

M.Sc. Syll
Microbiology

Master of Science
Discipline: Microbiology
(CBCS)
2024-2025



KERAL VERMA SUBHARTI
COLLEGE OF SCIENCE
SWAMI VIVEKANAND SUBHARTI UNIVERSITY,
MEERUT



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Dr. Adesh

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Course Code	Course Name	Course Type	Teaching load/week				Credits	Evaluation Scheme				
			L	T	P	Total		Sessional Exams			ESE	Total
								CT	AT	Total		
MSC-MB-101	Microbial Diversity and Microbial Cell Biology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB-102	Microbial Growth, Physiology and Metabolism	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB-103	Microbial Techniques	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB-104	Biostatistics, Computer Applications and Bioinformatics	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB-151	PRACTICAL I: (BASED ON MSC-MB-101 AND 102)	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-MB-152	PRACTICAL II: (BASED ON MSC-MB-103 AND 104)	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-MB-153	SEMINAR	Qualifying Course	1	0	0	1	0	0	0	50	0	50
	TOTAL		16	0	8	24	24	120	60	180	420	600
MSC-MB -201	Bacteriology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -202	Virology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -203	Microbial Immunology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -204	Microbial Genetics and Molecular Biology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -251	Practical III: (Based on MSC-MB-201 & 202)	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-MB -252	Practical IV: (Based on MSC-MB-203 & 204)	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-MB -253	Seminar	Qualifying Course	1	0	0	1	0	0	0	50	0	50

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TOTAL			16	0	8	24	24	120	60	180	420	600
MSC-MB -301	Introduction to Nano-materials	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -302	Entrepreneurial Microbiology	Core Course	4	0	0	4	4	20	10	30	70	100
MSC-MB -303	Industrial Microbiology	Elective Course (Select Any One)	4	0	0	4	4	20	10	30	70	100
MSC-MB -304	Environmental Microbiology											
MSC-MB -305	Medical Microbiology											
MSC-MB -306	Microbial Toxicology		Elective Course (Select Any One)	4	0	0	4	4	20	10	30	70
MSC-MB -307	Agriculture Microbiology											
MSC-MB -308	Plant Pathology											
MSC-MB -351	Practical V: (Based on MSC-BOT-301&302)	Core Course	0	0	4	4	4	20	10	30	70	100
MSC-MB -352	Practical VI: (Based on MSC-MB-303/ 304 & MSC-BOT-305/306)	Course	0	0	4	4	4	20	10	30	70	100
MSC-MB -353	Seminar	Qualifying Course	1	0	0	1	0	0	0	50	0	50
	Total		16	0	8	24	24	120	60	180	420	600

Semester- III

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Swami Vivekanand Subharti University, Meerut, Uttar Pradesh

Master of Science in Microbiology

Second Year/Fourth Semester

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme		Subject Total
				L	P	T	Total		Dissertation	Viva-Voice and Presentation	
Semester IV	M.Sc. MB 451	Project	Core Course	0	20	0	20	20	400	100	500
	M.Sc. MB 452	Seminar	Qualifying	0	1	0	1	1	100	0	100
	Total				0	20	0	20	20	400	100

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**M.SC. MICROBIOLOGY
FIRST SEMESTER**

CORE COURSE - I

CREDIT: 04

SUBJECT: MICROBIAL DIVERSITY AND MICROBIAL CELL BIOLOGY

SUBJECT CODE: MSC-MB-101

DURATION: 60 HOURS

Unit I:

12h

Discovery of microbial world; History, Scope and relevance of Microbiology; Current thoughts on microbial evolution including the origin of life; Introduction to microbial biodiversity distribution, abundance, ecological niche of bacteria and archaea.

Unit II:

12h

Principles of classification of microbes: Morphological, metabolic and molecular criteria for the classification, a brief introduction to major group of bacteria. Molecular and recent approaches to bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Salient features of Bergey's Manual of Systematic bacteriology. General characteristics including Ultra-structure of Bacteria, Archaea and Cyanobacteria.

Unit III:

12h

Extreme environments and extremophiles; Microbial diversity in different ecosystems (thermophiles, halophiles, mesophiles, thermophiles, acidophiles, alkalophiles, barophiles and other extremophiles) and their biotechnological applications. A brief account of genetic recombination in bacteria (transformation, conjugation and transduction).

Unit IV:

12h

General characters, nomenclature, classification, morphology and ultra-structure of viruses; Capsid and their arrangement; Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods (haeme-agglutination and ELISA). Assay of viruses (physical and chemical methods).

Unit V:

12h

Bacteriophages: Structure and life cycle patterns of T-even phages; One step growth curve; Bacteriophage typing; Structure of Cyanophages, Mycophages; General characters and structure of viroids, satellites and prions and major diseases caused by them.

Suggested Readings (Latest Editions):

1. Bergey's manual systematic Bacteriology (2011) 2nd edition Prakash S. Bisen (2012).
2. Microbes-concepts and applications, Wiley-Blackwell. J.D.S.Panwar (2012)-
3. Fundamentals of Microbiology-S.R.S Pub Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
4. Bisen, P.S. (2014) Microbes in Practices, I K international publication house pvt Ltd.



CORE COURSE - II**CREDIT: 04****SUBJECT: MICROBIAL GROWTH, PHYSIOLOGY AND METABOLISM****SUBJECT CODE: MSC-MB-102****DURATION: 60 HOURS****Unit I:****12h**

Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.

Unit II:**12h**

Solute Transport: Introduction, primary and secondary transport, kinetics. Membrane transport proteins: porins and aquaporins, mechanosensitive channels, ABC transporter, group translocation PEP-PTS system. Catabolite repression, inducer exclusion and expulsion.

Unit III:**12h**

Central Metabolic Pathways and Regulation: Glycolysis and its regulation, Gluconeogenesis, Pentose-Phosphate Pathway, Entner-Doudoroff Pathway, Citric Acid Cycle, alternate TCA, Glyoxylate Pathway and its regulation. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Co-metabolism of pentoses and hexoses, Succinic and citric acid production.

Unit IV:**12h**

Nitrogen metabolism: Inorganic nitrogen assimilation- nitrate and ammonia assimilation, regulation of glutamate synthetase, General reaction of amino acid and Stickland reaction. Glutathione: distribution in bacteria, biosynthesis and role in redox regulation. Outline of amino acid biosynthesis, protein utilization, detailed account of biochemistry of glutamate producing strains.

Unit V:**12h**

Enzymes: Introduction, activation energy, enzyme kinetics, significance of K_m , catalytic efficiency, turnover number. Methods of plotting enzyme kinetics data: Lineweaver -Burk plot, saturation kinetics. Enzyme inhibition, models and type of inhibition

Unit VI:**12h**

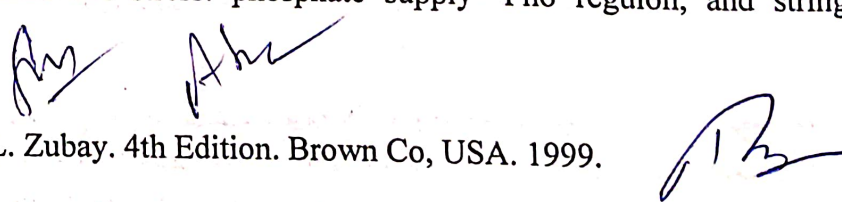
Metabolism of lipids and nucleotides: Biosynthesis and degradation of lipids and its regulation in *E. coli*, lipid accumulation in yeast. Purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis.

Unit VII:**12h**

Physiological Adaptation and Intracellular signaling: Introduction to two component system. Response to physiological stress: aerobic-anaerobic shifts- Arc and Fnr system, osmotic homeostasis. Response to nutritional stress: phosphate supply- Pho regulon, and stringent response.

Suggested Readings:

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA. 1999.

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2. Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
3. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6th Edition. W. H. Freeman. 2012
4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.
5. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.
6. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013
7. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.
8. Understanding Enzymes by T. Palmer, E. Horwood. 3rd Edition. Wiley. 1991.

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CORE COURSE - III

SUBJECT: MICROBIAL TECHNIQUES

SUBJECT CODE: MSC-MB-103

CREDIT: 04

DURATION: 60 HOURS

Unit I:

12h

Microscopy and Staining techniques: Basic principles for the examination of microbes by light, dark field, phase contrast, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry; Specimen preparation and basic principles of Simple, Gram's stain, Capsule, Endospore, Flagella, Acid fast and Nuclear/Geimsa's staining.

Unit II:

12h

Basic principles and methods of sterilization: control of microorganisms by physical methods: heat, filtration and radiation; chemical methods: phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness (evaluation of efficacy of disinfectants, determination of phenol coefficient), Principle and functioning of LAF.

Unit III:

12h

Basic principles and methods of media preparation: types of culture media: simple media, complex media, synthetic media, enriched media, selective media, indicator media, differential media, anaerobic media; pH and buffers; Pure culture techniques: streak plate, dilution plate and spread plate method; maintenance of pure cultures; methods of preservation of various microbes. maintenance of anaerobic bacteria, and accessing non-culturable bacteria.

Unit IV:

12h

Basic principles and applications of spectrophotometry and Chromatography: Beer Lambert law; interaction of radiation with matter, absorption of radiation, emission of radiation; UV-Vis spectrophotometry, Fluorimetry, Flame photometry and atomic absorption spectrophotometry; Chromatography (paper, thin layer, column, gel filtration, ion-exchange and affinity chromatography); GLC, HPLC, HPTLC and FPLC.

Unit V:

12h

Miscellaneous techniques: Principles and applications of Electrophoresis for protein and DNA; Iso-electric focusing and 2-D gel electrophoresis; Autoradiography, X-Ray diffraction; Centrifugation; Ultracentrifugation; Dialysis, Ultrafiltration; Lyophilization.

Suggested Readings (Latest Editions):

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Wilson K. and Walker J. (2013). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill.
4. Upadhyaya and Nath (2015) Biophysical chemistry, Himalaya pub. House.
5. T.A.Brown (2016). Gene cloning and DNA analysis, an introduction, Wiley Blackwell pub.

CORE COURSE - IV

SUBJECT: BIOSTATISTICS, COMPUTER APPLICATIONS AND BIOINFORMATICS
SUBJECT CODE: MSC-MB-104

CREDIT: 04

DURATION: 60 HOURS

Unit I:

12h

Presentation of data; Frequency distributions; Graphical representation of data by histogram, polygon, frequency curves and pie diagram. Measures of central tendency: Mean, median and mode; Measures of dispersion: Mean deviation, standard deviation, variance, standard error, coefficient of variation; Correlation and regression: properties, nature, coefficient of correlation, rank correlation, linear regression and regression equations and multiple linear regression, significance of correlation and regression.

Unit II:

12h

Probability: Basic concepts related to probability theory, classical probability. Probability Distributions: Introduction and simple properties of Binomial, Poisson and Normal Distributions and their applications in biology. Sampling: Concept of sampling and sampling techniques.

Unit III:

12h

Testing of hypotheses: Some basic concepts, Errors in hypothesis testing; critical region; Students t-test for the significance of population mean and the difference between two population means; Paired t-test; Chi square test for population variance, goodness of fit and for the independence of two attributes in a contingency table; F-test for the equality of two population variance; Analysis of variance- One-way and two-way analysis of variance.

Unit IV:

12h

Introduction to Computers: Definition, Components of computer, Classification of Computers, Generation of Computers; Number system; Introduction to Software; Translators (Compiler and Interpreter); Basics for operating systems (MS-DOS, Windows, Unix and Linux); Introduction to MS Office (MS-Word, MS-Excel, MS-Power Point); Introduction to Networking, Internet (E-Mail, File Transfer Protocol, Usenet, Telnet).

Unit V:

12h

Introduction to Bioinformatics: Definition and scope; Search engines: tools for web search; Introduction to biological databases (NCBI, EBI, DDBJ, GenBank, PDB, NDB and MMDB), Introduction to BLAST and FASTA; Brief idea about important softwares for microbiological studies.

Suggested Readings (Latest Editions):

1. Bailey, NT J (2000). Statistical Methods in Biology. English Univ. Press.
2. Campbell R.C (Latest Edition). Statistics for Biologist. Cambridge University Press, UK.
3. Sinha PK (Latest Edition). Fundamentals of computers. BPB Publication, New Delhi
4. Jonathan, P. 2008. Bioinformatics & Functional Genomics.
5. B.D.Singh(2015). Biotechnology, Kalyani Publication.
6. Sharma and Munjal (2015). A test book of Bioinformatics, Rastogi publication

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SECOND SEMESTER**CORE COURSE - I****CREDIT: 04****SUBJECT: BACTERIOLOGY****SUBJECT CODE: MSC-MB-201****DURATION: 60 HOURS****Unit I:****12h**

Bacterial cell structure and appendages: Overview of eubacterial cell organization: nucleoid, ribosomes, intracytoplasmic membranes and cell inclusions. Detailed account of biogenesis and function of various cell structure appendages: flagella- structure, assembly and mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures: capsule, glycocalyx, slime layer and S-layer

Unit II:**12h**

Bacterial cell wall and cell membrane: Overview of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS). Detailed account of cell wall synthesis and its inhibitors including different antibiotics.

Unit III:**12h**

Bacterial cell division and reproduction: Binary fission and other forms of reproduction in bacteria, bacterial cell cycle, assembly, maintenance and disassembly of Z ring, endospore structure and stages involved in endospore development in *Bacillus subtilis*.

Unit IV:**12h**

Archaeal diversity, cell structure and model organisms: Phylogenetic diversity and key features of different phyla. General characteristics of archaeal cell structure and comparison with eubacteria. Detailed account of model archaeal organisms: *Methanococcus*, *Halobacterium*, *Pyrococcus* and *Sulfolobus*.

Unit V:**12h**

Bacterial genome: Genome organization of *E. coli* and salient features of genomes of *Deinococcus radiodurans*, *Azotobacter vinelandii*, *Buchnera sp.*, *Agrobacterium tumefaciens* and *Epulopiscium sp.*

Unit VI:**12h**

Bacterial secretion system: Introduction. Sec secretion pathway, SecB secretion pathway, SRP pathway, Tat pathway. Protein secretion in Gram-negative bacteria: Type I- Type VI. Protein secretion in Gram-positive bacteria: Type VII, Sec A2, Sortases and Injectosome. Introduction to Type VIII and Type IX secretion systems.

Unit VII:**12h**

Quorum sensing: Discovery, role as illustrated by bioluminescence (*Vibrio fischeri*, *Vibrio harveyi*), virulence (*Pseudomonas aeruginosa*, *Staphylococcus*), competence and sporulation (*Bacillus subtilis*) and antibiotic resistance in bacteria. Quorum quenching: impact and mechanism.



Suggested Readings:

1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
4. Archaea Molecular and Cellular Biology by Ricardo Cavicchioli. American Society of Microbiology. 2007.

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CORE COURSE - II

SUBJECT: VIROLOGY

SUBJECT CODE: MSC-MB-202

CREDIT: 04

DURATION: 60 HOURS

Unit I:

12h

Classification and modes of propagation, bacterial, plant and animal viruses: morphology and ultra structure; assay of viral particle, cell culture, viral enzymes, nucleic acids,

Unit II:

12h

bacterio phages; lambda, T4, T7, M13, lytic cycle, lysogeny; viral replication, nucleic acid and protein synthesis,

Unit III:

12h

viral diseases. Virus host interaction: virus infection, viral diseases and pathogenesis: Herpes, adeno, hepatitis, rhabdo, oncogenic viruses etc.

Unit IV:

12h

DNA viruses: Herpes, hepatitis B, adenovirus; RNA viruses: polio, VSV, influenza, retroviruses: structure and life cycle, transformation; baculoviruses;

Unit V:

12h

molecular biology of genetic shift and drift in influenza virus, cellular tropism of HIV; Plant viruses: TMV.

Suggested Readings:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 4th edition. ASM Press. 2015.
2. Introduction to Modern Virology by N. Dimmock, A. Easton, K. Leppard. 7th edition. Blackwell Publishing. 2016.
3. Basic Virology by Edward K. Wanger, M. Hewlett, D. Bloom, D. Camerini. 3rd edition. Blackwell Publishing. 2007.
4. Principles of Molecular Virology by A.J. Cann. 6th edition. Elsevier Academic Press. 2015.

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CORE COURSE - III

CREDIT: 04

SUBJECT: IMMUNOLOGY

SUBJECT CODE: MSC-MB-203

DURATION: 60 HOURS

Unit I:

12h

Introduction to immune system: Cells and organs of immune system; hematopoiesis; Antigens, haptens, adjuvants immunoglobulins and monoclonal antibodies; B and T cell interaction. Antigen antibody interactions and its applications.

Unit II:

12h

Immunoglobulin and TCR genes and generation of diversity: Organization of Immunoglobulin and TCR genes; V(D)J rearrangements;

Unit III:

12h

somatic hypermutation and affinity maturation; immunoglobulin gene expression and its regulation; organization of TCR genes and mechanisms of diversity.

Unit IV:

12h

Major histocompatibility complex: Structure and function; immunological memory; complement system; action of cytotoxic T lymphocytes.

Unit V:

12h

Immunology in health and disease- Immunological disorders, graft transplantation and rejection concept of immunotherapy.

Suggested Readings:

1. Essentials of Clinical Immunology 5th Edition by Helen Chapel, Mansel Haeney, Siraj Misbah and Neil Snowden, Wiley-Blackwell (2006).
2. Roitt's Essential Immunology: Includes Free Desktop Edition (Essentials) 12th Edition by Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt Wiley-Blackwell (2011).
3. Immunobiology: The Immune System in Health and Disease, 6th Revised edition by Charles A. Janeway, Paul Travers, Mark Walport and Mark J. Shlomchik, Churchill Livingstone; (2004)
4. Clark WR (1991). The experimental foundations of modern immunology, John Wiley and Sons Inc. New York.
5. Kubey J. (2007) (6th edition). Immunology, W.H. Freeman and Co., New York. AMM-203: Microbial Genomics DNA/

CORE COURSE - IV

SUBJECT: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

CREDIT: 04

SUBJECT CODE: MSC-MB-204

DURATION: 60 HOURS

Unit I :

12h

Chromosome organization in prokaryotes and eukaryotes: Nucleic Acids - structure of DNA and RNA; DNA as genetic material - forms of DNA; Replication, enzymes and proteins involved in DNA replication; Mutation, DNA damage and repair mechanism; Types of RNA.

Unit II :

12h

Gene Transfer Mechanisms: Transformation, transduction, conjugation, recombination; Biology of Plasmids - Extra chromosomal heredity - biology of bacterial plasmids, structure of the plasmids, replication, control, partitioning, amplification, incompatibility and gene transfer; Transposons..

Unit III:

12h

Transcription: Basic features of genetic code, prokaryotic and eukaryotic ribosomes; General principles, basic apparatus, RNA polymerases, promoters, enhancers and other regulatory sequences; Mechanism of transcription and inhibitors of transcription; Post – transcriptional modifications.

Unit IV:

12h

Translation: Details of translation- initiation, elongation and termination, factors that control the above steps, inhibitors of protein synthesis; Post translational modifications: Protein folding, structural analysis, signal hypothesis protein targeting and secretion, in vitro transcription and translation systems

Unit V:

12h

Regulation of gene expression in prokaryotes and Eukaryotes: Operon concept (Lac operon, trpoperon, araoperon and his operon); Global regulatory responses: heat shock response, stringent response, SOS response and regulation; Eukaryotic translational control; translational control of gene expression; inhibitory RNA (RNAi); Hormone and environmental factors affecting gene expression.

THIRD SEMESTER

CORE COURSE - I

SUBJECT: INTRODUCTION TO NANO-MATERIALS

SUBJECT CODE: MSC-MB-301

CREDIT: 04

DURATION: 60 HOURS

Unit I

Introduction to nanobiotechnology: Nanomaterials and their dimensions, amorphous and crystalline materials, crystal lattices; History and applications of nanotechnology, nano-scale, nano-materials, nano-wires, nano-motors, nano-rings; Ethical, social and legal issues of nanotechnology

Unit II

Bottom-up synthesis approaches – Nanoprecipitation reaction, synthesis of zero-dimensional metal, metal oxides, semiconductor nanoparticles by nanoprecipitation routes, high-pressure homogenization; Top-down approaches: Fundamentals of nano-thin film Growth

Unit III

Nanostructured Materials Characterization Techniques: Working principles and methodology of: Scanning electron microscope and Transmission electron Microscope, particle size Dynamic Light scattering; Elemental analysis using energy dispersive X-ray diffraction, Fundamental working principles of scanning probe microscopy (Scanning-tunneling microscope), Atomic Force Microscopy, Confocal fluorescence microscopy

Unit IV

Nano-scale engineering and applications: Bacterial endospore; Cellulosome, Megnatosome, S-layer, Biopolymer; Application of bacteriophages in nanotechnology.

Unit V

Pharmaceutically important nanomaterials: Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions-Solid Lipid Nanoparticles (SLP)- Biofunctionalisation of SLP, Characterisation- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems-Nanotubes, Nanorods, Nanofibers, and Fullerenes for Nanoscale Drug Delivery, Carbon nanotubes biocompatibility and drug delivery

Suggested readings

1. Claudio Nicolini, Nanobiotechnology & Nanobiosciences Pan Stanford Publishing Pte. Ltd, 2009.
2. C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology, Concepts, Applications and perspectives, WILEY-VCH, Verlag Gmb H&Co, 2004.
3. S. David Goodsell, Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc, 2004.
4. Melgardt M.deVilliers, Pornanong Aramwit, Glen S.Kwon, Nanotechnology in Drug Delivery, Springer-American Association of Pharmaceutical Scientists Press 2009.
5. Robert A. Freitas Jr. Nanomedicine, Volume I:Basic Capabilities, Landes Bioscience,1999.

CORE COURSE - II

SUBJECT: ENTREPRENEURIAL MICROBIOLOGY

CREDIT: 04

SUBJECT CODE: MSC-MB-302

Unit I:

DURATION: 60 HOURS

12h

Entrepreneurship: Notions and theories of Entrepreneurship, Entrepreneurial traits and motivation- Nature and importance of Entrepreneurs, - Financial analysis Investment process, Break even analysis, Profitability analysis, Budget and planning process. Government schemes for commercialization of technology-Funding and support mechanisms for entrepreneurship.

Unit II:

12h

Production of microbial metabolites and Single cell proteins: Metabolic pathways and control mechanisms of primary and secondary metabolites; Commercially important metabolites: Primary – ethanol, citric acid; Secondary – β exotoxin; Single Cell Protein: Algae (*Spirulina maxima*, *Chlorella pyrenoidosa*) and Yeast (*Candida tropicalis*) as SCP, Mushroom Cultivation and Probiotics

Unit III:

12h

Biofertilizers and Biopesticides: Production of Rhizobium, Azotobacter, Azospirillum, Phosphobacterium, BGA (*Anabena*, *Nostoc*); Packing, Quality assurance, Field Application and Crop Response. Bioinsecticide: Mass Production, field Application, and Crop Response of Bacteria (*Bacillus thuringiensis*, *Bacillus papillae*, *Pseudomonas fluorescens*), Fungi (*Verticillium lecanii*, *Coelomyces*) and Viruses (Baculo viruses, NPV, Granulosis virus).

Unit IV:

12h

Commercial Products: Production and Application of TPA, HGH, Cytokines and Monoclonal Antibodies; Production of enzymes – Cellulase, Protease, Amylase and lipase Production of teaching kits-DNA isolation, widal

Unit V:

12h

Biofuels, Bioplastics and Biopigments: Biochemistry, Industrial Production and Application of biogas, bio-diesel, hydrogen fuel, gasoline; Bioplastics - PHB, PHA; Biopigments – Lycopene, Betacarotene, and its applications

CORE COURSE - III**SUBJECT: INDUSTRIAL MICROBIOLOGY (Elective Course -Optional)****CREDIT: 04****SUBJECT CODE: MSC-MB-303****DURATION: 60 HOURS****Unit I:****12h**

Sources and characters of industrial microbes, their isolation, purification and maintenance. Screening of useful strains: primary screening and secondary screening. Fermentation technology: microbial growth kinetics in batch, continuous and fed-batch fermentation process. Stirred aerobic bioreactor: principles and designing. Airlift, Fluidized Bed, Packed Bed, Photobioreactor, and Membrane bioreactor. Raw materials used in fermentation media. Solid state fermentation and submerged fermentation: their advantages and disadvantages.

Unit II:**12h**

Microbial transformations with special reference to steroids and alkaloids. Primary and secondary metabolites. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives.

Unit III:**12h**

Microbiology and production of alcoholic beverages: malt beverages, distilled beverages, wine and champagne. Commercial production of organic acids like acetic, lactic, citric, and gluconic acids. Commercial production of important amino acids (glutamic acid, lysine and tryptophan), insulin and vitamins (vitamin B₁₂, riboflavin and vitamin A).

Unit IV:**12h**

Immobilization of microbial enzymes and whole cells and their applications in industries. Food fermentations: bread, vinegar, fermented vegetables, fermented dairy products and their spoilage. Bioprocess Engineering: Downstream processing, various steps for large scale protein purification. Single cell proteins, Physiological aspects, SCP from waste materials and renewable resources.

Unit V:**12h**

Industrial enzymes production: Cellulases, Xylanases, Proteases, Amylases, Lipases and Pectinases and their applications. Bioconversion of waste for fuels (ethanol and methane). Mushroom cultivation. Petroleum microbiology. Patent protection for biological inventions.

Suggested Readings (Latest Editions):

1. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
2. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
3. Creuger and Creuger (2005). Biotechnology- A textbook of Industrial Microbiology, Panima pub.
4. Casida LE (2010). Industrial Microbiology, Wiley Eastern.

CORE COURSE - III

SUBJECT: ENVIRONMENTAL MICROBIOLOGY (Elective Course -Optional)

CREDIT: 04

SUBJECT CODE: MSC-MB-304

DURATION: 60 HOURS

Unit I:

12h

Development in field of environmental microbiology: Development of microbial ecology and emergence of field of environmental microbiology, significant applications of microbes in solving environmental pollution problems

Unit II:

12h

Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment: Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells, metagenomic analysis of solid and aquatic sediments

Unit III:

12h

Microbial diversity in extreme environments: Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles. Biotechnological applications of the same

Unit IV:

12h

Soil and water microbiology: Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

Unit V:

12h

Biomass waste management of plant's residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production.

Unit VI:

12h

Liquid and solid waste management: Treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters). Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management.

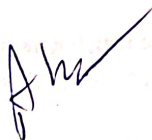
Unit VII:

12h

Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides, use of biosensors for their detection. Microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management.

Suggested Readings:

1. Microbial Ecology by R.M. Atlas, R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993.
2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.
3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland, D.A. Lipson, A. L. Mills, L.D. Stetzenbach. 3rd edition. Blackwell Publishing. 2007.
4. Environmental Microbiology edited by R. Mitchell, J-D Gu. 2nd edition. Wiley-Blackwell. 2009.
5. Environmental Microbiology by R. Maier, I. Pepper, C. Gerba. 2nd edition. Academic Press. 2009.
6. Environmental Microbiology: Principles and Applications by P.K. Jjemba, Science Publishing Inc. 2004.
7. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad, A. Singh. I.K. International. 2007.
8. Environmental Microbiology of Aquatic & Waste systems by N. Okafor. 1st edition, Springer, New York. 2011.



CORE COURSE - III

SUBJECT: MEDICAL MICROBIOLOGY (Elective Course -Optional)
SUBJECT CODE: MSC-MB-305

CREDIT: 04

Unit I:

DURATION: 60 HOURS

12h

Classification of medically important bacteria; Normal microflora of human body, role of the resident flora; collection of clinical samples and laboratory diagnosis of important bacterial infections, pathogenic microorganisms. Brief account of major air, water and soil borne diseases of microbial origin and their prevention and control measures.

Unit II:

12h

Bacteriology: Important human diseases caused by Staphylococcus; Streptococcus; Neisseria; Bacillus; Corynebacterium; Clostridium; Organisms belonging to Enterobacteriaceae (Escherichia coli, Klebsiella, Salmonella, Shigella and Proteus); Pseudomonas; Haemophilus; Mycobacterium; Antibacterial drugs and susceptibility test; Bacterial vaccines. Mechanism of drug resistance in pathogenic bacteria and fungi.

Unit III:

12h

Virology: Collection of clinical samples and laboratory diagnosis of important viral diseases; Mumps; Measles; Influenza; Adenovirus; Enterovirus; Rhinovirus; Poxvirus; Hepatitis; Herpesvirus; AIDS; Antiviral drugs; Viral vaccines; Interferons; Tumor viruses; antiviral agents and susceptibility test.

Unit IV:

12h

Mycology: Classification of medically relevant fungi: Collection of clinical sample and laboratory diagnosis of important human fungal diseases: Phycomycosis; Candidiasis; Dermatophytosis; Aspergillosis; Otomycosis; Cutaneous and subcutaneous mycoses; Systemic mycoses; Opportunistic mycoses; Antifungal agents and susceptibility test.

Unit V:

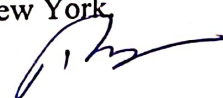
12h

Parasitology: Important diseases caused by intestinal and urogenital protozoa: Entamoeba; Giardia; Trichomonas; Blood and tissue protozoa; Plasmodium; Trypanosoma; Leishmania; Cestodes: Taenia; Trematodes: Schistosoma; Paragonimus; Nematodes: Ascaris; Ancylostoma; Necator; their laboratory diagnosis, treatment and prevention; anti-parasitic agents and susceptibility test.

Suggested Readings (Latest Editions):

1. Kenneth. J. Ryan (2010) Sheris's Medical Microbiology, Mc Graw Hill. Willey J, Sherwood L. and Woolverton C (2014).
2. Prescott's Microbiology, 9th edi McGraw Hill. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsevier.
3. Murray PR, Tenover FC and Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press. K.D Chattergy (2015). Parasitology, CBS Pub.
4. Harvey, R.A., Champe, P.C. and Fisher, B.D. (Latest Edition). Lippincott's Illustrated Reviews: Microbiology. Lippincott Williams and Wilkins, New Delhi/New York

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CORE COURSE - IV

CREDIT: 04

SUBJECT: MICROBIAL TOXICOLOGY (Elective Course -Optional)

SUBJECT CODE: MSC-MB-306

DURATION: 60 HOURS

Unit I:

Introduction: to microbial toxicology -Definition of microbial toxins - Historical background about the microbial toxins - Types of toxins (chemical or biological toxins) - An overview about Microorganisms produced Toxins

Unit II:

General properties of microbial toxins - Properties and Structures of microbial toxins -Mode of action of microbial toxins

UNIT III

Bacterial toxins -General properties of bacterial toxins - Microorganisms produced toxins -Type of bacterial toxins (Endotoxins, Exotoxins): Botulinum, Tetanus toxin, Staphylococcal toxins, Anthrax toxin, Diphtheria toxins, Shiga toxin, Salmonella toxins, Erythrogenic Toxins,etc. -Structure of bacterial toxins -Level of toxicity -Symptom of each bacteria toxins - Mechanism of action of bacterial toxins - Diseases caused by or associated with bacterial toxins: - Methods for detoxification of bacterial toxins

UNIT IV

Mycotoxins: -General properties of fungal toxins - Microorganisms produced toxins -Type of fungal toxins: (Aflatoxins, Ochratoxin, Citrinin, Ergot Alkaloids, Patulin, Fusarium toxins) -Structure of bacterial toxins -level of toxicity -Symptom of each bacteria toxins - Mechanism of action of bacterial toxins -Diseases associated with fungal toxins - Methods for detoxification of fungal toxins

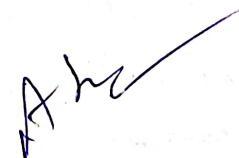
UNIT V

Production of microbial toxins Factors influence production of bacteria and fungal toxins

Suggested readings (Latest edition)

1- Microbial Toxins: Structure and Their Type Paperback – April 17, 2011 by Rajeeva Gaur (Author), Soni Tiwari (Author), Ranjan Singh (Author)

2 Microbial Toxins: Current Research and Future Trends by Thomas Proft (Editor), Publisher: Caister Academic Press (April 14, 2009)



CORE COURSE - IV

SUBJECT: AGRICULTURE MICROBIOLOGY (Elective Course -Optional)

CREDIT: 04

SUBJECT CODE: MSC-MB-307

DURATION: 60 HOURS

Unit I:

12h

Soil microbiology: Soil as a habitat for microorganisms; Soil enzymes, Soil water and microbial activity, Soil microorganisms and nutrient cycle. Soil fertility and management of agricultural soils; Microbiology of composting; Reclamation of barren lands using microbial technology; Microbiology of plant surfaces; Rhizoplane, phylloplane and rhizosphere microbes, their interaction with plants.

Unit II:

12h

Disease forecasting and basic principles of plant disease control. Etiology, causal organism, disease cycle and control of economically important crop diseases of wheat (Tundu, Rusts and smuts), rice (BLB, BLS and false smut) barley (stripe, powdery mildew), maize (downy mildew), sugarcane (red stripe, ratoon stunting, grassy shoot), vegetables (downy mildew of crucifers and cucurbits, white rust of crucifers) and pulses (wilt of pigeon pea, Phytophthora blight of pigeon pea).

Unit III:

12h

Microorganisms as biopesticides: Principles and mechanism of biological control; Biocontrol agents of pathogen insect pests and weeds. Commercial reality of biopesticides limitations for Indian agriculture; integrated pest management.

Unit IV:

12h

Microorganisms as biofertilizers: Biofertilizers and symbiotic associations: Rhizobium, Bradyrhizobium, Azospirillum, Frankia, Azotobacter, Mycorrhiza and actinorrhiza in plant nutrition and stress tolerance; Commercial production of biofertilizers. Biological Nitrogen fixation (mechanism), nitrification, denitrification, ammonification, transamination and deamination reactions. Plant growth promoting rhizobacteria; (PGPR), BGA, SRB and PSB.

Unit V: Biodeterioration of agricultural produce; Mycotoxins; Diseases of food products during transmit and storage and their management. Microbes in agriculture waste management.

Suggested readings (Latest edition)

1. Sharma, P.D. (2016). Plant Pathology, Rastogi publications
2. Rao, N.S.S. (2015). Soil Microbiology. Oxford & IBH Publishing Co., New Delhi.
3. Jeffery C. Pommerville (2014). Alcamo's Fundamental Microbiology, Jones pub.
4. Ghulam Hassan Dar (2010). Soil Microbiology and Biochemistry
5. Agrios G. N. 2005. Plant Pathology. 5th Edition, Academic Press, San Diego.



CORE COURSE - IV

CREDIT: 04

SUBJECT: PLANT PATHOLOGY (Elective Course -Optional)

SUBJECT CODE: MSC-MB-308

DURATION: 60 HOURS

Unit-1

12h

General introduction to Plant Pathology, chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases, Defense mechanism of the host, how the pathogen affects plant physiological functions

12h

Unit-2

Genetics of plant disease, effect of environmental factors on the plant disease development, Plant disease epidemiology: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds

12h

UNIT-3

Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management

12h

UNIT-4

Diseases caused by fungi, bacteria, viruses and mycoplasma

12h

Unit-5

Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants.

Suggested Literature:

1. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
2. Agrios, G. N., 1988. Plant Pathology, Academic Press.
3. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
4. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher
5. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.

FOURTH SEMESTER

CREDIT: 08

CORE COURSE - I

SUBJECT: DISSERTATION/ PROJECT

SUBJECT CODE: MSC-MB-451

DURATION: 60 HOURS

QUALIFYING COURSE - I

SUBJECT: SEMINAR

SUBJECT CODE: MSC-MB-452

CREDIT: 08



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