Total Credits = 21

SEMESTER 3rd		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MMBLS1-301	Food Microbiology	3	1	0	40	60	100	4
MMBLS1-302	Environmental Biotechnology	3	1	0	40	60	100	4
MMBLS1-303	Analytical Techniques in Microbiology	3	1	0	40	60	100	4
MMBLS1-304	Applied & Industrial microbiology	3	1	0	40	60	100	4
MMBLS1-305	Food Microbiology Lab	0	0	4	60	40	100	2
MMBLS1-306	Environmental & Industrial Microbiology Lab	0	0	6	60	40	100	3
	Total	**-**	**-**	**-**	**320**	**380**	**700**	**21**

Total Credits = 23

SEMESTER 4th		Contact Hrs.			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MMBLS1-401	Genome Technology	3	1	0	40	60	100	4
MMBLS1-402	Agricultural Microbiology	3	1	0	40	60	100	4
MMBLS1-403	Drug Design and Discovery	3	0	0	40	60	100	3
MMBLS1-404	Biosafety, Bioethics & IPR	3	0	0	60	40	100	3
MMBLS1-405	Research Assignment*	0	0	6	60	40	100	3
MMBLS1-406	Project Work**	0	0	12	50	150	200	6
	Total	**-**	**-**	**-**	**290**	**410**	**700**	**23**

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

**** Project work** the main objective of this course is to acquaint the student with various techniques used in contemporary research in microbiology/biotechnology that will be useful in successful completion of their project work in the fourth semester.
To develop synopsis of a defined research problem.
To conduct the bench work
To prepare the research report and its oral demonstrations.
A grant proposal on any relevant topic in biology will have to be prepared by students. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.
Students will be evaluated on all the topics discussed in the two years programmed by a panel of experts

Overall Marks / Credits

Semester	Marks	Credits
1st	800	29
2nd	700	24
3rd	700	21
4th	700	23
Total	**2900**	**97**

FOOD MICROBIOLOGY

Subject Code: MMBLS1-301 **L T P C** **(Duration: 60hrs)**

3 1 0 4

Course Objective:

- To study general principles of food microbiology, food preservation, fermented and microbial foods.
- To study epidemiology of food-borne microorganisms of public health significance and food spoilage microorganisms.
- To study microbiological examination of foods, microbiological quality Control and quality schemes.

Course Outcome:

- Illustrate the role of microorganisms in food safety
- Cultivate and enumerate microorganisms from various food samples
- Compare various physical and chemical methods used in the control of microorganisms

Unit: 1 (15Hrs)

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

Unit: 2 (15Hrs)

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

Unit: 3(15Hrs)

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

Unit: 4 (15Hrs)

- **Microbiology quality control -** Hazard analysis and critical control points (HACCP). Sampling plan. Methods for microbiological examination of foods (direct examination,

cultural techniques), enumeration methods. Alternate indirect methods (dye reduction, electrical, ATP), rapid methods for detection of specific organisms and toxins (immunological/molecular methods). cleaning-in-place (CIP) in food industry.

Books Recommended:

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

FOOD MICROBIOLOGY LAB

Subject Code: MMBLS1-305 **L T P C** **(Duration: 60hrs)**

0 0 4 2

Course Objective:

- To study microbiological examination, production, estimation and prevention.
- To study the extraction and estimation of toxin and isolation food poisoning.
- To study analytical techniques in food quality control.

Course Outcome:

- Illustrate the role of microorganisms in food safety
- Cultivate and enumerate microorganisms from various food samples
- Compare various physical and chemical methods used in the control of microorganisms

Experiment

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

References

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.
9. Freeman and Co. Dairy Microbiology by Robinson. Volume II and I.

ENVIRONMENTAL BIOTECHNOLOGY

Subject Code: MMBLS1-302 **L T P C** **(Duration: 60hrs)**

3 1 0 4

Course Objective:

- To study the presence of pathogens in drinking water.
- To study the relationship between microorganisms and geochemistry.
- To understand the role of microorganisms as agents of environmental change.
- To use microorganisms as indicators of alteration of an ecosystem.
- To know and understand the role of microbes in the environment and evaluation of anthropogenic activities on pollution, climate change as well as environmental protection.

Course Outcome:

- Students will learn about the different fields in microbiology.
- Students will gain knowledge about the different types of microorganisms and their significance.
- Students will study different techniques used in microbiology.

Unit: 1 (15Hrs)

- **Introduction to Microbial Ecology:** Evolution of Life on Earth, History and scope of ecology, Concept of autecology, synecology, population, community, biome. Ecological succession.
- **Microorganism in aquatic Environment:** major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes. Biofilms, Production in lakes, rivers, estuaries and wetlands. Nutrient dynamics in lakes, rivers, estuaries and wetlands.

Unit: 2 (15Hrs)

- **Aquatic Microbiology:** Fresh and marine ecosystem (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem; upwelling, eutrophication; food chain in aquatic ecosystems. Role of methanotrophs in ecosystem. Potability of water, microbial assessment of water, water purification. Ground water types and their contamination. Biofilm. Waste treatment: Sewage and effluent treatment; Primary, secondary and tertiary treatment, Solid waste treatment. Solid wastes as sources of energy and food.

Unit: 3 (15Hrs)

- **Aerobiology:** Airspora in different layers of the atmosphere, bioaerosol, assessment of air quality using air sampler based principles of sedimentation, impaction, impingement, suction and filtration. Brief account of transmission of airborne microbes, indoor and outdoor microbial quality. Allergy: Causes and tests for detection of allergy. Endotoxin in air and its hazards. Molecular methods for air quality assessment. Historical development of space microbiology, Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic)

Unit: 4 (15Hrs)

- **Role of microbes in degradation:** Biodegradation of xenobiotic – hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/ bioaccumulation of heavy metal. Bioremediation of soil, air and water: various methods, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium.

Books Recommended:

1. Bioremediation by Baker K.H. And Herson D.S. 1994.. MacGraw Hill Inc. N.Y.
2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
3. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
4. Environmental Microbiology edited by Ralph Mitchell. A John Wiley and Sons. Inc. 5. Waste Water Microbiology 2nd Edition by Bitton.
5. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. Wiley Interscience Publications.
6. Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
7. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
8. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
9. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications. 11. Biodegradation and Bioremediation, Academic Press, San

Diego. 12. Biotechnology in the sustainable environment, Plenum Press, N.Y. 13. Basic Principles of Geomicrobiology by A. D. Agate, Pune.

ANYLYTICAL TECHNIQUES IN MICROBIOLOGY

Subject Code: MMBLS1-303 **L T P C** **(Duration: 60hrs)**

3 1 0 4

Course Objectives:

- To understand the working principles and applications of the instruments used in the microbiological study.

Course Outcomes:

- To understand the principles and applications of electrophoresis
- To understand the need of centrifuges and their uses in research
- To know the importance of spectroscopic and chromatographic techniques

UNIT-1 **(15 Hrs)**

- **Chromatographic techniques:** Basic principles, working and applications of Column chromatography, thin layer chromatography, affinity chromatography, gas chromatography, Ion exchange chromatography and High performance liquid chromatography.

UNIT-2 **(15 Hrs)**

- **Spectroscopic techniques**: Working principle and applications of IR spectroscopy, Fluorescent spectroscopy, Mass Spectroscopy and atomic absorption spectroscopy. Basic principles and working of pH meter.

UNIT-3 **(15 Hrs)**

- **Electrophoresis and Centrifugation**: Principle of electrophoresis, Factors affecting electrophoresis, Support media used in electrophoresis and types of electrophoresis. Centrifugation: Principles, types of centrifuges- Micro centrifuge, high speed refrigerated centrifuges, ultra centrifuges, differential and density gradient centrifugation. Sonication.

UNIT-4 **(15 Hrs)**

- **Microscopy:** Confocal scanning microscope, Electron Microscope- working principles and applications of Scanning electron microscope, transmission electron microscope. Principle and application of Phase contrast microscope and fluorescent microscope.

Reference Book:

1. Research methodology for biological sciences by N. Gurumani
2. Instrumental Methods of Chemical Analysis, Chatwal & Anand, 2018..
3. Practical Biochemistry and Molecular Biology: Principles and techniques, Wilson & Walker,2018
4. Physical Biochemistry: Application to Biochemistry and Molecular biology, Freifelder, 2nd Ed., 1982.
5. Biophysical Chemistry: Principles and techniques, Upadhyay & Nath, 2009

APPLIED & INDUSTRIAL MICROBIOLOGY

Subject Code: MMBLSI-304 **L T P C** **(Duration: 60hrs)**

3 1 0 4

Course Objectives: Applied Microbiology course aims to impart the knowledge of basic principles of Microbiology and their applications to humankind.

Course Outcome: After completion of the course, a student will be able to achieve these outcomes

- Learn about industrial microbiology.
- Learn about the microbial production of metabolites
- Gain knowledge of fermented microbial products.
- Acquire knowledge on microbial enzymes.
- Learn Biofuels & Biopolymers

Unit- 1 (15 hrs.)

- **Basics of Industrial Microbiology:** Historical account of microbes in industrial microbiology; sources and characters of industrially important microbes; their isolation, purification and maintenance; Screening of useful strains; primary screening and secondary screening; Strain improvement through random mutation and genetic engineering; types of fermentation and fermenters. Microbial growth kinetics in batch, continuous and fed-batch fermentation process

Unit- 2 (15 hrs.)

- **Microbial production of metabolites:** Microbial production of Primary and secondary metabolites. Metabolic engineering, Pathways involved in secondary metabolite production, Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. Microbial transformations: steroids and alkaloids production. Large scale production of recombinant molecules interferon, human proteins-insulin, somatostatin, vaccines and anticancer agents.

Unit- 3 (15 hrs.)

- **Fermented Microbial products:** Microbiology and production of alcoholic beverages; Malt beverages, distilled beverages, wine and champagne; Pathways involved in primary metabolite production, Commercial production of organic acids like acetic, lactic, citric,

and gluconic acids; Commercial production of important amino acids (glutamic acid, lysine and tryptophan), and vitamins (riboflavin and vitamin A).

Unit- 4 (15 hrs.)

- **Microbial enzymes:** Immobilization of microbial enzymes and whole cells and their applications in industries; Industrial enzymes production; Cellulases, Xylanases, Pectinases, Amylases, Lipases and Proteases and their applications. Enzymes involved in microbial biocatalysis / transformations.
- **Biofuels & Biopolymers:** Biofuels (ethanol and methane) from organic residues; fuels from algae; Microbial fuel cells, Mushroom cultivation; other microbial products - Biopolymers and EPS, Bioplastics, Biosurfactants.

Recommended Text Books:

1. Nduka Okafor, Benedict C. Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2nd Edition: CRC Press Publishers.
2. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2002). Industrial Microbiology: An Introduction. Blackwell Science Publishers.
3. W. Crueger & A. Crueger (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology. Edited by K.R. Aneja. Panima Publishing Corporation.
4. Reed. G. (1999). Prescott and Dunn‘s Industrial Microbiology. CBS Publishers.
5. Demain, A. L. (2001). Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
6. P.F. Stanbury, W. Whitaker & S.J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevier publication.
7. Richard H. Baltz, Julian E. Davies, and Arnold L. Demain (2010). Manual of Industrial Microbiology and Biotechnology. 3rd Edition, ASM Press.
8. Daniel Forciniti (2008). Industrial Bioseparations: Principles and Practice. 1 st Edition, Wiley-Blackwell.
9. Nduka Okafor, Benedict C. Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2nd Edition: CRC Press Publishers.

ENVIRONMENTAL & INDUSTRIAL MICROBIOLOGY LAB

Subject Code: MMBLS1-306 **L T P C** **(Duration: 90hrs)**

0 0 6 3

Course Objectives: Aims to impart the knowledge of basic principles of Microbiology and their applications to humankind.

- To study analysis, determine BOD/COD
- To study isolation, utilization and purification of microbes
- To study biotransformation and microbial dye

Course Outcome: After completion of the course, a student will be able to achieve these outcomes

- Learn about the microbial production of metabolites
- Gain knowledge of fermented microbial products.
- Acquire knowledge on microbial enzymes.
- Students will learn about the different fields in microbiology.
- Students will study different techniques used in microbiology.

Experiment:

- Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
- Determination of indices of pollution by measuring BOD/COD of different effluents.
- Bacterial reduction of nitrate from ground waters
- Isolation and purification of degradative plasmid of microbes growing in polluted environments.
- Recovery of toxic metal ions of an industrial effluent by immobilized cells.
- Utilization of microbial consortium for the treatment of solid waste [Muncipal Solid Waste].
- Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species.
- Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds.
- Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.
- Microbial dye decolourization/adsorption.

Book Reference:

1. Bioremediation by Baker K.H. And Herson D.S. 1994.. MacGraw Hill Inc. N.Y.
2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
3. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
4. Environmental Microbiology edited by Ralph Mitchell. A John Wiley and Sons. Inc.
5. Waste Water Microbiology 2nd Edition by Bitton.
6. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. Wiley Interscience Publications.
7. Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
8. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
9. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.

4th

SEMESTER

GENOME TECHNOLOGY

Subject Code: MMBLS1-401 **L T P C** **(Duration: 60hrs)**

3 1 0 4

Course objective: The Genome Technology course aimed to transform advanced developments in genomic science to the students.

Course outcome: This course would develop the students becoming knowledgeable/skilled in new methods, technologies and instruments that enable rapid, low-cost determination of DNA sequence, SNP genotyping, functional genomics and synthetic biology.

Unit-I (15 Hrs.)

- **An introduction to genetic technology:** Enzymes used in genetic engineering- Restriction endonucleases, DNA polymerases, Reverse transcriptase, Ligases, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Klenow fragment, Terminal deoxynucleotidyl transferase, RNase. Vectors for cloning- Plasmids, Bacteriophage , Filamentous phage vectors, Cosmids, Phagemids, PACs, YACs. Ligation of DNA fragments with vectors - Homopolymer tailing, Ligation of cohesive termini, Blunt-end ligation, Linker molecules.

Unit-II (15 Hrs.)

- **Introducing genes into bacterial systems**: Natural gene transfer methods- Transformation, transduction, calcium chloride mediated transformation, Transfection with phage vectors. Introducing genes into eukaryotes- Gene transfer by viral transduction, Calcium phosphate mediated transformation; Liposome mediated transformation, Microinjection, Electroporation.

Unit-III (20 Hrs.)

- Producing genomic libraries, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Cloning in E.coli, Identifying the recombinant DNA and its productsGenome Engineering, genome editing and CRISPR-CAS tools.
- Prokaryotic expression systems Gene expression based on bacteriophage T7 RNA polymerase, Eukaryotic expression systems- Fused genes, Unfused genes, Secreted proteins, Gene expression by transcription factors- Nfkb, PPAR, Antisense RNA technology- SiRNA, miRNA.

Unit IV (10 Hrs.)

- **Techniques in genetic technology-** Hybridization technique, Southern, Northern-Western blotting techniques, Site directed mutagenesis, Restriction mapping, DNA profiling in forensic science, Chromosome walking, Chromosome jumping, DNA sequencing, PCR. Basic concepts of Intellectual property rights.

Recommended Text Books:

1. Sandy B. Primrose, Richard Twyman (2004), Genomics : Applications in Human Biology. Wiley and Sons.
2. Mount D (2004). Bioinformatics: Sequence and Genome Analysis by. Cold Spring
3. Diana Marco (2014). Metagenomics of the Microbial Nitrogen Cycle: Theory, Methods and Applications Book: 978-1-908230-48-5. ebook: 978-1-908230-60-7, Caister Academic Press.
4. Pilar Francino, M (2012). Horizontal Gene Transfer in Book: 978-1-908230-10-2. ebook: 978-1-908230-72-0, Caister Academic Press.
5. Muhammad Jamal (2017). The CRISPR/Cas System: Emerging Technology and Application. Caister Academic Press.
6. Manuel Fuentes, Joshua LaBaer (2014). Proteomics: Targeted Technology Innovations and Applications. Book: 978-1-908230-46-1. ebook: 978-1-908230-62-1. Caister Academic Press.
7. Patrick Arbuthnot and Marc S. Weinberg (2014). Applied RNAi: From Fundamental Research to Therapeutic Applications. Book: 978-1-908230-43-0. ebook: 978-1- 908230-67. Caister Academic Press.
8. Jianping Xu (2014). Next-generation Sequencing: Current Technologies and Applications. Edited by: Published: 2014 Book: 978-1-908230-33-1. Ebook: 978-1-908230-95-9. Caister Academic Press.
9. Maria S. Poptsova (2014). Genome Analysis: Current Procedures and Applications. Book: 978-1-908230-29-4. ebook: 978-1-908230-68-3. Caister Academic Press.
10. Diana Marco (2011). Metagenomics: Current Innovations and Future Trends. Book: 978-1-904455-87-5. Horizon Scientific Press.
11. S. B. Primrose (2002). Principles of Genome Analysis. A Guide to Mapping and Sequencing DNA from Different Organisms. Blackwell publishing.

AGRICULTURAL MICROBIOLOGY

Subject Code: MMBLS1-402 **L T P C** **(Duration: 60 hrs)**

3 1 0 4

Course objective: This course designed to introduce the essential fundamentals of Agriculture Microbiology.

Course outcome: This course focuses on the concepts of Agricultural Microbiology such as Soil Environment, Major plant diseases caused by fungi, bacteria and viruses, biopesticides & biofertilizers and plant microbe-interactions.

Unit-I (15 Hrs.)

- **Soil Environment-** Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins). Biogeochemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulphur, iron and phosphorus cycles. PGPR-Rhizosphere – Rhizosphere Microorganisms, Siderophores. PGPM-Plant growth promoting microorganisms. plant-microbe beneficial interactions. Mechanisms of plant growth promotion

Unit-II (15 Hrs.)

- Major plant disease symptoms caused by fungi, bacteria and viruses. Plant diseases – Principles, symptoms and control measures of the following diseases: Fungal – Tikka, red rot of sugarcane, Fusarium wilts (red gram and cotton), Sclerotium rolfsii and Macrophomina phaseolina (collar rot disease, charcoal rot). Bacterial – Blight of rice, citrus canker, Xanthomonas (black rot). Viral and mycoplasmal – Bud necrosis of groundnut, citrus mosaic, little leaf of brinjal, tomato leaf curl. Principles of plant disease control. Protection - Diseases of field, vegetable, orchard and plantation crops of India and their control; causes and classification of plant diseases; principles of plant disease control biological control of diseases.

Unit-III (15 Hrs.)

- **Biofertilizers –** Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- Rhizobium, Azotobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculation of Rhizobium, Azotobacter, Azospirillum, Azolla and cyanobacteria, Carrier-based

inoculants, methods of application, quality control, agronomic importance. Application methods for different biofertilizers – Vermicomposting

Unit-IV (15 Hrs.)

- **Biopesticides –** Principles of biological control – antagonism, parasitism, Bacillus thuringiensis, B. sphaericus, B. popilliae, Pseudomonas syringae. Biocontrol-nematophagy - Microbial control of plant pathogens- Trichoderma. Useful genes from microorganisms for agriculture (herbicide resistant, Bt, viral). Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.
- **Molecular plant microbe-interactions:** Cell signalling, Quorum sensing, and Biofilm formation. Invasion of plant tissue- resistance mechanisms against attack by plant pathogens. Molecular detection of pathogens. Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; Recycling of agricultural wastes - Microbiology and biochemistry of biogas, bioethanol and other value added products.

Recommended Text Books:

1. Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
2. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
3. Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. Subba Rao.
4. Microbes For Sustainable Agriculture by K.V.B.R. Tilak, K.K. Pal, Rinku Dey
5. Soil Microbiology and Plant Growth, 1995, by N.S. Subba Rao.
6. Plant Growth and Health Promoting Bacteria by Dinesh K. Maheshwari
7. Plant-microbe interactions, Volume 1 by Gary Stacey and Noel T. Keen
8. Biological control of crop diseases Volume 89 of Books in soils, plants, and the environment by S. S. Gnanamanickam
9. Plant-microbe interactions and biological control Volume 63 of Books in soils, plants, and the environment by Greg J. Boland, L. David Kuykendall

DRUG DESIGN AND DISCOVERY

Subject Code: MMBLS1-403 **L T P C** **(Duration: 45 hrs)**

3 0 0 3

Course Objectives: Drug Design and Discovery course introduce the basic principles of modern drug design, discovery and development. The course deals with the different source of drug with specific focus on microbial source, drug development and manufacturing process

Course Outcome: The course will imparts knowledge on detection, selection, and validation of new antibacterial targets, vaccines and the use of gene technology in pharmaceutical industry

Unit-I (12 Hrs.)

- **Introduction-** History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products, Pharmaceuticals of microbial origin (macrolides, ansamycins, Peptide and other antibiotics) animal origin (sex hormones androgens, Oestrogens, Progesterone and progestogens etc), plant origin (Alkaloids Atropine and scopolamine Morphine and cocaine Additional plant alkaloids)

Unit-II (10 Hrs.)

- **Sources of Drugs-** Microbial drugs, Plants as a source of drugs, E. coli as a source of recombinant therapeutic proteins. Expression of recombinant proteins in yeasts, animal cell culture systems. Additional production systems: Fungal production systems, Transgenic animals, Transgenic plants and Insect cell-based systems. Rational drug design and Combinatorial approaches to drug discovery, Antibody Drug Conjugates.

Unit-III (5 Hrs.)

- **Drug development process-** Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics, Model systems in the development of drugs, Nanoscaffolds for Drug Delivery.
- **Drug manufacturing process-** Guides to good manufacturing practice, Production of final product - Cell banking systems, Upstream processing, Microbial cell fermentation, Mammalian cell culture systems, Downstream processing, Final product formulation, Freezedrying, Labelling and packing.

Unit-IV (18 Hrs.)

- **Vaccines and adjuvant-** Traditional vaccine preparations, attenuated, dead or inactivated bacteria, Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations. Impact of genetic engineering on vaccine technology. Peptide vaccines Vaccine vectors. Development of an AIDS vaccine, Difficulties associated with vaccine development, AIDS vaccines in clinical trials, Cancer vaccines, Recombinant veterinary vaccines. Adjuvant technology: Adjuvant mode of action, Mineral-based adjuvants, Oil-based emulsion adjuvants Bacteria/bacterial products as adjuvants, Biosimilars.
- **Nucleic acid as drugs**- Gene therapy: Basic approach to gene therapy, Vectors used in gene therapy -Retroviral vectors, Additional viral-based vectors, Manufacture of viral vectors, Non-viral vectors. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene based vaccines.

Recommended Text Books:

1. Kristian Stromgaard, Povl Krogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press, 2017.
2. Thomas J. Dougherty and Steven J. Projan. Microbial Genomics and Drug Discovery, Taylor and Francis, 2003.
3. Kenneth M. Merz, Dagmar Ringe and Charles H. Reynolds. Drug Design: Structure- and Ligand-Based Approaches, Cambridge University press, 2010.
4. Kristian Stromgaar, Povl Krogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press, 2017.
5. David B. Weiner and William V. Williams. Biological Approaches to Rational Drug Design (Handbooks in Pharmacology and Toxicology) CRC press, 1994.
6. Gary Wlash (2004). Biopharmaceuticals, Biochemistry and Biotechnology. 2nd edition. Wiley publisher.

BIOAFETY, BIOETHICS & IPR

Subject Code: MMBLS1-404 **L T P C** **(Duration: 45 hrs)**

3 0 0 3

Course Objective: This soft course teaches students about biosafety, bioethics and IPR, which are highly essential and must to learn for science students.

Course Outcome: Through this course students will acquire knowledge on good laboratory practices, safety guidelines and ethics to be followed in science. This course will be helpful for students to perform best in the bioscience laboratory.

Unit-I (10 Hrs.)

- **Introduction to Biosafety:** Biological laboratory, Biosafety, Need for biosafety, Good laboratory practices (GLP) - Fundamental points and resources of GLP, Standard operating procedures (SOPs), Implementation of GLP.

Unit-II (10 Hrs.)

- **Biosafety levels:** Types of biosafety levels (Biosafety level I, II, III, IV), Requirements of Biosafety levels, Operational guidelines for biosafety levels. Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals

Unit-III (5 Hrs.)

- **Biosafety facilities:** Animal Biosafety facilities (ABSL), Plant Biosafety facilities (PBSL), Aquatic organism Biosafety facilities (AQBSL), Operational guidelines for ABSL, PBSL, AQBSL.

Unit-IV (20 Hrs.)

- **Bioethics:** Introduction to Ethics, Ethical issues in Biosciences, Ethical committee, Guidelines for research that involve animals, Human, Microorganism, Genetic engineering, Gene therapy, organ transplantation & Stem cells.
- **IPR:** Forms of IPR, IPR in India, WTO ACT, Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological materials.

Reference Books:

1. Lewis Vaughn. Bioethics: Principles, Issues and Cases, 2nd Edition. Oxford University Press
2. Deepa Goel, Shomini Parashar. (2013). IPR, Biosafety and Bioethics.Pearson.
3. Handbook Good Laboratory Practices, World Health Organization, Second edition.
4. Regulations and guidelines on biosafety of recombinant DNA research and biocontainment, DBT, Government of India, 2017.