Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

॥अंतरी पेटवू ज्ञानज्योत॥

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

SYLLABUS
for
Master of Science (M. Sc. I)
Microbiology

As per

Choice Based Credit System
(Outcome Based Curriculum)

And

National Education Policy (NEP)-2020

For
Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University
Jalgaon 425 001 (MS)

2023 - 2024

Program at a Glance

Name of the program (Degree)	**:**	*M. Sc.*
Subject	**:**	*Microbiology*
Faculty	**:**	*Science and Technology*
Duration of the Program	**:**	*Two years (four semesters)*
Medium of Instruction and Examination	**:**	*English*
Credits of the program	**:**	*Total 88 credits*
Examination Pattern	**:**	*The 60 : 40 (60 marks University assessment (exam) and 40 marks continuous internal college assessment (exam)*
Evaluation mode	**:**	*CGPA*
Passing standards	**:**	*The 40% in each exam separately (separate head of passing)*
Result	**:**	*As per the University's rules of CGPA system*

Prologue

The requirement for trained and skilled human resource is the need of time in the higher education and industry to match with rapid pace of technology development. Students need to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods in the subject. Thus, it is imperative to revise and update the curriculum to accommodate the fundamental aspects as well as advanced developments in various disciplines of Microbiology and to complement the needs of its applied sectors. The program is designed to provide skilled manpower in this subject, facilitate to improve linkages with industries, and intended to offer practical skills needed to pursue the jobs in a chosen profession. Beside this, the students will be enlightened with knowledge in the newer areas of Bioinformatics, Bioinstrumentations, Biomolecules, Genetics, Immunology, etc. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively through their dissertations or the project work. The students are encouraged to deliver seminars to develop presentation skills and enable to build confidence which will lead them to read about different themes and enhances their assimilation abilities. A project component in the final semester will enable students to select a research problem, plan to execute experiments related to it, collect data and analyze it, and present the results in the form of an oral presentation as well as a thesis. This not only equips the student for a career in research as well as industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in this subject as well

as be familiar with the most recent advances in the field of Life Sciences and will have gained hands-on experience in this subject of study. The student will be able to take up a suitable position in academia or industry and will be equipped to pursue a career in research or be an entrepreneur if so desired.

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure. When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated, over meetings between the faculty members and the students. Several alumni contributed to useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members, and feedback obtained from students, alumni, external experts and members of industry.

The student will acquire knowledge about Microbiology such as Genetic Engineering, plant-microbes interaction, and Microbial Diversity, Molecular Biology, Pharmaceutical Microbiology, Fermentation Technology Applied and Environmental Microbiology, Industrial Microbiology Immunology, Agricultural and Food Microbiology. The student can design and execute experiments related to Basic Microbiology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics and can execute a short research project incorporating techniques of Basic and Applied Microbiology under supervision.

Structure of M.Sc. program in Microbiology

M.Sc. Microbiology program is of two years duration and is conducted into four semesters. Since inception, the program was mostly student centric. Now in lieu of accreditation standards of NAAC, the university adopted an outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project, seminars, assignments, etc. Two categories of courses are being offered in this program: (A) Prerequisites and Core courses (B) Skill Based/ Subject Elective courses. The core courses of 2 or 4 credits include theory as well as practical. The core courses embody a research-based course that leads to a project dissertation. The student is required to accumulate 22 credits each semester, a total of 88 credits, to fulfil the requirements for a M.Sc. degree. Forty percent of the total marks for each course will be awarded through internal assessment. Final examinations for four credit courses will be of three hours duration while examinations for each laboratory- based courses will be held over two days of three hours (incubation based practicals) each or one day of 5-6 hours each. However, there could be certain changes in the number of classes of theory and practicals, ways of teaching either through online or offline mode and even the examination pattern owing to the prevailing situation like pandemic and as per the need by following the rules and regulations.

Duration

The duration of M.Sc. degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course should be completed in about 60 lectures.

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for this M.Sc. course must have 75% attendance in each course to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
PO2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments
PO3	Analyse the given scientific experimental data critically and systematically and the ability to draw the objective conclusions.
PO4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively
PO5	Model and formulate the real problems and find solution based-on knowledge acquired
PO6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.

Program Specific Outcomes (PSOs) for M.Sc. Microbiology program:

Students who graduate with a Master of Science in Microbiology will:

PSO No.	PSO	Cognitive level
PSO1	Understand the structure and metabolism of macromolecules, the regulation of metabolic pathways and role of microbes in industry, health and environment.	**2**
PSO2	Gain proficiency in laboratory techniques in both microbiology and molecular biology and apply scientific methods to the processes of experimentation and hypothesis testing.	**3**
PSO3	Acquire significant knowledge of various aspects related to microbiology including biochemical techniques, immunology, physiology, agriculture, environment, pharmaceutical, molecular biology, applied recombinant DNA technology and technical skills related to microbial metabolites.	**4**
PSO4	Develop the ability to understand and practice the ethics surrounding scientific research.	**5**
PSO5	Realize the impact of science in society and plan to pursue research.	**5**
PSO6	Learn to work as a team as well as independently to retrieve information, carry out Research investigations and result interpretations.	**6**

Distribution of Course papers for M. Sc. Part I Microbiology Subject

Semester-wise Course Structure, Course Code and Credit distribution of Two Years/ One Year M. Sc. Microbiology Programme as per NEP2020, for Affiliated Colleges w.e.f – June 2023.											
SEMESTER – I, Level – 6.0											
Course	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Teaching Hours/ Week**			**Marks (Total 100)**			
					T	**P**	**Total**	**Internal (CA)**		**External (UA)**	
								T	**P**	**T**	**P**
DSC-25	DSC	MB-411	Microbial Taxonomy and Diversity	4	4	--	4	40	--	60	--
DSC-26	DSC	MB -412	Molecular Biology	2	2	--	2	20	--	30	--
DSC-27	DSC	MB -413	Microbial Biochemistry	4	4	--	4	40	--	60	--
DSC-28	DSC	MB -414	Laboratory course on Microbiology and Molecular Biology	2	--	4	4	--	20	--	30
DSC-29	DSC	MB -415	Laboratory course on Biochemistry	2	--	4	4	--	20	--	30
SE-5	DSE	MB -416(A)	Food and Dairy Microbiology	4	4	--	4	40	--	60	--
		MB -416(B)	Cell biology	4	4	--	4	40	--	60	--
RM	RM	MB -417	Research Methodology	4	4	--	4	40	--	60	--
SEMESTER – II, Level – 6.0											
DSC-30	DSC	MB -421	Bioinstrumentation	4	4	--	4	40	--	60	--
DSC-31	DSC	MB -422	Bioinformatics	2	2	--	2	20	--	30	--
DSC-32	DSC	MB -423	Immunology	4	4	--	4	40	--	60	--
DSC-33	DSC	MB -424	Laboratory course on Immunology and advances in microbiology	2	--	4	4	--	20	--	30
DSC-34	DSC	MB -425	Laboratory course on Enzymology	2	--	4	4	--	20	--	30
DSE-6	DSE	MB -426(A)	Microbial enzymology	4	4	--	4	40	--	60	--
		MB -426(B)	Advanced Bio techniques	4	4	--	4	40	--	60	--
OJT	*OJT/Int	MB -427	(On Job Training) OJT	4	--	8	8	--	40	--	60
Cumulative Credits For First Year – 44											

Semester-wise Course Structure, Course Code and Credit distribution of Two Years/ One Year M. Sc. Microbiology Programme as per NEP2020, for Affiliated Colleges w.e.f – June 2023.

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
SEMESTER – III, Level – 6.5											
DSC-35	DSC	MB -511	Pharmaceutical Microbiology	4	4	--	4	40	--	60	--
DSC-36	DSC	MB -512	Applied Molecular Biology	2	2	--	2	20	--	30	--
DSC-37	DSC	MB -513	Applied and Environmental Microbiology	4	4	--	4	40	--	60	--
DSC-38	DSC	MB -514	Laboratory course on Pharmaceutical Microbiology	2	--	4	4	--	20	--	30
DSC-39	DSC	MB -515	Laboratory course on Applied Microbiology	2	--	4	4	--	20	--	30
DSE-7	DSE	MB -516(A)	Microbial genetics	4	4	--	4	40	--	60	--
		MB -516(B)	Animal and Plant Tissue culture	4	4	--	4	40	--	60	--
RP	RP	MB -517	Research Project	4	-	8	8	--	40	--	60
SEMESTER – IV, Level – 6.5											
DSC-40	DSC	MB -521	Fermentation technology	4	4	--	4	40	--	60	--
DSC-41	DSC	MB -522	Agricultural Microbiology	4	4	--	4	40	--	60	--
DSC-42	DSC	MB -523	Laboratory course on Biotechnology	2	-	4	4	--	20	--	30
DSC-43	DSC	MB -524	Laboratory course on agricultural microbiology	2	--	4	4	--	20	--	30
DSE-8	DSE	MB -525(A)	Clinical and diagnostic Microbiology	4	4	--	4	40	--	60	--
		MB -525(B)	Biostatistics	4	4	--	4	40	--	60	--
RP	RP	MB -526	Research Project	6	-	12	12	--	60	--	90
Cumulative Credits For Second Year – 44											
2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree											

M.Sc. Part I Microbiology (Semester I)

DSC MB - 411: Microbial Taxonomy and Diversity

Credit 4		**Total Hours 60**
	Course Objectives: 1. To understand the ubiquitous nature of microbes to build a basic concept 2. To give basic knowledge on extremophiles 3. To provide knowledge on characteristics of various microbes	
Unit 1	**Microbial Taxonomy** • Concept: Taxonomic ranks, Domain and species • Introduction to Bergey's manual of Systematic bacteriology, 9th edition • Current techniques used for identification: DNA fingerprinting electrophoresis, Ribotyping, DNA Fingerprinting using Pulsed Field Gel Electrophoresis (PFGE), Randomly amplified polymorphic DNA (RAPD), RFLP, AFLP, Fatty acid analysis, Use of Nucleic acid probes • Metagenomics concept, culturable and non-culturable microbial diversity	12L
Unit 2	**Extremophilic bacteria and Archea** • Biotopes, Biochemistry and Physiology of adaptation to extreme environment and cultivation strategies of: Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkaliphile, Methanogens • Applications of extremophiles	12L
Unit 3	**Algae** • Characteristics: Algae (Colonial Algae, Filamentous Algae, Siphonous Algae, Parenchymatous and Pseudo parenchymatous algae), • Cytomorphology and Ultrastructure: algal cell (Mucilage and Sheaths, Frustule, Cell Wall, Flagella and Associated Structures, Plastids, algal movement) • Nutrition: Physical and chemical requirements, Types based on nutrition • Reproduction: Vegetative, Asexual Reproduction, Binary Fission or Cellular Bisection, Zoospore, Aplanospore, Autospore. Fragmentation, Resting Stages, Sexual Reproduction. • Significance of algae: Biogeochemical role, Food, Extracts (Agar, Alginate, Carrageenan), Animal Feed, Fertilizers, Cosmetics, Therapeutic Supplements, Algal pigments, Microalgae as biofertilizer, Lichens • Algal farming for biodiesel • BGA: General features, cultivation and significance • Prochloronus and cyanelles	12L
Unit 4	**Fungi** • Characteristics: Fungi (Yeast, moulds and dimorphic fungi) and their Classification • Cyto-morphology and Ultrastructure: Fungal hyphae, thallus • Nutrition: Physical and chemical requirements, Types based on nutrition • Reproduction: sexual, asexual, fungal spores and parasexual • Endophytic fungi: Characteristics, cultivation and significance • Ecological significance and applications of Fungi: Biogeochemical role of fungi, Mycoses, Mycotoxins, Biocontrol, Mycorrhiza and Insect symbionts	12L

Unit 5	**Virus** • Virus structure: Virus proteins, Capsids, Virion membranes, Ultrastructure of HIV, plant virus (TMV) and bacterial virus (T4 virus) • Classification of viruses • Methods used in virology: Cultivation of viruses, Isolation of viruses, Centrifugation, Structural investigations of cells and virions, Electrophoretic techniques, Detection of viruses and virus components, Infectivity assays. • Detection and enumeration of viruses • Viruses in cancer: oncogenic viruses, sources and mechanism of oncogenesis, Epstein-Barr virus-linked cancers, Kaposi's sarcoma, Cell lines derived from virus-associated cancers, Prevention of virus-induced cancers, Diagnosis and treatment • Emerging viruses: Viruses in new host species and in new areas, recently discovered viruses, Re-emerging viruses, Virus surveillance • Prions: nature of prions, Prion transmission, Transmissible spongiform encephalopathy	12L
	Suggested Reading: 1. Alexopoulous, C. J. and Mims, C. W. (1979) Introduction to Mycology, Wiley Eastern Ltd., Delhi 2. Bergey's Manual of Systematic Bacteriology (2001) Editor-in-chief: Garrity, George M. Boone, David R.; Castenholz, Richard W. (Eds.), (4 Volumes) Springer/ Williams and Wilkins, USA 3. Carter, John B and Saunders, Venetia A. (2007) **Virology:** Principles and applications, John Wiley and Sons Ltd., London 4. Dimmock, N. J. Easton, A. J. and Leppard, K. N. (2001) Introduction to Modern Virology, 5th Edn., Blackwell Science, London 5. Horikoshi, K., Grant, W.D. eds. (1998) Extremophiles, Microbial Life in Extreme Environments. Wiley-Liss Publishers, New York. 6. Hull, R. (2002) Matthew's Plant Virology, 4th Edn., Academic Press, London 7. Jim Deacon (2006) Fungal Biology, 4th Ed. Blackwell Publishing Ltd., West Sussex 8. Kathy Talaro and Barry Chess (2012) Foundations in Microbiology, 8th Edn., The McGraw-Hill Companies, Inc., New Delhi 9. Kevin Kavanagh (2005) Fungi: Biology and Applications, John Wiley & Sons Ltd., West Sussex, 10. Kushner, D.J. eds. (1978) Microbial life in extreme environments. Academic Press, London. 11. Laura Barsanti, and Paolo Gualtieri (2006) Algae: Anatomy, Biochemistry and Biotechnology, Taylor & Francis Group, UK 12. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark, (2009) Brock Biology of Microorganism, Benjamin Cummings, California, USA. 13. Prescott, Harley and Klein's (2002) Microbiology, 5th Edn. The McGraw-Hill Companies, Inc., 14. Tortora, Funke and Case (2010) Microbiology, 10th Edn., Brenjamin Cummings Inc., California 15. Wagner, E. K. and Hewlett, M. J. (2004) Basic Virology, 2nd Edn., Blackwell Publications, Oxford,	

Course Outcomes (CO):
On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C511.1	Differentiate various groups of microbes and microbial taxonomy	**2**
C511.2	Acquire knowledge on adaptability of extremophiles and microbial diversity	**3**
C511.3	Acquaint with the scope of microbiology in different diversified areas.	**4**

M.Sc. Part I Microbiology (Semester I)

DSC MB – 412: Molecular Biology

Credit 2		**Total Hours 30**
	Course Objectives: 1. To extend the knowledge on structure and functions of genetic material 2. To introduce genome organization, transcription and translation process in Prokaryotes 3. To study various tools to understand molecular mechanisms.	
Unit 1	**Basics molecular biology** • DNA: topological properties (linking, writhing, twisting number), Structure of super helix, Base flipping, Palindrome, Inverted repeats and stem and loop. • RNA: Structure, types and functions • Denaturation and renaturation kinetics of nucleic acids • Proteins: Domain and motifs Histone proteins, • DNA-Protein interactions: helix-loop-helix, helix-turn-helix, leucine zipper, Zinc finger motifs,	**10 L**
Unit 2	**Transcription** • Types of RNA polymerase (prokaryotic & eukaryotic), Process of transcription • mRNA processing, editing: capping, adenylation, splicing, RNA transport • Transcriptional regulation: transcriptional bursting/pulsing, specificity factors, enhancers, repressors, activators and general transcription factors • Post-transcriptional modifications, RNA degradation, nuclear transport, mRNA localization, anti-sigma factors, RNAi (siRNA, miRNA and CRISPR mechanism)	**10L**
Unit 3	**Translation and protein targeting** • Ribosome (structure and composition), Activation of tRNA, tRNA synthetase • Genetic code and its properties • Steps: Initiation: factors and their regulation, Elongation, Termination Inhibitors • Post translational modification of proteins and protein degradation • Translational regulation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping • Protein targeting	**10 L**

	Suggested Readings: 1. Bates, AD and Maxwell, A (2006) DNA Topology, Indian Edn., Oxford University Press, New Delhi (ISBN: 0-19-56831-X) 2. Brown, TA (1995) Essential Molecular Biology, Vol. I, A Practical Approach, IRL Press, Oxford, UK 3. Klug, WS and Cummings, MR (2003) Concepts of Genetics, 7th edn., Pearson Education Inc., (ISBN: 81-7808-884-3) 4. Lewin B. (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA (ISBN: 0-13-123826-4) 5. Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones and Batiett, London. (ISBN: 0-7637-2133-6) 6. Nelson DL & Cox MM (2005) Lehninger's Principles of Biochemistry, 4th edn., McMillan Worth Publ. Inc. NY 7. Oliver, RP and Schweizer, M. (1999) Molecular Fungal Biology, Cambridge University Press, Cambridge, UK (ISBN: 0-521-56784-X) 8. Russell, PJ (1998) Genetics, 5th edn, Benjamin-Cummings Publ. Co. Inc., NY (ISBN: 0-321-0038-2) 9. Stryer, Lubert (2002) Biochemistry 5th edn. W. H. Freeman and Co. New York 10. Turner, PC, McLennan, AG, Bates AD and White, MRH (2002) Instant Notes: Molecular Biology, 2nd edn., Viva Books Pvt. Ltd., New Delhi (ISBN: 81-7649-215-9) 11. Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2007) Molecular Biology of the Gene, 6th edn., Benjamin Cummings- CSHL Press, USA 12. Weaver, RF (1999) Molecular Biology, WCB McGraw-Hill Co. Inc., NY (ISBN: 0-697-14750-9) 13. Wink M. (2006) An Introduction to Molecular Biotechnology, Wiley-VCH Verlag Gmbh and Co., Weinheim, Germany (ISBN: 978-3-527-31412-6/3-527-31412-1)	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C512.1	Receive elaborate knowledge on molecular biology	**3**
C.512.2	Understand the process of transcription	**3**
C.512.3	Understand the process of translation	**3**

M.Sc. Part I Microbiology (Semester I)

DSC MB – 413: Microbial Biochemistry

Credit 4		**Total Hours 60**
	Course Objectives: 1. To know the structural organization, characteristics and metabolism of biomolecules 2. To learn microbial metabolic pathways and its enzymatic regulation 3. To acquire knowledge on transport of solute and energy metabolism	
Unit 1	**Structure and properties of Biomolecules** • Classification, Structure and function of: carbohydrates, lipids, proteins, nucleic acids and vitamins. • Conformation of proteins: Primary, secondary, tertiary and quaternary structure; Ramachandran plot, domains; motif and folds • Structural stability: protein and nucleic acid	**12 L**
Unit 2	**Transport and Energy metabolism** • Cell membrane and its ultrastructure • Types of cellular transport: passive, facilitated, active, translocation, liposomes for transduction, Na/K+ ATPase, ABC transporter • Response to stress. • Energy metabolism: Free energy, Bacterial and Mitochondrial ETC, ATP Synthase complex, inhibitors of ETC and energetics of ETC	**12 L**
Unit 3	**Metabolism of carbohydrates** • Metabolic pathway, bioenergetics and regulation of: EMP, HMP, TCA, Glyoxylate pathway, C3 and C4 pathway • Alternative glycolytic pathways	**12 L**
Unit 4	**Metabolism of Lipids** • Metabolic pathway, bioenergetics and regulation of Fatty acid synthesis • Oxidation of fatty acids: alpha, beta, omega • Biosynthesis of fatty acid: saturated and unsaturated • Metabolism of phospholipids • FAS Complex	**12 L**
Unit 5	**Amino acid and Nucleotide metabolism** • Metabolic pathway, Bioenergetics and regulation of: amino acid • Metabolic fates of amino groups • Metabolic pathway, Bioenergetics and regulation: Purines and Pyrimidine biosynthesis: De novo pathway and Salvage pathway, • Ribonucleotide reductase	**12 L**

	Suggested readings: 1. Cohen, G.N. (2014) Microbial Biochemistry, 2nd edn., Springer 2. Doelle, H.W. (1975) Microbial Metabolism, 2nd Edn, Academic Press, London 3. Gottschalke, G (2004) Bacterial Metabolism, Springer, Weinheim 4. Jain, J.L., Jain, S. and Jain, N. (2009) Fundamentals of Biochemistry, S Chand, New Delhi 5. Moat, A. G., Foster, J. and Spector, M.P. (2002) Microbial Physiology, 4th edn., Wiley Interscience Publ., New York 6. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2003) Harper's Biochemistry. Appleton and Lange, Stamford, Connecticut. 7. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi 8. Price, N.C. and Stevens, L. (2000) Fundamentals of Enzymology, 3rd edn., Oxford University Press, NY, USA. 9. Stryer, L. (2002) Biochemistry, 5th Edn., W.H. Freeman and Co., New York, USA 10. Voet, D., Voet, J.G. and Pratt C.W. (1999) Fundamentals of Biochemistry. John Wiley and Sons, Inc., Chicheter, UK 11. White, D. (2000) The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York, USA 12. White, D., Drummond, J. and Fuqua, C. (2011) The Physiology and Biochemistry of Prokaryotes, 4th edn., Oxford University Press, New York	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C513.1	Acquire knowledge on metabolism of biomolecules	**3**
C513.2	Familiarize with amino acids, proteins, lipids, nucleic acids and enzymes	**4**
C513.3	Understand biochemical reactions in microbial cells and metabolic pathway diversity	**2**

M.Sc. Part I Microbiology (Semester I)

DSC MB-414: Laboratory course on Microbiology and Molecular Biology

Credit 2		Total Hours 60
	Course Objectives: 1. To impart hands on training in molecular biology 2. To learn the basic microbial techniques used for characterization of microbial system 3. To know about isolation techniques for DNA, plasmid and its amplification tech	
	1. Isolation and cultivation of cyanobacteria/ Algae 2. Study on fungal hyphal growth and study on isolation, morphology of Actinomycetes 3. Isolation of Bacteriophage by plaque assay and enumeration	

	4. Isolation and partial characterisation of Acidophile/ Alkalophiles/ Halophile/ Thermophile/ Psychrophile bacteria from acidic/alkaline/high salt/high/low temperature environments 5. To study bacterial transformation 6. To study bacterial conjugation 7. Isolation and detection of bacterial/ Fungal DNA 8. Plasmid isolation 9. Plasmid curing 10. Restriction digestion by endonucleases 11. PCR amplification of DNA 12. To study the spontaneous mutation by Fluctuation test 13. Bacterial gene expression using IPTG inducible promoter 14. SDS PAGE of protein 15. Agarose gel electrophoresis of DNA	
	Suggested readings: 1. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edn., Wishwa Prakashan, New Delhi. 2. Benson, H.J. (2001) Microbiological Applications Lab Manual, 8th Edn. The McGraw−Hill Companies, New York 3. Cappuccino, J.G. and Sherman, N. (2014) Microbiology: A Laboratory Manual. 10th Edition, Pearson Education Inc., San Francisco 4. Dubey, R.C. and Maheshwari, D.K. (2004) Practical Microbiology, S. Chand and Co. New Delhi. 5. Harley, J. P., Lansing, M. Prescott, H. (2002) 5th Edn., Laboratory Exercises in Microbiology, The McGraw−Hill Companies, New York 6. Norris, J. R. Ribbons D. W. (Ed) (1969) Methods in Microbiology, Volume 1, Academic Press Inc. Ltd., London 7. Parija, S.C. (2005) Text Book of Practical Microbiology, Ahuja Publishing House, New Delhi	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C514.1	Develop expertise in basic analytical techniques of microbiology.	**3**
C514.2	Get knowledge in the analysis of biomolecules	**3**
C514.3	Carry out microbial techniques related to isolation, identification of algae, fungi, archea	**4**

M.Sc. Part I Microbiology (Semester I)

DSC MB-415: Laboratory course on Biochemistry

Credit 2		Total Hours 60
	Course Objectives: 1. To familiarize the student in biochemical techniques and learn basic microbial biochemistry 2. To estimate the biomolecule using various techniques	
	1. Basic biochemical techniques: Use of hand glove, Use of pipette aid, Preparation of standard solutions and buffers, Dilution approaches. 2. Preparation of buffers of various pH and determination of pKa of a buffer system 3. Quantitative analysis reducing sugar by DNSA method 4. Quantitative analysis of total carbohydrate by Phenol sulphuric acid method 5. Quantitative analysis of protein by Folin-Ciocalteu / Biuret method 6. Quantitative analysis of protein by UV absorption method 7. Quantitative analysis of amino acids by ninhydrin method 8. Quantitative estimation of fatty acids by titration method 9. Determination of Iodine number and acid number of lipid sample 10. Detection of changes in the conformation of bovine serum albumin by viscosity measurement 11. Identification of the C-terminal amino acid of Protein 12. Quantitate estimation of DNA by Diphenyl Amine method 13. Quantitate estimation of RNA by Orcinol method 14. Estimation of vitamin C (Ascorbic acid) by titration method.	
	Suggested readings: 1. Jayaraman, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi. 2. Plummer, D.T. (2001) An Introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. New Delhi 3. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi. 4. Schmauder, H.P, Schweizer, M. and Schewizer, L.M. (2003) Methods in Biotechnology, Taylor and Francis Ltd., London 5. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi. 6. Thomas, G.M. and Shalkhammer, (2004) Analytical Biotechnology, Springer, New Delhi	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C 515.1	Acquire expertise in basic biochemical techniques	**3**
C 515.2	Get knowledge in the analysis and estimation of biomolecules	**4**
C 515.3	Carry out biochemical analysis	**5**

M.Sc. Part I Microbiology (Semester I)
DSE MB – 416 A: Food and Dairy Microbiology

Credit 4		**Total Hours 60**
	Course Objectives: 1. To introduce the basics of food and dairy fermentation 2. To understand food spoilage and food preservation 3. To learn concepts of Food Safety and Quality Assurance	
Unit 1	**Food fermentations** • Introduction to food fermentation. • Oriental fermented foods (Soya sauce, Natto, Miso), • Cereal products, mixed preparations (Idle, Dhokala, Khamang, Papadam and Jilebies), • Fermented cassava flour, fermented pea nut milk, and grape based fermented products- wine (general method of wine preparations) • Fermented vegetables – Saurkraut, • Fermented Meat – Sausage	**12L**
Unit 2	**Dairy fermentations** • Acid fermented milks (Acidophilus milk, yoghurt). • Slightly acid fermented milks (Cultured butter milk), • Acid-alcoholic fermented milk (Kefir). • Fermented milk production with extended self life (labneh), Biochemical changes in fermented milk • Starter cultures for fermented dairy products (*Streptococcus thermophillus, Lactobacillus bulgaricus*,), Probiotic role of lactic acid bacteria and fermented milk products. • Cheese- biological entities in cheese systems (Milk, microorganisms, enzymes and other additives). Cheese production (Milk quality and composition, steps involved in production of cheese, preservation, classification and nutritional aspects)	**12 L**
Unit 3	**Microbial products in Food and dairy** • Applications of microbial enzymes in food and dairy industry [Protease, Lipases], • Microbial anti-oxidants and biosurfactants as emulsifiers • Microbial polysaccharides as stabilizers and thinkers, flavors (esters, diaacetyl, pyrazines, lactones and terpenes, monosodium glutamate • Microbial pigments in foods. • Production and application of Bakers Yeast • Fermentation: Tea, coffee and vinegar	**12 L**
Unit 4	**Food spoilage and preservation** • Factors affecting the growth and survival of microorganisms in foods: Intrinsic, Extrinsic • Food borne infections and intoxications; bacterial with examples of infective and toxic types –, *Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria*. • Mycotoxins in food (Types, structures, producer organism and its toxicity).	**12 L**

	Food preservation • Radiations (UV, Gamma and microwave), • Temperature: low and high • Control of water activity • Preservatives: chemicals, natural organic molecules (nisin)	
Unit 5	**Food Safety and Quality Assurance** • Microbiological examination of foods – sampling, culturing/analysis including newer methods such as PCR, magnetic separation. • Plant sanitation • Food Safety Act and Trade Regulations • Good Manufacturing Practice (GMP) and Quality Systems • Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI	**12 L**
	1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New Delhi 2. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi. 3. Bilgrami, K. S, Dube, H. G., (1994), Text book of Modern Plant pathology, Vikas Publ., New Delhi. 4. Frazier, W. C, Westhoff, D. C., (1988), Food Microbiology, Tata McGraw Hill, New Delhi. 5. James M. Jay, Martin J. Loessner, David A.(2012) Modern Food Microbiology, 7th Edition(Food Science Texts Series) **6.** Ray B (2005) Fundamental Food Microbiology, CRC press, London 7. Singh B. D. (2014) Biotechnology: exploring horizons, Kalyani publishers, Ludhiana **8.** Winton, A. L, Winton, K. B, (1998), Milk and Milk Products, Agro-botanical Publ, Bikaner.	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C516B.1	Acquire basic understanding food and dairy microbiology	**3**
C516B.2	Get knowledge food spoilage and preservation	**4**
C516B.3	Learn the details of Food Safety and Quality Assurance	**5**

M.Sc. Part I Microbiology (Semester I)
DSE MB – 416 B: Cell biology

Credit 4		**Total Hours 60**
	Course Objectives: 1. To introduce the basics of cell biology 2. To understand the cellular organization and transport 3. To learn cell division and human genetics	
Unit 1	**Introduction to cell biology** • Cell theory and its implications in modern biology • Protoplasm theory • Cell types- Bacteria, Archaea (prokaryotic) and eukaryotic cells and evolutionary perspectives • Cytoskeleton dynamics and its role in cellular architecture • Tools and techniques used in cell biology- CRISPR-Cas9 Gene Editing and live cell imaging (fluorescent probes and time-lapse microscopy).	**12 L**
Unit 2	**Cell Membrane Dynamics and Transport** • Structure and organization of cell membranes • Membrane lipid composition and its impact on function • Protein-lipid interactions and membrane fluidity • Membrane transport mechanisms: diffusion, facilitated transport, active transport • Membrane receptors (GPCRs, RTKs, ion channel and nuclear) • Endocytosis and exocytosis: mechanisms and regulation • Intracellular membrane trafficking and vesicular transport	**12 L**
Unit 3	**Cell Organelles and Subcellular Structures** • Nucleus: organization, chromatin structure • Endoplasmic reticulum: protein synthesis (brief overview), protein folding and quality control • Golgi apparatus: processing, sorting, and trafficking of proteins • Mitochondria: structure and functions • Lysosomes: function, autophagy, and cellular waste disposal • Peroxisomes: roles in metabolism and reactive oxygen species detoxification • Cytoskeleton: microtubules, microfilaments, and intermediate filaments	**12 L**
Unit 4	**Cell cycle and Cell Division** • Cell cycle control: checkpoints, cyclin-cdk complexes, and regulatory proteins • Mitosis and cytokinesis: spindle assembly, chromosome segregation, and cleavage furrow formation • Meiosis and sexual reproduction: gametogenesis, recombination, and genetic variation	**12 L**

Unit 5	**Human cytogenetics** • Pedigree analysis; amniocentesis • Twins: monozygotic and dizygotic • Human traits • Disorders due to mutant genes: Huntington's chorea, tongue rolling, phenylketonuria, alkaptonuria, albinism, sickle cell anaemia • Human cytogenetics: Banding techniques; sex determination; sex linkage; chromosomal aberrations	**12 L**
	Suggested readings: 1. De Roberties E. D. P. and De Roberties E. M. F. (2005) Cell and molecular biology (8th Ed), Lippincott Williams and Wilkins, Philadelphia 2. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., NewYork. 3. Madigan M.T. and Martinko J.M., (2005) Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 4. Pawar C. B. (2007) Cell biology, Himalaya Publishing House, Mumbai 5. Rasoti S. C. (2005) Cell biology, New Age Int., New Delhi. 6. Verma P. S. and Agrawal V. K. (2018) Cell biology, genetics, molecular biology, evolution and ecology, S. Chand, New Delhi.	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C516A.1	Acquire basic understanding of cell biology	**3**
C516A.2	Get knowledge cell organelles and transport	**4**
C516A.3	Learn the steps in cell cycle and human genetics	**5**

M.Sc. Part I Microbiology (Semester I)

RM MB – 417: Research Methodology

Credit 4		**Total Hours 60**
	Course Objectives: To make the students familiar with the, 1. To learn the basics of science, scientific research its importance. 2. To learn the Ethics and plagiarism precautions to be taken while doing research. 3. To understand the detailed referencing and literature review procedure before beginning the research. 4 To understand the process of writing research papers, research project report and research proposal. 5 To learn various advanced tools useful for the science and aware about the laboratory safety.	
Unit	**Course Contents (Topics and subtopics)**	**Lecture**
Unit 1	**Science and Scientific Research** What is Science? Characteristics of Science, Technology and techno-science, Meaning of Research, Characteristics and types of research, Importance of research activities, Principles of quality research work, Problems in research, Scientific attitude and temper, Qualities of good researcher, Scientific community, Non-science and Pseudoscience, Scientific realism.	**12**
	Ref. 1: 1-24 and 49-54; Ref. 2: 1-71; Ref. 3: 1-21.	
Unit 2	**Design and Criteria of Scientific Research** Introduction, Research planning and design, Selection of research topic, Criteria for good research problem, Source of research Idea, Principles of good research, Criteria of good research, Guidelines for research skill and awareness, Research validity and reliability, Artefact and bias in research. **Scientific methodology:** Rules and principles of scientific methods, Research methods versus methodology, Hypothesis and testing of hypothesis. Research ethics: Principles and values. Plagiarism: its types and how to avoid it.	**12**
	Ref. 1: Pages: 1-24, 55-92 and 233-262; Ref. 3: 24-52.	
Unit 3	**Literature Survey** Literature review, Approaching the literature, Scholarly literature, Data provenance and evaluation, Intellectual property. **Sources of information:** Primary, Secondary, Tertiary sources, Patents, Journals (Print and e-journal), Type of Journals, Conference Proceedings. Journal Impact Factor, Citation index, *h*-index. **Understanding of literature:** Reading A Scientific Paper, Abstracts, Current titles, Reviews, Monographs, Books, Current contents, Cross referencing, Indian patent database.	**12**

	Tools for Digital Literature Survey: Scientific databases, e-journals, INFLIBNET, Shodsindhu, Shodhganga, Google/Google Scholar, ResearchGate, PubMed, finding and citing Information.	
	Ref. 1: 148-180; Ref. 4: 299-317; Ref. 5: 1569-1603	
Unit 4	**Scientific Writing** Introduction to scientific writing, writing science laboratory Notebook. **Writing Research Paper:** Title, Abstracts, Keywords, Introduction, Material and Methods, Results and discussion, Conclusion, Acknowledgement, References and Supplementary data. Difference between research communication and Review article, Reply to Referee comments for science research paper. Preparation of Poster and Oral Presentation **Writing Proposals:** Research grant and its various components	**12**
	Ref. 1: 180-229; Ref. 6: 29-43; Ref. 7: Relevant Pages	
Unit 5	**Advanced Scientific Tools and Laboratory Safety** **A) Advanced Tools:** Tools for citing and referencing: Mendeley, Zotero, Endnote etc. **Styles of referencing:** Referencing from reputed publishing houses National and International. **Online searching Databases**: *SciFinder*, *Scopus, Web of Science, ACM Digital Library, ProQuest Biological Sciences (All the databases only introduction).* **B) Laboratory Safety** Laboratory safety, Laboratory manual, Lab as a safe place: habits, Cause of accidents and What to do in case of an accident, Personal protective equipment, Emergency equipment for general purpose. Laboratory ventilation. **C) Introduction to Intellectual Property** Introduction, Role of IP in the economic and cultural development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP, History of IP in India (Introduction: Patents, Copyrights and Related Rights, Trademarks, Geographical Indications, Trade Secrets, Semiconductor Integrated Circuits and Layout Designs, Plant Varieties, Traditional Knowledge, Industrial Designs, Biodiversity Conservation). Categories of Intellectual Property, Conditions for Obtaining a Patent Protection.	**12**
	Ref. 8, and 9: Relevant Pages, Ref. 10: 1-44 and Relevant Pages ***Ref. 11 onwards: Relevant Pages and Links***	
	References: 1. Research Methodology for Scientific Research, K. Prathapan, I.K. International Pvt. Ltd., New Delhi – 110002, (2019). 2. Research Methodology: The Aims, Practices and Ethics of Science, Peter Pruzan, Springer International Publishing (2016). 3. Research Methodology: Methods and Techniques, 3rd edition, Kothari, C.R. Published by New Age International (P) Ltd., Publishers (2004).	

4. Teaching to Avoid Plagiarism How To Promote Good Source, Diane Pecorari, Use-Open University Press (2013).
5. APPENDIX A: The Literature of Organic Chemistry March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition, by Michael B. Smith and Jerry March Copyright John Wiley & Sons, Inc. (2013).
6. Joaquín Isac-García, José A. Dobado, Francisco G. Calvo-Flores, Henar Martínez-García - Experimental Organic Chemistry laboratory manual, Academic Press (2016)
7. A Practical Guide to Scientific Writing in Chemistry Scientific Papers, Research Grants and Book Proposals Tyowua, A. T., CRC Press is an imprint of Taylor & Francis Group, LLC (2023).
8. Chemical Information for Chemists: A Primer, edited by Currano, J. N., Roth, D. L. Publisher The Royal Society of Chemistry (2014).
9. Handbook of Safety in Science Laboratories Education Bureau Kowloon Tong Education Services Centre, Hong Kong (2013).
10. Intellectual Property A Primer for Academia, Tewari, R., Bhardwaj, M. Publication Bureau, Panjab University, Chandigarh, © Panjab University, Chandigarh, ISBN: 81-85322-92-9, (2021).
11. A Manual for Referencing Styles in Research, M. H. Alvi (2016)
12. https://academic.oup.com/pages/authoring/books/preparing-your-manuscript/referencing-styles
13. https://revvitysignals.com/products/research/chemdraw
14. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing, http://static.latexstudio.net/wp-content/uploads/2015/03/LaTeX_Beginners_Guide.pdf
15. Falagas, M.E., Pitsouni, E.I., Malietzis, G.A. and Pappas, G. (2008), Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. The FASEB Journal, 22: 338-342. https://doi.org/10.1096/fj.07-9492LSF
16. Plagiarism, Citation and Referencing: Issues and Styles, A Manual for Referencing Styles in Research, Mohsin Hassan Alvi, DOI: 10.13140/RG.2.1.5149.6408 http://bit.ly/46nFwYi
17. Citation tools: Easing up the researchers' efforts, Dhiraj Kumar, Gyankosh: The Journal of Lib. & Info. Management Vol 4 No. 2 Jul-Dec, 2013
18. Citation Management: How to use citation managers such as EndNote and Zotero.
    URL: https://guides.lib.uchicago.edu/citationmanagement
19. https://pubs.acs.org/doi/full/10.1021/acsguide.40303
20. https://edu.rsc.org/resources/how-to-reference-using-the-rsc-style/1664.article
21. https://www.springer.com/gp/authors-editors/journal-author/journal-author-helpdesk/preparation/1276
22. https://service.elsevier.com/app/answers/detail/a_id/28224/supporthub/publishing/

	23. EndNote: A comprehensive guide to the reference management software EndNote. URL: https://aut.ac.nz.libguides.com/endnote 24. Zotero: Learn how to use the reference management software Zotero. URL: https://aut.ac.nz.libguides.com/zotero 25. Mendeley: Learn how to use the reference management programme Mendeley. URL: https://aut.ac.nz.libguides.com/mendeley 26. Grammarly User Guide, https://bpb-ap se2.wpmucdn.com/blogs.auckland.ac.nz/dist/3/316/files/2020/02/Grammarly-Manual-Feb-2020-1.pdf 27. Online Resources: Publishers, Chemical Societies, Electronic Journals etc.: https://www-jmg.ch.cam.ac.uk/data/c2k/cj/ 28. https://scholar.google.com/ 29. https://shodhganga.inflibnet.ac.in/ 30. https://patents.google.com/ 31. https://ipindia.gov.in/history-of-indian-patent-system.htm 32. https://www.cas.org/about-us 33. https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/ 34. https://www.mendeley.com/guides	
	Course Outcomes:	
	On completion of this course, the students will be able to: • Students will understand the basic concept of science and scientific research. • Learn and follow the ethical guidelines while doing research avoid plagiarism in research publications. • Able to write a comprehensive literature review on a given research topic. • To be able to write a crisp research proposal or research project independently. • To be learn most advanced chemistry tools for the efficient research work. • Acquire knowledge about various hazardous chemical handling procedures and implement it while working in the laboratory.	

M.Sc. Part I Microbiology (Semester II)
DSC MB – 421: Bioinstrumentation

Credit 4		**Total Hours 60**
	Course Objectives: 1. To introduce the student to the variety of biophysical and biochemical techniques 2. To learn various separation techniques 3. To make them familiar with various approaches of analytical techniques	
Unit 1	**Principles of biophysical chemistry** • Concept of pH, pOH and pKa, Isoelectric pH, • Henderson-Hasselbalch equation, buffer, colligative properties • Thermodynamics (I-III thermodynamic laws, enthalpy, entropy, Gibbs energy) and its application in characterization of proteins by ITC and DSC calorimetries. • Chemical equilibria with special attention to acid-base equilibria of peptides and proteins and association/dissociation constant in biochemistry	**12L**
Unit 2	**Separation techniques** • Chromatography: Principle, design and applications of TLC, HPTLC, GC, HPLC, Gel filtration, • Electrophoresis and electrofocusing: Principle, design and applications of Agarose gel and capillary electrophoresis, PAGE, Iso-electric focusing. • Centrifugation and Ultracentrifugation	**12 L**
Unit 3	**Biophysical methods** • **Analysis of biomolecules**: UV/visible spectrophotometer, fluorescence, circular dichroism, IR, NMR and ESR spectroscopy, • **Structure determination**: X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry.	**12 L**
Unit 4	**Radiolabeling techniques** • Properties of different types of radioisotopes used in biology, • Detection and measurement of radioactivity • Incorporation of radioisotopes in biological tissues and cells, • Safety guidelines for Radiolabeling techniques	**12 L**
Unit 5	**Microscopic techniques** • Scanning and transmission microscopes • Different fixation and staining techniques for Electron microscope, freeze-etch and freeze-fracture methods for Electron microscope, • Cryo electronmicroscopy • Atomic force microscope and confocal microscope, • fluorescence microscopy	**12 L**

	Suggested readings: 1. Bengt Nölting (2009) Methods in Modern Biophysics, 3rd Edn., Springer, Berlin 2. Friefelder A, D. (1993) Physical Biochemistry, 2nd Edn. W. H. Freeman & Co., USA. 3. Mikkelsen, S.R. and Corton, E. (2004) Bioanalytical Chemistry, Wiley Interscience, New York 4. Sivasankar, B. (2005) Bioseparations Principles and Techniques, Prentice Hall of India Pvt. Ltd., New Delhi 5. Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando 6. Upadhyay, A., Upadhyay, K. and Nath, N. (2000) Biophysical Chemistry, Himalaya Publisher, Nagpur. 7. Van Holde, K. E. (1985) Physical Biochemistry, 2nd Edn., Prentice Hall Inc. New Jersey. 8. Willard, H.H. and Merrit, Jr. L.L. (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi 9. Wilson, K. and Goulding, K.H. Biologists Guide to Principle and Techniques of Practical Biochemistry, ELBS Publications, London 10. Wilson, K. and Walker, J. (2000) Practical Biochemistry: Principles and techniques, 5th Edn., Cambridge University Press, Cambridge,	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C521.1	Acquire knowledge on basic biophysical and biochemical aspects	**3**
C521.2	Learn purification of molecules, analytical tools, electrophoretic separation	**4**
C521.3	Learn how to interpret protein mobility on page under native and SDS	**3**

M.Sc. Part I Microbiology (Semester II)

DSC MB – 422: Bioinformatics

Credit 2		**Total Hours 30**
	Course Objectives: 1. To introduce the basic principles of bioinformatics 2. To understand the sequence alignment technique	
Unit 1	**Basics of biological databases** • Importance of biological databases browsers. • Types of database: Primary and secondary, sequence and structure databases • Nucleic acid databases (GenBank, EMBL, DDBJ) • Protein sequence data base (UniProt, PDB)	**10 L**
Unit 2	**Sequence and Multiple alignment** • Scoring matrices, local. global and multiple sequence alignment • Database search for homologous sequences, BLAST and FASTA	**10 L**

	• Sequence alignment: Pair wise sequence alignment- Dynamic Programming for Sequence Similarity- Smith Waterman Algorithm and Needleman Wuntch Algorithm. Pairwise alignment tools • Multiple Alignments: Progressive and iterative alignment and tools based on these algorithms- ClustalW and MultAlign. • Introduction and basic tools for phylogenetic analysis.	
Unit 3	**Gene and protein prediction tools**: • ORF search, Exon region prediction • Promoter prediction in eukaryotic and prokaryotic sequences. • Protein Profile and Pattern searching. • Primary and secondary structure prediction tools. • Structure visualization tools.	**10 L**
	Suggested Readings: 1. Baxevanis, A. D. and Ouellette, B. F. F. (2001) Bioinformatics: A practical guide to the analysis of genes and proteins. Second Edition. John Wiley & Sons, New York. 2. Ignacimuthu S. (2013) Basic bioinformatics 2nd Ed. Alpha Science publication International, UK. 3. Korf, I, Yandell, M and Bedell, J (2003) An Essential Guide to the Basic Local Alignment Search Tool-BLAST, O'Reilly Network Publishers, Tokyo (ISBN:) 4. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York. 5. Zoe L. and Terence C. (2004) Bioinformatics: Managing Scientific Data, Morgan Kaufmann Publishers, New Delhi.	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C 522.1	Receive elaborate knowledge on biological databases	**2**
C 522.2	Understand sequence alignment	**2**

M.Sc. Part I Microbiology (Semester II)

DSC MB - 423: Immunology

Credit 4		Total Hours 60
	Course Objectives: 1. To understand various components of host immune system, its structure and function 2. To acquaint with operational mechanisms of the host defence system, 3. To learn concepts of hyper immune response and immunotechniques	
Unit 1	**Overview of the Immune System** • Cells and organs of the immune system • Cytokines and Interleukins • Characteristics and Types: Antigen, Immunogen, Allergen.	**12 L**

	• Antibody: Types, structure, Antibody diversity (Somatic gene recombination, Genesis of light and heavy chain) • Major Histocompatibility Complex: properties of MHC genes, structure, properties and cellular distribution of MHC molecules, binding of peptides to MHC	
Unit 2	**Immune Response** • Cell mediated Immune response: T cell, Types of T cells, T cell activation • Humoral Immune response: B cell, Plasma cell, B cell activation (T dependent and T-independent pathway), regulation of humoral immune responses by Fc receptors • Complement system and Opsonisation • Inflammatory response • Immunologic tolerance: General features of immunologic tolerance, T and B lymphocyte tolerance, tolerance induced by foreign protein antigens	**12 L**
Unit 3	**Hyper immune response** • Graft rejection: Immunological basis, First set and second set of reaction, Significance of HLA and MHC, Immunological Tolerance • Hypersensitivity: types and mechanism with example	**12 L**
Unit 4	**Immune response to infections and diseases** • Immunity against viral and protozoal infections • Cancer immunology: Types of tumours, oncogenesis and tumour antigens (TATAs, TSTA) • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organ-specific and systemic, Treatment of autoimmune diseases • Immunodeficiency diseases (e.g. SCID, CVI, AIDS)	**12 L**
Unit 5	**Histochemical and immunotechniques** • Production of monoclonal and polyclonal antibodies, detection of molecules using ELISA, RIA, western blot, immunoprecipitation and immuno-fluorescence microscopy, • *in situ* localization by FISH and GISH	**12 L**
	Suggested readings: 1. Banerjee, A. K. and Banerjee, N. (2006) Fundamentals of Microbiology and Immunology, New Central Book Agency (Pvt.) Ltd., Kolkata 2. Barrett, James T. (1998) Microbiology and Immunology Concepts, Lippincott Williams & Wilkins, Philadelphia, PA 3. Coleman, R.M., Lombard, M.F. and Sicard, R.E. (2000) Fundamental Immunology, 4th edn., WmC Publications, London 4. Goldsby, R.A., Kindt, T.J. and Osborne, B. and Kuby, A. (2003) Immunology, 5th edn., W. H. Freeman and Company, New York. 5. Janeway, Charles, Travers, Paul, Walport, Mark and Shlomchik, Mark (2004) Immunobiology, Garland Science,	

	6. Owen, J.A., Punt, J. and Stranford, S.A. (2013) Kuby Immunology, 7th edn, WH Freeman, USA 7. Paul, W. E (2013) Fundamental Immunology, 7th edn., Lippincott Williams and Wilkins Publishers, USA 8. Roitt, I. (2000) Essentials of Immunology, 5th edn., Blackwell ELBS Science Publication, Oxford. 9. Tizard, I. R. (1995) Immunology: An Introduction, Saunders College Publishing, Philadelphia	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C523.1	Understand fundamental basis of immune system and immune response	**2**
C523.2	Apply host defence, allergy, organ transplant and immunological diseases	**3**
C523.3	Use various immunochemical techniques for diagnosis of diseases.	**5**

M.Sc. Part I Microbiology (Semester II)

DSC MB - 424: Laboratory course on Immunology and advances in microbiology

Credit 2		Total Hours 60
	Course Objectives: 1. To acquaint with biosafety rules in microbiology 2. To learn various immunochemical techniques 3. To familiarize the student with advance techniques in microbiology	
	1. Biosafety: Safe Laboratory techniques, Equipment related hazards, Biosafety cabinets, Transport of infectious material/cultures, Waste disposals, Fire and electricity hazards, Immunisation to staff. 2. Growth Curve of yeast by Turbidity (Spectrophotometer/ Nephelometer) and Dry mass (Centrifugation) measurement 3. Cultivation of cancer cell lines (HeLa/ CHO/---) 4. Gel Permeation Chromatography/Affinity chromatography 5. Immuno-diffusion by Ouchterlony double diffusion 6. Immuno-electrophoresis 7. Demonstration of ELISA 8. 16S rRNA gene sequence analysis using BLAST and preparation of phylogenetic tree 9. Visualization protein structure using RASMOL/ SPDBV software 10. Structural prediction using ExPaSy server 11. Western blotting for protein separation 12. Southern/Northern blotting nuclic acid separation 13. TLC for detection of biomolecules: Sugars and amino acids 14. Calibration of pH meter/ LAF/ Balance 15. Demonstration of HPLC/ GC/AASs	
	Suggested readings: 1. Davis, L.G., Dibner, M.D. and Battey, J.F. (1986) Basic Methods in Molecular Biology, Appleton and Lange, Norwalk.	

	2. Joe Sambrook (2001) Molecular Cloning: A Laboratory Manual, 3rd Edn., (3 volume set) Cold Spring Harbor Laboratory Press, 3. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi. 4. Schmauder, H. P., Schweizer, M. and Schweizer, L. M. (2003) Methods in Biotechnology, Taylor and Francis, London 5. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, Delhi.	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C524.1	Know about biosafety rules for microbiology.	**2**
C524.2	Apply molecular diagnostic and immunodiagnostic techniques.	**3**
C524.3	Use the advance instrumentation related to microbiology	

M.Sc. Part I Microbiology (Semester II)

DSC MB - 425: Laboratory course on Enzymology

Credit 2		Total Hours 60
	Course Objectives: 1. To introduce qualitative and quantitative tools to search for enzyme from microbes 2. To study the effect various factors on enzyme activity 3. To learn enzyme characteristics and identify use of enzyme	
	1. Qualitative assay of enzyme detection in microbial source 2. Quantitative assay of enzyme (activity and specific activity) 3. Effect of pH on enzyme activity 4. Effect of temperature on enzyme activity 5. Effect of activator on enzyme activity 6. Effect of inhibitor on enzyme activity 7. Effect of organic solvent on enzyme activity 8. Partial Purification of enzyme by ammonium sulphate precipitation and dialysis and yield calculations. 9. Purification of enzyme by TPP method 10. Enzyme Purification by Ultrafiltration/ column chromatography 11. Determination of Km and Vmax of enzyme 12. Kinetic study of Inhibitors on Km and Vmax 13. Native PAGE 14. Enzyme stabilization by immobilization technique: gel entrapment/ crosslinking 15. Production of maltodextrin using amylase or blood stain removal / gelatinolysis of X-ray film by protease	
	Suggested readings: 1. Bisswanger, Hans (2011) Practical Enzymology, Wiley-VCH, Germany 2. Jayaraman, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi	

	3. Plummer, D.T. (2001) In introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. Delhi 4. Robert Eisenthal and Michael Danson (2002) Enzyme Assays: A Practical Approach, 2nd Edn. Oxford University Press, USA 5. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi. 6. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, Delhi.	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C525.1	Isolate, purify enzyme of interest from microbial system, characterize the enzyme and trace out application(s) of that enzyme	**5**
C525.2	Use the technique of enzyme assay to determine its specific activity, pH and temperature optima, Km, Vmax, Kcat of enzyme and activation energy using Arrhenius plot.	**4**
C525.3	Immobilize enzyme for particular application and familiarize with algorithm for protein	**5**

M.Sc. Part I Microbiology (Semester II)

DSE MB – 426A: Microbial Enzymology

Credit 4		Total Hours 60
	Course Objectives: 1. To understand basic aspects of microbial enzyme 2. To learn the kinetics of enzyme catalysed reactions and applications of enzymes 3. To introduce what kind of catalytic mechanism is adopted in enzyme	
Unit 1	**Basic Enzymology** • General Characteristics of enzyme, Ribozyme, Abzyme and Coenzymes • Enzyme Nomenclature, classes of enzymes, enzyme activity, Specific activity, katal, Substrate specificity, Active site • Effects of pH, temperature, substrate concentration, activator on enzyme activity • Enyme turnover: Concept and significance. • Isoenzyme: concept and properties, ex. LDH • Multienzyme complexes: pyruvate dehydrogenase and fatty acid synthetase, advantages of multienzyme complex	**12L**
Unit 2	**Enzyme Kinetics** • Elementary reactions, Reversible reactions, Rates of reactions, Transition state, • Equilibrium and steady state theory • The Michaelis–Menten Equation, Concept of Km and Vmax, Double reciprocal plot, Analysis of Kinetic Data. • Enzyme Inhibition: Competitive Inhibition, Non-competitive, Uncompetitive Inhibition and Mixed Inhibition, • Bi-substrate, and Multi substrate reactions	**12 L**

Unit 3	**Catalytic Mechanisms and regulation** • Acid–Base Catalysis, Covalent Catalysis, Metal Ion Catalysis, Electrostatic Catalysis, Catalysis through Proximity and Orientation Effects, Catalysis by Preferential Transition State Binding • Serine Proteases: Kinetics and Catalytic Groups, X-Ray Structures, Catalytic Mechanism, Testing the Catalytic Mechanism, Zymogens • Enzyme regulation: feedback inhibition, feed forward stimulation, enzyme reparation, induction and degradation, enzyme regulation by cAMP, covalent modification, allosteric regulation of enzymes w.r.t. ATCase	**12 L**
Unit 4	**Industrial applications of Enzymes** • Perspective of use of enzyme in industry • Source, Significance and biotechnological applications of Cellulases, Proteases in dough/Flour and protein hydrolysate, Amylases in starch industry, Lipases in oil industry, Pectinases in fruit industry, Laccases	**12 L**
Unit 5	**Extremozymes** • Microbial source, characteristics and biotechnological significance of extremozymes of thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles • Non-aqueous enzymology	**12 L**
	Suggested readings: 1. Cook, Paul, F. and Cleland, W.W. (2007) Enzyme Kinetics and Mechanism. Garland Science, New York. 2. Dixon, M. Webb, E. C., Throne, C.J.R. and Tipton, K. F., Enzymes, Academic Press, NY. 3. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi. 4. Nooralabettu, K. P. (2011) Enzyme Technology Pacemakar of Biotechnology, PHI Learning Pvt. Ltd., New Dehli 5. Palmer, T. (2004) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Affiliated East-West Press Pvt. Ltd., New Delhi 6. Price, N. C. and Stevens, L. (2000) Fundamentals of Enzymology, Oxford University Press, New York. 7. Satyanaryana, T. (1999) Biochemistry, Books and Allied Pvt. Ltd., Calcutta 8. Shanmugam, S. and Sathishkumar, T. (2009) Enzyme Technology, I K International, Delhi 9. Stryer, L. (2004) Biochemistry, 5th Edn., W. H. Freeman & Co., New York	

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C526A.1	Understand fundamental as well as kinetics of enzyme catalysed reactions	**2**
C526A.2	Apply the knowledge to explore applications of various enzymes	**3**
C526A.3	Identify how extremophiles act as a source of extremozyme.	**5**

M.Sc. Part I Microbiology (Semester II)

DSE MB – 426 B: Advanced Bio techniques

Credit 4		**Total Hours 60**
	Course Objectives: 1. To understand techniques related to enzyme and protein purification 2. To learn the Diagnostic and detection methods for Viruses 3. To introduce animal and plant tissue culture	

Unit 1	**Enzyme technology**
	• Basic principle of enzyme assay
	  o Initial velocity, progressive curve, transient kinetics & relaxation
	• Standardization and optimization of enzyme assay
	  o The concentration of substrate, activators & inhibitors
	  o Optimum pH, Ionic strength and temperature
	• Measurement of enzyme activity
	  o Direct & fixed incubation method - continuous and discontinuous assay
	  o Indirect/kinetic study
	• Immobilisation of enzyme
	  o Adsorption, covalent binding, entrapment & membrane confinement
	  o Kinetics of immobilized enzyme
	  o Effect of diffusion and productivity
	  o Application of immobilized enzyme
		12 L

Unit 2	**Protein purification**
	• Sample preparation
	  o Define the properties of a target protein
	  o Develop analytical assay
	  o Sample extraction and clarification
	• Three-phase purification strategy
	  o Capture – removal of contaminant Streamlining
	  o Intermediate purification
	  o Polishing
	• Example of any one purification strategy, e.g. enzyme/antigen/membrane protein
	Sample storage conditions
		12 L

Unit 3	**Diagnostic and detection methods for Viruses** • Sampling techniques and Processing of samples – Enrichment and concentration • Direct methods of detection – light microscopy (inclusion bodies), electron microscopy and fluorescence microscopy • Immunodiagnosis, hemagglutination, and hemagglutination-inhibition tests Complement fixation, neutralization, Western blot, Radioactive Immunoprecipitation Assay (RIPA), Flow cytometry and Immunohistochemistry. • Nucleic acid-based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing, LINE probe assay • Infectivity assay for animal and bacterial viruses - plaque method, pock counting, endpoint methods, LD50, ID50, EID50, TCID50 • Infectivity assays of plant viruses	**12 L**

Unit 4	**Animal tissue and cell culture** • Animal tissue culture laboratory: facilities, aseptic condition and risk • Applications of animal cell culture. • Advantages and limitation of animal tissue culture • Cultural media: Physicochemical properties and composition • Cultured cells: o Characteristics, o Cell adhesion, proliferation and differentiation o Initiation and development of cell culture o Senescence and apoptosis • Primary cell culture and cell lines	**12 L**
Unit 5	**Plant tissue culture** • Laboratory organization of PTC, aseptic techniques and significance • Definition: Ex-plant, callus, differentiation, re-differentiation, Totipotency • Basic techniques of plant tissue culture • In vitro germplasm conservation and Cryopreservation. • Types of PTC o Culture media composition o Callus culture and Cell culture o Protoplast culture o Somatic hybridization: fusion of protoplast, mechanism of fusion, selection of hybrid cells, cybrids, applications and limitation o Organ culture: Androgenesis and Gynogenesis. o Micropropagation: Techniques, multiplication by axillary buds and apical shoots, Bud culture, somatic embryogenesis, application	**12L**
	Suggested readings: 1. Arora M.P. (2003), Biotechnology, Himalaya Publishing House, Mumbai. 2. Brian W.J. Mahy, Hillar O. Kangro, (1996), Virology Methods Manual, Elsevier Science & Technology Books. 3. Chawla HS (2002) Introduction to plant biotechnology, Oxford and IBH publishing Co Pvt. Ltd. New Delhi 4. Das H. K. (2005) Text book of Biotechnology, Wiley Dreamtech India Pvt. Ltd., New Delhi 5. Edward K. Wagner, Martinez J. Hewlett, (2004), Basic Virology, Blackwell Publishing 6. Flint S. J., V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka, (2003), Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society Microbiology 7. Freshney R. Ian (2006), Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, Inc., New York 8. Gangal Sudha (2007), Principles and Practice of Animal Tissue Culture, Universities Press India Pvt. Ltd 9. Gupta P.K (2004), Biotechnology and Genomics, Rastogi Publication Meerut 10. Haaheim L. R., J. R. Pattison and R. J. Whitley, (2002), A Practical Guide to Clinical Virology. 2nd Ed. Edited by, John Wiley & Sons, Ltd. 11. Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai 12. Knipe David M., Peter M. Howley, Diane E. Griffin, Robert A. Lamb, Malcolm	

	A. Martin, Bernard Roizman, Stephen E. Straus, (2007), Field's Virology, 5th Ed. Lippincott Williams & Wilkins 13. Kulkarni N. S. and Deshpande M. S. (2007) General enzymology, Himalaya publishing, Delhi 14. Nooralabettu Krishna Prasad (2011) Enzyme technology – pacemaker of biotechnology, PHI learning Pvt. Ltd., New Delhi 15. Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi 16. Satyanarayana U (2005) Biotechnology, Books and Allied (P) ltd, Kolkata 17. Sing B.D. (2005), Biotechnology, Kalyani publisher, New Delhi. 18. Stephenson John R. (Editor), Alan Warnes, (1998), Diagnostic Virology Protocols: Methods in Molecular Medicine, Humana Press	

Course Outcomes (CO):

On completion of this course, the student will be able to:

CO No.	Course Outcomes	Cognitive level
C526B.1	Understand fundamental of enzyme technology and protein purification	**2**
C526B.2	Apply the knowledge to diagnostic tool in virology	**3**
C526B.3	Comprehend the knowledge of ATC and PTC	**5**

M.Sc. Part I Microbiology (Semester II)

Course Title: On Job Training	**Course Category: MB**-426
Total Contact Hours: 60	**Course Credits:** 4
Internal Evaluation (CA) Marks: 40	**End Semester Evaluation (UA) Marks:** 60

Students need to complete one month on job training (OJT) or internship (Int.) in any industry related to major subject.