

Faculty of Life Sciences

Syllabus

For

M.Sc. MICROBIOLOGY (CBCEGS)
(Semester: I - IV)

Examinations: 2016–17



Guru Nanak Dev University
Amritsar.

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M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)
(Under Credit Based Continuous Evaluation Grading System)

Program Code: MCB

SCHEME OF COURSES

Semester I

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
Core Course						
MCL401	C	General Microbiology	3	0	0	3
MCL402	C	Bacteriology	3	0	0	3
MCL403	C	Virology	3	0	0	3
MCL404	C	Mycology and Plant Pathology	3	0	0	3
MCL 405	C	Microbial Genetics	3	0	0	3
MTL 261	C	Biostatistics	4	0	0	4
MCP421	C	Microbiological Techniques–I	0	0	3	3
MCP422	C	Microbiological Techniques–II	0	0	4.5	4.5
		Total Credits:	-	-	-	26.5

M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)
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SCHEME OF COURSES

Semester-II:

Course No.	C/E/I	Course Title	Credits			Total
			L	T	P	Credits
Core Course						
MCL451	C	Concepts in Immunology	3	0	0	3
MCL452	C	Medical Microbiology	3	0	0	3
MCL453	C	Microbial Physiology & Biochemistry	3	0	0	3
MCL454	C	Molecular Biology and Genetic Engineering	4	0	0	4
MCL455	C	Environmental Microbiology	3	0	0	3
MCP471	C	Lab Techniques in Medical Microbiology & Immunology	0	0	3	3
MCP472	C	Applied Microbiology Lab	0	0	4.5	4.5
		Total Credits:	-	-	-	23.5

M.Sc. MICROBIOLOGY (SEMESTER SYSTEM)
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Semester–III

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
MCL501	C	Clinical And Diagnostic Microbiology	3	0	0	3
MCL502	C	Environmental Biotechnology	3	0	0	3
MCL503	C	Industrial Microbiology	3	0	0	3
CSL 591	C	Computer Applications	3	0	0	3
	I	Interdisciplinary Course**	3	0	0	3
MCP521	C	Food Microbiology Lab	0	0	3	3
MCP522	C	Environmental & Industrial Microbiology Lab	0	0	4.5	4.5
		Total	-	-	-	22.5

**** Interdisciplinary Course will be selected from schemes of courses of other Departments.**

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

Course No.	C/E/I	Course Title	Credits			Total
			L	T	P	Credits
						S

Core Course

MCL551	C	Recent advances in Microbiology	4	0	0	4
MCL552	C	Advances in Industrial Microbiology	3	0	0	3
	E	Elective Course*	3	0	0	3
	I	Interdisciplinary Course**	3	0	0	3
MCP571		Research Assignment	0	0	4	4
MCP572	C	Field Study	0	0	1	1
MCP573	C	Advanced Practicals in Microbiology	0	0	4.5	4.5
		Total Credits				22.5

Elective courses*

MCL 452 Food Microbiology

MCL 581 Microbial fertilizers and Microbial pesticides

MCL582 Advanced Virology

MCL-583: Biochemical Biophysical Techniques

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

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCL-401: GENERAL MICROBIOLOGY

Credits: 3-0-0

Historical developments of microbiology, scope of microbiology, Brief account of organization and classification of microorganisms. Differences between prokaryotic and eukaryotic cell. Overview of bacterial cell structure, (size, shape, arrangement, membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore) The brief account of fungi, structure, physiology and classification. brief account of viruses (bacteriophages) structure, life cycle (lytic and lysogenic). 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. 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. bacterial genome and its organization. Control of microbes by physical and chemical agents. Antibiotics, properties and mode of action; Drug resistance and its significance. Antibiotic sensitivity test. Industrial uses of bacteria, yeast & molds.

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. Mc Graw 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)
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MCL-402: BACTERIOLOGY

Credits: 3-0-0

General characteristics of bacteria. Bacterial growth, cell division, reproduction and nutrition. The Archaea and Deeply Branching Phototrophic Bacteria : Domain Archaea ; Methanogens, Thermoplasmas, Extremely Thermophilic Sulphur Metabolizers.

Domain Bacteria; Aquificales and Thermotogae, Deinococcus- Thermus, Photosynthetic Bacteria: Chloroflexi, Chlorobicyanobacteria

The Proteobacteria; -proteobacteria, -proteobacteria, -proteobacteria, -proteobacteria and -proteobacteria.

The low G+C Gram Positive Bacteria: Clostridia, Mollicutes, Bacilli. The high G+C Gram Positive Bacteria; Actinobacteria, Planctomycetes, Spirochetes, Fibrobacters, Bacteriodes, 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, 9th 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 6th Edition, McGraw Hill, London (2005)

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCL-403: VIROLOGY

Credit: 3-0-0

Historical account and development of virology.

General characteristics, morphological variations, envelope, capsid, nucleic acid & classifications of plant viruses, animal & human viruses, bacterial viruses.

Assay 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, use of electron microscopy & Natural & Mechanical in virology.

Transmission of viruses isolation & purification of viruses, criteria of purity of viruses, general properties of bacteriophage, one step growth, type of phages, life cycle of M13 phage. Viral diseases of plants, (papaya, banana, tomato) symptoms, infections & multiplication (TMV). Transmission by vectors, other means & control of Viral diseases of animals including (Ranikhet disease of poultry farm, foot & mouth disease of cattle, bird flu & SARS).

Role of viruses in genetic engineering. Brief concept of viroids and prions.

Books Recommended:

- Cann, Allanj. 1997. Principles of Molecular Virology, Academic Press London.
- Mathews REF 1998. Plant Virology, Academic Press, London.
- Viruses & Mycoplame diseases in India, Raychandri, S.P. & Nariani, T.R. 1994. Malhotra Publishing House. New Delhi.
- N. Dimmock, A. Earnton and K. Leppard : Introduction to Modern Virology, Blackwell Publishing (2007)
- E.K. Wagner and M.J. Hewlet. Basic virology (2nd Edn) Blackwell publishing (2004)
- Field Virology (2001) Bernard N Field by Lippin Colt Williams Wilkins.

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCL-404: MYCOLOGY AND PLANT PATHOLOGY

Credit: 3-0-0

Introduction, distribution, thallus organization, cell structure, nutrition, factors affecting growth, sexual and asexual reproduction, heterothallism, parasexuality in fungi, control of reproduction. Systems of classification (Alexopolous and Ainsworth), General life cycles of Myxomycetes, Oomycetes, Zygomycetes, Ascomycetes and Basidiomycetes.

Fungal diseases of plants: symptoms, transmission & control measures (biological, chemical, regulatory, physical). Rust 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.

Economic importance of fungi: Role of fungi in food, biocontrol, enzyme production, medicine etc.

Books Recommended:

- Agriose, G.N. 2005, Plant Pathology, 5TH edition Academic Press, Inc., Ainsworth, G.C. and Sussman, A.A. (Eds).
- Alexopolous, C.J. and Mims, C.W., Blackwell, M 1996. Introductory mycology IV Edn., John Wiley and Sons inc., New York.
- Carlile, M.J. Watkinson, S.C. and Gooday, G.W. (2001) The Fungi, 2nd Edition. Academic Press.
- Zhiquiang Au, (2005) Handbook of Industrial Mycology, Marcel Dekker, USA.
- J.W. Deacon (1997) Modern Mycology (Basic Microbiology) 3rd Ed. Wiley Blackwell.

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCL-405: MICROBIAL GENETICS

Credits: 3-0-0

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

Generalized recombination: Molecular mechanism and proteins involved in recombination, Transposable elements: types and mechanism of transposition, significance. Phage Mu.

Transformation: competence factors and DNA uptake, significance. Conjugation: F-factor, Hfr strain and interrupted mating. Transduction: generalised and specialized transduction, mechanism.

Phage : gene organization, lytic and lysogenic phase.

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-I)
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MTL 261- BIOSTATISTICS

Credit: 4-0-0

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

Statistical Method: Collection of data. Frequency distribution and its graphical representation. Measures of central tendency, dispersion, skewness and kurtosis moments.

(12 Lectures)

Correlation and Regression: Relationship between variables, covariance, Karl-Pearson's correlation coefficient, Spearman's rank correlation coefficient, interpretation of correlation coefficients. Least square technique for regression lines (without proof), regression coefficients, relationship between correlation analysis and regression analysis.

(07 Lectures)

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 Distribution of binomial, poison and normal Properties of these distributions (Applications only).

(08 Lectures)

Hypothesis Testing: Sample population statistics and parameters, null hypothesis, level of significance. Definitions of Chi-square test, 't' and 'f' varieties and their Pdf 3 only, Application of these distributions in testing of hypothesis.

(10 Lectures)

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 observations for cell, analysis of variance for two-way classified data with multiple but equal number of observations per cell (data analysis only).

(08 Lectures)

Test Books:

1. Raghavarao, D.: Statistical Techniques in Agricultural and Biological Research (1983), Oxford and IBH Publishing Co. [Chapters: 2,3,4,5,7,8,9 and 10].
2. Fowler J.; Cohen L. and Jarvis, P.: Practical Statistics for Field Biology, 2nd Edition (1998), John Wiley and sons. [Chapters: 4,5,6, (7.1-7.6), 9 (9.1-9.4), 12(12.1- 2.7), 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)].

Reference Books:

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

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCP - 421: Microbiological Techniques-I

Credits: 0-0-3

1. The general microbiological instruments used in laboratory.
2. Microscopy.
3. Staining Techniques (Simple, Gram's, Spore, Capsule, Acid fast, Flagella).
4. Media preparation, sterilization and inoculation.
5. Total cell count by haemocytometer.
6. Determination of cell size of different microorganisms.
7. Determination of cell count by SPC method and DMC method.
8. Microbiological Quality of Water.
9. To isolate fungi and yeast from various sources and study their morphology.
10. To study the pathology of various plant diseases.
11. To study the permanent slides and specimens of fungi.
12. Measurement of fungal growth by linear determination.
13. Measurement of fungal growth by weight determination.

M.Sc. MICROBIOLOGY (SEMESTER-I)
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MCP- 422: MICROBIOLOGICAL TECHNIQUES-II

Credits: 0-0-4.5

1. Isolation and enumeration of bacteria from soil by serial dilution agar plating method.
2. Isolation and enumeration of actinomycetes from soil.
3. Morphological and cultural characterization of bacteria and actinomycetes.
4. To perform various physiological tests of bacteria: Acid and gas production from sugars, gelatin liquefaction, starch hydrolysis, casein hydrolysis, nitrate reduction, indole production, H₂S production, methyl red test, Voges Proskauer test, citrate utilization, catalase activity, urea activity, oxidase activity.
5. Symptoms of virus infected plants.
6. To study Biophysical properties of plant virus.
7. Demonstration of virus isolation.
8. Phage isolation from sewerage water.
9. Indication of plant virus infection.
10. UV spectrophotometer of purified/semi purified virus preparation.
11. Agarose Gel electrophoresis.
12. SDS- PAGE electrophoresis.
13. Estimation of Protein in virus infected & normal plants.

M.Sc. MICROBIOLOGY (SEMESTER-II)
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MCL-451: Concepts in Immunology

Credits: 3-0-0

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.

Primary and secondary lymphoid organs-Thymus, spleen, lymph nodes, lymphatic system, mucosal-associated lymphoid tissue (MALT), lymphocyte traffic.

Antigen-antibody interactions, affinity and avidity, high and low affinity antibodies, immunoglobulins, classes and structure, complement fixing antibodies and complement cascade.

Characteristic properties of antigens, adjuvants, T-dependent and T-independent antigens, recognition of antigens by T-cell and role of MHC.

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

Various types of immunodiffusion and immunoelectrophoretic procedure, Immunoblot, ELISA, RIA, agglutination of pathogenic bacteria, hemagglutination and hemeagglutination inhibition.

Books Recommended:

- Kuby, J. (1992), Immunology, W.H. Freeman, USA.
- Paul, W.E (1991), Immunology: Recognition and Responses W.H. Freeman, New York.
- Playfair, J.H.L. (1992), Immunology at a Glance (5th Ed), Blackwell Scientific publication, Oxford.
- Roitt IM, Brostoff J, Male DK (2001) Immunology, Mosby Inc, UK.
- 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)
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MCL-452: MEDICAL MICROBIOLOGY

Credits: 3-0-0

History and scope of medical microbiology. Microorganisms and Diseases: Host Microbial Interaction governing the Infection and establishment of disease, factors affecting virulence, Portals of entry and portals of exit.

Normal microbial residents of human body, characteristics of normal flora, distribution and occurrence of normal flora ; skin, respiratory tract, gastrointestinal tract and genitourinary tract.

Sources and transmission of infection, Reservoirs of infection. Human sources, animal sources and inanimate sources, trans placental infection, respiratory tract infection, food and water borne infections.

The innate defenses of the body: outer defenses, inner defenses, intracellular killing of microbes by professional phagocytes, need of chemical switch for phagocytosis, role of complement fixation & activation, Factors modifying innate resistance.

Book Recommended:

1. Medical Microbiology by C.G.A. Thomas, 1988. Bailion Tindall, London.
2. Medical Microbiology by Mims, Playfiar, Roitt, Wakelin and Williams, 1993, Mosby-year Book Europe Ltd., U.K.
3. Microbiology: Concepts and Applications by Pelczar, Chan and Krieg, 1993. Mc Graw Hill, Inc., U.S.A.
4. Microbiology: A Human Perspective by Nester, E.W. Roberts C.E., Nester, M.T. 1995. WM. C. Brown Communication Inc. U.S.A.
5. Medical Microbiology 4th edu, S. Baron NCBI/ 2004
6. Medical Microbiology (Eds) F.H. Kayser, K.A. Bieng, J. Eckest, R.H. Zinkernagel. Georg Thieme Virology (2008)

M.Sc. MICROBIOLOGY (SEMESTER-II)
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MCL-453: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY

Credits: 3-0-0

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 organelles of microbial cell. Role of cell wall and cell membrane in form and function of microbial cells, Biofilm formation & its significance.

Mode of nutrition, classification of microorganisms on the basis of energy and carbon source requirements. Role of vitamins and growth factors. Optimization of medium components.

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. Physiology and genetic regulation of endospores formation and its regeneration.

Bioenergetics, basic concepts, redox pairs in energy productions, substrate level, oxidative and photo phosphorylations, Components of ETC, chemiosmosis and ATP production. Intermediary metabolism of carbohydrates, formation of precursors and reducing power. Biosynthesis of cell wall, nucleotides and amino acids. Nitrogen fixation and assimilation. Chemolithotrophs, Metabolism of C₁ compounds.

General properties of Archaeobacteria, Salient features and differences from eubacteria and eucaryotes. Brief account of physiology of thermophiles, halophiles and methanogens.

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. 4th edition, Wiley-Liss.
4. Edwards, Clive, 1990. Microbiology of Extreme Environments. Mc Graw Publishing. Co.

M.Sc. MICROBIOLOGY (SEMESTER-II)
(Under Credit Based Continuous Evaluation Grading System)

MCLL-454: MOLECULAR BIOLOGY & GENETIC ENGINEERING

Credits: 4-0-0

Nucleic acids: structure of DNA, functions, replication, DNA damage and repair, isolation and sequencing. Transcription; types of RNA and their role in gene expression, Translation; components involved, t-RNA as adapter, genetic code and its salient features, gene expression; inducible and repressible operon (account of *lac* operon and *trp* operon regulation) Molecular cloning; techniques and their importance, cloning vectors; properties and uses of phage vectors, plasmids, cosmids and phasmids, cloning strategies; cloning of genomic DNA, cDNA cloning, selection and characterization of clones, gene probes, labeling. PCR: principle, types and role in molecular biology

Books Recommended:

1. Friefelder, D. 1987. Microbial Genetics. Narosa Publication.
2. Friefelder, D., Maloy, S.R. and Cronana, J.E. 1994, Microbial Genetics, IInd edition, Jones and Barlett Publishers.
3. Lewin, B. 1990. Gene V. Oxford Univ. Press.
4. Malacinski, G.M. & Friefelder, D. 1993. Essentials of Molecular Biology, IInd Edition. Jones and Bartlett Publishers.
5. Synder, L. and Champness, W., 1997. Molecular Genetics of Bacteria, ASM Press.

M.Sc. MICROBIOLOGY (SEMESTER-II)
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MCL-455: ENVIRONMENTAL MICROBIOLOGY

Credits: 3-0-0

Define the concept of Environment, Microenvironment and Microbial Ecology. Distribution of microorganisms in different ecosystems: Air, Water and Soil. The significance of cell number methods for enumerating microbes, biomass and activities, viable cell count procedures, biochemical methods for measurement of microbial biomass.

Microbial Interactions: The concept of positive, negative and neutral interactions: Parasitism, Predation, Neutralism, Commensalism, Amensalism, Mutualism, Synergism and Competition.

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. Microbiology of methane formation.

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.

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.

M.Sc. MICROBIOLOGY (SEMESTER-II)
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MCP-471: LAB TECHNIQUES IN MEDICAL MICROBIOLOGY & IMMUNOLOGY

Credits: 0-0-3

1. Preparation of some medically important media viz. Muller-Hinton agar, Blood agar, Baird Parker medium, Bismuth sulphate agar etc.
2. Antimicrobial susceptibility testing Kirby Bauer method.
3. Determination of MIC and MDC.
4. Demonstration of alpha, beta and gamma haemolysis in *Streptococcus*, *Staphylococcus*.
5. Demonstration of some serological reactions, Vidal tests, VDRL test.
6. Gel diffusion test, (Agarose Gel Diffusion test)
7. Estimation of Total and differential lymphocyte count using haemocytometer
8. Immunoelectrophoresis.
9. PCR based detection of pathogens.
10. Urinary tract infection (UTI), a case study.

M.Sc. MICROBIOLOGY (SEMESTER-II)
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MCP-472: APPLIED MICROBIOLOGY LAB

Credits: 0-0-4.5

1. Enumeration and screening of industrially important bacteria fungi, actinomycetes from different ecosystems.
2. To study the effect of different sugar and NaCl concentration on yeast growth.
3. Effect of different temperatures on yeast growth.
4. Isolation of N₂ fixing bacteria, Sulphate reducing bacteria, Nitrifying and denitrifying bacteria.
5. To isolate different organism such as:
 - i) Psychrophiles
 - ii) Mesophiles
 - iii) Thermophiles
 - iv) Halophilic microorganisms from different sources.
6. To study the effect of physiological parameters on growth.
 - i) Effects of Carbon
 - ii) Nitrogen
 - iii) pH, etc.
7. To study the diauxic growth.
8. Calculation of generation time and growth rate of bacterial culture.
9. To isolate spontaneous mutants from various samples.
10. Plasmid curing
11. To induce the mutagenesis by different mutagenic agents (U.V./NTG).
12. To characterize the auxotrophic mutants by replica plating method.
13. Protoplast formation, regeneration & fusion.
14. DNA isolation & gel-electrophoresis.
15. To study the basic parts and operation of lab scale production of yeast biomass.
16. Production of enzymes by solid state and submerged culture
17. Production of citric acid
18. Production of antibiotics and plate assay.

M.Sc. Microbiology (Semester-III)
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MCL-501: CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Credits : 3-0-0

Collection, transport, and examination of clinical specimens, preliminary processing of biological samples: Stool, blood, urinary and Gastro intestinal tract, Culture containers, media, Storage of clinical specimens.

Adaptive Immunity, type and components of adaptive immune response, features of adaptive immune responses, cells of Immune system recognition of antigen, activation of lymphocytes, effector phase of immune responses. Immunity to viruses, evasion of immune mechanisms by parasites, vaccine development.

Clinical features, laboratory diagnosis, treatment and prevention of: Cholera, Diphtheria & DPT vaccination, Tuberculosis DOT treatment, MDR tuberculosis Pneumonia, Typhoid, Hepatitis: type of hepatitis, vaccine schedule of hepatitis and AIDS. Control of communicable diseases.

AIDS definition, types of HIV receptor & co-receptor associated with AIDS, control & vaccine: General studies on Plague, Rickettsia, yellow fever, Amoebiasis, Trypanosomiasis, Malaria and Syphilis.

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, Mosby-year 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.
6. Microbiology: A Human Perspective by Nester, E.W. Roberts C.E., Nester, M.T. 1995. Wm. C. Brown Communication. Inc., U.S.A.

M.Sc. Microbiology (Semester-III)
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MCL-502: ENVIRONMENTAL BIOTECHNOLOGY

Credits: 3-0-0

Purification of waste water by aerobic processes, Communal sewage and industrial effluents, Aims and limitations of aerobic bioprocessing. Activated sludge process. Trickling filter process, lagoon process. Purification of effluents by anaerobic processing. Biology of methane formation,.

Microbiology of cellulose degradation, Enzymatic aspects of cellulolysis. Potential application of Microbial cellulases. Microbiology of lignin degradation ,white-rot, brown-rot, and soft-rot type fungal attack in ligninolysis. Enzymology of lignin degradation and their biotechnological applications. Brief account of microbial degradation of pectin and hemicellulose with their potential applications.

The concept of 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, Microbes as sources of Atmospheric pollutants, microbes as sinks for Bioscrubbers and biofilters.

Microbial Insecticides: *Bacillus thuringensis*. The concept of endotoxins and cry genes, *B. thuringensis* as a present day bioinsecticide. (*Bacillus sphaericus*) *B. popilliae*) 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, uranium leaching.

Books Recommended:

1. Atlas. R.M. and Bartha, M (1981). Microbial Ecology Fundamentals and applications, Addison-Wesley, Philipines.
2. Campbel, 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.

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MCL-503: INDUSTRIAL MICROBIOLOGY

Credit: 3-0-0

Definition and scope: Historical developments in Industrial Microbiology, Isolation and screening of industrially important microorganisms, maintenance of industrial cultures.

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

Primary products of microbial metabolism: Beer, alcohol, Single cell protein, amino acids (lysine and glutamic acid), production of citric acid by Koji process and submerged process, enzymes production, nucleic acids.

Secondary products of microbial metabolism, Antibiotics (penicillin, tetracycline), alkaloids, taxol, fermentation economics, product recovery of alcohol, citric acid, enzymes, antibiotics, alkaloids.

Books Recommended:

1. Industrial Microbiology Ed. Casida, L.E (1996) New Age International Publishers.
2. Industrial Microbiology Eds. Prescott and Dunn (1991)
3. Biotechnology 2nd Edition W. Crueger and A. Crueger. (1992) Panima Publishers.
4. Microbial Technology. Vol. I and II Eds. Pepler and Perlman, (1979) Academic Press
5. Principles of Fermentation Technology Stansbury and Whittaker Pergamon Press (2006)

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Test Books:

1. Raghavarao, D.: Statistical Techniques in Agricultural and Biological research (1983), Oxford and IBH Publishing Co. [Chapters: 2,3,4,5,7,8,9 and 10].
2. Fowler J.; Cohen L. and Jarvis, P.: Practical Statistics for Field Biology, 2nd Edition (1998), John Wiley and sons. [Chapters: 4,5,6,(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)].

REFERENCE BOOKS:

1. Wayne W. Daniel: Biostatistics: A Foundation For analysis In Health sciences, 7th Edition (1999), John Wiley and sons.
2. Finney D.J.: Statistics for Biologists (1980),Chapman and Hall Ltd.
3. Hoel, P.G.: Elementary statics 3rd Edition (1971), John Wiley and sons.
4. Ross, S.M.: Introductory Statics,2nd Edition (2005),Academic Press.
5. Bland, M.: An introduction to Medical Statistics, 3rd Edition (2006), Oxford University Press.
6. Woodworth, G.: Biostatistics: A Bayesian Introduction (2004), John Wiley and sons.

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CSL-591: COMPUTER APPLICATIONS

Credits: 3-0-0

Unit-I

Computer fundamentals, Introduction to digital computers, Organization, Number system, I/O devices, Storage devices, MS-Windows basics, MS-office, MS-Word-Meaning of word-Processing, Creating, Saving, Printing Documents, Page Setup, Formatting, Spell-Check, Adding page numbers, Header and Footer, Macros, Creating tables, Converting table to text and vice-versa, Mail Merge

Ms-Excel-spreadsheets, Using different types of formulae, Creating graphs and charts, Exporting charts to MS-Word, MS-Power Point, Creating presentations, Formatting, Adding effects and timings

Unit-II

Introduction to Data, Information, Database, DBMS (Advantages and disadvantages), MS-Access, Basics of MS Access, Introduction to SQL (Data retrieval)
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. Types of errors and level of significance, Tests of significance, (F and t-test); Chi-square tests

Unit-III

Internet basics, Introduction to internet and its applications-www, email, ftp.
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 End Note 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>

Books Recommended:

1. Sinha, P.K. (2004). Computer Fundamentals
2. Peter Norton's Introduction to Computers, 6th.Ed.
3. Windows Based Computer Courses, Sumit Kumar, Maalti, Sandeep Sood JBD Publishers.
4. Gupta, S.C. (2008).Fundamentals of Statistics. Himalaya Publishing House.

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MCP-521: FOOD MICROBIOLOGY LAB**Credits: 0-0-3**

1. The enumeration and identification of micro flora involved in spoiled foods through SPC and microscopic method in food items such as vegetables, fruits, milk, Jam, Butter, cheese.
2. To study microbiological quality of raw milk, pasteurized milk and dry milk by MBRT test.
3. To estimate LPS endotoxins in food by Limulus Amoebocyte Lysate (LAL) Test
4. Detection of mycotoxins in food
5. To compare the percentage acidity of milk and curd.
6. To check the quality of pasteurization by phosphate test.
7. To determine to ascorbic acid content of given food material by 2, 6-dichlorophenol indophenols method.
8. To prepare the fermented food sauerkraut and study its microbiology and spoilage.
9. To determine and compare the effect of deep-freezing and refrigeration on the viability of microorganisms.
10. To determine the D and Z value of spoilage causing pathogenic bacteria.
11. Standardization of milk.
12. To prepare yogurt and shrikhand
13. Preparation of bread and cakes.
14. Preparation of tofu, idli, dhokla, dosa and isolate the microorganisms responsible for their fermentation.
15. To study the production of wine and vinegar,

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MCP-522: ENVIRONMENTAL & INDUSTRIAL MICROBIOLOGY LAB**Credits: 0-0-4.5**

1. Enumeration of microorganisms from different ecosystems.
2. To study the effect of different sugar and NaCl concentration on yeast growth.
3. Effect of different temperatures on yeast growth.
4. Isolation of N₂ fixing, Nitrifying and denitrifying bacteria.
5. Soil Enrichment Technique.
6. To study the BOD & COD levels of different water systems.
7. Isolation of cellulase producing fungi.
8. Differentiation of white-rot and brown-rot fungi.
9. Bacteriological analysis of water by presumptive, confirmatory and completed tests.
10. Screening industrially important microorganisms from soils, food processing wastes, animal droppings.
11. To evaluate the production of alcohol from molasses & lignocellulosics.
12. Microbial biomass production (fungi/bacteria/yeast) batch and continuous culture.
13. To compare production of citric acid using sucrose and molasses as carbon source.
14. Production of lactic acid using cheese whey as substrate.
15. Production of extracellular enzymes (pectinase and xylanase) by thermophilic and mesophilic fungal culture.
16. To isolate rare genera of microorganisms for novel antibiotic production, and to evaluate the potential of different media for antibiotic production.
17. To study the protoplasting and regeneration in fungi.
18. Isolation of fungi genomic DNA and plasmid DNA by mini prep protocol.
19. To study the role of plasmid in degradation of xenobiotic compounds and curing of plasmid.
20. PCR amplification of DNA from natural sources.
21. Purification of proteins and SDS-PAGE

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MCL- 551: Recent Advances in Microbiology

Credits 4-0-0

The syllabus for this paper will consist of topics of current research. Every year the scientific articles will be selected from leading journals, reviews and books.

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MCL-552: ADVANCES IN INDUSTRIAL MICROBIOLOGY

Credits: 3-0-0

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.

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, Single cell oil, polysaccharides (xanthan), fermentation of pharmaceutical molecules lovastatin, carotene, production of recombinant vaccines, insulin..

Industrially important biotransformation, Immobilization of whole cells and enzymes, protein engineering, metabolic engineering, inverse metabolic engineering, Intellectual property rights (IPR) and patents laws governing in Indian patents related to microbial products and processes.

Books Recommended :

1. Manual Industrial Microbiology and Biotechnology (eds) A.L. Demain 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 2nd Edition W. Crueger and A. Crueger. (1992) Panima Publishers.
5. Microbial Technology. Vol I and II Eds. Peppler and Perlman, (1979) Academic Press.
6. Comprehensive Biotechnology Vol III and IV Ed. Moo Young (1984) Pergamon Press.
7. Recent review and research articles from scientific journals
8. Industrial Microbiology :An Introduction. Waites, M.J., Morgan, N., Rockey, J.S.,and Higton, G. (2001). Blackwell publishing
9. Proteomics and protein protein interactions : Biology, chemistry, bioinformatics and drug design. Waksman.(2006).

M.Sc. Microbiology (Semester-IV)
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MCL 452: FOOD MICROBIOLOGY (Elective)

Credits: 3-0-0

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. 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); Cereal products (Soya sauce, miso, tempeh. Idli, dosa, bread); Milk and milk products: Cheese, yogurt, kefir, koumiss, fermented milks.

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, Food Laws.

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. 4th edition. McGraw Hill Inc., New York.
3. Jay, J.M., 1986. Modern Food Microbiology 3rd Edition, Van Nostrand Reinhold.
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.

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

Credits: 3-0-0

Microbial Fertilizer:

Introduction and history, 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, 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.

Microbial Pesticides :

Introduction, Historical background, Role of microbial pesticides in sustainable agriculture, safety, limitations, advantages and disadvantages of microbial pesticides

Microbial insecticides based on *Bacillus* : toxins produced and their mode of action. Role of baculoviruses in controlling insect pests of crops.

Role of Fungi in pest control : Entomopathogenic fungi, Fungal disease symptoms on insects, development of mycosis, *Trichoderma* as biocontrol agent, Formulations of microbial pesticides, stabilization, handling and application.

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.

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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.
9. H.D. Burges 1998. Formulation of microbial pesticides: beneficial microorganisms and seed treatment. Kluwer Academic Publishers, Netherlands.

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MCL-582: Advanced Virology (Elective)

Credits : 3-0-0

Viruses that cause cancer and the mechanisms by which they do so: DNA cancer viruses RNA cancer viruses (retroviruses)

The biology of the virus that causes AIDS. History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotypic and DNA vaccines. Drugs that have been used against viruses: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors. Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Mechanisms by which interferon exerts its antiviral activity. Contributions of various host defense mechanisms in viral infections. The diseases that are caused by the hepatitis viruses. Rhabdoviruses and the disease of rabies. The viruses that cause common colds and severe acute respiratory syndrome. Nobel Laureate of virology & immunology.

Books Recommended:

1. Introduction to modern virology, N. J. Dimmock, Andrew J. Easton, Keith Leppard - 2007
2. Basic virology, Edward K. Wagner - 2008
3. Field Virology. Bernard N Field by Lippin Colt Williams Wilkins-2001
4. Principles of Virology: 2 Volume , S. J. Flint, L. W. Enquist, V. R. Racaniello - 2009
5. Principles of Molecular Virology, Alan J. Cann, John Biggs - 2011
6. Principles and practice of clinical virology, Arie J. Zuckerman – 2004
7. Virology, Jay A. Levy, Heinz Fraenkel-Conrat, Robert A. Owens - 1994

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MCL-583: BIOCHEMICAL BIOPHYSICAL TECHNIQUES (Elective)

Credits: 3-0-0

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

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

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

Theory and application of UV- visible spectroscopy, Infrared spectroscopy, NMR , MS, GC/LC-MS spectrometry.

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

Books Recommended:

1. Friefelder. D. (1982) Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd ed. W.H. Freeman and Company, San Fransisco.
2. Griffiths, O.M. (1983). Techniques of Preparative, Zonal and Continuous Flow Ultracentrifugation. Bechman's Ultracentrifuge Manual.
3. William, B.L. and Wilson, K. (1986). A Biologist Guide to Principles and Techniques Practical Biochemistry, 3rd ed., Edward Arnold Publisher, Baltimore, Maryland (USA).
4. Slater, R.J. (1990). Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.

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MCP-571: Research Assignment

Credits: 0-0-4

Syllabus include practical research assignment

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MCP-572: Field Study

Credit: 0-0-1

Includes visit to Food, Fermentation and Pharmaceutical Industries and submission of report on technical problems faced by the industry in production, quality control, packaging and waste management and suggestions for improvement.

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MCP-573: Advanced Practicals in Microbiology

Credits 0-0-4.5

1. Production of enzymes by submerged culture and Solid state fermentation.
2. Enzyme assays based on natural and synthetic substrates.
3. Purification of enzymes
 - Ultrafiltration
 - Ion Exchange Chromatography
 - Gel Filtration
 - Hydrophobic interaction chromatography
4. SDS PAGE and Gel filtration for determining the molecular weight and purity of protein.
5. Iso electric focusing of the purified protein for determining the pI of purified enzyme.
6. Zymogram for localization of the enzyme activity using PAGE.
7. Profiling of enzyme activity in IEF gels.
8. Characterization of purified enzyme for optimal pH, temperature, thermostability, effect of metal ions, substrate specificity.
9. Enzyme kinetics determining the K_m and V_{max} values.
10. 2 DE for proteome based analysis of enzymes.