D. 1993. Essentials of Molecular Biology, IInd Edition. Jones and Bartleet Publishers.
- Synder, L. and Champness W. 1997. Molecular Genetics of Bacteria, ASM Press.
- Stent G.S. & Calender, R. 1986. Molecular Genetics 2nd Edition, CDS Publishers.

**M.Sc. Microbiology (Semester-II)**  
**(Credit Based Evaluation & Grading System)**

**MCL-454: MOLECULAR BIOLOGY & GENETIC ENGINEERING**

**Time: 3 Hours**

**Credits: 4-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Nucleic acids: Structure and functions of DNA, denaturation and renaturation of DNA (melting curve and  $T_m$  value of DNA); Isolation and sequencing of DNA; Replication of DNA : De novo replication, topoisomerases, helicase, DNA polymerases, nick translation, discontinuous replication (Okazaki fragments), primase, covalent extension mode of replication, bidirectional replication.

**SECTION-B**

Transcription: transcription signals, promoters, open promoter complex, intrinsic and Rho-dependent terminators, RNA polymerases; types of RNA molecules and their role in gene expression; Translation: components involved, t-RNA as adapter, genetic code and its salient features, Wobble hypothesis, overlapping genes, polyribosomes.

**SECTION-C**

Regulation of gene activity: transcriptional regulation, positive and negative regulation, inducible and repressible operon, lac operon, trp operon and attenuation, autoregulation, posttranscriptional control, Feedback inhibition and allosteric control.

**SECTION-D**

Molecular cloning; techniques and their importance, cloning vectors; properties and uses, selection and characterization of clones, gene probes, labeling. PCR; principle, types and role in molecular biology Bioinformatics ; proteomics and genomics studies and their significance.



**M.Sc. Microbiology (Semester-II)**  
**(Credit Based Evaluation & Grading System)**

**Books Recommended:**

1. Friefelder, D. 1987. Microbial Genetics. Narosa Publication.
2. Friefelder, D., Maloy, S.R. and Cronana, J.E. 1994, Microbial Genetics, II<sup>nd</sup> edition, Jones and Barlett Publishers.
3. Malacinski, G.M. & Friefelder, D. 1993. Essentials of Molecular Biology, II<sup>nd</sup> Edition. Jones and Bartlett Publishers.
4. Synder, L. and Champness, W., 1997. Molecular Genetics of Bacteria, ASM Press.
5. Primrose, S.B. Twyman, R.M. and Old, R.W., 2001. Principles of gene manipulation, Sixth edition, Blackwell Science Ltd., UK.

**M.Sc. MICROBIOLOGY (SEMESTER-II)**  
**(Credit Based Evaluation & Grading System)**

**MCL-455: ENVIRONMENTAL MICROBIOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Define the concept of Environment, Microenvironment, Microbial Ecology and Biosphere. Enumeration and estimation of microbial biomass. Sample collection and handling.

The significance of cell number methods for enumerating microbes, biomass and activities, viable cell count procedures, biochemical and molecular based approaches for measurement of microbial biomass/activity.

**SECTION-B**

Air microbiology: Atmospheric layers and their microflora. Sources of microorganisms in the air, concept of air sampling and enumerating the air microflora. Microorganisms as Air pollutants. Significance of air microbiology.

Soil microbiology: Soil Composition and Microorganisms in Soils. Rhizosphere and rhizospheric effect. Microbial mobilization and immobilization of carbon within the biosphere. The nitrogen cycle: general aspects of nitrogen cycling. Ammonification and ammonia assimilation, nitrification, nitrate reduction and nitrogen fixation. The phosphorus cycle.

**SECTION-C**

Microbiology of water: forms of water, aquatic environment, physico-chemical conditions in aquatic environment, substrate for microbial growth. Abundance, distribution and survival of microorganisms in different layers of water. Purification of waste waters and communal sewage by aerobic processes. Activated sludge process, Trickling filter process, Rotating Biological Contactors, lagoon process. Purification of waste waters and effluents by anaerobic processing

**M.Sc. MICROBIOLOGY (SEMESTER-II)**  
**(Credit Based Evaluation & Grading System)**

**SECTION-D**

General concept of Microbial Interactions: positive, negative and neutral interactions: Parasitism: ecto and endo parasitism, concept of hyperparasitism, Temperate bacteriophage, Predation, Neutralism, Commensalism, Amensalism, Competition, Mutualism and Symbiosis.

**Books Recommended:**

1. Microbial Ecology Fundamentals and applications, Atlas. R.M. and Bartha, M. (1981). Addison-Wesley, Philippines.
2. Principles of Microbial Ecology: Brock, T.D. (1966). Prentice hall, USA.
3. Environmental Microbiology, Grant, W.D. and Long P.E. (1981). Blackie, London.
4. Microbial Ecology, Campbell, R. (1977). Blackwell Scientific, London.
5. Sodhi, G. S. (2005). Fundamental concepts in environment chemistry. Narosa Publishing House Pvt. Ltd. New Delhi.

**M.Sc. MICROBIOLOGY (SEMESTER-III)  
(Credit Based Evaluation & Grading System)**

**MCL-501: CLINICAL & MEDICAL MICROBIOLOGY**

**Time: 3 Hours**

**Credits : 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

Microorganisms and Diseases: spread of disease in populations, reservoirs of infection (human, animal, and non-living reservoirs), portals of entry and exit, modes of transmission (droplet, contact, vehicles, vectors), Factors affecting virulence of microorganisms.

**Section-B**

Collection, transport, storage and examination of biological samples: Stool, blood, urinary and gastro-intestinal tract. Distribution of human normal microflora and their functions in different body parts.

**Section-C**

Clinical features, pathophysiology, laboratory diagnosis, treatment and prevention of bacterial diseases such as: Diarrhea, Pneumonia, Diphtheria, Meningitis, Tuberculosis, Typhoid, Gas gangrene, botulism and tetanus;

**Section-D**

Clinical features, pathophysiology, laboratory diagnosis, treatment and prevention of parasitic and fungal infections such as, Amoebiasis, Trypanosomiasis, Leishmaniasis and Malaria. Mycoses, dermato-mycosis, cryptococcosis, candidiasis, aspergillosis, zygomycosis.

**Books Recommended:**

1. Medical Microbiology by C.G.A. Thomas, 1988. Baillion Tindall, London.
2. Essential of Medical Microbiology by R. Bhatia and R.L. Ichhpujani, 1994. Jaypee Brothers Medical Pub. (p) Ltd. New Delhi.
3. Medical Microbiology by Mims, Playfiar, Roitt, Wakelin and Williams, 1993, Mosbyyear Book Europe Ltd. U.K.
4. Mackie and Mc Cartney Practical Medical Microbiology (Ed.) Geranld College, J. Fraser, A.G., Marmoin, B.P. and Simmons, A. 1996. Churchill Divingstone.
5. Microbiology: Concepts and Applications by Pelczar, Chan and Krieg, 1993. Mc Graw Hill, Inc. U.S.A. 21

**M.Sc. MICROBIOLOGY (SEMESTER-III)  
(Credit Based Evaluation & Grading System)**

**MCL-502: ENVIRONMENTAL BIOTECHNOLOGY**

**Time: 3 Hours**

**Credits: 3-0-0**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Biomass a major source of organic chemical energy: Major components of biomass: Cellulose, Hemicellulose, lignin and pectin etc. Factors affecting organic matter decomposition. Microbiology of cellulose degradation, Enzymatic aspects of cellulolysis. Concept and architecture of bacterial cellulosome. Potential applications of Microbial cellulases.

**SECTION-B**

Brief account of microbial degradation of pectin and hemicellulose with their potential applications.

Microbiology of lignin degradation, white-rot, brown-rot, and soft-rot type fungal attack in ligninolysis.. Enzymology of lignin degradation and their biotechnological applications.

**SECTION-C**

The concept of xenobiotics, recalcitrant compounds, persistence and biomagnification. Bioremediation efficacy testing, approaches to bioremediation: Environmental modifications for Bioremediation, Microbial seeding and Bioengineering approaches to the bioremediation of pollutants. Gaseous and Heavy metal air pollutants and concept of Bioscrubbers and biofilters.

**SECTION-D**

Microbial Insecticides: Bacillus thuringiensis. The concept of endotoxins and cry genes, B. thuringiensis as a present day bioinsecticide. (Bacillus sphaericus, B. papillae) and Baculoviruses. Biology of baculoviruses, Baculoviruses as Insecticides and their future potential. Bacterial leaching from ores, microorganisms associated with recovery of copper by direct and indirect leaching, Microorganism for removal of heavy metals from effluents, metal transformation accumulation by microorganism. Microbial mechanism for removal of metallic ions.

**Books Recommended:**

1. Atlas. R.M. and Bartha, M (1981). Microbial Ecology Fundamentals and applications, Addison-Wesley, Philipines.
2. Campbell, R. (1977). Microbial Ecology, Balckwell Scientific London.
3. Grant, W.D. and Long P.E. (1981). Environmental Microbiology, Balckie, London.
4. Bioreactors in Biotechnology: A practical approach (1991). Scragg. A.H. Ellis Horwood Ltd.17
5. Higgins. Fundamentals of Biotechnology.
6. Glazer A.N. and Nikado H. (2007), Microbial Biotechnology, Fundamentals of Applied Microbiology, Cambridge University press

**M.Sc. MICROBIOLOGY (SEMESTER-III)  
(Credit Based Evaluation & Grading System)**

**MCL-503: INDUSTRIAL MICROBIOLOGY**

**Credits: 3-0-0**

**Time: 3 Hours**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Definition and scope: Historical developments in Industrial Microbiology, Methods for isolation of diverse microorganism from nature, Methods of screening industrially important microorganisms for enzymes, amino acids, antibiotics, enzyme inhibitors and lipid production, maintenance of industrial cultures.

**SECTION-B**

Definition of fermentation, fermentor/bioreactor. Brief description and design of CSTR fermentor. Fermentation media, inoculum preparation.

**SECTION-C**

Industrial alcohol, beer, whisky, amino acids (lysine and glutamic acid), and production of citric acid by Koji process and submerged process, lactic acid, acetic acid, IMP and GMP production.

**SECTION-D**

Enzyme production, Antibiotics (penicillin, tetracycline), alkaloids, microbial transformation of steroids and sterols, fermentation economics, product recovery of alcohol, citric acid, enzymes, antibiotics, alkaloids and steroids.

**Books :**

1. Industrial Microbiology Ed. Casida, L.E (1996) New Age International Publishers.
2. Industrial Microbiology Eds. Prescott and Dunn (1991)
3. Biotechnology 2<sup>nd</sup> Edition W. Crueger and A. Crueger. (1992) Panima Publishers.
4. Microbial Technology. Vol I and II Eds. Pepler and Perlman, (1979) Academic Press

**M.Sc. MICROBIOLOGY (SEMESTER-III)  
(Credit Based Evaluation & Grading System)**

**CSL-591: COMPUTER APPLICATIONS**

**Time: 3 Hours**

**Credits: 3-0-0  
Max. Marks: 100  
Mid Semester Marks : 20  
End Semester Marks : 80**

**Mid Semester Examination: 20% weightage  
End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

Computer fundamentals, Internet basics and MS-Office 2003, Introduction to digital computers, Organization, Number system, I/O devices, Storage devices, Introduction to internet and its applications – www, email, ftp. MS-Windows basics, MS-Word – Meaning of Word-Processing, Creating, Saving, Printing documents, Formatting, Spell-Check, Adding page numbers, Header and Footer, Macros, Creating tables, Converting table to text and vice-versa, Mail Merge.

**Section-B**

MS-Excel – Spreadsheets, Using different types of formulae, Creating graphs and charts, Exporting charts to MS-Word, MS-PowerPoint – Creating presentations, Formatting, Adding effects and timings. Types of errors and level of significance, Tests of significance (F and t-test), Chi-square tests.

**Section-C**

Data analysis and database – Brief description and tabulation of data, Measure of central tendency and dispersion – Mean, Median, Mode, Range, Standard Deviation, Variance and Correlation coefficient using SPSS. Introduction to Data, Information, Database, DBMS (Advantages and disadvantages), Introduction to SQL (Data retrieval).

**Section-D**

Virtual library and some useful sites on Internet – Searching MEDLINE on the Pubmed system from National Centre for Biotechnology and Information. Assessing full text journals on the internet and printing articles using EndNote.

**Books Recommended:**

1. Sinha, P.K. (1992). Computer Fundamentals.
2. Peter Norton's Introduction to Computers, 6<sup>th</sup> ed.
3. Windows Based Computer Courses, Sumit Kumar, JBD Publishers.
4. Gupta, S.C. (2004). Fundamentals of Statistics. Himalaya Publishing House.

**Website Links**

Databases (Genes Bank), search tools and software at  
<http://www.ncbi.nlm.nih.gov>.

Restriction enzyme site digestion webcutter2.0 at  
<http://www.firsmarket.com/cutter/cut2.html>.

PCR and multiplex PCR guide and troubleshooting at  
<http://www.med.yale.edu/genetics/ward/tavi/Trblesht.html>

Image analysis program at  
<http://www.scioncorp.com>.

**M.Sc. Microbiology (Semester-IV)  
(Credit Based Evaluation & Grading System)**

**MCL-551: Recent Advances in Microbiology**

**Credits: 4-0-0**

**Based on seminars to be delivered by M.Sc. IVth semester students. Since each year the chosen topics will be different therefore no syllabus can be defined in sections. The exam of the above will be conducted internally.**



**M.Sc. Microbiology (Semester-IV)**  
**(Credit Based Evaluation & Grading System)**

**MCL 552 Advances in Industrial Microbiology**

**Credits: 3-0-0**

**Time: 3 Hours**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Microbial biodiversity and its importance in industrial microbiology, methods of isolation. High throughput screening (HTS) of microbes and metagenomic libraries for industrially important enzymes, bio-molecules (anti-cancer, anti-inflammatory antimicrobial compounds, etc). raw materials of industrial importance. Continuous and fed batch cultures.

**SECTION-B**

Strain development by mutagenesis, protoplast fusion and transformation . Methods for cloning the genes. System biology (genome, transcriptome, proteome, metabolome, fluxome) in strain improvement. Important microbial products and technology for production of bioethanol from cellulosic waste,

**SECTION-C**

Single cell oil, polysaccharides (xanthan), fermentation of pharmaceutical Molecules, Statins: structure, mode of action, biosynthetic pathway, production; carotene : biosynthesis, and production; production of recombinant proteins (in *Pichia pastoris*)

**SECTION-D**

Industrially important biotransformation, Immobilization of whole cells and enzymes, protein engineering, metabolic engineering, Intellectual property rights (IPR) and patents laws governing in Indian patents related to microbial products and processes. Treatment of industrial effluents (penicillin/alcohol industry) using activated sludge and anaerobic treatment options.

**Books :**

1. Manual Industrial Microbiology and Biotechnology (eds) A.L. Devain and Solomon, N. A. (1986). ASM, Washington. D.C.
2. Principles of Fermentation Technology Stansbury and Whittaker Pergamon Press.
3. Recombinant microbes for industrial and agricultural application (eds) Y. Murroka, T. Imanuka (1994) Marcel Dekker Inc.
4. Biotechnology 2<sup>nd</sup> Edition W. Crueger and A. Crueger. (1992) Panima Publishers.
5. Microbial Technology. Vol I and II Eds. Pepppler and Perlman, (1979) Academic Press.
6. Comprehensive Biotechnology Vol III and IV Ed Moo Young (1984) Pergamon Press.

**M.Sc. Microbiology (Semester-IV)**  
**(Credit Based Evaluation & Grading System)**

**MCL-581: Microbial Fertilizers and Microbial Pesticides (Elective)**

**Credits: 3-0-0**

**Time: 3 Hours**

**Max. Marks: 100**  
**Mid Semester Marks : 20**  
**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**  
**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Introduction and history of microbial fertilizer, Definition and types of biofertilisers, Importance and contribution of biofertilisers in agriculture, Characteristics of microbial biofertilisers: Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Azolla, Phosphate-Solubilising Microorganisms, Mycorrhiza, different media used to study biofertilisers,

**SECTION-B**

Types of raw materials for biofertiliser production: carrier, packing materials, adhesives, Strain selection and fermentation, Production Technology for major biofertilisers, Estimation of biological nitrogen fixation. Biofertilize technology: Physical, chemical, biological and technical constraints. Application techniques, Quality control and standards.

**SECTION-C**

Introduction, Historical background of microbial pesticides, Role of microbial pesticides in sustainable agriculture,; safety, limitations, advantages and disadvantages of microbial pesticides. Microbial insecticides based on Bacillus spp: toxins produced and their mode of action. Role of baculoviruses in controlling insect pests of crops.

**SECTION-D**

Role of Fungi in pest control : Entomopathogenic fungi, Beauveria and Metarhizium: Fungal disease symptoms on insects, development of mycosis, Factors affecting virulence; Mode of actions Trichoderma as biocontrol agent, Formulations of microbial pesticides. Role of protozoa and nematodes in biocontrol.

**Books Recommended:**

1. Motsara, M.R., Bhattacharayya, P. and Srivastava, B. 1995 . Biofertiliser technology, marketing and usage (HLS Tandon, Ed.).
2. Kannaiyan, S. 2002. Biotechnology of Biofertilizers. Kluwer Academic Publishers, Boston, London. Narosa Publishing House, New Delhi, India
3. NIIR Board .2004. The complete technology book on Bio-Fertilizer and Organic farming National Institute of Industrial Research (India)
4. Rai, M.K.2006. Handbook of Microbial biofertilizers. Howarth press. New York
5. Koul, O and Dhaliwal, G.S. 2002. Microbial Pesticides. Taylor and Francis publishers.
6. S.R. Joshi. 2006. Biopesticides: a biotechnological approach. New age Publishers. Delhi. Nutan
7. Kaushik 2004 . Biopesticides for sustainable agriculture: prospects and constraints. TERI Press, Delhi.
8. R.P. Srivastava 2003. Biopesticides and bioagents in integrated pest management of agricultural crops. International book distributing company, Lucknow.

**M.Sc. Microbiology (Semester-IV)**  
**(Credit Based Evaluation & Grading System)**

**MCL 583 BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES (Elective)**

**Credits: 3-0-0**

**Time: 3 Hours**

**Max. Marks: 100**  
**Mid Semester Marks : 20**  
**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**  
**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Concept of buffers and their significance

Theory and applications of chromatographic techniques: Thin layer and column chromatography, ion exchange and affinity chromatography, reverse-phase chromatography, GLC/HPLC and FPLC.

**SECTION-B**

Theory and application of electrophoresis of proteins and nucleic acid, polyacrylamide gel electrophoresis, isoelectric focusing, pulse field gel electrophoresis, immune diffusion and immuno electrophoresis methods.

**SECTION-C**

Theory and application of analytical and preparative centrifugation. Concept of continuous and zonal rotors, analytical centrifuges

Theory and application of spectroscopy UV, visible and, infrared spectroscopy

**SECTION-D**

NMR, MS, GC-MS spectroscopy.

Introduction to radioisotopes and their monitoring concepts of counting efficiency and auto radiography, Principles and applications of serodiagnostic techniques.

**Books Recommended:**

1. Friefelder. D. (1983) Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd ed. W.H. Freeman and Company, San Fransisco.
2. William, B.L. and Wilson, K. (1986). A Biologist Guide to Principles and Techniques Practical Biochemistry, 3rd ed., Edward Arnold Publisher, Baltimore, Maryland (USA).
3. Slater, R.J. (1990). Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.
4. Upadhyay, A, Upadhyay, K and Nath, M (2015) Biophysical Chemistry Principles and Techniques, Himalaya Publishing House, New Delhi
5. Wilson, K and Walker, J (2013) Principles and Techniques of Biochemistry and Molecular Biology 7<sup>th</sup> Edition, Cambridge University Press India Pvt Ltd., New Delhi.

**M.Sc. MICROBIOLOGY (SEMESTER-IV)  
(Credit Based Evaluation & Grading System)**

**MCL-584: WASTE RECYCLING (Elective)**

**Credits: 3-0-0**

**Time: 3 Hours**

**Max. Marks: 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Ecological aspects of biodeterioration control soil, waste and water management, treatment of solid wastes (landfills, sanitary landfills, composting aerobic and anaerobic).

**SECTION-B**

Treatment of liquid waste: Waste water characteristics, activated sludge process, waste stabilization ponds, anaerobic fixed film systems, anaerobic degradation of toxic and hazardous wastes. Mixed culture interaction during waste water treatment, high rate anaerobic filters. Upflow anaerobic sludge blanket. Down flow stationary fixed film reactor.

**SECTION-C**

Testing for biodegradability, biomagnification, bioremediation, efficacy testing, side effect testing, approaches to bioremediation. Environmental modification for bioremediation.

**SECTION-D**

Microbial seeding, a bioengineering approaches to the bioremediation of pollutants. Role of microbial sensors in environment monitoring: BOD and methane sensors.

**Books Recommended:**

1. Tandon, H.L.S. (Ed) 1995. Recycling of crop, animal human and Industrial wastes in agriculture. Fertilizer development and consultation organization New Delhi, India.
2. Wesley Eckenfeldev. W. 1989. Industrial waster pollution control. McGraw Hill Inc. U.S.A.
3. Atlas, R.M. and Bartha, M. 1991. Microbial Ecology; Fundamentals and applications ddison Wesley, Philippines.