Shobhit
Institute of Engineering & Technology
Deemed to-be-University
EDUCATION EMPOWERS

Syllabus
M.Sc. Microbiology

Approved and adopted in year 2018 (Board of Studies, August 10, 2018)
by 23rd Academic council (Agenda no-3.2 e)

SCHEME OF TEACHING – M.Sc. (Microbiology) 2020-2022,
FIRST YEAR

Semester: I					
Course Code	Course / Title	L	T	P	Credit
MBMS-101	Principles of Microbiology	3	1	0	4
MBMS-102	Biochemistry	3	1	0	4
MBMS-103	Fundamentals of Bioinformatics	3	1	0	4
MBMS-104	Enzymology	3	1	0	4
MBMS-105	Intellectual property rights, Biosafty & Bioethics	2	0	0	2
MBMS-151	Principles of Microbiology Lab	0	0	2	1
MBMS-152	Biochemistry Lab	0	0	2	1
MBMS-107	Fundamentals of Computer & IT	3	1	0	4
	Total	17	5	4	24

Semester: II

Course Code	**Course / Title**	**L**	**T**	**P**	**Credit**
MBMS-201	Food & Dairy Technology	3	1	0	4
MBMS-202	Immunotechnology	3	1	0	4
MBMS-203	Bacteriology & Virology	3	1	0	4
MBMS-204	Cell Biology	3	1	0	4
MBMS-251	Food & Dairy Technology Lab	0	0	2	1
MBMS-252	Immunotechnology Lab	0	0	2	1
BTMS- 206	Bioenergy Engineering	2	0	0	2
BMMS-203	Molecular Oncology	3	1	0	4
	Total	**17**	**5**	**4**	**24**

Semester: III

Course Code	Course / Title	L	T	P	Credit
MBMS-301	Microbial Genetics	3	1	0	4
MBMS-302	Recombinant DNA Technology	3	1	0	4
MBMS-303	Microbial Physiology & Diversity	3	1	0	4
MBMS-304	Environmental Biotechnology	3	1	0	4
MBMS-351	Microbial Genetics Lab	0	0	2	1
MBMS-352	Recombinant DNA Technology Lab	0	0	2	1
BTMS- 311	Biostatistics	2	0	0	2
BMMS-301	Pharmacology & Toxicology	3	1	0	4
	Total	**17**	**5**	**4**	**24**

Semester: IV

Course Code	Course / Title	L	T	P	Credit
MBMS-481	Seminar	0	0	04	2
MBMS-491	Dissertation	0	0	24	12
	Total	**0**	**0**	**28**	**14**

Program Educational Objectives (PEOs):

PEO1. Explain relationships and apply appropriate terminology relating to the structure, metabolism, genetics, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses.

PEO2. Explain interactions between opportunistic and pathogenic microorganisms and susceptible hosts in contacts that result in infection and/or disease and apply these interactions to disease symptoms.

PEO3. Explain nonspecific body defences and the immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases.

PEO4. Explain principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases.

PEO5. Exhibit strong, independent learning, analytical and problem solving skills with special emphasis on design, communication, and ability to work in teams.

Program Outcomes (POs):

PO 1. Students will be able to acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology.

PO 2. Students will acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.

PO 3. Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.

PO 4. Students will demonstrate engagement in the Microbiology discipline through involvement in research or internship activities, the Microbiology Student Association club (MSA) and outreach or mentoring activities specific to microbiology.

PO 5. Graduates will be able to decide and apply appropriate tools and techniques in microbial manipulation.

PO 6. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in microbiology practices

PO 7. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.

PO 8. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO 9. Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.

PO 10. Recognize the need for, and an ability to engage in life-long learning.

PO 11. Acquire knowledge of contemporary issues.

PO 12. Graduates will be able to demonstrate knowledge of project and finance management when dealing with Biotechnology Engineering problems.

Program Specific Outcomes (PSOs):

PSO 1. Demonstrate proficiency in basic science and foundation clinical courses.

PSO 2. Demonstrate a working knowledge of advanced microbial techniques and life science for the industrial applications and human welfare.

PSO 3. Demonstrate the application in microbial, biotechnology, and allied industries designing, developing and providing solutions for product/processes/technology development.

SEMESTER: I

PRINCIPLES OF MICROBIOLOGY

MBMS-101

Unit I: Basics in Microbiology:
Brief history and scope of microbiology. Methods & basis of microbial classification, culture techniques, methods of isolation and identification of microbes. Staining of microbes: simple, special and differential staining.

Unit II: Microorganisms– Bacteria:
Morphology and structure of bacteria. Ultrastructure of bacterial cell wall, difference in gram positive and gram negative bacteria, archaebacteria, actinobacteria. Nutritional requirement and growth curve, autotropic and heterotropic bacteria, batch and continuous cultures of microbes, pure cultures, growth inhibitory substances, physical and chemical methods of microbial control. Microbial genetics, Reproduction methods in bacteria.

Unit III: Microorganisms- Fungi:
General characteristics of fungi, morphology and structure of fungi, nutrition, metabolism and reproduction of economically important fungi. Mycotoxicoses

Unit IV: Microorganisms- Viruses:
Virus and virus like structure: An introduction, multiplication of viruses. Isolation, cultivation of viruses. Bacterial viruses, animal viruses, plant viruses, Viroids, prions.

Unit V: Medical Microbiology:
Scope of medical microbiology, Diseases caused by bacteria, mycoplasma, fungi, virus and their symptoms. Biotechnological methods to deal with diseases caused by microorganisms.

Unit VI: Biotechnological applications of microorganisms:
Classification of microbial products. Equipments and accessories for industrial processes- fermenters, scaling-up of processes, downstream processing of products. Microbes in organic acid, solvents, antibiotics, enzymes, exo- and endo-polysaccharide production. Beverage fermentation- beer, wine, liquor fermentation. Microbiology of milk, dairy and food, preservation of food, food additives and supplements. Genetic engineering of microbes for industrial uses. Microorganisms for bioremediation, sewage treatment, biofertilizers, biopesticides, biofuels, biogas, bioenergy, microbial leaching of ores.

Course outcomes (COs):

a. Basic information regarding the microbes, types, their importance and the development of Microbiology.

b. Understand the advanced microscopic techniques in the morphological identification of microorganisms along with the microbial structural information.

c. Describe the information about the microbial metabolism and the nutritional requirements.

d. Basics of microbial growth, isolation and quantification methods and how the energy is being utilized to synthesis the biomolecules.

e. The basic characteristics, and reproduction of fungi, mold and bacteriophages togetherwith industrial aplications explained in detail.

REFERENCE BOOKS:

1. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2008. Prescott, Harley and Klein's Microbiology (7th eds.). Mc Graw Hill, USA
2. Subbarao, M.S. 2007. Soil Microbiology (4th eds.). Oxford and IBH, New Delhi.
3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2008. Microbiology (5th eds.). Tata Mc Graw Hill, New Delhi
4. Dubey, R.C. and Maheswari, D.K. 2008. A text book of Microbiology (2nd eds.). S. Chand Publications
5. Stanier, R.Y. 2008. General Microbiology (5th eds.). Mac Millan Press, Replica Press Pvt. Ltd.
6. Sullia, S.B. and Shantaram, S. 2005. General Microbiology (2nd eds.). Oxford and IBH Publications.
7. Nicklin, J. Instant Notes- Microbiology (2nd eds.). Viva Books Pvt Ltd.
8. Waites, M.J., Morgan, N.L. and Rocky, J.S. 2007. Industrial Microbiology (An Introduction), Indian eds., Backwell Publishers.
9. Kannan, N. 2002. Laboratory manual in general microbiology (2nd eds.). Panima Publishers.
10. Frazier. 2008. Food Microbiology (4th eds.), Mc Graw Hill, USA.

BIOCHEMISTRY

MBMS-102

Unit I:

Interaction in biological system: Importance of water, pH and buffer, level of organization, cell structure and organelles,

Thermodynamic principles: First law of thermodynamics, isothermal process, entropy, second law of thermodynamics, reversible and irreversible process, free energy, chemical potential, Gibbs free energy, redox potential.

Unit II:

Carbohydrates: Classification and basic structure, properties of monosaccharides, disaccharides and polysaccharides, isomerism, mutarotation and functions, role of carbohydrates.

Unit III:

Lipids: Nomenclature **of** Fatty acids, glycerol, phospholipids, sphingolipids, sterols, lipoproteins, prostaglandins.

Unit IV

Amino acids, peptides and proteins: General structure of amino acids and proteins, classification by R group, non-protein amino acids, essential amino acids, primary, secondary, tertiary and quaternary structures of proteins.

Unit V

Enzymes: General characteristics and nomenclature, classification and catalytic power of enzymes, activation energy, vitamins, coenzymes and metal cofactors, enzyme inhibition, activation of enzymes, multienzyme complexes.

Course outcomes (COs):

a. Provide basic understanding of carbohydrates, lipids, and proteins and their roles in normal biological processes.

b. Explain the metabolic pathways of carbohydrates along with their roles in providing energy.

c. Knowledge about the structural units of proteins, amino acids, and their metabolism will be given.

d. Information about fatty acids and its metabolism and the structural units of genetic code will be provided.

e. Describe the cellular processes involved in the generation of energy using different source materials.

REFERENCE BOOKS:

1. Nelson, D.L. and Cox, M.M. 2007. Lehninger Principle of Biochemistry (4th eds.). W. H. Freeman and Co.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L. 2007. Biochemistry (6th eds.). W.H. Freeman and Co.
3. Voet, D.J., Voet, J.G. and Pratt, C.W. 2008. Fundamentals of Biochemistry (3rd eds.). John Wiley Sons Inc.
4. Satyanarayana, U. and Chakrapani, U. 2007. Essentials of Biochemistry (2nd eds.). Books and allied Pvt. Ltd.
5. Murray, R.K., Granner, D.K. and Rodwell, V.W. Harper's illustrated biochemistry (27th eds.) Mc Graw Hill, USA.
6. Hames, D. and Hooper, N. 2008. Instant notes on biochemistry (3rd eds.). Taylor and Francis.

FUNDAMENTALS OF BIOINFORMATICS

MBMS-103

Unit I:
History and basics of Bioinformatics: Basics of computer, input/ output tools; Application of computer in Biotechnology, Biological Databases for nucleic acids and proteins; Pubmed, NCBI and EBI. Retrieval of data from public Databases.

Unit II:
Nucleotide and Protein sequence databases: NCBI, GeneBank, EMBL, DDBJ etc; Specialized sequence databases of EST, Unigene, ACeDB, SGD, Data retrieval with ENTREZ, SRS, DBGET.
Protein sequence databases: Protein primary sequence databases: UniProt, PIR, SwissProt, MIPS, TrEMBL, Expasy, etc. Secondary databases Pfam, PROSITE, BLOCK, PRINTS

Unit III:
Structure classification Databases: Protein Data Bank, Nucleic Acid Data Bank, MMDB; Protein Classification Databases: SCOP, CATH; Metabolic Pathways Databases: KEGG.

Unit III:
Pairwise Sequence Alignment
Pair wise alignment: Local alignment, Smith Waterman algorithm , Global alignment & Needleman and Wunsch algorithm, Semi global alignment – Algorithms, Dot matrix, Dynamic Programming, Heuristic alignment algorithm: BLAST, FASTA.

Unit IV:
Multiple Sequence Alignment
Multiple Sequence Alignment: Progressive method and Iterative method, Scoring matrices, Profile analysis, BLOCK analysis, Pattern, Searching databases with multiple alignments.

Unit V:
Protein structure prediction: Secondary and tertiary structures; Homology Modelling, ORF prediction, Gene prediction, Micro array data analysis.

Course outcomes (COs):

a. Infer the biological problems using appropriate in silico approaches.

b. Select the suitable tools or servers to solve the specific biological issue and curate experimental data.

c. Perform and analyze database similarity search and sequence alignment.

d. Construct and analyze phylogenetic trees.

e. Use appropriate tools and packages to analyze varied range of biological problems.

REFERENCE BOOKS:

1. David W. Mount. Bioinformatics: Sequence and Genome analysis, Cold Spring Harbor Laboratory Press.
2. Jones, N.C. and Pevzner, P. A. 2004. An Introduction to Bioinformatics Algorithms. The MIT Press.

ENZYMOLOGY

MBMS-104

Unit I:

Basics in enzymology: Classification of enzymes, quantification of enzyme activity and specific activity, determination of primary, secondary, tertiary and quarternary structure of enzymes, transient state kinetics of enzymes, stability of enzymes, allosterism, isoenzymes, importance of enzyme.

Unit II:

Enzyme engineering: Isolation and purification of enzymes (intra- and extracellular enzymes) and their methods, enzyme stabilization by genetic engineering, specific examples of enzyme engineering, tyrosyl tRNA synthetase, dihydrofolate reductase, subtilisin, enzyme turn over, abzymes, ribozymes.

Unit III:

Enzyme immobilization: Basic info on immobilization, Methods of immobilization: entrapment, covalent, membrane confinement, adsorption, reactor and process design for immobilization of enzymes, enzymatic reaction kinetics, biotransformation, uses of immobilized enzymes.

Unit-IV

Cytoplasmic membrane systems and protein trafficking: Synthesis of secretary, lysosomal or plant vacuolar proteins, integral membrane protein on rough endoplasmic reticulum, glycosylation in rough ER, vesicular transport, glycosylation in golgi complex.

Unit-V

Cell cycle: Steps in cell cycle, cell cycle regulation and control;
Cell communication and signaling: Cell receptors, signal transduction pathways in prokaryotes and eukaryotes, secondary messengers, GPCRs; Structure and function of intracellular cell organelles; Membrane structure and function;

Course outcomes (COs):

a. To understand the IUBMB system of enzyme classification To learn the factors involving and factors affecting the enzyme activity To know the catalytic activity of enzyme and its regulation To learn the enzyme used in clinical diagnosis and industries.

b. To learn the kinetics of single and multi enzyme substrate enzyme catalysed reaction Know to solve the problems based on single and multi substrate reactions.

c. To learn the enzyme inhibition kinetics and the problems related to it To learn the enzyme immobilization; methods of immobilizing the enzymes and their kinetics.

d. To understand the analytical techniques available for enzyme analysis.

REFERENCE BOOKS:

1. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. Kuby's Immunology (4^{th} eds.). W H Freeman and Company.
2. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2008. Prescott, Harley and Klein's Microbiology (7^{th} eds.). Mc Graw Hill, USA.
3. Playfair, J. and Bancroft, G. 2007. Infection and Immunity (3^{rd} eds.). Oxford University Press.
4. Chakravarty, A.K. 2008. Immunology and Immunotechnology (3^{rd} eds.). Oxford University Press.
5. Tizard. 2008. Immunology: An introduction (4^{th} eds.). Cengege learning.
6. Rao, C.V. 2008. Immunology: A text book. Narosa Publishing House.
7. Cell (A Molecular approach): Cooper, G. M.
8. Cell and Molecular Biology (1996) Karp, G.

INTELLECTUAL PROPERTY RIGHTS, BIOSAFTY & BIOETHICS

MBMS-105

Unit I:
Intellectual Property: Patents, Trademarks, Copyright, Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs,IPs of relevance to Biotechnology and Case Studies; Agreements and Treaties, Indian Patent Act 1970 & recent amendments

Unit II:
Patents and Concept of Prior Art: Types of patent applications, Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees, Invention in context of "prior art".

Unit III:
Patent Filing Procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting–disclosure/non-disclosure; Patent licensing and agreement Patent infringement.

Unit IV:
Biosafety: Introduction to Biological Safety Cabinets; Biosafety Levels of Specific Microorganisms; Biosafety guidelines:Definition of GMOs & LMOs;

Unit V:
Bioethics: Ethical implications of biotechnological products and techniques, Social and ethical implications of biological weapons. Bioethical guidelines and regulation in India as given by ICMR.

Course outcomes (COs):

a. Understand the Fundamentals of intellectual property systems and the new regimes for trade and exchange of genetic resources and the prospects/problems/risks for developing countries.

b. Description and discussion of various IPR regimes governing the exchange of genetic resources.

c. Skilled and able to describe the subjects of strategic importance to economic and social development.

d. Make the long-term perspective and help to contribute to institutional strengthening and capacity development in the cooperating countries.

e. Suggested Readings & References

REFERENCE BOOKS:

1. Dubey, R.C. 2007. A textbook of Biotechnology. S. Chand and Company Lld.
2. Gupta, P.K. 2008. Biotechnology and Genomics. Rastogi Publications.
3. Singh, B.D. 2008. Biotechnology-Expending horizons. Kalyani Publications.
4. Rao, R., Rao, A. and Bhanoji. 2008. Intellectual Property Rights- A Primer. Eastern Book Company.
5. Acharya, N.K. 2006 Text Book on Intellectual Property Rights. Asia Law House, Hyderabad.
6. Chawala, H.S. 2009 Introduction to Plant Biotechnology. Oxford and IBH.

FUNDAMENTALS OF COMPUTER & IT

MBMS-107

Unit-I

Computer System: Basics of computer systems, history, types, capability and limitations of computer systems, Changed scenario of computing: Desktop, client-server & embedded computers.

Hardware Organization: Anatomy of a digital computer, CPU, Accumulator and instruction characteristics, Internal architecture of CPU, Instruction cycle, Introduction to microprocessors: Clock speed, buses, processor types, generations of Microprocessor, CPU related technology, Motherboards-CPU interface, FSB.

Memory Units: Hierarchy, primary memory-RAM, ROM, cache; Auxiliary storage devices: magnetic tapes and disks, hard disks, floppy disks, CD-ROM, optical disks.

Unit-II

Input and Output Devices: Input devices: Keyboard, MICR, OCR, OMR, Digitizer, mouse, light pen, and offline input devices; Output Devices: Printers-impact printers: line-character printers, Non impact printers -ink-jet, laser printers; Display devices- Raster scan, Vector scan and storage tube display.

Input Output Ports: Power connectors-AT, ATx connectors. Monitor socket, VGA connector, serial parallel, USB, PS-2 ports, PCI/MCI socket, and keyboard socket, External storage connectors-IDE connectors, FDD connector; Power supplies: Basic terms, Power conditioning devices, SMPS.

Number System: Decimal , binary, octal, hexadecimal numbers and their inter-conversions; Representation of information inside the computers, Integer representation- Signed 1's and signed 2's complement representation, Floating point representation; Character Codes: BCD, ASCII, ISCII and Unicode, Concept of parity bit.

Unit-III

Basics of Programming Languages and Operating Systems: Low level programming languages: Machine and Assembly languages, High level languages-procedure oriented languages, problem oriented languages. Translation process- Assembler, Complier, Interpreter. Popular programming languages.

Unit-IV

Graphical User Interface and Windows- Working with windows operating systems, Introduction to system software systems, Operating System Principles- Concept of process, multiprogramming, Functions of an operating system, Processor Management (scheduling), Memory Management, Device Management, File Management, Difference between Buffering and Spooling, Types of Operating Systems.

Unit-V

Computer Network: Applications of Networks, Point-to-Point network and Broadcast Network, LAN, MAN, WAN and Wireless LAN, Network structure and architecture, the OSI reference model, TCP/IP Architecture, Networks topology, Layer's design issues. Connecting Devices: Repeaters, Amplifiers, Hubs, Head End, Bridges, Switches, Routers, Gateway

Course outcomes (COs):

a. Understanding the concept of input and output devices of Computers and how it works and recognize the basic terminology used in computer programming

b. Write, compile and debug programs in C language and use different data types for writing the programs.

c. Design programs connecting decision structures, loops and functions.

d. Explain the difference between call by value and call by address.

e. Understand the dynamic behavior of memory by the use of pointers.

REFERENCE BOOKS:

1.Sharma, A.K. *Fundamentals of Computers and Programming with C*. Dhanpat Rai Publications, New Delhi, 2005.

2.Williams, Brian K. and Stacy C. Sawyer. *Using Information Technology*. TMH, New Delhi, 2003.

3.Curtin, Dennis P., Kim Foley, Kunal Sen, and Cathleen Morin. *Information Technology* TMH, 1998.

4.King, K.N. *C Programming – A Modern Approach*. WW Norton & Co., 1996.

5.Ritchie, Dennis M. and Brian W. Kernigham. *The C Programming Language*. PHI, New Delhi, 1988.

SEMESTER: II

FOOD & DAIRY TECHNOLOGY

MBMS-201

Unit – 1 Industrial Food fermentations:

Microorganisms used in food industry, Preparation of their starter cultures, production and preservation of the following fermented foods: Soy sauce fermentation by Moulds, Fermented vegetables – Saurkraut, Fermented Meat – Sausages, Production and application of Bakers Yeast, Application of microbial enzymes in food industry

Unit – 2 Quality assurances in foods

Food spoilage and microbes responsible for this, *Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria*. Mycotoxins in food, Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Unit –3 Food preservation methods

Importance of food preservation, Radiations - UV, Gamma and microwave, Temperature, Chemical and naturally occurring antimicrobials, Biosensors in food industry.

UNIT – 4 Microbiology of cheese and beverage fermentation.

Fermented milk products and their microbiology (acidophilus milk, yoghurt), Role of microorganisms in beverages – tea and coffee fermentations, Vinegar Fermentation

Unit - 5 Advanced Food Microbiology

Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases], Utilization and disposal of dairy by-product - whey.

Course outcomes (COs):

a. To understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in food and dairy.
b. To know the spoilage mechanisms in foods and dairy and thus identify methods to control deterioration and spoilage
c. To recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods and dairy.
d. To learn various methods for their isolation, detection and identification of microorganisms in food and dairy and employ in industries
e. To identify ways to control microorganisms in food and dairy and thus know the principles involving various methods of food preservation

REFERENCE BOOKS:

1. Food Microbiology. 2nd Edition By Adams
2. Basic Food Microbiology by Banwart George J.
3. Food Microbiology: Fundamentals and Frontiers by Dolle
4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
5. Fundamentals of Dairy Microbiology by Prajapati.
6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students Edition.
7. Microbiology of Fermented Foods. Volume II and I. By Brian J. Wood.Elsiever Applied Science Publication.
8. Microbiology of Foods by John C. Ayres. J. Orwin Mundt. William E. Sandinee. W. H. Freeman and Co

IMMUNOTECHNOLOGY

MBMS-202

Unit I:

Introduction to Immunology: History and terminology, components of innate and acquired immunity, active and passive immunity, phagocytosis; complement and inflammatory responses, cells (T-cells, B-cells) and organs of immune system, cell mediated and humoral immunity, cytokines, toll-like receptors.

Unit II:

Antibody: Classification, isotypes, fine structure**,** biosynthesis of immunoglobulin, rearrangement of genes and class switching, complement system.

Antigen: Nature of antigens, haptens, adjuvants, vaccines. Advanced immunological techniques - RIA, ELISA, western blotting, ELISPOT assay

Unit III:

MHC complex: Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Unit IV:

Principles of virulence and pathogenicity: Host-parasite interactions.

Transplantation and tumor immunology: Tumor cell immunity, transplantation of tissues and organs, relationship between donor and recipient, role of MHC molecules in allograft rejection, bone marrow and haematopoietic stem cell transplantation, tumor antigen, tumor immunoprophylaxis.

Autoimmune diseases: Autoimmune hemolytic anemia, systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis, AIDS, diabetes mellitus.**Inflammation and hypersensitivity**: Hypersensitivity reactions, inflammasome.

Unit V:

Applied immunotechnology: Antigen-antibody interaction, affinity and avidity, agglutination and precipitation reactions, immunoflourescence, fluorescence activated cell sorting analysis.

Antibody engineering: Hybridoma and monoclonal antibody (Mab), recombinant antibody molecules, human and humanized antibodies, uses of Mab.

Antigen engineering: ELISA, RIA, immunodiffusion, immunoelectrophoresis, immunoblotting, antibody for diagnosis, antibody for therapy, cytokine therapy

Course outcomes (COs):

a. After providing basic knowledge of .immunology, its two arms of immunity will be discussed in detail. further, the external agents that provoke immune responses will be taught.

b. Information about humoral immunity, the involvement of b lymphocytes and its product, antibody, in immunity will be explained monoclonal antibody production and its use in therapy and diagnosis will be taught. a basic understanding about the various immunological techniques will be taught.

c. Another important topic of mhc that governs antigen processing will explained.

d. The ways through which t and b lymphocytes get activated so that they can play a role in the elimination of antigens will be discussed.

e. Some of the diseases that involve the innate and acquired immunity will be taught along with current vaccine strategies used.

REFERENCE BOOKS:

1.Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2008. Prescott, Harley and Klein's Microbiology (7th eds.). Mc Graw Hill, USA.

2., J. and Bancroft, G. 2007. Infection and Immunity (3rd eds.). Oxford University Press.

3.Chakravarty, A.K. 2008. Immunology and Immunotechnology (3rd eds.). Oxford University Press.

4.. 2008. Immunology: An introduction (4th eds.). Cengege learning.

5. Rao, C.V. 2008. Immunology: A text book. Narosa Publishing House.

BACTERIOLOGY & VIROLOGY

MBMS-203

Unit I

Microorganisms and their positions in different classification: Haeckel's three kingdom system, Whittaker's five kingdom system, three domain system of Carl Woese. Historical account of

bacterial classification. Detailed account of bacterial classification according to the 1st edition of Bergey's Manual of Systematic Bacteriology (up to sections); Detailed account of bacterial classification according to the 2nd edition of Bergey's Manual of Systematic Bacteriology (up to orders).

Unit II

General characteristics, classification and economic importance: Spirochetes, Gram – negative aerobic rods and cocci: Facultative anaerobic Gram - negative rods, Rickettsia and Chlamydia; Mycoplasma, Endospore-forming Gram - positive rods and cocci; Mycobacteria, Anoxygenic photosynthetic bacteria and Oxygenic photosynthetic bacteria; Aerobic chemolithotrophic bacteria, Archaea and Actinomycetes

Unit III

Discovery of viruses, Taxonomy of viruses: classification and nomenclature of viruses as per ICTV; chemical composition of viruses; morphology, composition, principles of symmetry with reference to T4, TMV, Adeno, Polio, Influenza, Rhabdo, Reo and HIV viruses. Nucleic acid diversity in viruses; sub viral particles satellite viruses, viroids, DI particles and prions; Isolation, purification, cultivation, assay and characterization of plant, animal and bacterial viruses.

Unit IV

Life cycles of bacterial viruses; one step growth curve, lytic and lysogenic cycles with reference to T4, _ and _ X 174. Bacteriophage: structural organization and life cycle. Brief details on M13, Mu, T3, T4 and Lambda P1.

Classification and nomenclature of plant viruses, replication of TMV and CaMV; Classification and replication of animal viruses (Adeno, Influenza, Herpes, Hepatitis , Covid, Retro viruses); Transmission and management of plant and animal viral diseases (interferons, antiviral drugs and vaccines etc.)

Course outcomes (COs):

a. Apply principles of safety, quality assurance, and quality control.

b. Evaluate specimen acceptability.

c. Describe basic morphology and physiology of parasites and fungi.

d. Classify parasites and fungi.

e. Perform appropriate laboratory techniques used in the processing of specimens and identification of parasites and fungi.

f. Evaluate and correlate test results with patient condition(s).

REFERENCE BOOKS:

1 Sneath, P.H.A .and R.R. Sokal 1973 Numerical taxonomy .The Principles and Practice of Numerical Classification, San Francisco. W.H. Freeman
2 Sneath, P.H.A 1989 Analysis and Interpretation of sequence data for bacterial Systematic. The view of a Numerical taxonomist .*Syst.Appl.Microbiol.12:*15-31
3 Tom Parker, M. Lerline , H.Collier,1990,Principles of Bacteriology, Virology and Immunity, VIII Ed.
4 Woese,.C,R 1981 Archeabacteria , *Sci. Am*. 244:98-122
5 Woese,C.R.,Kandler,O. and M.L.Wheelis 1990 Towards a natural System of organisms: Proposal for the Domains Archea, Bacteria and Eucarya. *Proc. Nati, Acad, Sci.* ,87: 4576- 4570
6 Woese, C. R 1987 Bacterial evolution, *Microbiological Reviews*. 51: 221-271
7 Madigan, M. T.,J.M.Mrtinko and J.Parker 2000 Brock Biology of Microbiology IX Ed .Prentice Hall Inter, Inc.
7 Holt, J.G, and N.R.Krieg, 1984-1989 Bergey's Manual of Systematic Bacteriology Ist Ed (Vol 1-4) Williams and Wilkins Co Baltimore,Springer.
8 Holt , J.G, and N.R. Krieg, P.H .A .Sneath, J.T.Staley and J.T. Williums ,1994 Bergey's ManualDeterminative Bacteriology IX Ed. Williams and Wilkins Co Baltimore, Springer
9 Garrity George, M. Edieor-In Cheaf 2005 Bergey's Manual of Systematic Bacteriology II Ed. (Vol- I-V) .J.Brenner,K.R.Krieg, J.T.Stanly. Editors. Springer-Verlog
10 Garrity, M. George. Winters, B.S.Denise 2001 Taxonomic outline of the prokaryotic genera Bergeys Manual of Systematic Bacteriology. II Ed.
11 Balows, A.A.G. Thuper, M. Dworker, W. Harder, K.Schleifer 1991 The Prokaryotes , Springer
12 VerlogGunsales and Stainer, The Bacteria I-V vol. Academic press
13 Prescott, L.M., J.P Harley and D.AKlein, 2007 Microbiology VII Ed. Mc Grow Hill,
14 Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
15 Stainer General Microbiology, V Ed., Printice Hall of India Pvt,Ld. New Delhi

CELL BIOLOGY

MBMS-204

Unit I:

Structure and function of intracellular cell organelles: Cell wall, nucleus, nucleolus, endoplasmic reticulum, golgi complex, plastids, ribosomes, mitochondria, lysosome, peroxisome, vacuoles, structure and function of cytoskeleton and its role in motility.

Unit II:

Membrane structure and function: Structure of model membrane, lipid bilayer, membrane lipids, carbohydrates, protein, fluidity, diffusion, osmosis, ion channels, active transport, ion pumps, electrical properties of membranes, membrane potential and nerve impulse, neurotransmission.

Unit III:

Cytoplasmic membrane systems and protein trafficking: Synthesis of secretary, lysosomal or plant vacuolar proteins, integral membrane protein on rough endoplasmic reticulum, glycosylation in rough ER, vesicular transport, glycosylation in golgi complex, types of vesicular

transport in golgi complex, COPII, COPI and clathrin coated vesicles, targeting vesicles to a particular compartment, protein destruction in proteosomes.

Unit IV:
Cell cycle: Steps in cell cycle, cell cycle regulation and control.

Unit V:
Interaction between cells and environment: Extra cellular matrix, integrins, focal adhesion, hemidesmosomes, selectins, cadherins, cell adhesion receptors, tight junctions, gap junctions and plasmodesmata
Cell communication and signaling: Cell receptors, signal transduction pathways in prokaryotes and eukaryotes, secondary messengers, GPCRs, tyrosine kinase receptor, signaling pathways in plants, apoptosis, quorum sensing.

Course outcomes (COs):

a. Describe the cell structure, components of cell, enzymes to emphasize the importance of cell as the basic unit of an organism.

b. An understanding about the role of various cellular organelles in modifying the functions of the cells, especially, metabolism and protein synthesis.

c. The role of cytoskeleton and modes of cellular transport will be discussed.

d. Understanding the cellular regulation through various types of cell signaling, cell division, apoptosis and cell differentiation.

e. Provide an overall understanding of the epithelial cells and cancer with a focus on neurobiology and neurodegenerative diseases.

REFERENCE BOOKS:

1. Cooper, G.M. and Hausman, R.E. The Cell- A molecular approach (4th eds.). A S M Press, Sinauer Associate Inc.
2. Karp, G. Cell and Molecular Biology, Concepts and Experiments, John Wiley and Sons.
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. 2008. Molecular Biology of Cell (5th eds.). Garland Sciences.
4. Benjamin Lewin. 2008. Genes IX. Oxford University Press.
5. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. 2008. Molecular Biology (6th eds.). W H Freeman and co.
6. Power, C.B. 2008. Cell Biology (3rd eds.). Himalaya Publishing House.
7. Gupta, P.K. 1999. Cell and Molecular Biology. Rastogi Publication, Meerut.

FOOD & DAIRY TECHNOLOGY LAB.

MBMS-251

1. Production and estimation of lactic acid by Lactobacillus Sp. or Streptococcus Sp.
2. Extraction and estimation of diacetyl.
3. Sauerkraut fermentation
4. Isolation of food poisoning bacteria from contaminated foods, Dairy products
5. Extraction and detection of afla toxin for infected foods.
6. Preservation of potato/onion by UV radiation
7. Production of fermented milk by Lactobacillus acidophilus.
8. Rapid analytical techniques in food quality control using microbial Biosensors.

Course outcomes (COs):

a) Basics of lactic acid by Lactobacillus Sp. or Streptococcus Sp

b) Understanding the food fermentation and food preservation methods

c) To analytical techniques in food quality control using microbial Biosensors

d) Describe the dairy microbiology and Production of fermented milk by Lactobacillus acidophilus

e) Skilled to developed the dairy technology industry

IMMUNOTECHNOLOGY LAB.

MBMS-252

1. Blood film preparation and identification of cells.
2. Identification of blood group.
3. RBC and WBC count by hemocytometer.
4. Lymphoid organs and their microscopic organization.
5. Immunization, collection of serum.
6. Different types of antigen–antibody cross reaction.
7. Immunodiffusion and Immunoelectrophoresis.
8. ELISA (Enzyme linked immunosorbent assay).

Course outcomes (COs):

a) To understanding the preparation and identification of cells
b) To describe Immunization, collection of serum
c) Knowledge of different types of antigen–antibody cross reaction
d) Various experiments on Immuno diffusion Immuno-electrophoresis is widely used

BIO-ENERGY ENGINEERING

MBMS- 205

Unit I:

Biomass Sources, Characteristics & Preparation: Biomass Sources and Classification, chemical composition and properties of different biomass materials and bio-fuels, sugar cane molasses and other sources for fermentation ethanol, sources and processing of oils and fats for liquid fuels, energy plantations, preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass.

Unit II:

Biogas Technology: Feedstock for biogas production, aqueous wastes containing biodegradable organic matter, animal residues, microbial and biochemical aspects, Operating parameters for biogas production, Kinetics and mechanism, dry and wet fermentation, digesters for rural application, high rate digesters for industrial waste water treatment.

Unit III:

Bio-Ethanol and Bio-Diesel Technology: Production of Fuel Ethanol by Fermentation of sugars, gasohol as a substitute for leaded petrol, trans-esterification of oils to produce bio-diesel.

Unit IV:

Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno-cellulose biomass, biomass processing for liquid fuel production, pyrolysis of biomass, pyrolysis regime, effect of particle size, temperature, and products obtained, thermo-chemical gasification principles, effect of pressure, temperature and of introducing steam and oxygen, design and operation of fixed and fluidized bed gasifiers.

Unit V:

Combustion of Biomass and Cogeneration Systems: Combustion of woody biomass, theory, calculations and design of equipments. Cogeneration In Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration.

Course outcomes (COs):

a. Define process control terminologies and identify suitable mode of controlling a given process.

b. Develop suitable control equations for bioprocess dynamics..

c. Examine the closed loop control system and select suitable control action.

d. Analyze the stability of control system in Laplace and frequency domain.

e. This unit also help students for design the equipments in biomass production industries .

REFERENCE BOOKS:

1. Klass, D.L. and Emert, G.M. Fuels from Biomass and Wastes. Ann Arbor Science pub. Inc. Michigan,
2. Chakraverthy, A. Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes. Oxford & IBH publishing Co., New Delhi,
3. Mital, K.M. Biogas Systems: Principles and Applications, New Age International Publishers (p) Ltd.,
4. Ramana, P.V. and Srinivas, S.N. 1996. Biomass Energy Systems. Tata Energy Research Institute, New Delhi.
5. Khandelwal, K.C. and Mahdi. Bio-gas Technology. Tata McGraw-Hill pub. Co. Ltd., New Delhi
6. Chawla, O.P. 1970. Advances in bio-gas Technology, I.C.A.R., New Delhi.

MOLECULAR ONCOLOGY

BMMS-201

Unit I: Introduction to Cancer:

The Cancer Problem Epidemiology, Environmental carcinogens and risk factors, life style, changing patterns, the Indian scenario. Mechanisms of Carcinogenesis Various theories, multi-step and multistage processes, Initiation, Promotion and Progression. Role of DNA damage, repair and mutations by physicochemical agents and viruses, interaction of various agents. Differentiation: hyperplasia and precancerous lesions. Strategies of chemoprevention. Tumor types and leukemia Benign and malignant tumors, localized and metastatic disease, Schemes of classification, WHO classification, staging and grading, degree of malignancy. Classification of leukemia, types of chromosomal translocations.

Unit II: Tumor Immunology and cell death:

Immune suppression and role of immune survelliance in growth of tumors. Tumor specific antigens and immune response. Modulation of immune response and immunotherapy, cancer vaccines. Modulation of the Eukaryotic Cell Cycle in cancer Cell cycle and its control: Mechanism of deregulation of cell cycle during cancer. Apoptosis, Necrosis, Proapoptotic and Antiapoptotic proteins and mechanism of action.

Unit III: Tumor suppressor genes and Viral oncogenes

Mechanisms of P53, Rb, Ras action in normal and transformed cells and viral oncogenes, Role of oncogenes in gene regulation using examples erb, rel, jun-fos, large Tantigen etc.

Unit IV: Signalling pathways and Cell Interactions:

Growth factor-signalling pathways in cancer Relationship between oncogene products and growth factors, using example of Src, Wnt, Abl, GAP and growth factors. Effect of viral

infection on signal transduction. Cell-cell interaction, integrins, invasions, invasions by cancerous cells. Angiogenesis, Neoarrgiogenesis, Stem Cell Differentiation, Morphogens

Unit V: Experimental Model and Emerging Therapy in Cancer Research

Microbial Models, Primary Cell Cultures, Established Cell Lines, Organ Cell Cultures, Spheroids. Cellular, tissue and molecular markers, potential targets for Cancer Therapy, Drug Discovery Strategy

Course outcomes (COs):

a. It is an elective paper which deals with fundamentals required for understanding the cancer at molecular level.

b. It helps the students to appreciate the phases of cell cycle and mechanisms involved in apoptosis.

c. It helps students to learn the updated therapeutics of cancer as well.

d. It helps the students to appreciate the phases of cell cycle and mechanisms involved in apoptosis.

e. It helps students to learn the updated therapeutics of cancer as well

Suggested Readings:

1. Genes by Benjamin Lewin Ed. 7th; Oxford; 2000.

2 Principles of Genetics by Eldon J. Gardner and Michael J. Simmons and D. Peter Snustad; Ed. 8th; John Wiley, 2005.

3 Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6th; W H Freeman and Company; New York; 2008.

SEMESTER: III

MICROBIAL GENETICS

MBMS-301

Unit – 1 DNA Structure and Mutagenesis
Molecular basis of spontaneous and induced mutations [physical and chemical mutagenic agents], Types of mutation: point, frameshift, lethal, conditional lethal, inversion and deletion, null mutation, reversion of mutations, intra and intergenic suppression mutations. Environmental mutagenesis, toxicity testing and population genetics. Systems that safeguard DNA. DNA methylation and DNA repair mechanisms - excision, mismatch, SOS , photoreactivation, recombination repair and glycocylase system.

Unit – 2 Prokaryotic Transcription and Translation
Organization of transcriptional units and regulation of gene expression Mechanism of transcription of prokaryotes-Structure and function of RNA polymerase, [DNA foot printing], termination and antitermination – N proteins and nut sites in DNA binding proteins, enhancer sequences and control of transcription, RNA processing (Capping, polyadenylation, splicing, introns and exons) Ribonucleoprotein, structure of mRNA, rRNA, tRNA.

Unit – 3 Regulation of gene expression in prokaryotes
Operon concept, co-ordinated control of structural genes, stringent response, catabolite repression, instability of bacterial RNA, positive regulation in *E.coli* [Arabinose operon] and negative regulation in *E.coli* [lac operon], inducers and repressors, regulation by attenuation by trp operon.

Unit - 4 Genetic recombination
Genetic recombination processes: Role of rec proteins in homologous recombination. Conjugation: Discovery, F+, F- and Hfr cells, types of Hfr; F+ and F- and Hfr and F- genetic crosses. Mechanism of conjugation. Sexduction, conjugational transfer of colicinogenic and resistance transfer factors. Genetic mapping. Plasmid Replication and Incompitability, Control of copy number. Transposons – Insertion sequences and composite transposons, phages as transposons replicative, non-replicative and conservative transposition. Mutations i.e. deletions, inversions and frameshift due to transposition.

Unit – 5 Phage Genetics
T4 virulent phage: structure, life cycle, genetic map and DNA replication. Lamda temperate phage: Structure, genetic map, lytic and lysogenic cycle, lysogenic repression and phage immunity. [Lambda regulon] applications of phages in microbial genetics.

Course outcomes (COs):

a. Students will be taught cell division, genetic materials, their structure and types, mechanism of replication of DNA.

b. Students gain knowledge in gene concepts and genetic code, gene expression, gene regulation and also learn about mutation.

c. By the end of study in this course, the student will be able to identify and distinguish genetic regulatory mechanism at different levels

d. Developed a fairly good knowledge about the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.

e. Hands on skills of isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis.

REFERENCE BOOKS:

1. Microbial Genetics by Maloy ET. Al. 1994. Jones and Bartlett Publishers.
2. Molecular Genetics of Bacteria by J. W. Dale. 1994. John Wiley and Sons.
3. Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.
4. Moleculat Biology of the Gene 4th Edition by J.D. Watson, N.H. Hoppkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. 1987, The Benjamin / Cummings Publications Co. Inc. California.
5. Gene VII by Lewin Oxford University Press. 2000.
6. Bacterial and Bacteriophage Genetics. 4 th Editions by Birge.
7. Microbial Genetics by Frefielder. 4th Edition.
8. Organization of Prokayotic Genome. 1999 by Robert L.Charlebois, ASM Publications.
9. DNA repair and mutagenesis. 1995 by Errol C. Friedberg, Graham C. Walker and Wolfram, Siede, ASM Publications.
10. Molecular Genetics of Bacteria, 1997 by Larry, Snyder and Wendy, Champness, ASM Publications.
11. Methods of General and Molecular Bacteriology, 1993. Edited by Philip. Gerhardt, ASM Publications.
12. Recombinant DNA by Watson, J.D.
13. Essentials of Molecular Biology by Malacimski.
14. Mobile DNA II by Nancy Craig, Martin Gellet Allan Lambowitz.

RECOMBINANT DNA TECHNOLOGY

MBMS-302

Unit I:

Molecular tools of genetic engineering: Types of restriction endonucleases, isoshizomers, DNA Polymerase I, Klenow fragment, T7 DNA Polymerase, DNA ligases, Topoisomerase, Kinases and phosphatases, prokaryotic and eukaryotic host cells.

Cloning and expression vectors: Properties of a vector DNA molecule, Plasmids, pBR322, pUC series, Lambda phage vectors, Insertional vectors, replacement vectors, M-I3 phage vectors cosmids, artificial chromosomes (BAC, PAC, YAC, MAC), Fosmid vectors, expression vectors

Unit II:

Construction and screening of genomic and c-DNA libraries: Construction of chimeric DNA, staggered cleavage, linkers, adapters, addition of poly-dA and poly-dT, blunt end ligation by T4 DNA ligase, selection of recombinant clones, molecular probes, screening of c-DNA and genomic libraries by colony and plaque hybridization, preparation of oligonucleotide, c-DNA and antibody probes, radioactive labeling, nonradioactive labeling, cloning in bacteria other than *E. coli*., cloning in *S. cerevisiae*

Unit III:

Genetic engineering and transgenic plants: Agrobacterium medicated gene transfer Ti-plasmid and Ri-plasmid mediated gene transfer, geminivirus and RNA plant virus mediated gene transfer, direct DNA transfer viz. electroporation, biolistics, microinjection, liposome mediated transformation, calcium phosphate coprecipitation method.

Genetic engineering and transgenic animals: Gene transfer methods in animal cell, chemical tranfection, physical transfection: ultrasound transfection, use of viruses as gene transfer vectors: Aderoviral, Baculoviral, unarmed herpes, retroviral and vaccinia viral vectors, transgenic mice, rabbit, cattle, goat, sheep, gene knockout in animals, somatic and germ line therapy.

Unit IV:

Basic techniques in genetic engineering: Southern, northern and western blotting, DNA sequencing, DNA fingerprinting.

Unit V:

Applications of recombinant DNA technology: Transgenic animals and plants as bioreactors, production of recombinant therapeutic proteins in bacteria, yeast and mammalian cells, improving agronomic traits by genetic modification, gene medicines, DNA vaccines, gene augmentation therapy.

Course outcomes (COs):

a. Learn about the vectors and their ideal characteristics.
b. Understand different methods of recombinant DNA techniques like labeling DNA,PCR and gene sequencing.
c. Gain knowledge about prokaryotic and mammalian expression vectors and cloning in plants.
d. Learn about preparation of genomic and cDNA libraries, mutagenesis, and cloning techniques for altering gene expression.
e. Learn about various applications of rDNA technology and how to handle the genetically modified organism.

REFERENCE BOOKS:

1. Primrose, S.B. and Twyman, R.M. 2006. Principles of gene manipulation and genomics (7th eds.). Blackwell Publishing.
2. Winnacker, Ernst-L. 2003. From Gene to Clone Introduction to gene technology. Panima publishing Corp., New Delhi.

3. Old, R.W. and Primrose, S.B. 1985. Principles of gene manipulation: An introduction to genetic engineering. Blackwell Science Publication.
4. Brown, T.A. 2008. Gene Cloning and DNA analysis (5th eds.). Blackwell Sciences LTD.
Gupta, P.K. 2008. Biotechnology and Genomics (1st ed.). Rastogi Publication

MICROBIAL PHYSIOLOGY & DIVERSITY

MBMS-303

UNIT I

Respiration: Aerobic and anaerobic carbohydrate metabolism (EMP pathway). Alternate route of glucose metabolism, pentose phosphate pathway, Kreb's cycle, glyoxylate shunt, oxidation of pyruvate as central hub to various metabolic pathways, Metabolism of volutin (polyphosphates), glycogen, poly β-hydroxybutyrate.

UNIT II

Respiratory Electron Transport chain- Components of electron transport chain, energy transduction and proton motive force, chemiosmotic theory of ATP generation, mechanism of ATP generation.Lipid metabolism- α and β oxidation, protein metabolism, urea cycle.

UNIT-III: -Microbial Diversity: Archea

General Metabolism and Autotrophy in archea; Phylum Euryarchaeota:-Halophilicarchaea, methanogens, thermoplasma; Phylum Crenarchaeota:-Energy metabolism, Thermoproteales, sulfolobales, desulfolobales; PhyllumNanoarchaeota:-Nanoarchaeum; Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.

UNIT-IV :-Microbial Diversity: Bacteria

Phylum Proteobacteria:-Free living N2 fixing bacteria,purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria; Phylum prochlorophytes and cyanobacteria; Phylum:Planctomyces; Phylum;Verrucomicrobia.

UNIT-V :- Microbial Diversity.

Phylum: Cytophaga, Phylum: Green Sulfur Bacteria. Phylum: Deinococci; Phylum: Green non – sulfur bacteria; Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex; Phylum:Nitrospira and Deferribacter.

Course outcomes (COs):

a. Describe common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments.
b. Describe for cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups.
c. Describe genomic-based methods to study microbial diversity in nature and for the mechanisms behind it.
d. Dscribe important interactions within microbial communities and between microorganisms and plants and animals.

e. Evaluate, synthesise and present scientific studies of genetic and functional microbial diversity in different ecosystems

References:

1. Microbial Physiology, Moat, AG, Foster, JW and Spector, MP, Edition 4th, John Willey Publication.
2. Biology of microorganisms by Madigan, MT, Martinko, JM, stahl, DA and clark, DP, Edition 13th Benjamin Cummings.
3. Advances in Microbial Physiology by Rabert Poole, RK., Volume 53 Elsevier Science & Technology
4. Microbial Physiology and Metabolism by Caldwell, DR, Edition 2nd, Star Pub Co.

ENVIRONMENTAL BIOTECHNOLOGY

MBMS-304

Unit I:

Environmental Pollution: Land, water, air, and noise (introduction, sources, effects and measurements) Pollution monitoring, bioindicators and biomarkers for monitoring pollution, cleaner technology for prevention of pollution.

Unit II:

Biological waste Treatment:

Treatment of distillery effluent, chlorinated effluent of paper industry, heavy metals in industrial effluents, biodegradation of pollutants, toxic site reclamation, toxicity testing using luminescent organisms, Types of wastes , properties and steps involved in aerobic and anaerobic treatments of solid waste ,sewage and industrial effluents and their reuse sewage treatment.

Unit III:

Bioremediation : Removal of spilled oils using naturally occurring and genetically engineered microbes (GEM), bioremediation of agricultural pesticides, biosensors to detect environmental pollutants, *In-situ* bioremediation of soil and ground water contamination, bioaugmentation, bioventing, biosparging, bioremediation techniques *ex situ*, GEM for detecting PAHs in soil, metals bioremediation, GEM for sequestering of heavy metals, gaseous bioremediation, phytoremediation, rhizofiltration, rhizostimulation, phycoremediation.

Unit IV:

Bioenergy and biofuels: Fossil fuels, emissions from fossil fuels, greenhouse gases, non-conventional sources of energy, conservation of energy; **Restoration of degraded lands:** Reforestation through micropropagation, use of microbes for improving soil fertility.

Unit V:

Biodiversity and its conservation: *In situ* and *ex situ* conservation, gene banks, CBD biodiversity bill in India.

Unit VI:

Biotechnology and climate change: Nature of expected climatic changes and their impact, recommendation of IPCC (Inter Governmental panel for Climatic Change), method for dealing with suggested changes to cope with climatic changes.
Current Environmental Issues of Importance: Population Growth,
Climate Change and Global warming- Effects, Urbanization, Automobile pollution, Acid Rain, Ozone Layer depletion.

Course outcomes (COs):

a. Understand and assimilate The concepts and specific terminology of environmental biotechnology.
b. Search and manage information from various sources
c. Describe the scientific bases that are applied by environmental biotechnology.
d. Describe the properties of microorganisms with potential application to processes of environmental biotechnology.
e. Explain the technologies, tools and techniques in the field of environmental biotechnology.

REFERENCE BOOKS:

1. Gray, N.E. 1989. Biology of wastewater treatment. Oxford University Press, Oxford.
2. Hall, E.A.H. 1990. Biosensors. Open University Press, Milton Kenynes.
3. Head, I.M., Singleton, I. and Milner, M. 2003. Bioremediation: A critical review. Horizon Scientific Press, Norfolk.
4. Scragg. 2008. Environmental Biotechnology. Oxford University Press.

MICROBIAL GENETICS LAB.

MBMS-351

1.Purification of chromosomal / plasmid DNA and studyof DNA profile:
* Confirmation of nucleic acid by spectral study.
* Quantitative estimation by diphenylamine test
* DNA denaturation and determination of Tm and G+C content.
* Agarose gel electrophoresis of DNA.

2.Effect of UV radiations to study the survival pattern of E. coli/yeast. Repair mechanisms in E. coli/yeast (Dark and photoreactivation)

3.Isolation of antibiotic resistant mutants by chemical mutagenesis.

4.Ampicillin selection method for isolation of auxotrophic mutant.

5.Extraction and Purification of RNA from S. cerevisiae.

6.Studies on gene expression in E.coli with reference to lac operon.

7.Study of conjugation in E. coli.

8.Restriction digestion and agarose gel electrophores is of DNA.

9.Generalized transduction in E. coli using P1 phage

Course outcomes (COs):

a) Students will be taught cell division, genetic materials, their structure and types, mechanism of replication of DNA.
b) Students gain knowledge in gene concepts and genetic code, gene expression, gene regulation and also learn about mutation.
c) By the end of study in this course, the student will be able to identify and distinguish genetic regulatory mechanism at different levels.
d) Developed a fairly good knowledge about the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.
e) Hands on skills of isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis

RECOMBINANT DNA TECHNOLOGY LAB.

MBMS-352

1. General guidelines for working in rDNA technology.
2. Preparation of commonly used chemicals and reagents for rDNA technology lab.
3. Isolation of genomic DNA.
4. Agarose Gel Electrophoresis.
5. Digestion of DNA with restriction endonucleases.
6. Isolation of plasmid DNA.
7. Bacterial transformation.
8. Polymerase chain reaction.
9. Primer designing by software.

Course outcomes (COs):

a) Learn about the vectors and their ideal characteristics.
b) Understand different methods of recombinant DNA techniques like labeling DNA,PCR and gene sequencing.
c) Gain knowledge about prokaryotic and mammalian expression vectors and cloning in plants.
d) Learn about preparation of genomic and cDNA libraries, mutagenesis, and cloning techniques for altering gene expression.
e) Learn about various applications of rDNA technology and how to handle the genetically modified organism.

BIOSTATISTICS

BTMS- 311

Unit-I

Data type, classification and summarization of data, diagrams and Graphs, Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, variance, Frequency distribution and its types, cumulative frequency, Skewness and kurtosis.

Unit-II

Introduction to probability, Laws of probability, Baye's theorem, Binomial distribution, Mean and variance of binomial distribution, introduction to normal distribution, random variable and Poison distribution.

Unit-III

Positive and Negative correlation, rank correlation coefficient, Non parametric tests, Linear and Non linear regression, multiple regression, equation of line of regression, regression coefficient.

Unit-IV

Hypothesis tests, Chi squire tests and F-tests, Variant, analysis of variants, ANOVA.

Unit-V

Principles of experimental design and analysis.

Course outcomes (COs):

a. Critically analyse research methodologies identified in existing literature.
b. Propose and distinguish appropriate research designs and methodologies to apply to a specific research project.
c. Use basic and modern statistical software to analyse the biological and clinical data/
d. Develop a comprehensive research methodology for a research question.
e. Apply the understanding of feasibility and practicality of research methodology for a proposed project.

REFERENCE BOOKS:

1. George W. and William G., Statistical Methods; IBH Publication.
2. Ipsen J et al; Introduction to Biostatistics, Harper & Row Publication.
3. N.T.J. Baily; Statistical methods in Biology; English University Press.
4. R.Rangaswami; A Text book of Agricultural statistics; New Age Int. Pub.
5. P.S.S.Sundar Rao; An Introduction to Biostatistics; Prentice Hall.

PHARMACOLOGY AND TOXICOLOGY

BMMS-301

Unit I: Pesticides

Brief classification with examples, residual and non-residual pesticides. Mode of entry and mode of action of pesticides in target and non-target organisms; metabolism of pesticides, phase I and phase II reaction, elimination. Pesticide bioaccumulation, biomagnification through food chain. Environmental alteration of pesticides - microbial and solar, fate and dissipation of pesticides residue under tropical and temperature conditions.

Unit II: Pesticide hazards to man Accidental and occupational exposure, entry through air, food and water, Main routes of entry and factors affecting intake, distribution, biotransformation and elimination dynamics.

Unit III: Chemotherapeutic agents: Chemotherapy of microbial diseases, urinary antiseptics, sulfonamides, penicillins, streptomycin, tetracyclines and other antibiotics; antitubercular drugs, antifungal agents, antiviral drugs, antileprotic drugs. Chemotherapy of protozoal diseases, Drugs used in cancer, Disinfectants and antiseptics

Unit IV: Drugs acting on the central nervous system: General anesthetics, adjunction to anesthesia, intravenous anesthetics. Analgesic and non-steroidal anti-inflammatory drugs, narcotic analgesics, antirheumatic and antigout remedies, sedatives and hypnotics, pshychopharmacological agents, anti-convulsants, analeptics.

Unit V: Overall Pharmacological agents . Drugs acting on the blood and blood forming organs, haematinics, coagulants and anticoagulants, haemostatics, blood substitutes and plasma expanders. Drugs affecting renal function- diuretics and antidiuretics. Hormones and hormone antagonists- hypoglycemic agents, antithyroid drugs, sex hormones and oral contraceptives, corticosteroids.

Course outcomes (COs):

a. Demonstrate the principles of pharmacodynamics and pharmacokinetics
b. Discuss drug dosage, exposure and target specificity

c. Demonstrate the basic principles of toxicology

d. Illustrate toxicity risk assessment and fate of toxicants in humans

e. Demonstrate the experimental approach for analyzing drug action. Evaluate acute and chronic toxicity of environmental chemicals

REFERENCE BOOKS:

1 Essential of medical pharmacology; 5th Ed. By K.D. Tripathi; Jaypee Brothers; New Delhi; 2003.

2 Goodman & Gilman's the pharmacological basis of therapeutics by Joel G. Hardman and Lee E. Limbird; 9th Ed.; 1995.

3 Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed.5th; Churchill Livingstone, 2003.

4 Integrated pharmacology by Clive P. Page and M.J. Curtis and M.C. Sutter and M.J. Walker and B.B. Hoffman; Mosby; 1997.

5 Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed.2nd; CRC Press; 2006

6 Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed.4th; Taylor & Francis; 2002

7 Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed.7th; McGraw Hill; New York; 2007

8 Toxicology by Hans Marquradt and S.G. Schafer and R.D. McClellah and Academic Press; 1999

9 Principles and practice of toxicology in public health by Ira R. Richards; Jones and Bartlett Publishers; 2007 10 Handbook of human toxicology by E.J. Massaro; CRC Press; 1997

SEMESTER: IV

MBMS-481 SEMINAR

MBMS-491 DISSERTATION

Course Objective:
The students are expected to utilize their scheduled periods by undertaking the project that would be completed during the semester. Every student shall undertake a major Project. The major Project shall be undertaken in some biotechnology industry or laboratory of repute. Each student shall be assigned to a faculty who shall continuously monitor the progress of the Project in the concerned laboratory or industry. The faculty, in consultation with the concerned scientist of the industry/laboratory, shall decide the topic of the project. At the conclusion of the project the student shall submit a seminar and a dissertation. The dissertation shall be evaluated by the internal faculty/examiner. The student then shall have to appear for the viva voce examination.

GUIDELINES FOR DISSERTATION:
Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student. Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage. The File is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include:
• A short account of the activities that were undertaken as part of the project;
• A statement about the extent to which the project has achieved its stated goals.
• A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;
• Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting
from the project;
• Any problems that have arisen that may be useful to document for future reference.
Report Layout
The report should contain the following components:

Title or Cover Page.

The title page should contain the following information: Project Title; Student's Name; Course; Year; Supervisor's Name.

Acknowledgements (optional)

Acknowledgment to any advisory or financial assistance received in the course of work may be given.

Abstract

A good "Abstract" should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project

Table of Contents

Titles and subtitles are to correspond exactly with those in the text.

Introduction

Here a brief introduction to the problem that is central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

Materials and Methods

This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modifications if any.

Results and Discussion

Present results, discuss and compare these with those from other workers, etc. In writing these section, emphasis should be given on what has been performed and achieved in the course of the work, rather than discuss in detail what is readily available in text books. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow.

Note that in writing the various secions, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary never write in "point" form.

Conclusion

A conclusion should be the final section in which the outcome of the work is mentioned briefly.

Future prospects

Appendices

The Appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

References / Bibliography

This should include papers and books referred to in the body of the report. These should be ordered alphabetically on the author's surname. The titles of journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognized system. Examples:

For research article:

Voravuthikunchai SP, Lortheeranuwat A, Ninrprom T, Popaya W, Pongpaichit S, Supawita T. (2002) Antibacterial activity of Thai medicinal plants against enterohaemorrhagic Escherichia coli O157: H7. Clin Microbiol Infect , **8** (suppl 1): 116–117.

For book:

Kowalski,M.(1976) Transduction of effectiveness in Rhizobium meliloti. SYMBIOTIC NITROGEN FIXATION PLANTS (editor P.S. Nutman IBP), **7**: 63-67

ASSESSMENT OF THE DISSERTATION:

Essentially, marking will be based on the following criteria: the quality of the report, the technical merit of the project and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in.

The File should fulfill the following **assessment objectives:**

- **Range of Research Methods used to obtain information**
- **Execution of Research**
- **Data Analysis**
  Analyze Quantitative/ Qualitative information Control Quality
- **Draw Conclusions**
- **Reference for further information:**
  Clifford Hawkins and Marco Sorgi; Research: How to Plan, Speak and write about it; Narosa Publishing House, New Delhi 1994

Course outcomes (COs):

a. Prepare project report for biotechnology entrepreneurship.
b. Address the market challenges for a new enterprise.
c. Setup enterprise for new biotechnology product.

d. Assess the global market scenario of their product.

e. commercialization of products in national and international markets .