M. Sc. Microbiology

Syllabus

UNIVERSITY DEPARTMENT

Program Code: MBTB

2021 – 2022 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Program Educational Objectives (PEOs)	
The **M. Sc. Microbiology** program describe accomplishments that graduates are expected to attain within five to seven years after graduation	
PEO1	Graduate would become a microbiologist involved in research
PEO2	The candidate shall become an entrepreneur commercializing his own microbial product
PEO3	The candidate would be able to join Industries maintaining quality of products
PEO4	The candidate would be able to establish a clinical diagnostic laboratory
PEO5	The graduate can become a teacher of microbiological subjects in schools or colleges
PEO6	The graduate can become a bioprocess engineering designing fermentation processes

Program Specific Outcomes (PSOs)	
After the successful completion of M.Sc. program, the students are expected to	
PSO1	Know the role of microorganisms in human life
PSO2	Explain the causes of infectious diseases
PSO3	Capable of identifying microorganisms from various sources
PSO4	Capacity to design a fermentation process using a microbe
PSO5	Capable of constructing a recombinant strain for commercial purpose

Program Outcomes (POs)	
On successful completion of the M. Sc. Microbiology program	
PO1	Able to have a deep insight into the world of microorganisms that exist in all environments
PO2	The candidate is able to understand the pivotal role of the microorganism in science
PO3	Candidate is able to explain the role of microbes in the human health and diagnosis of infectious diseases
PO4	Able to comprehend the Importance of Microorganism in Agriculture, Environment and attain competency to get placed in industry sectors
PO5	The student is able to understand the genetics of microbes and manipulate the genes in microbes, animal and plant systems for human welfare
PO6	The student is able to genetically modify the microorganism to suit the human needs
PO7	Know about the production / fermentation process of microorganisms and commercialization of the product in Industries
PO8	Able to explain the difference between the beneficial and pathogenic microorganism
PO9	Able to emphasis the precautions to be taken at various levels of handling microbes
PO10	Able to comprehend the role of artificial intelligence in microbiological applications and attain competency in teaching techniques.

BHARATHIAR UNIVERSITY: COIMBATORE 641 046 M.Sc.,
Microbiology Curriculum (University Department)
(For the students admitted during the academic year 2021-22 *onwards)*

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
21MBTMC01	Fundamentals of Microbiology	4	50		50	50	100
21MBTMC02	Microbial Physiology and Biochemistry	4	58		50	50	100
21MBTMC03	Microbial genetics and recombinant DNA technology	4	60		50	50	100
21MBTMC04	Agricultural Microbiology	4	72		50	50	100
21MBTME12A	Elective 1 A	4	62		50	50	100
21MBTME12B	Elective 1 B		63				
10 MBTS1	Supportive 1	2	30		25	25	50
21MBTMCP01	Practical – I: Basic Microbiological Techniques	4		90	50	50	100
	Total	26			325	325	650
SECOND SEMESTER							
21MBTMC05	Immunology and Immuno techniques	4	54		50	50	100
21MBTMC06	Medical Microbiology	4	64		50	50	100
20MBTMC07	Biosafety, Bioethics , IPR and Biostatistics	4	59		50	50	100
21MBTMC08	Environmental Microbiology	4	61		50	50	100
21MBTME13A	Elective 2 A	4	72		50	50	100
21MBTME13B	Elective 2 B		52				
09 MBTS2	Supportive 2	2	30		25	25	50
21MBTMCP02	Practical – II: Advanced Microbiological Techniques	4		90	50	50	100
	Total	26			325	325	650
THIRD SEMESTER							
21MBTMC09	Bioprocess Technology	4	64		50	50	100
21MBTMC10	Pharmaceutical Chemistry	4	64		50	50	100
21MBTMC11	Food Microbiology	4	58		50	50	100
21MBTMC12	Research Techniques	4	70		50	50	100
21MBTME14A	Elective 3 A	4	70		50	50	100
21MBTME14B	Elective 3 B		54				
09MBTS3	Supportive 3	2	30		25	25	50

21MBTMCP03	Practical – II: Applied Microbiological Techniques	4		90	0	50	100
	Total	26			325	325	650
FOURTH SEMESTER							
21MBTME15A	Elective 4 A	4	30		50	50	100
21MBTME15B	Elective 4 B						
	Project viva voce*	6			75	75	150
	Industrial / Institute visit and Summer Training (Viva voce)**	2			50		50
	Total	12			175	125	300
	Grand Total	90			666	1584	2250

ELECTIVE COURSES OFFERED

Semester/ Code No.	Subject	Credits	University examination		
			Internal Mark	External Mark	Total Mark
21MBTME12A	Molecular Cell Biology	4	50	50	100
21MBTME12B	Biomolecular Metabolism	4	50	50	100
21MBTME13A	Plant Biotechnology	4	50	50	100
21MBTME13B	Animal Biotechnology	4	50	50	100
21MBTME14A	Bioinformatics and Nano-biotechnology	4	50	50	100
21MBTME14B	Good Manufacturing Practices and Quality Assurance	4	50	50	100
	FINISHING SCHOOL PAPER				
21MBTME15A	Entrepreneurship development	4	50	50	100
21MBTME15B	Teaching Techniques in Sciences	4	50	50	100

SUPPORTIVE COURSES OFFERED

Semester	Paper	Subject	Credits	Hrs Per week	University examination	
					Hrs	Max Marks
SEMESTER I	10MBTS1	Microbial Biotechnology	2	2	2	50
SEMESTER II	09MBTS2	Clinical Microbiology	2	2	2	50
SEMESTER III	09MBTS3	Food Biotechnology	2	2	2	50

JOB ORIENTED COURSES OFFERED*

Semester	Paper	Subject	Hrs Per week	University examination		Credits
				Hrs.	Max. Marks	
SEMESTER I	21MBTJOC1	Quality control Chemist-Microbiology	2	2	50	2
SEMESTER II	21MBTJOC2	Bioprocess Engineer	2	2	50	2

* Offered in collaboration with industries. The candidate will be evaluated by NSDC skill sectors and certification by NSDC

VALUE ADDED COURSES OFFERED**

Semester	Paper Code	Subject	Hrs. Per week	University examination		Credits
				Duration in Hrs.	Max. Marks	
ODD	21MBTVAC1	Genome Editing	2	2	50	2
	21MBTVAC2	Spirulina cultivation	2	2	50	2
	21MBTVAC3	Functional foods	2	2	50	2
EVEN	21MBTVAC4	Organic Farming	2	2	50	2
	21MBTVAC5	EM (Effective microorganisms) - Technology	2	2	50	2

** Offered in the department

First Semester

Course code	20MBTMC 01	FUNDAMENTALS OF MICROBIOLOGY	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Knowledge on microorganisms	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Recalling the history and theories in Microbiological Research.
Gaining information on staining and sterilization techniques.
Impart knowledge on the classification of microbes like bacteria, algae, fungi, viruses and protozoa along with their mode of nutrition and reproduction.
Learning the concept of AI in Microbiology for Industry 4.0

Expected Course Outcomes:

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

1	Gain a strong foundation on basic microbiological practices.	K3
2	Pursuing high skills and knowledge on bacterial isolation, identification and classification.	K4
3	Know about the important aspects of microbial taxonomy.	K4
4	Would be able classify and know about different microbes structure, nutrition and reproduction	K2
5	Quick process of Microbe Identification through AI	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Early History & Scope of Microbiology	8 hours

History of Microbiology- Spontaneous generation conflict - Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Winogradsky, Paul Ehrlich, Lederberg and Zinder, Lwoff, Arber and Smith, Temin and Baltimore.
Scope of Microbiology- Applications of Microbiology in various fields- Industries, Food, Agriculture, Environment, Medical and Research.

Unit:2	Microbiological Techniques	12 hours

Microscopic techniques: Principles, working mechanism and application-simple, compound, dark field and phase contrast microscope, fluorescence, SEM & TEM.
Methods of sterilization: Physical methods-Dry heat, moist heat, radiation methods, filtration methods. Chemical methods & their application. Preservation and maintenance of Microbial cultures- Lyophilization and Deep freezing.
Pure Culture Techniques: Methods of pure culture technique- Serial Dilution, Pour Plate, Spread Plate and Streaking methods.Microbiological Media- Types and composition of media.
Staining Techniques: Simple, Negative staining, Differential-Gram's staining, Capsular staining, Spore staining, Acid Fast Staining.Fungal Staining – LPCB method.

Unit:3	Microbial Taxonomy	8 hours

Domains and Kingdoms of Life- Bacterial Nomenclature- Classification of Bacteria by Physiological, Metabolic and Molecular methods. Numerical Taxonomy, 16S rRNA based classification. Bergey's Manual of Systematic Bacteriology with general characteristics of each division. Archeabacterium, Actinomycetes - Structure and Classification.

Unit:4	**Algal and Fungal Classification**	**8 hours**
General Characteristics and Classification of Algae (Fritsch Method). General Characteristics and Classification of Fungi (Alexopolus). General Characteristics and Classification of Protozoa. Structure and Reproduction of *Paramecium* sp.		
Unit:5	**Viruses- Properties and Classification**	**10 hours**
General Properties and Classification of Viruses. Cultivation of Plant and Animal Viruses, Characterization and Enumeration of Viruses- Quantitative assay. Viral Genome replication- Protein synthesis and assembly. DNA containing Plant Viruses- CaMV and Gemini Virus. RNA containing Plant Viruses- TMV, Cowpea Mosaic Viruses.		
Unit:6	**AI in Microbiology**	**2 hours**
Expert lectures, online seminars – webinars		
Application of Artificial Intelligence in Microbiology: Classification and Prediction in Microbiology- Prediction of microbial species, prediction of Environmental and host phenotypes. Application of machine learning /Artificial intelligence in Microbiology-Review article https: //doi.org/10.3389/fmicb.2019.00827 https://www.researchgate.net>2901 Classification and prediction in Microbiology Ref: Frontiers in Microbiology, Systems Biology.		
E- Learning		**2 hours**
https://www.cliffsnotes.com>biology https://www.westlab.com>blog>different sterilization methods used in the lab www.microscopemaster.com>paramecium Virology-online.com>general>replication www.immunology.org>pathogens-and-diseases>viruses...		
	Total Lecture hours	**50 hours**

Text Book(s)	
1	Dubey RC and Maheswari DK (2012). A Text of Microbiology (Revised edition). S. Chand and Company Ltd., New Delhi.
2	PelczarTR M J Chan ECS and Kreig N R (2006). Microbiology. Fifth edition, Tata McGraw-Hill INC. New York.
3	Hans G. Schlegel. General Microbiology. 7th edition. Cambridge University press (1993).
4	GeetaSumbali and Mehrotra RS (2009). Principles of Microbiology. First edition, Tata McGraw Hill P. Ltd., New Delhi.
Reference Books	
1	Prescott L M, J P Harley and DA Klein (2005). Microbiology. Sixth edition, International edition, McGraw Hill.
2	Microbiology: An Introduction, 12th Edition. Gerald J Tortora

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.cliffsnotes.com>biology

2	https://www.westlab.com>blog>different sterilization methods used in the lab
3	www.microscopemaster.com>paramecium Virology-online.com>general>replication www.immunology.org>pathogens-and-diseases>viruses...

Course Designed By: Dr.K.Preethi

COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	M	S	S	S	S	S	S	M	M	S
CO2	S	S	S	S	S	M	S	S	S	S
CO3	S	S	M	M	S	M	S	M	M	L
CO4	S	S	S	M	S	M	S	M	S	M
CO5	M	S	M	S	M	L	S	L	S	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC02	MICROBIAL PHYSIOLOGY & BIOCHEMISTRY	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Organization and metabolism of microbial cells	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
To describe the mechanism of microbial fermentation process.
To provide the information about the nutritional uptake of microbial cells.
To familiarize the energy driven process of the microbes from inorganic substances.
To know the regulatory responses of the environmental stress and changes in microbes.
To learn the basics of biochemistry

Expected Course Outcomes:

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

1	Appreciate how biochemical pathways and processes are integrated into a network, which provides robustness to life.	K2
2	Analyze the role of fermentation in the overall cell function.	K4
3	Describe how the microbes can regulate their structure and metabolism in response to environmental stimuli.	K3
4	Design, carry out, and report on lab experiments in microbial metabolism and microbial regulation.	K5
5	To learn about the enzymes and co-enzymes	K2
6	Machine learning in analysis of interaction between microbes	

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Mode of Nutritional Uptake	10 hours

Entry of nutrition in the cell, passive diffusion, facilitated diffusion and different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms and their mechanisms. Utilization of nutrients that cannot enter the cell.

Unit:2	Principles of microbial metabolism, Bioenergetics, Energy from visible radiation	12 hours

Methods used to study, microbial metabolism – nutrient balance, metabolically blocked microbes; radiolabelled compounds.

Energy yielding metabolism – Energy from organic compounds – carbohydrates – aerobic (EMP, HMP, ED, TCA, ET) in prokaryotes and eukaryotes; complete oxidation.

Photosynthesis in eukaryotes, blue-green algae, bacteria.

Unit:3	Anaerobic Fermentation, Energy from Inorganic Compounds	12 hours

Anaerobic fermentation – alcoholic fermentation, propionic acid fermentation, formic acid fermentation.

Electron Transport in chemolithotrophs - ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera., production of reducing power in chemolithotrophs - Oxidation of molecular hydrogen by Hydrogenomonas species Ferrous and sulfur/sulfide oxidation by Thiobacillus species.

Unit:4	Stress Physiology	10 hours
Effect of oxygen toxicity ,pH, osmotic pressure, heat shock etc on bacteria Adaptations in thermophiles, halophiles ,alkaliphiles ,acidophiles , Extremophiles – adaptations & significance in biotechnology.		
Unit:5	**Enzymes and co –enzymes**	**8 hours**
IUBMB classification and nomenclature of enzymes, active site, Lock and key Machanism and induced fir hypothesis, Enzyme kinetics- enzyme inhibition: Reversible – Competitive, Noncompetitive, uncompetitive, Irreversible inhibition.		
Unit:6	**AI in Microbial Physiology**	**4 hours**
Expert lectures, online seminars – webinars		
Machine Learning Algorithms for single cell imaging, Flux balance analysis on biosynthesis. ML approaches for microbial structure and functional analysis. Raman, K., & Chandra, N. (2009). Flux balance analysis of biological systems: applications and challenges. *Briefings in bioinformatics*, *10*(4), 435-449. https://www.nature.com/articles/single cell imaging Copeland, W. B., Bartley, B. A., Chandran, D., Galdzicki, M., Kim, K. H., Sleight, S. C., ... & Sauro, H. M. (2012). Computational tools for metabolic engineering. *Metabolic engineering*, *14*(3), 270-280.		
E-learning		**2 hours**
https://ocw.mit.edu/courses/biology/7-343-sophisticated-survival-skills-of-simple-microorganisms-spring-2008/ https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/ Enzymes and catalysis https://swayam.gov.in/nd2_cec20_bt14/preview - Microbial Physiology & Metabolism https://swayam.gov.in/nd2_cec20_ag01/preview - Nutritional & Clinical Biochemistry		
	Total Lecture hours	**58 hours**

Text Book(s)	
1	Microbial Physiology, 4thEdition Michael P. Sector),Albert G. Moat(Editor),John W. Foster(Editor),Michael P. Spector
2	Chemical microbiology –An introduction to microbial physiology –AH Rose, Butterworth, London
Reference Books	
1	Brock Biology of Microorganisms (14thEdition) Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley,David A. Stahl, January 12, 2014; ISBN-10:0321897390; ISBN-13:978-0321897398
2	The Physiology and Biochemistry of Prokaryotes-4thEdition David White, James Drummond ,Clay Fuqua,December 2011
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://ocw.mit.edu/courses/biology/7-343-sophisticated-survival-skills-of-simple-microorganisms-spring-2008/
2	https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/Enzymes and catalysis

3	https://swayam.gov.in/nd2_cec20_bt14/preview - Microbial Physiology & Metabolism
4	https://swayam.gov.in/nd2_cec20_ag01/preview - Nutritional & Clinical Biochemistry

Course Designed By: Dr.V.S.Gnanambal

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	S	L	M	M	M	L	S	L
CO2	M	L	S	L	S	L	L	S	S	L
CO3	S	L	L	L	S	L	L	L	L	L
CO4	M	L	L	L	M	L	L	S	L	L
CO5	L	L	M	M	L	L	L	L	L	L
CO6	L	L	L	L	M	L	L	M	L	L

Course code	20MBTMC03	MICROBIAL GENETICS AND rDNA TECHNOLOGY	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite	Should have the knowledge about the structure of DNA		Syllabus Version	2021-22		

Course Objectives:

The main objectives of this course are to:
Understand the mechanism of genetic mutations
Recalling the molecular genetics concepts and genetic transformation
To familiarize gene expression in prokaryotes
To learn gene cloning strategies and expression analysis
Applications of recombinant DNA technology in various fields

Expected Course Outcomes:

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

1	tify and distinguish genetic regulatory mechanisms at different levels	K3
2	Differentiate between natural and artificial transformation in prokaryotes	K4
3	Design a vector for cloning	K5
4	Construct a recombinant strain for expression studies	K6
5	Understand the mechanism of gene based diagnostic kits	K2
6	Decipher the genetic mutation	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	ORIGIN OF MICROBIAL GENETICS	10 hours

Mutations - Luria and Delbruck‟s Fluctuation Test; Types: Spontaneous mutations – nonsense (cystic fibrosis), missense (sickle cell anemia), frame-shift mutations (Taysach's disease), insertion (Huntington's disease) , deletion (Turner syndrome), duplication (Cri du chat), repeat expansion (Kennedy's disease); Induced mutagenesis - Physical agents (UV, X-Rays) (non melanoma skin cancer, Muller's discovery), Chemical agent (Base analogs: direct mutagenesis; Nitrous acid: deaminates C to produce U and guanine analog; Alkylating agents and Arylating agents produce lesions (indirect mutagenesis); Intercalators: insertion and deletion mutations); Suppression of nonsense, missense and frame-shift mutations-Intragenic and extragenic suppressions of mutations-modern aspects-structure and function relationship**; DNA mutation diagnosis**: allele specific oligonucleotides (ASO), protein truncation test, single strand conformational polymorphism (SSCP), Nucleotide sequencing, Denaturing gradient gel electrophoresis, heteroduplex analysis, DNA micro array analysis; Reversion - AMES Test

Unit:2	GENE TRANSFER IN BACTERIA	12 hours

Transformation - discovery and its significance- factors involved in competence and recombination, joint transformation and its uses; **Conjugation** - F+ and F⁻ nature of *E.coli*; Origin of Hfr and F‟ strains - Zygotic induction -Chromosome transfer by Hfr - circular nature of *E.coli* DNA -Use of Hfr strains in genetic mapping; **Transduction** - Specialized transduction and λ phage - Generalised transduction - P1 phage-origin of transducing particles, Co-transduction-fine structure mapping of genes by P1 transduction-Wu's Formula-Ratio Test, C-value paradox; **Transposons**: Types - class II, class I (Retrotransposons); Mechanism; Characteristics; regulation of transposition; **Prokaryotic DNA Replication**- Semiconservative mechanism, Rolling circle, Replication phases – initiation, elongation, termination; **DNA damage** - SOS response, DNA repair; **DNA damage detection strategies** TUNEL assay, Immuno dot-blot assay, NMR spectroscopy

Unit:3	ELUCIDATION OF GENETIC CODE	10 hours
Benzer, Khorana and Crick‟s contributions-Triplet nature of the Genetic code and Adaptor hypothesis-Wobble hypothesis; **Prokaryotic transcription** – Initiation, elongation and termination, regulation; **Prokaryotic translation** and regulation; Regulation of gene expression- well studied operon models-*lac*, *trp* and *ara* operon		
Unit:4	**BASICS OF r-DNA TECHNOLOGY**	**10 hours**
Restriction enzymes and their role in r-DNA technology - Restriction-modification system methylase, ligase, adaptors, linkers, homopolymer tailing; **Vectors**: Plasmids (pBR 322) Bacteriophages (λ, M13) mediated vectors; Eukaryotic expression vectors, prokaryotic expression vectors; Vectors for protein over expression, protein secretion and controlled expression; **Cloning strategies**: Cloning into gram negative, gram positive bacteria and Yeast; Screening of recombinants- α complementation and blue-white selection.		
Unit:5	**APPLICATION OF rDNA TECHNOLOGY**	**10 hours**
Types of PCR - Real-Time PCR (quantitative PCR or qPCR), Reverse-Transcriptase (RT-PCR), Multiplex PCR, Nested PCR, High Fidelity PCR, Fast PCR, Hot Start PCR, GC-Rich PCR; **Library construction** - Construction of cDNA Library - use of phagemids and Cosmids; **Genome editing**: Double stranded DNA breakage - Homologous recombination - Non homologous recombination - site specific recombination - engineered nuclease - mega nucleases, Zinc finger nucleases, TALEN, MAGE – CRISPR; Base editing **DNA sequencing**- DNA and RNA hybridization- Southern and Northern blotting - Sangers method - Basics of pyrosequencing, Next Generation Sequencing strategies - western blotting for proteins; **Application** in human genetics and forensic science - RAPD, RFLP, AFLP, SSCP, Dot and colony blotting		
Unit:6	**AI in rDNA technology**	**6 hours**
Expert lectures, online seminars – webinars		
Machine Learning in Genomics – Current Efforts and Future Applications Synthetic Biology, Artificial Intelligence, and Quantum Computing DNA as digital storage tool		
E-learning		**2 hours**
https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3 Genetic Engineering & r DNA technology – site directed mutagenesis Cloning strategies Molecular therapeutics – gene editing, gene regulation and gene silencing https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2 Molecular Biology, genetic engineering & Biotechnology – DNA repair; DNA damage; Genetic recombination		
	Total Lecture hours	**60 hours**

Text Book(s)

1	Principles of Gene Manipulation and Genomics- S.B.Primrose and R.M.Twyman, John Wiley & Sons Ltd, 7th edition, 2006
2	Molecular Genetics: An introductory narrative, Second Edition - Gunther.S.Stent and Richard Calendar, 2002. CBS Publishers and distributors.
3	Gene cloning and DNA anlaysis, T.A. Brown, John Wiley & Sons, 2013

Reference Books

1	Microbial Genetics, Stanley R Maloy; John E Cronan; David Freifelder, Boston : Jones and Bartlett Publishers, second edition, ©1994.

2	A Short Course in Bacterial Genetics: A Laboratory Manual and Handbook for Escherichia coli and Related Bacteria- Jeffrey. H. Miller, 1992.CSHL Press
3	Genetics of microbes**,** Brian W. Bainbridge, **DOI**https://doi.org/10.1007/978-1-4615-7093-6
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://swayam.gov.in/nd1_noc20_bt32/preview - Genetic engineering
2	Synthetic Biology, Artificial Intelligence, and Quantum Computing DOI: http://dx.doi.org/10.5772/intechopen.83434
3	Machine Learning in Genomics – Current Efforts and Future Applications https://emerj.com/ai-sector-overviews/machine-learning-in-genomics-applications/
4	DNA digital data storage https://geneticeducation.co.in/dna-digital-data-storage/; https://www.nature.com/articles/s41576-019-0125-3
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Course Designed By: Dr. J. Angayarkanni	

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	S	L	L	L	L	S	M	L	L
CO2	M	S	L	L	L	L	S	S	L	L
CO3	L	L	L	L	L	L	S	S	M	L
CO4	L	L	L	L	L	L	S	S	M	L
CO5	L	L	L	M	L	L	S	S	L	L
C06	L	L	L	L	L	L	S	S	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC04	AGRICULTURAL MICROBIOLOGY	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite		Basic knowledge in microbiology and agriculture	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
To gain knowledge about fundamentals of Agriculture Microbiology.
To understand the concept of microbial interactions with plants and diseases caused by microbes.
To learn about Biopesticides, Bioherbicides and Biofertilizers.
To learn the scope and applications of Artificial intelligence and Machine learning in agricultural microbiology
To learn about role of earth worms-microbes interactions.

Expected Course Outcomes:

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

1	Gain wide information about agricultural microbiology.	K3
2	Able to formulate, produce and guide the usage of biopesticides, bioherbicides and biofertilizers to the needy farmers	K6
3	Able to understand the scope and applications of AI & ML.	K4
4	Able to start small scale industries on spirullina and mushroom cultivation.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	BASICS OF SOIL MICROBIOLOGY	10 hours

Soil Microbiology-Structure, Types, Physical and Chemical properties-Soil microbes (Types and Enumeration)-Weathering and Humus formation, Soil pollution-Sources. Biogeochemical cycling-Nitrogen, Carbon, Phosphorous, Sulphur, Iron cycles and its importance.

Unit:2	MICROBIAL INTERACTIONS	15 hours

Microbial interaction-among microbes- Neutralism, Commensalism, Symbiosis, Synergism, Amensalism, Parasitism, Predation and Competetion. With plants- Phyllosphere, Rhizosphere, Mycorhizzae - vesicular arbuscular mycorrhizae -VAM) - ecto, endo, ectendomycorrhizae .
Symbiotic and free-living nitrogen fixers (Rhizobium, Azotobacter, Azospirillum, Frankia, BGA and Azolla -Phosphate solubilizers (Phosphobacterium and Aspergillus) Interrelationships between soil microbes and plants, Rhizosphere concept, R:S ratio, rhizoplane; spermosphere; phyllosphere, Mycorrhizae-types, Rumen flora, Insects microbial interactions.

Unit:3	PHYTOPATHOLOGY	10 hours

Phytopathology – Classification of plant diseases, signs, and related terminology. Bacterial disease – Citrus canker, Blight of paddy, Fungal Disease- Red rot of sugarcane, Black stem rust of wheat, Tikka leaf spot, Wilt of cotton, Viral Disease – TMV, Vein clearing disease. Principles and methods of plant disease management, integrated plant disease management.

Unit:4	BIOCONTROL AGENTS	10 hours

Interaction of pesticides with soil microorganisms. Biopesticides- *Bacillus thuringiensis*, *B. Sphaericus, B. Popilliae, Psuedomonassyringae*. Microbial control of plant pathogens- *Trichoderma,* Use of Baculovirus, NPV virus, Protozoa & Fungi in biological control. Microbial herbicides-Useful genes from microorganisms for agriculture (Herbicide resistant, Bt, Viral). Agricultural antibiotics.

Unit:5	SYMBIOTIC MICRO OR GANISMS	13 hours
Earthworms and microorganisms- The effects of earthworms on the number, biomass and activity of microorganisms, Role of Earth worms in organic agriculture. Production, formulation, packing and marketing of single cell proteins (mushrooms, spirullina and yeast); Biofertilizers- Introduction, biofertilizers using nitrogen fixing microbes- phosphate solubilisation- Rhizobium, Azospirillum, Azolla; Anabaena symbiosis, Blue green algae and Ecto and Endomychorizae. Cultivation, mass production and inoculation of Rhizobium, Azobacter, Azospirillum, Azolla and Cyanobacteria, Carrier- based inoculants, methods of application, quality control and agronomic importance. Application methods. Microorganisms for Bioassay and Biological warfare.		
Unit:6	**AI in Agricultural microbiology**	**12 hours**
Expert lectures, online seminars – webinars		
Scope of Artificial intelligence (AI) -Disease detection-health monitoring of crops. Applications of machine learning (ML)-prediction of microbial species-microbial communities to predict disease-interaction between microbes; Microbiome –disease association.		
E-learning		**2 hours**
https://apsjournals.apsnet.org/doi/full/10.1094/PDIS-03-15-0340-FE https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6482238/ https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0215502 https://www.frontiersin.org/articles/10.3389/fmicb.2019.00827/full https://www.softwebsolutions.com/resources/plant-diseases-detection-using-iot.html		
	Total Lecture hours	**72 hours**

Text Book(s)	
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 D.J.Bagyaraj, Prentice Hall India.
3	Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. SubbaRao.
4	Microbes for Sustainable Agriculture by K.V.B.R. Tilak, K.K. Pal, RinkuDey
5	Soil Microbiology and Plant Growth, 1995, by N.S. SubbaRao.
6	Plant Growth and Health Promoting Bacteria by Dinesh K. Maheshwari
Reference Books	
1	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
2	Plant-microbe interactions and biological control Volume 63 of Books in soils, plants, and the environment by Greg J. Boland, L. David Kuykendall
3	Plants, genes and agriculture by M.J. Chrispeels and D.F. Sadava.2000.The American Scientific Publishers, USA.
4	Practical Application of Plant Molecular Biology by R.J. Henry.1997. Chapmans and Hall.
5	Plant Biotechnology and Transgenic Plants, Edited by Kirsi-MarjaOksman- Caldentey and Wolfgang H. Barz. 2002, Marcel Dekker, Inc. New York.
6	Chauhan, A. (2012)Vermitechnology, Vermiculture, Vermicompost and Earthworms: Vermiculture, Vermicomposting, Vermitechnology and Mirobes,Lambert Academic Publishing, Germany

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/126/105/126105014/
2	https://swayam.gov.in/nd1_noc19_ag04/preview
3	https://www.youtube.com/watch?v=-UFiFpMxM3M
4	https://www.youtube.com/watch?v=mU1tlx0JGM8
5	https://www.youtube.com/watch?v=gsH3kR-6mG4
6	http://agrimoon.com/agricultural-microbiology-icar-ecourse-pdf-book/
7	https://www.youtube.com/watch?v=U9sDkDhmf08
8	https://www.frontiersin.org/articles/10.3389/fpls.2019.01457/full
9	https://www.youtube.com/watch?v=8YuqlgsC4ns
10	https://www.frontiersin.org/articles/10.3389/fpls.2016.01419/full

Course Designed By:**Dr.G.KAPILDEV**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	S	S	M	L
CO2	L	M	M	M	L	S	L	S	M	M
CO3	L	L	L	L	L	S	L	S	L	L
CO4	M	L	L	M	L	S	M	S	M	M

*S-Strong; M-Medium; L-Low

Course code	20MBTMCP1	BASIC MICROBIOLOGICAL TECHNIQUES	L	T	P	C
Practical -I			-	-	6	4
Pre-requisite	Basic Knowledge in handling of Microbial cultures		Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Hands on training on staining and sterilization techniques.
To prepare microbiological media for organism isolation and cultivation.
Identify the bacterial culture through microscopic and Biochemical techniques.
Gain adequate knowledge on various intrinsic factors of growth and growth rate of bacteria

Expected Course Outcomes:

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

1	Gain a strong foundation on basic microbiological techniques.	K3
2	Pursuing high skills and hands on training on bacterial isolation and identification.	K4
3	Acquires knowledge on various intrinsic factors of growth and growth rate of bacteria.	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Media preparation – Liquid and Solid media, Agar deep, slant and plate.
Pure culture techniques – Streak plate, pour plate, spread plate, decimal dilution.
Motility determination- soft agar inoculation.
Enumeration of microorganisms from soil: Bacteria, Fungi and Actinomycetes.
Staining: Smear fixation, Simple, Gram, Spore, Capsule and Negative and LPCB
Growth curve and Effect of various intrinsic factors such as pH, Temperature on the growth of Bacterium-Spectroscopic method
Anaerobic culture techniques; Mc IntoshFildes anaerobic jar, Wright‟s tube method.
IMVIC test
Hydrogen sulphite test
. Oxidase test
. Catalase test
. Urease test
. Nitrate reduction test
. Polymer degradation – Starch, Gelatin, Casein.
. Carbohydrate fermentation.
. Observation of mitotic cell division using onion root tips -Demo.

Total Practical hours	**90 Hours**

Reference Book(s)

1	Cappuccino, J and Sherman, N. (2014) Microbiology. A Laboratory Manual. 10th Edition. Pearson Education Publication, New Delhi
2	Emanuel Goldman and Lorrence H. Green (2015) Practical Hand Book of Microbiology, 3rdEdition, CRC Press. Taylor and Francis Group.
3	Alfred E. Brown (2010) Benson's Microbiological Applications: Laboratory Manual in General Microbiology, 11th Edition, McGraw-Hill Companies.
4	Practical Microbiology- Dr.D.K.Maheshwari and Dr.R.C.Dubey

E –Learning
Labster.com/microbiology-virtual-labs/ http://www.microbiologyonline.org.uk/media/...sgm_basic_practical_microbiology_2.pdf_
Course Designed By: Dr.K.Preethi

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	S	S	S	S	M	M	S
CO2	S	S	S	M	S	M	M	S	S	S
CO3	S	S	M	M	S	M	M	M	M	L

*S-Strong; M-Medium; L-Low

Second Semester

Course code	20MBTAC05	IMMUNOLOGY AND IMMUNO-TECHNIQUES	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Prior exposure to immune system and its related disease and immunity	Syllabus Version		2021-22	

Course Objectives:

The main obctives of this course are to:
Provide knowledge on the mechanism of action of immune system.
Understanding principle and methodology of various immunological techniques.
Learning the fundamental mechanism behind organ transplantation, autoimmune disorders and hypersensitive reactions.
To learn about various vaccines and vaccination methods.
Perceiving information on Artificial intelligence in Immunotherapy.

Expected Course Outcomes:

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

1	Able to understand the structure, function, principles and practices outlining various key concepts in immunology.	K2
2	Equipped to perform various immunological assays.	K3
3	Learning the result of immunotherapy using AI	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Immunity and Types	8 hours

History and Scope of Immunology, Immunity:Types-innate and acquire, active and passive, Cell mediated and Humoral Immunity. Hematopoiesis- origin, development and differentiation of immune cells.

Unit:2	Cells and Organs of the Immune System	10 hours

Lymphoid organs and tissues. Cells of the immune system: Macrophages, B and T lymphocytes-Activation and types, Dendritic cells, Natural Killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils, Mast cells. Antibody- Production, Primary and Secondary antibody response. Immunoglobulin- structure, types and functions. Antigen- types. Haptens, adjuvants, carriers, Bacterial, Viral and Tumour antigens, autoantigens, blood group antigens and Rh factors.

Unit:3	Immunological Techniques	10 hours

Antigen-Antibody reactions. Factors governing antigen-antibody interactions; affinity, avidity, valency, cross reactivity. Applications of Immunological techniques- Immunofluorescence, RIA, RAST, ELISA and Flowcytometry. Structure and Functions of MHC molecules. Response of B cell to antigen. T cell products.

Unit:4	Transplantation Immunology	10 hours

The complement systems: Mode of activation and pathways. Transplantation immunology: MLR, HLA Typing. Bone marrow transplantation, organ transplants. Cancer of the immune system and Tumor immunology. Autoimmune disorders. Immunology of infectious diseases – Viral, Bacterial and protozoan. Immunodeficiency diseases.

Unit:5	Vaccines and Immunotherapy	10 hours

Hypersensitivity reactions and types. Immune tolerance and suppression.

Immunotherapy.Hybridoma technology- Monoclonal Antibody production and applications in diagnosis and therapy. Catalytic antibodies. FACs., Vaccine Technology in Immunotherapy.

Unit:6	**AI in Immunology**	**4 hours**

Expert lectures, online seminars – webinars

Artificial Intelligence in Autoimmune diseases
Artificial Intelligence in Immunotherapy.
A systematic review of the applications of artificial intelligence and machine learning in autoimmune diseases. npj Digital machine 3, Article no: 30, (2020)
Artificial intelligence in immunotherapy- Artificial intelligence predicts response to immunotherapy. Written by Caitlin William. Labroots.com 2018, Immunology.
Using artificial intelligence to determine whether immunotherapy is working. https:// www.sciencedaily.com 2019
https:// www.tandfonline.com

E Learning **2 hours**

History of Immunology - link.springer.com>chapter
Applications of modern immunological techniques – link.springer.com>chapter
Applications of Immunology- www.lamission.edu>lifesciences>steven
Immunity types- health.mil>clinical-consultation-services>Immunology
www.narayanahealth.org>organ-transplant

Total Lecture hours **54 hours**

Text Book(s)

1	Rao, C.V. (2012) An Introduction to Immunology. 2nd Edition, Narosa Publishing House, India.
2	Janeway, C.A., Travers, P., Walport, M. and Shlomchik, M.J. (2001) Immunobiology: The Immune System in Health and Disease, 5th Edition, Garland Publishing, USA.
3	Immunology, an Introduction: Tizard, Ian R, 1984

Reference Books

1	Kubey, J. 1993. Immunology Freeman and company.
2	Ivan M. Roitt and Peter J. Delves (2016) Essential Immunology, 13th Edition, Blackwell Science Ltd. Oxford.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Immunology - Swayam.gov.in/nd1_noc20_bt43/preview
2	Immunology - Swayam.gov.in/nd2_cec20_bt05/preview
3	www.helmberg.at>immunology

Course Designed By:Dr. K. Preethi

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	S	L	L	M	M	L	L	M
CO2	L	L	M	M	L	L	L	L	L	S
CO3	L	L	M	L	L	M	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC06	MEDICAL MICROBIOLOGY	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite		Basic Knowledge on microbial pathogens and its diagnosis	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
derstand basic information on bacterial, fungal and viral diseases.
a knowledge on parasites
an awareness on the infection caused by the organisms

Expected Course Outcomes:

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

1	Gain wide information regarding various types of bacterial and viral infections.	K2
2	Identify proper diagnosis and treatment of various infections caused by pathogens	K4
3	Make appropriate and effective on-the-job professional decisions in the processing of clinical samples.	K5
4	Differentiate the proper and inappropriate sample for analysis	K5
5	Apply the role of AI in Diagnostics	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction to infectious Diseases and Diagnosis	12-- hours

Introduction to infectious Diseases-Milestones in Medical Microbiology - Infectious Diseases process –Virulence factors of bacteria – Host parasite relationship- Normal microflora.
Diagnosis – Process of sample collection, transport, examinations and discarding of clinical specimens. Antibiogram and serological test. Diagnostic methods- non-cultured: PCR based microbial typing: Eubacterial identification based on 16s rRNA sequences-Amplified ribosomal DNA Restriction analysis (ARDRA)-Culture independent analysis of bacteria-DGGE and TRFLP; Molecular diagnosis of fungal pathogens based on 18s rRNA sequences; Detection of viral pathogens through PCR.

Unit:2	Bacteriology	14-- hours

Bacteriology: Gram positive organisms - Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of Staphylococcus aureus, Streptococccus pyogenes, Pneumococcus, Bacillus anthracis, Corynebacterium diphteriae, Mycobacterium tuberculosis, Mycobacterium leprae. Spirochaetes – Treponema pallidum. Gram negative organisms:- Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of E. coli, Klebsiella pneumoniae, Salmonella typhi, Shigella dysentriae, Pseudomonas aeruginosa, Vibrio cholerae, Bordetella pertusis, Neiserria gonorrhoeae, and Neiserria meningitidis.

Unit:3	Mycology	8-- hours

Mycology: General properties and approaches to laboratory diagnosis. Mycosis – Superficial, Subcutaneous and Systemic infections – Cryptococcosis, Madura mycosis, Histoplasmosis, Candida albicans, Aspergillosis and Blastomycosis.

Unit:4	Parasitology	8-- hours

Parasitology: Life cycle, Pathogenicity and laboratory diagnosis of Entamoeba histolytica, Trichomonas vaginalis, Plasmodium vivax, Leishmania donovani, Taenia solium, Ascaris lumbricoides, Enterobious vermicularis and Wucheraria bancrofti.

Unit:5	Virology	12-- hours
Virology: Pathogenesis and laboratory diagnosis of: DNA containing animal viruses - Adeno viruses, Herpes viruses-type-I and type-II, Pox viruses – Variola virus. RNA containing animal viruses: Picorna virus, Rhabdo virus, Hepatitis viruses -A, B and C, Orthomyxo virus – Influenza H1N1, Paramyxovirus, Retroviruses – HIV, Rubella virus and Corona virus, Arbo virus – Dengue virus, Ebola virus, Prions.		
Unit:6	**Contemporary Issues**	**10 hours**
Expert lectures, online seminars – webinars		
AI in PCR diagnosis AI in Bioimaging		
	Total Lecture hours	**64 hours**

Text Book(s)	
1	Textbook of Microbiology – Ananthanarayanan and Jayaram Panicker
2	Textbook of Medical Parasitology – Subash. C. Parija
3	Medical Microbiology - Geo. F. Brooks.
4	Medical Mycology – Jagadesh Chander.
Reference Books	
1	Manual of Clinical Microbiology – Lenetle, E, Balows H.A
2	Essentials of Diagnostic Microbiology – Lisa Anne Shimeld, Anne T. Rodgers,
3	Bailey and Scott‟s Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby
4	Fundamental of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Sauders group
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Analytical Techniques: https://www.classcentral.com/course/swayam-analytical-techniques-13896
2	MedicalMicrobiology: http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/248
Course Designed By: Dr. V. Brindha Priyadarisini	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	L	L	L	L	M	S
CO3	M	M	S	L	L	L	L	L	S	S
CO3	M	M	L	L	L	L	L	L	S	S
CO4	L	L	L	L	L	L	L	L	S	M
CO5	L	L	L	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC07	BIOSAFETY, BIOETHICS, IPR & BIOSTATISTICS	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite		Rights and responsibilities of persons	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:

Study of the ethical issues emerging from advances in biology and medicine.

To address a broad swathe of human inquiry; ranging from debates over the boundaries of life

Get acquainted with principles of biosafety and gain knowledge about basic and advanced laboratory practices and safety precautions followed during biotechnological work.

Gain Ethical, Legal and Social Implications of Human Genome Project

Expected Course Outcomes:

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

1	erstand safety and ethical issues raised for GM crops and human cloning.	K2
2	Acquire knowledge of long-standing social and moral value system of our society.	K1
3	Apply the biosafety aspects in various health-care systems as hospitals, diagnostic laboratories, animal care systems, biological laboratories.	K3
4	Protection of ideas, businesses and individuals to reap the full benefits of their inventions.	K3
5	Disentangle the data received and make valid inferences.	K5
6	Approach to AI grounded in IPR, medical ethics, innovation and economic growth.	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Introduction to Bioethics	8 hours

Perspective of Ethics, Personal vs professional ethics: Moral Reasoning – Ethical theories Deontological, Utilitarianism, Virtue ethics – Ethical leadership (integrity and ingenuity) - framework for ethical decision making- Michael Macdonald model & Storch model.

Unit:2	Biotechnology & Ethics	12 hours

Biotechnology in agriculture and environment: GM crops and GMO's - benefits and risks – ethical aspects of genetic testing – ethical aspects relating to use of genetic information and bio-warfare. Ethical implications of cloning -Reproductive cloning, therapeutic cloning; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Biotechnology and biopiracy – ELSI of human genome

Unit:3	Introduction to Biosafety	10 hours

Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containment

Unit:4	Introduction to IPR	12 hours

Types, patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).

Unit:5	Basics of Biostatistics	12 hours

Definition-Scope of Biostatistics, Measures of central tendency- Arithmetic Mean, Median, Mode. Measures of Dispersion, Standard deviation, Standard error, Correlation & Regression. Basic ideas of

significant testing- Hypothesis testing, Level of significant test, t test, chi square.		
Unit:6	**AI in Bioethics, Biosafety & IPR**	**3 hours**
Expert lectures, online seminars – webinars		
AI for identification of documentation forging. Machine learning algorithms for IPR screening and classification, Medical ethics considerations on AI. https://www.allerin.com/blog/ai-based-forgery-is-now-a-reality-heres-how-you-can-counter-it Aristodemou, L., & Tietze, F. (2018). The state-of-the-art on Intellectual Property Analytics (IPA): A literature review on artificial intelligence, machine learning and deep learning methods for analysing intellectual property (IP) data. *World Patent Information*, *55*, 37-51. Keskinbora, K. H. (2019). Medical ethics considerations on artificial intelligence. *Journal of Clinical Neuroscience*.		
E-learning		**2 hours**
https://ocw.mit.edu/courses/linguistics-and-philosophy/24-06j-bioethics-spring-2009/ - bioethics-study material of MIT https://shodhganga.inflibnet.ac.in/handle/10603/83393 - Biomedical ethics **SWAYAM Course** https://swayam.gov.in/nd1_noc19_bt19/preview- Introduction to Biostatistics https://swayam.gov.in/nd2_imb19_mg18/preview - Intellectual Property.		
	Total Lecture hours	**59 hours**

Text Book(s)	
1	Bioethics by Shaleesha A Stanley (Author),Wisdom Educational Service (Publisher),2018.
2	Bioethics and Biosafety by Sateesh MK, I K International Publishing House Pvt. Ltd ISBN: 9788190675703.
Reference Books	
1	Principles of cloning, 2nd E6dition, Jose Cibelli, Robert Lanza , Keith H.S. Campbell, , Michael D. West, 2013
2	Ethics in Engineering 4th Edition by Martin, Mike W.; Schinzinger, Tata McGraw Hill Science, 2005
3	Introductory Biostatistics, 2nd Edition - Chap T. Le, Lynn E. Eberly,ISBN: 978-0-470-90540-1 June 2016 .
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://ocw.mit.edu/courses/linguistics-and-philosophy/24-06j-bioethics-spring-2009/ - bioethics-study material of MIT
2	https://shodhganga.inflibnet.ac.in/handle/10603/83393 - Biomedical ethics
3	https://swayam.gov.in/nd1_noc19_bt19/preview- Introduction to Biostatistics
4	https://swayam.gov.in/nd2_imb19_mg18/preview - Intellectual Property
Course Designed By: Dr.V.S.Gnanambal	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	L	L	M	M	L	L	L	S	L
CO2	L	L	L	L	L	L	L	L	M	L
CO3	M	L	M	L	M	L	L	L	M	L
CO4	M	L	M	M	S	L	L	L	M	L
CO5	L	L	M	L	M	L	L	L	L	L
CO6	L	L	L	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC08	ENVIRONMENTAL MICROBIOLOGY	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Aware of environmental problems	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:

- e main objective is to understand the role of microbes in biogeochemical processes in different ecosystems.
- give information about various pollution sources and preventive measures to control pollution.
- learn in depth of various effluent treatments
- cognise and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.

Expected Course Outcomes:

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

1	Understand the various concepts of ecology	K2
2	Aware of biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved	K2
3	Capable to assess the quality of water	K3
4	Able to analyze solid waste management by various methods	K4
5	Apply the various effluent treatment methods	K3
6	Monitor the health status of ecosystems using AI	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Basic Concepts of Ecology	10 hours

Interaction between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and tropic levels; Ecological pyramids and recycling, biotic community-concept, structure, dominance, fluctuation and succession; N.P.C and S cycles in nature. Soil Microbiology-Structure, Types, Physical and Chemical properties-Soil microbes (Types and Enumeration)-Weathering and Humus formation, Soil pollution-Sources.

Unit:2	Aerobiology	12 hours

Aerobiology-Microbial contamination of air-Sources of contamination-Biological indicators of air pollution. Enumeration of bacteria from air, Air sampling devices. Significance of air Microflora, Air sanitation. Air pollution : Types, source, method of sampling, measurement, impact on ecosystem and control. Control of noise and air pollution by biotechnological methods. Gaseous pollutants and odours: General sources, methods of control; fundamentals of adsorption, mechanism of adsorption.Application of adsorption for control of gaseous and odour emission. Noise pollution: Source, measurement, impact on ecosystem and control.

Unit:3	Aquatic Microbiology	12 hours

Microbiology of water (Aquatic environment-Fresh and Marine)-Water pollution: Impurities in water, water pollution by industrial waste, examination of water, collection of water samples, water analysis – physical, chemical and biological. Assessment of water quality (Chemical and Microbial-indicator organisms) Water treatment processes: Primary treatment, screening, skimming with coagulants, flocculation, filtration, aeration and disinfection; Secondary treatment: Aerobic processes – activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, Up flow anaerobic sludge blanket reactors; Tertiary treatment: Activated carbon treatment, reverse osmosis and electro dialysis. Water borne pathogens.

Unit:4	Solid Waste Management	10 hours
Sewage sludge treatment and utilization, refuse disposal, excreta disposal in unsewered area; composting and vermiculture.; bioconversion of cellulosic wastes into protein and fuel ;biodegradation of noncellulosic wastes for environmental conservation; bioaugmentation and biostimulation,; biodegradation of xenobiotics; bioremediation of contaminated soils and waste lands; radioactive product waste disposal.		
Unit:5	**Effluent Treatment**	**12 hours**
Case studies: Sources of pollution, impact on ecosystem and treatment of following industrial effluents: starch, paper and pulp, tannery, dairy, textile, distillery, oil refineries and pharmaceutical. Significance of ETP, STP, AHU, Bio inactivation plant. Microbes in mining, ore leaching, oil recovery, biopolymers, biosurfactants.		
Unit:6	**AI in Environmental Microbiology**	**3 hours**
Expert lectures, online seminars – webinars Artificial Intelligence in monitoring the environment, species protection, saving energy and efficient agriculture. Hsieh, William. (2009). Machine learning in the environmental sciences. Neural networks and kernels. https://doi.org/10.1017/CBO9780511627217.		
E-learning		**2 hours**
https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14 Environmental Science – All modules https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/syllabus/ Environmental Microbiology – study materials of MIT **Swayam course** https://swayam.gov.in/nd1_noc20_ce17/preview - Applied Environmental Microbiology		
	Total Lecture hours	**61 hours**

Text Book(s)	
1	Environmental Biotechnology by Alan Scragg.(2005). IInd edition. Pearson Education Limited, England.
2	Environmental Biotechnology by S.N. Jogdand. (1995). Ist edition. Himalaya Publishing House.Bombay.
Reference Books	
1	Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata McGraw Hill, NewDelhi.
2	Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi.
3	Introduction to Biodeterioration by D. Allsopp and k.J. Seal, ELBS/Edward Arnold.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=14 Environmental Science – All modules
2	https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/syllabus/ Environmental Microbiology – study materials of MIT
3	https://swayam.gov.in/nd1_noc20_ce17/preview - Applied Environmental Microbiology

Course Designed By: Dr.V.S.Gnanambal

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	L	L	S	L	L	L	L	L
CO2	S	L	L	L	S	L	L	L	L	L
CO3	M	L	M	M	S	L	L	L	M	L
CO4	M	L	M	M	S	L	L	L	M	L
CO5	M	L	M	L	S	L	L	L	M	L
CO6	M	L	M	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMCP2	ADVANCED MICROBIOLOGICAL TECHNIQUES	L	T	P	C
Practical –II			-	-	6	4
Pre-requisite		Basic Microbiological Techniques	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Hands on training of isolation of different bacterial isolates
To provide the Isolation of DNA and Protein biomolecules.
To assess the water Quality analysis

Expected Course Outcomes:

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

1	Gain a strong foundation on environmental and agriculture microbiological techniques.	K3
2	Pursuing high skills and hands on training on Microbial Molecular analysis.	K3
3	Acquires knowledge on water quality analysis parameters	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Practical

Wine production
Organic acid production – Citric acid – Solid state and submerged fermentation.
Isolation of nitrogen fixers – free living, symbiotic, ammonification, nitrification, denitrification.
Isolation of Phosphate solubilizers.
Isolation of Coliphage.
Isolation of Plasmids and chromosomal DNA from microbes.
Restriction digestion and ligation of bacterial DNA
Preparation of competent cells
Gene transfer in bacteria by calcium mediated method and identification of recombinants by antibiotic marker
. Size determination and fractionation of nucleic acids and proteins – Agarose gel electrophoresis, SDS – PAGE.
. Identification of food pathogen
. Estimation of coliforms by MPN in water
. Determination of BOD of effluent
. Determination of COD of effluent

Total Practical hours	**90 hours**

Reference Book(s)

1	Cappuccino, J and Sherman, N. (2014) Microbiology. A Laboratory Manual. 10th Edition. Pearson Education Publication, New Delhi
2	Emanuel Goldman and Lorrence H. Green (2015) Practical Hand Book of Microbiology, 3rdEdition, CRC Press. Taylor and Francis Group.
3	Alfred E. Brown (2010) Benson's Microbiological Applications: Laboratory Manual in General Microbiology, 11th Edition, McGraw-Hill Companies.
5	Practical Microbiology- Dr. D.K.Maheshwari and Dr.R.C.Dubey

E –Learning

https://youtu.be/FAIyzK9cqPY
https://youtu.be/YJ2UiuSHpuU
https://youtu.be/u84bTjqrt7k

https://youtu.be/i_6y6Z5UvwE
https://youtu.be/wRHKOGM6GHA
https://youtu.be/Gh0hXROo2ds
https://youtu.be/tcPgdR9_t64
. https://youtu.be/GsWo8dCivWs
. https://youtu.be/1Lm2C1fzGtQ
. https://youtu.be/m1z7RxrjHOc

Course Designed By: Dr. M. Gnanadesigan

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	L	M	L	M	L	L	L
CO2	L	L	L	L	L	S	L	L	L	L
CO3	L	L	L	L	L	L	L	L	S	L

*S-Strong; M-Medium; L-Low

Third Semester

Course code	20MBTMC09	BIOPROCESS TECHNOLOGY	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite		Aware of industrially important microbes and its products	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Impart knowledge on the Components and units of a bioprocess industry
Enabling the students to Design and control the process & production in the industry
Familiarize with the Equipments and Microbes employed for the production unit
Provide the student with an understanding of the Economics, Control systems, Quality analysis and assurance
Learning on Artificial Intelligence role in relevant industries

Expected Course Outcomes:

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

1	Parts of a fermentation unit	K1
2	Select and design a fermentation process for a specific product	K3
3	Identify industrially important microbes & its potential applications	K2, K4
4	Troubleshoot the production rate of existing fermentation processes	K5
5	Understand the role of AI in the bioprocessing unit	K2
6	The project economics of the production unit	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Design & Types Of Bioreactor	12-- hours

Fermentor Structure - Construction Material, Basic Components – Agitator, Aerator, Valves And Steam Traps, Seals And Stirrer Glands. Measurement And Control Parameters (On-Line And Off Line Sensors) – Temperature, Flow Rate, Pressure, Ph, DO, Gas Analysis; Types Of Fermentors - Air-Lift, Stirred Tank, Tower, Fluidized Bed, Packed Bed, Pulsed, Photo Bioreactors, CSTR, PFR.

Unit:2	Process Kinetics	12-- hours

Growth Kinetics - Batch, Continuous And Fed Batch; Sterilization Methods – Batch, Continuous, Medium, Air, Equipment; Fermentation Methods - Solid State, Surface, Submerged, Aerobic And Anaerobic Fermentation; Inoculum Development – Yeast, Bacteria, Mycelia, Vegetative Fungi - Aseptic Inoculation - Immobilization Of Cells & Co-Immobilization; Chemical Kinetics And Classification Of Chemical Reactors; Transport Phenomena - Mass Transfer, Heat Transfer, Oxygen Transfer.

Unit:3	Production Kinetics	12-- hours

Design Of Single Reactor, Multiple Reactor Systems For Single Reaction, Reactions In Parallel, And In Series; Kinetics Of Heterogeneous, Non Catalytic, Catalytic Reactions; Non Ideal Flow - Residence Time Distribution (RTD) Studies, C,E, F And I Curves; Models For Non Ideal Flow – Zero, One And Two Parameter

Unit:4	Downstream Processing	8-- hours

Removal Of Microbial Cells And Solid Matter, Foam Separation, Precipitation, Filtration,

Centrifugation; Cell Disruptions, Liquid-Liquid Extraction, Chromatography, Membrane Process; Drying And Crystallization.		
Unit:5	**Quality Assurance**	**10-- hours**
Quality Analysis And Product Formulation - Product Appearance, Product Stabilization And Shelf Life Analysis; Fermentation Economics Of Citric Acid – Process & Project Economics;		
Unit: 6	**Contemporary Issues**	**10 – hours**
Applications of Artificial Intelligence In Bio-Industry – Clinical Trials, Big Data Processing, Machine Learning & Automation. Industry video tours, Seminars/Webinars, Expert lectures		
	Total Lecture hours	**64-- hours**

Text Book(s)	
1	Principles of fermentation technology, Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Third edition, Elsevier publications, 2017
2	Bioprocess engineering- second edition, DG. Rao, Tata McGrawHill Publishing Co. Ltd., New Delhi, 2010
Reference Books	
1	Instrumentation, measurement and analysis, II edition, Nakra BC and Chaudhry KK, Tata McGrawHill Publishing Co. Ltd., New Delhi, 2004
2	Fermentation Microbiology and Biotechnology, Mansi El-Mansi and Charlie Bryce, CRC press, 4th edition, 2018
3	Manual of Industrial Microbiology and Biotechnology, III edition, Richard H. Baltz, Arnorld L. Demain and Julian E. Davies, ASM press, Washington DC, 2010
4	Biochemical Engineering Fundamentals, Baily, J., Bailey J. and Ollis,D.F., McGraw-Hill Book Co. New York, 2015
5	Bioprocess Engineering: Basic concepts, 3rd edition, Michael L. Schuler, Fikret Kargi, Matthew Delisa, Pearson publishers, 2017
6	Handbook of Downstream processing, Edin Goldberg, Blackie and Academic Professional, 1997
7	Ali, S., Rafique, A., Ahmed, M., & Sakandar, S., 2018. Different Type of Industrial Fermentors and Their Associated Operations for the Mass Production of Metabolite. Eur. J. Pharm. Med. Res., 5(5), 109-119.
8	Nduka Okafor,2017, Modern industrial microbiology and biotechnology, CRC Press 2nd Edition
9	Nooralabettu Krishna Prasad, 2010, Downstream Process Technology: A new horizon in Biotechnology, PHI Learning Pvt Ltd, New Delhi
10	Instrumentation, measurement and analysis, II edition, Nakra BC and Chaudhry KK, Tata McGrawHill Publishing Co. Ltd., New Delhi, 2003, Second Edition.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	SWAYAM - https://www.classcentral.com/course/swayam-principles-of-downstream-techniques-in-bioprocess-3967
2	NPTEL - https://nptel.ac.in/courses/102/105/102105064/# Aspects of Biochemical Engineering, Prof. Debabrata Das, IIT Kharagpur
3	NPTEL - https://nptel.ac.in/courses/102/106/102106083/ Transport Phenomena in Biological Systems- Prof.Suraishkumar, IIT Madras
4	Industrial Biotechnology https://online-learning.tudelft.nl/courses/industrial-biotechnology/

5	Downstream processing https://www.sartorius.com/en/knowledge/trainings/downstream-processing
6	Recent Technology biogas industry - https://www.bioprocesscontrol.com/academy/online-courses/
7	Transport Phenomena - https://online-learning.tudelft.nl/courses/the-basics-of-transport-phenomena/
8	Machine Learning in bioprocessing- https://www.europeanpharmaceuticalreview.com/article/79130/machine-learning-bioprocessing/
9	Applications of Ai in biotech industry https://gpuoncloud.com/applications-of-artificial-intelligence-in-biotechnology-pharmaceutical/https://www.genengnews.com/insights/trends-for-2020/artificial-intelligence-is-helping-biotech-get-real/
10	AI for fermentation - https://www.arcweb.com/blog/ai-enabled-predictive-analytics-optimizes-fermentation-production https://www.mdpi.com/1424-8220/20/6/1771

Course Designed By: Dr.Sentila Rajan,

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	M	S	M	S	S	L	S	M	M
CO2	M	M	M	S	S	S	S	S	M	S
CO3	M	S	S	S	M	S	L	S	S	S
CO4	M	M	S	M	M	M	M	S	S	S
CO5	M	L	M	S	M	M	S	M	S	S
CO6	S	S	S	S	M	M	L	S	M	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC10	PHARMACEUTICAL CHEMISTRY	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Basic knowledge on pharmaceuticals	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Enable the students to understand the basics of drug administration and metabolism.
Provide the knowledge about drug discovery, designing, and testing.
Impart the real-life difficulties encountered in the pharmaceutical industry.
Give a detailed outline on the natural resources for the drug production.

Expected Course Outcomes:

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

1	Understand the right choice of drug from, the mode of drug administration and correct drug concentration required	K2
2	Have an insight on various natural raw materials as resources for the drug production and the candidates will gain the ability to think of an unexplored resource for a new type of diseases.	K3
3	Select various methods of drug designing through virtual-wet lab combinations and will impart the technical details of pre-clinical trials.	K5
4	Understand the application of AI	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction to Pharmaceuticals	8-- hours

Introduction to Pharmaceuticals : Routes of drug administration, Pharmacokinetics: Absorbtion, Distribution, Metabolism- Oxidation, reduction, hydrolysis, conjugation and Elimination, absorption enhancement / solubility factor/ bioavailability; Pharmacodynamics; Assay systems and models (e.g., Knock-out Mice); Inter species scaling.

Unit:2	Drug discovery	7-- hours

Drug discovery: Need for developing new drugs: Substances derived from bacteria, plants, insects, and animals; Sources of active principles; Combinatorial Synthesis: Chemistry, Biology, and Biotechnology**.**

Unit:3	Drug designing	15-- hours

Drug designing: Procedure followed in drug design; Molecular modification of lead compounds and proteins; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors; Protein molecular modeling by computer: Docking studies; Structure based drug designing using software.

Unit:4	Pharmaceutical products	12-- hours

Pharmaceutical products: Microbial products - Antibiotics (penicillin, streptomycin, Griseofulvin, Nystatin), probiotics. Plant secondary metabolites -alkaloids, flavanoids, steroids, terpenoids**. A**nimal vaccines-DNA vaccines, Subunit vaccines, peptide vaccines, attenuated and vector vaccines. Antivirals –Pencoclovir, Sofosbuvir. Clinical trials.

Unit:5	Therapeutic proteins	12-- hours

Therapeutic proteins: Insulin, human growth hormone, clotting factors, interferons, interleukins,

tissue plasminogen activators, erythropoietin, DNAseI, alginate lyase, muteins; Production, advantages, limitations and applications of monoclonal antibody.		
Unit:6	**Contemporary Issues**	**10 hours**
Expert lectures, online seminars – webinars		
AI in Drug designing AI in Vaccine Development		
	Total Lecture hours	**64-- hours**

Text Book(s)	
1	Daan Crommelin, Robert D Sindelar, "Pharmaceutical Biotechnology", Tailor andFrancis Publications, New york, 2002.
2	Remington"s Pharamaceutial sciences, 18th edtion, Mack publishing & Co., Easton, PA (20 Ed, 2000).
Reference Books	
1	Heinrich Klefenz, "Industrial Pharmaceutical Biotechnology", WILEY-VCH Publication, Germany, 2002.
2	Jay P Rho, Stan G Louie, "Hand book of Pharmaceutical Biotechnology", Pharmaceutical products press, New York, 2003.
3	Lachman L Lieberman, HA, Kanig, J, "Theory and practice of industrial pharmacy", 3rd edition, Varghese publishing & Co, New Delhi, 1986.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Computer Aided Drug design-https://swayam.gov.in/nd1_noc19_bt22/preview
2	Medicinal Chemistry-https://swayam.gov.in/nd1_noc20_cy16/preview
3	Introduction to molecular Modelling-https://www.schrodinger.com/schrodinger-online-learning
4	Drug delivery: Principles and Engineering-https://swayam.gov.in/nd1_noc19_bt23/preview
Course Designed By: Dr. V. Brindha Priyadarisini	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	S	L	L	L	L	L	L	L	L
CO2	M	L	M	S	L	L	L	L	L	L
CO3	L	L	L	S	L	L	L	L	L	L
CO4	L	L	L	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMC11	FOOD MICROBIOLOGY	L	T	P	C
Core Paper			3	1	-	4
Pre-requisite		Basic Knowledge about food safety and the role of microorganisms in food	Syllabus Version		2021-22	

Course Objectives:

To impart knowledge about the various areas related to food science as a discipline
To encode the importance of the role of microorganisms in food industries both in beneficial and harmful ways
To develop an understanding of food composition, principles of preservation, new product development, food quality and analysis and food safety standard law.

Expected Course Outcomes:

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

1	Explain importance of different types of food in balanced diet and diet planning	K3
2	Differentiate between different nutrient components in food and their role in processing and consumption	K4
3	Determine food quality by food analysis as per food safety standard law and the their importance in food industry	K4
4	Apply traditional methods for food preservation in developing a new food product.	K3
5	Able to identify the characteristics of foodborne, waterborne and spoilage microorganisms	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	**Fermentation Products**	**10-- hours**

Dairy products: - Production of starter cultures; Cheese - principles of cheese making. Cheddar Cheese, Swiss Cheese, Surface ripened Cheeses; Mold ripened Cheeses. General principles of manufacture of Yogurt, acidophilus milk, Kefir, Koumiss. Fermented foods: Soy sauce, Miso, Sufu, Natto, Idli, fermented fish products. Fermented vegetables: Sauer kraut, pickles, Olives. Fermented sausages.

Unit:2	**Distilled beverages & Food additives**	**10-- hours**

Alcohol, wine, brandy and beer.
Production of additives - organic acid (acetic acid, lactic acid and citric acid), amino acids (glutamic acid, lysine, threonine, arginine and histidine), food flavourants and pigments

Unit:3	**Food Spoilage and Public Health & Food Preservation**	**12-- hours**

Staphylococcal, Salmonellosis, E.coli, Botulism, aflatoxin and amine production; food spoiling enzymes; Deterioration of foods- vegetables, meat, poultry, sea food and fruits,
Principles of food preservation – methods of preservation: Physical (irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere); Chemical (Sodium benzoate Class I & II); Biological: Probiotics and bacteriocins.

Unit:4	**Indicator Organisms**	**8-- hours**

Direct examination – culture techniques – enumeration methods – plate – Viable & Total Count; Alternative methods – Dye reduction tests , electrical methods , ATP determination: Rapid methods, immunological methods – DNA / RNA methodology – Laboratory accreditation,

Unit:5	**Food Process Technology**	**12-- hours**

Packaging and canning of foods – preparation for packaging, thermal processing of foods:

Microwave heating, thermal inactivation of microorganisms, thermal process, evaluations, freezing and thawing of foods. Food process operations: Evaporation - single and multi-effect evaporation, dehydration, psychomatric charts, drying-tunnel, tray, spray, drum, freeze, distillation; food processing aid through biotechnology, **Food sanitation:** Good manufacturing practices – Hazard analysis, Critical control points, Personnel hygiene. Food safety regulation in India

Unit:6	**Contemporary Issues**	**4 hours**

Expert lectures, online seminars – webinars

Machine learning in food industry
https://spd.group/machine-learning/machine-learning-and-ai-in-food-industry/
Examples of AI application in food industry
https://foodindustryexecutive.com/2018/04/6-examples-of-artificial-intelligence-in-the-food-industry/
AI in Food Processing – Use Cases and Applications That Matte
https://emerj.com/ai-sector-overviews/ai-in-food-processing/
Application of Machine Learning in Microbiology
https://www.frontiersin.org/articles/10.3389/fmicb.2019.00827/full

E-learning **2 hours**

https://www.studocu.com/row/document/egerton-university/food-nutrition-and-dietetics/lecture-notes/food-science-and-technology-module-pdf/5275169/view
https://www.studocu.com/row/document/jagannath-university/food-microbiology/lecture-notes/food-microbiology-lecture-notes-1/3561336/view
http://ecoursesonline.iasri.res.in/course/view.php?id=131

Total Lecture hours **58 hours**

Text Book(s)

1	Industrial Microbiology, 1983, 4th Edition, Prescott and Dunn's, Gerald Reed, AVI Publishing Company Inc. Conneticut.
2	Food Microbiology- Frazier, 1987, Tata McGraw-Hill Education

Reference Books

1	Food Biotechnology. 1982. by Knorr, D. Marcel Dekker, New York
2	Biotechnology, 1983, VI-VIII, Rehm, H.J. and Reed,G, Verlag Chemie,Wainheim
3	Genetic Engineering Applications for Industry, 1981, Paul,J.K.,Noyer Corporation, New Jersey
4	Fundamentals of Food Process Engineering, 1980, Toledo,R.T., AVI Publishing Co., USA.
5	Food Engineering Operations, 1979, 2nd Edition, Brennan,J.G., Bulters,J.R., Gowelx,N.D and Lilly, A.E.V., Applied Science Publishers
6	Food Process Engineering, 1977, 2nd Edition, Heldman, D.R., AVI Publishing

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Food Science and Processing https://swayam.gov.in/nd2_cec19_ag05/preview
2	Food Microbiology and Food Safety https://swayam.gov.in/nd2_cec20_ag13/preview
3	Food Preservation Technology https://swayam.gov.in/nd2_cec19_ag01/preview

4	Introduction to food Microbiology https://nptel.ac.in/courses/126/103/126103017/
Course Designed By: Dr.M.Thandeeswaran	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	M	L	M	L	M	M	M
CO2	S	M	S	S	M	M	S	S	S	S
CO3	S	S	S	S	S	M	L	S	S	S
CO4	S	M	S	S	M	M	M	S	M	S
CO5	S	S	S	S	M	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code	20MBTMC12	RESEARCH TECHNIQUES	L	T	P	C
Core Paper			4	-	-	4
Pre-requisite		Basic Knowledge about Research	Syllabus version	2021-22		

Course Objectives:

To learn the basics of Research methodologies in the Designing of Research methods.
To equip the students with the structure of proposals, modes of presenting and disseminating research findings
To import the knowledge of methods of data acquisition and interpretation using the computational applications.
To impart the knowledge of, principles and applications of biomolecules separation and analytical instruments
To learn the importance of the Artificial intelligence/Machine learning in Research Techniques

Expected Course Outcomes:

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

1	The students will acquire the knowledge of research methodologies in modern biological sciences	K2
2	The students will acquire the knowledge of Article, Proposal preparation & submission.	K3
3	The student will learn the Computational tools and software's for Research applications	K3
4	The students will acquire the knowledge of biomolecule separation and analytical methods in life science applications.	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	BASIC CONCEPTS	13 hours

Definition of Research, Components of Research Problem, Theory & Facts, Steps in Scientific Research, Types of Research, Hypotheses-Research Purposes -Types, Research Design - Survey Research - Case Study Research- Experimental Research- Quasi Experimental- Mixed Method Design.

Research Process: Objectives and Dimensions, Systematic literature Review-Purpose-Sources of Review, Features of good research study, Research Ethics, Qualities of Researcher.

Unit:2	Scientific & Proposal Writing	13 hours

Scientific Document - Definition, Strategies & Pattern of Writing, Component of Research Article. Steps in Journal submission Process (Elsevier & CSIR). Impact Factor, H-Index, i10 index, Citation Index.

Research proposal/ Grant- Definition, Structure, Specific aims, Background and Significance, Budget allocation. Hierarchy of funding agencies in India-Progress in Scientific Research. Preparation and Submission of Research Projects to Funding Agencies.

Unit:3	RESEARCH TECHNIQUE TOOLS	13 hours

Computer and its role in Research Execution; Computational Data Analysis & Scenario, Statistics-Definition- Scope & Applications. Descriptive Statistics: Measures of Central Tendency, Dispersion, Discrete Distribution & Continuous Distribution, Correlation & Regression, Confidence Interval, ANOVA, Generating Charts /Graph. Effective use of Internet in Research.
Strategies of Online Searching Tools- PubMed, Google Scholar, Elsevier. Formatting Tool

Strategies- Plagiarism Tools, Mendeley, Style Writer.		
Unit:4	**Bioinstrumentations: Separation of Biomolecules**	**12 hours**
Centrifugation-Preparative, Analytical and Density gradient centrifugation. Chromatographic Techniques-Theory and application of Paper, TLC and HPLC Chromatography, Gel Filtration, Ion Exchange, Column, Gel permeation, Chiral, Hydroxy apatitie, Immuno adsorption, Affinity Chromatography. Electrophoretic Techniques: Theory and Application of PAGE, SDS PAGE. Staining & detection methods-Isoelectroporesis, iso electric principle.		
Unit:5	**Structural analysis of Biomolecules:**	**10 hours**
UV, NMR, GC-MS, LC-MS, Mass Spectroscopy, MALDI-ToF, 2D gel, Fluorescence Spectroscopy, Calorimetry, flame photometry and ESR principles.		
Unit:6	**AI in Research Techniques**	**7 hours**
Expert lectures, online seminars – webinars		
AI in Life science Research: https://www.genengnews.com/magazine/314/ai-in-the-life-sciences-six-applications/ AI in drug discovery https://www.biopharmatrend.com/post/34-biopharmas-hunt-for-artificial-intelligence-who-does-what/ Developing Deep Learning Applications for Life Science and Pharma Industry https://www.thieme-connect.de/products/ejournals/pdf/10.1055/s-0043-124761.pdf Artificial Intelligence for Clinical Trial Design https://www.sciencedirect.com/science/article/pii/S0165614719301300 Looking beyond the hype: Applied AI and machine learning in translational medicine https://www.sciencedirect.com/science/article/pii/S2352396419305493 What Should An AI-Driven Search Engine Be Able To Do? https://www.cmswire.com/digital-workplace/what-should-an-ai-driven-search-engine-be-able-to-do/ How Artificial Intelligence (Ai) Impacts Search and SEO https://www.seomechanic.com/artificial-intelligence-impacts-search-engine-optimization/ Pattern Recognition and Artificial Intelligence in Molecular Biology https://www.sciencedirect.com/science/article/pii/B9780444871374500369 Artificial Intelligence in Molecular Biology: A Review and Assessment https://www.jstor.org/stable/56107?seq=3#metadata_info_tab_contents Use of artificial intelligence in analytical systems for the clinical laboratory https://www.sciencedirect.com/science/article/pii/000991209500002Q		
E Learning		**2 hours**
Research methodology: https://shodhganga.inflibnet.ac.in/bitstream/10603/173748/8/08_chapter%202.pdf Basics of Research Methodology: http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/library_and_information_science/informetrics_&_scientometrics/basics_of_research_methodology/et/4616_et_m18.pdf Analytical Instrumentation https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=944 Instrumentation: http://shodhganga.inflibnet.ac.in/jspui/bitstream/10603/222042/8/08_chapter%203.pdf		
Total Lecture Hours		**70 Hours**

Text Book(s)	
	Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill
	Biophysical chemistry – Upadhyay., Upadhyay and Nath
	Practical Biochemistry – Principles and techniques -Wilson. K and Walker. J,
	Kothari: Research Methodology, New Age International, 2004
Reference Books	
	Wilkinson &Bhandarkar: Methodology and Techniques of Social Research.
	Pauline Vyoung: Scientific Social Surveys and Research.
	Panneerselvam, R., Research Methodology, Prentice Hall of India, New Delhi, 2004.
	Sellitz, et al: Research Methods in Social Relations.
	Jerrold H. Zar. Biostatistical Analysis (4th edition).
	Janet Buttolph Johnson and Richard A. Joslyn, Political Science Research Methods (Washington D.C.: CQ Press, 2001), pp. 131-145.
	Instrumental methods of chemical analysis – P.K. Sharma
	Marder M P (2011) Research Methods for Science, Cambridge University Press
	Rosner B (2010) Fundamentals of Biostatistics, 7th Edition, Brooks/Cole Cengage Learning Publication
	Dunleavy P (2003) Authoring a PhD: How to Plan, Draft, Write and Finish a Doctoral Thesis or Dissertation. Palgrave Macmillan
	A Biologist"s guide to principle and techniques of practical biochemistry – Brigan L. Williams.
	Experimental methods in Biophysical chemistry- Nicolau, C.
	Chromatographic methods- Alan Braithwaite, Frank J. Smith
	Gel Electrophoresis of Nucleic acids-A Practical approach. Rickwood D and BD Hames.
	Introduction to Spectroscopy- DonaldL.Pavia Gary M.Lipman, George S Kriz.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
	swayam.gov.in/nd1_noc19_hs59/preview pment Research Methods
	swayam.gov.in/nd2_cec20_hs17/preview **rch Methodology**
	https://swayam.gov.in/nd1_noc20_ge01/preview Qualitative Research Methods and Research Writing
Course Designed By: Dr. M. Gnanadesigan	

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	L	L	L	L	L	L	L	M
CO2	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	M	L	L	L	M	L	L

*S-Strong; M-Medium; L-Low

Course	20MBTMCP3	APPLIED MICROBIOLOGICAL	L	T	P	C

code		TECHNIQUES				
Practical -III			**-**	**-**	**6**	**4**
Pre-requisite		**Aware of clinically important microbes and its diagnosis**	**Syllabus Version**		**2021-22**	

Course Objectives:

The main objectives of this course are to:
Provide hands on training on isolation and identification of pathogen from patient.
Train on characterization of pathogenic organism.
Develop skill on Immuno-techniques
Gain adequate knowledge on various method for separation of biomolecules

Expected Course Outcomes:

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

1	Isolate and identify pathogenic organism.	K4
2	Characterize the isolated pathogenic organism	K5
3	Hands on training on Immunotechniques.	K3
4	Analyse given compound using separation techniques	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Practical titles

1. Diagnostic Microbiology: Isolation and identification of pathogens from clinical specimens- Swab/ Urine
2. Haemolytic testing of bacteria
3. Differential test of Staphylococci through growth on agar plates (Mannitol agar, DNA agar plate and Coagulase test method)
4. Isolation and identification of clinically important fungi - Candida albicans, Aspergillus sp
5. Antibiotic susceptibility test. - Kirby Bauer technique
6. Identification and enumeration of Lymphocytes.
7. Agglutination reaction - Blood grouping & Rh Typing – Cross matching demonstration.
8. Precipitation reaction – ODD Test.
9. Serological Tests – WIDAL (Slide & Tube Test), RPR.
10. Immunoelectrophoresis – Counter Current & Rocket Immunoelectrophoresis.
11. ELISA – HIV, HBV & HCV.
12. Separation techniques: Chromatography - Paper, TLC and Column.
13. Virus cultivation – Egg inoculation techniques.-Demo

Total Practical hours **90 hours**

Reference Book(s)

1	Cappuccino, J and Sherman, N. (2014) Microbiology. A Laboratory Manual. 10th Edition. Pearson Education Publication, New Delhi
2	Lab Manual on Industrial Biotechnology, K. Swaminathan, J. Angayarkanni, V. Brindha Priyadarisini and K. Preethi, 2017, Thannambikkai Publications,Coimbatore
3	Bailey and Scott‟s Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby

E –Learning

Course Designed By: Dr.V. Brindha Priyadarisini

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	S	S	L	L	L	L	L	M	S
CO2	L	S	S	L	L	L	L	L	M	S
CO3	L	L	S	M	L	L	L	L	L	L
CO4	L	L	M	M	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

ELECTIVE PAPERS

Course code	20MBTME12A	MOLECULAR CELL BIOLOGY	L	T	P	C
Elective Paper			3	1	-	4
Pre-requisite		Should know the basic cell structure	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Recalling the structural organization of organelles in both prokaryotic and eukaryotic cells
Providing information on the functional aspects of the cellular organelles
Understanding the molecular interaction of cells with regard to metabolism and cell cycle
Perceiving the molecular interactions in terms of regulation of cell cycle

Expected Course Outcomes:

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

1	to coordinate structural organization with functions	K3
2	Abe to differentiate the prokaryotic and eukaryotic cells	K1
3	Capable of understanding the molecular mechanism of several diseases	K2
4	Capacity to determine the causes of cancer and drug resistance	K4
5	Able to understand the molecular mechanisms of body movement	K3
6	Able to explain the process of development of organisms to adult	K4

K1 - Remember; **K2** - Undestand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Unit:1	Cell Architecture	12 hours

Structure of cells – structure of prokaryotic and eukaryotic cells; Surface appendages – Cilia and Flagella, Capsules, Pili, Fimbriae and slime layers; Cell walls – Algae, fungi, bacteria ; Membranes of Gram positive, Gram negative bacteria and acid fast bacteria; protoplast, spheroplast and endospores; Transport across membrane – active and passive transport, transport channels and pumps, transport across nuclear membrane; Neurotransmission, neuromuscular junction.

Unit:2	Cellular Constituents	10 hours

Cytoskeleton and structural components – Microfilaments, Intermediate filaments, Microtubules; Mitochondria – structure, biogenesis; Chloroplast – structure, biogenesis; Endoplasmic reticulum and Golgi complex – structure, function, vesicular transport and import into cell organelles; Structure and function of ribosomes, mesosomes, lysosomes, peroxysomes.

Unit:3	Nucleus	10 hours

Nucleus structure – structural organization, nucleosome, supranucleosomal structures, specialized chromosomes, polytene and lamp brush chromosomes and chromosome banding; Nucleic acid structure: DNA and RNA; Replication – prokaryotes and eukaryotes; Transcirption and regulation – prokaryotes and eukaryotes; Translation – prokaryotes and eukaryotes, regulation and posttranslational modification.

Unit:4	Cell Cycle	10 hours

Mechanism of cell division – Mitosis, meiosis and genetic recombination; regulation of cell cycle – factors and genes regulating cell cycle (Cyclins, CDK and CDKI). Biochemistry and molecular biology of Cancer – malignant growth, tumour suppressor genes (p53, RB) and oncogenes (Ras), chemical carcinogenesis, hormonal imbalances.

Unit:5	Cellular Development	12 hours
Extracellular matrix – cell to cell and cell-matrix adhesion, cell junctions; Cellular 49ystematic – components of 49ystematic, receptors (cell surface – GPCR, RTK, TGF-β, Hedgehog, Wnt, Notch-Delta, NF-Kb, ion channels; intracellular – NO, Nuclear receptor), secondary messengers, effectors ; cell differentiation; gametogenesis and fertilization; development of Drosophila and Arabidopsis – spatial and temporal regulation of gene expression.		
Unit:6	**AI in Cell Biology**	**6 hours**
Expert lectures, online seminars – webinars		
Machine learning in cell biology – teaching computers to recognize phenotypes https://jcs.biologists.org/content/126/24/5529 Deep learning for biology https://www.nature.com/articles/d41586-018-02174-z Deep learning sharpens views of cells and genes https://www.nature.com/articles/d41586-018-00004-w Deep Learning Algorithms Identify Structures in Living Cells https://www.the-scientist.com/notebook/deep-learning-algorithms-identify-structures-in-living-cells-65778 The application of convolutional neural network to stem cell biology https://inflammregen.biomedcentral.com/track/pdf/10.1186/s41232-019-0103-3 Artificial intelligence sheds new light on cell developmental dynamics https://phys.org/news/2019-04-artificial-intelligence-cell-developmental-dynamics.html; https://www.nature.com/articles/s41587-019-0071-9 AI improves biology models to better predict cell processes https://www.gold.ac.uk/news/ai-improves-biology-models-/; https://www.pnas.org/content/116/36/18142.short?rss=1		
E-learning		**2 hours**
https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4 Cell biology – All modules https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/ Cell biology – study materials of MIT		
	Total Lecture hours	**62 hours**

Text Book(s)	
1	Text book of Cell and Molecular Biology (New Edition), Ajoy Paul, 2015, Books & Allied publishers,
2	Molecular Biology of the Cell, Alberts, B et al., 5th Edition
Reference Books	
1	Karp's Cell and Molecular Biology – Gerald Karp, 2016
2	Lodish's Molecular Cell biology, Lodish et al., 7th edition
3	Genes XI (9th Edition) Benjamin Lewin, Jones & Bartlett Learning, 2008
4	Gene cloning and DNA analysis – An Introduction – 6th edition, 2019
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4 Cell biology – All modules
2	https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/ Cell biology – study materials of MIT
3	Cell Biology https://swayam.gov.in/nd2_cec20_ma14/preview

Course Designed By: Dr. J. Angayarkanni

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	S	L	L	L	M	M	L	L
CO3	L	L	S	L	L	L	L	M	L	L
CO3	M	L	S	L	L	L	L	L	L	M
CO4	M	L	L	L	L	L	L	L	L	L
CO5	L	L	M	L	L	L	L	L	L	L
CO6	L	L	M	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTME12B	BIOMOLECULAR METABOLISM	L	T	P	C
Elective Paper			3	1		4
Pre-requisite		Basic knowledge on Biochemistry	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Provide information about the significance of biomolecules
Recall the fundamental concepts of biochemistry
Learn the structure and functions of biomolecules

Expected Course Outcomes:

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

1	Get a distinct idea about structure and function, synthesis and breakdown of Biomolecules.	K2
2	Understand metabolic events that occur in cells.	K2
3	Distinguish the mechanism of regulation associated with these metabolic events.	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Foundations of Biochemistry	9-- hours

Foundations of Biochemistry: Chemical foundations of Biology: pH, pK, acids, bases and buffers, Henderson-Hasselbalch Equation, biological buffer solutions. Concept of free energy:

Unit:2	Principles of thermodynamics	10-- hours

Principles of thermodynamics: Laws of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds and weak interactions; Coupled reactions; group transfer; biological energy transducers.

Unit:3	Amino acids	12-- hours

Aminoacids: Structural features of amino acids, classification of amino acids, peptide linkage, determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides), structural classification of proteins, primary, secondary, tertiary, quaternary structures of proteins, protein detection and estimation.

Unit:4	Carbohydrates	12-- hours

Carbohydrates: Monosaccharides, Disaccharides and Polysaccharides, Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids. Carbohydrate metabolism: Glycogenolysis, Gluconeogenesis, interconversion of hexoses and pentoses

Unit:5	Lipids	10-- hours

Lipids: Classification, chemical nature, properties. Biosynthesis of fatty acids. Oxidation of fatty acids. Storage Lipids, Structural Lipids in Membranes, Lipids as Signals, Cofactors, and Pigments.

Unit:6	Contemporary Issues	10 hours
Expert lectures, online seminars – webinars		
	Total Lecture hours	63-- hours

Text Book(s)

1	Chemistry of Biomolecules an Introduction, Richard J. Simmons, Royal Society of Chemistry, 1992

Reference Books	
1	Microbial Biochemistry-2nd Edition - Georges N. Cohen Springer, Feb 2, 2011 – SCIENCE
2	Lehninger Principles of Biochemistry by Albert L. Lehninger, David L. Nelson, Michael M. Cox
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Biochemistry: https://onlinecourses.nptel.ac.in/noc20_cy10/preview
2	Biochemistry of Biomolecules: https://onlinecourses.swayam2.ac.in/cec20_bt12/preview
3	Thermodynamics for Biological systems: https://onlinecourses.nptel.ac.in/noc20_bt14/preview
4	Henderson-Hasselbalch Equation : https://www.youtube.com/watch?v=lwj64JhMK5Y
Course Designed By: Dr. V. Brindha Priyadarisini	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	L	L	L	L	L	L	L	L
CO2	M	L	M	L	L	L	L	M	L	L
CO3	L	L	L	L	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTMGE13A	PLANT BIOTECHNOLOGY	L	T	P	C
Elective Paper			3	1	-	4
Pre-requisite		Basics idea of plant tissue culture	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
To understand the basic and latest techniques for in vitro culture of plants.
Providing advanced knowledge about use of plant biotechnology in breeding and micropropagation techniques.
To introduce the students to the theory and practice of plant tissue culture and their role from modifying plants in plant biotechnology to the propagation of endangered plants.

Expected Course Outcomes:

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

1	Capable of understanding the totipotency of plants.	K2
2	Able to identify the cell differentiation and optimization using classical techniques and ANN.	K4
3	Able to understand cell and tissue culture contributes to global sustainability	K5
4	Abe to develop the graduate capabilities of knowledge ability, comprehension andapplications of plants in cell, tissue culture and genetic engineering.	K3
5	It will also develop the practical skills and confidence of students to successfully	K3
6	Capacity to establish commercial plant tissue culture lab.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	BASICS OF PLANT TISSUE CULTURE	8 hours

Laboratory organization and Techniques in Plant Tissue Culture. Organ culture, root, shoot tip or meristem, ovary, flower and ovule culture and their importance.

Unit:2	PRINCIPLES OF CELL CULTURE	10 hours

Callus culture-principle, protocol and significance, Cell suspension culture – Principle, protocol and its importance. Totipotency, cytodifferentiation and organogenesis – Principle, factors influencing Organogenesis and applications.

Unit:3	CULTURE TECHNIQUES	15 hours

Somatic embryogenesis and synthetic seeds – Principle, protocol and importance. Single cell culture, embryo culture – Principle, protocol and applications.
Anther and Pollen culture – Principle, protocol, and its significance. Protoplast, isolation, fusion and culture somatic hybridization, chemofusion, electrofusion, important properties of protoplast, somatic hybrids, cybrids – Principle, protocol and importance.

Unit:4	APPLICATIONS OF PLANT TISSUE CULTURE	15 hours

Somaclonal variation – Causes and significance, plant tissue culture in forestry, micro propagation, clonal propagation production of useful biochemicals – Gene conservation bank – plant tissue culture in biotechnology-commercial aspects of plant tissue culture

Unit:5	APPLICATIONS IN PLANT GENETIC ENGINEERING	15 hours

Application of transgenic plants for Biotic Stress tolerance: Herbicide resistance:

phosphoinothricin and glyphosate; Insect resistance: *Bt*genes and alpha amylase inhibitor. Disease resistance: chitinase and 1,3-beta glucanase; Virus resistance: coat protein mediated, nucleocapsid gene; Nematode resistanc;. **Abiotic stress:** Drought, cold and salt; Post-harvest losses: long shelf life of fruits and flowers, male sterile lines, RNAi and Reverse genetics; Nutritional enhancement- Golden rice; Edible vaccine.

Unit:6	**ANN IN PLANT TISSUE CULTURE**	**7 hours**

Expert lectures, online seminars – webinars

. Introduction to Artificial Neural Network (ANN), optimization of culture conditions in plant tissue culture using ANN.

E-Learning **2 Hours**

https://www.nature.com/articles/s41598-020-60278-x
https://www.frontiersin.org/articles/10.3389/fpls.2016.00274/full
https://nptel.ac.in/courses/102/103/102103016/

Total Lecture hours **72 hours**

Text Book(s)

1	Kalyanakumar De. 1997. An Introduction to Plant Tissue Culture, New Central Book Agency, Calcutta.
2	Plant Biotechnology by H. S. Chawla, Oxford and IBH, 2009
3	Plant Biotechnology by B D Singh. Kalyani publisher, 2003
4	Dixon, R.A. and Gonzales, R. A. (Eds.) 1994. Plant Cell Culture - A Practical Approach. Oxford University Press, New York. 7. Gamborg, O.L and Phillips, G.C. 1998. Plant Cell, Tissue Organ Culture. 1998. Narosa Publishing House, NewDelhi
5	Gamborg, O.L and Phillips, G.C. 1998. Plant Cell, Tissue Organ Culture. 1998. Narosa Publishing House, NewDelhi.

Reference Books

1	Edwin F. George and Paul Sherington, D. 1984. Plant Propagation by Tissue Culture, Exegetics Ltd., Edington, Westbury, England.
2	Indra K. Vasil, 1980. Cell Culture and Somatic Cell Genetics of Plants. Academic Press Inc., New York.
3	Plant Biotechnolgy-the genetic manipulation of plants, 2nd Edition by A Slater, N.W. Scott M.R. Fowler, Oxford Univ Press (2008)
4	R.L.M. Pierik, 1987. In vitro culture in higher plants.MartinusNijhoff Publishers, Boston.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://actascientific.com/ASAG/pdf/ASAG-02-0156.pdf
2	https://www.sciencedirect.com/science/article/pii/S2214317319300940

Course Designed By:**Dr.G.KAPILDEV**

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	S	M	L	M	S	L	M	S	L
CO2	S	M	L	S	M	L	M	S	M	L
CO3	M	L	S	L	M	S	;L	M	S	L
CO4	L	M	S	M	L	M	S	L	S	M
CO5	M	L	S	S	M	M	L	M	L	S
CO6	S	L	M	S	M	L	M	L	S	M

*S-Strong; M-Medium; L-Low

Course code	20MBTME13B	ANIMAL BIOTECHNOLOGY	L	T	P	C
Elective Paper			3	1	-	4
Pre-requisite		Aware on animal cell culture	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:

To impart the theoretical knowledge on animal cell and tissue culture techniques.

To give a hands-on practical exposure on explants isolation, cell derivation, culturing and maintenance.

To enable the learners explore advancements of the field and recent technical updates.

To provide the knowledge on various aspects of applications including therapeutics, diagnostics and cell culture based products.

To understand the principles and application of tissue engineering.

Expected Course Outcomes:

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

1	Understand and appreciate basic and advanced methods of mammalian Animal tissue culture techniques	K2
2	The practical exposure would kindle the ideas of students to come up with novel applications of the field	K3
3	The technical details would expand the knowledge on the field that would equip the students to implement their views.	K3
4	Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine	K3
5	Ability to understand the components of the tissue architecture	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction	8-- hours

Basics of animal cell culture techniques. Types of animal cell/tissue culture. Advantages and limitations of animal cell culture techniques. Aseptic techniques inside the cell culture laboratory. Biology of cultured cells.

Unit:2	Basic requirements for animal cell culture	8-- hours

Equipment's and culture vessels. Media and supplements- physical, chemical and metabolic functions of different constituents of culture medium; various media- Complete and defined media, serum and protein free media. Antibiotics in culture media. Media preparation and sterilization.

Unit:3	Establishment of primary culture	10-- hours

Methods of cell disaggregation. Subculture and cell line propagation. Cloning and selection of cultured cells. Cell separation techniques. Cell synchronization. Cryopreservation of cultured cells. Contamination in cultured cells. Cell Line Characterization: based on Morphology and Chromosome Analysis. Large scale production of therapeutic proteins, hormones and vaccines from cultured animal cells.

Unit:4	Stem cell Biology	14-- hours

Introduction, biology and classification-Unipotent, Pluripotent and Totipotent. Sources of stem cells-embryonic stem cells, embryonic germ cells and adult stem cells (Mesenchymal, Hematopietic,

Induced pluripotent stem cells (iPS), Umbilical cord blood cells, Adipose tissue). Stem cells characterization-Genetic markers and membrane markers. Therapeutic applications of stem cell		
Unit:5	**Tissue Engineering**	**8-- hours**
Principles, tissue engineering triad – Basic Constituents (Matrix molecules, Ligands, Growth factors, Biomaterials). Tissue engineering bioreactors. Biodegradable polymers in tissue engineering. Therapeutic applications of tissue engineering		
Unit:6	**AI in Animal Biotechnology**	**2 hours**
Expert lectures, online seminars – webinars		
Machine learning software in toxicology: a step toward lab animal reduction https://www.biocompare.com/Editorial-Articles/351896-Realizing-New-Possibilities-for-Cell-Line-Optimization/ https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0213626 https://www.sciencedirect.com/science/article/pii/S2452310018300027 https://jandeboerlab.com/research/computational-sciences/machine-learning https://www.nature.com/articles/s41598-019-50208-x		
	E-Learning	**2 hours**
https://ocw.mit.edu/courses/biology/7-013-introductory-biology-spring-2013/video-lectures/lecture-23-stem-cells/ http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3 https://www.ptglab.com/support/cell-culture-protocol/introduction-to-cell-culture/		
	Total Lecture hours	**52-- hours**

Text Book(s)	
1	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition- R. Ian Freshney (Wiley Publishing)
2	Animal Cell Culture: A Practical Approach, 3rd Edition -John R. W. Masters (Oxford University Press)
3	Principles of Tissue Engineering, 4th Edition, Robert Lanza, Robert Langer, Joseph P. Vacanti.(Academic Press)
4	Principles of genetic manipulation; Ed. Old and Primrose, 6th Edition. Blackwell science publication.
Reference Books	
1	Methods in cell biology; Volume 57, Animal cell culture methods, Ed. Jennie P. Mather, David Barnes, Academic press.
2	Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford University press.
3	Stem Cells: Scientific Progress and Future Research Directions (http://stemcells.nih.gov/)
4	Essentials of Stem Cell Biology, 2nd Edition - Robert Lanza, John Gearhart, Brigid Hogan, Douglas Melton, Roger Pedersen, E. Donnall Thomas, James Thomson and Sir Ian Wilmut (Academic Press)
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Animal Cell Biotechnology
2	Cell Culture Technologies https://swayam.gov.in/nd1_noc20_me04/preview

3	Biomaterial for bone tissue engineering applications https://swayam.gov.in/nd1_noc19_mm24/preview
4	Tissue Engineering https://nptel.ac.in/courses/102/106/102106036/
Course Designed By: Dr. M. Thandeeswaran	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	L	L	L	L	S	L	M	S	M
CO3	L	L	L	L	L	S	L	S	M	L
CO3	L	L	M	L	L	S	L	M	L	M
CO4	L	L	M	M	L	S	L	M	L	M
CO5	L	L	L	L	L	S	L	L	L	L

*S-Strong; M-Medium; L-Low

Course code	20MBTME14A	BIOINFORMATICS AND NANOBIOTECHNOLOGY	L	T	P	C
Elective Paper			3	1	-	4
Pre-requisite		Basic Knowledge about Bioinformatics and Nano particle	Syllabus Version	2021-22		

Course Objectives:

The main objectives of this course are to:

This paper is aimed to provide an enhanced and understanding the basics of the nanobiotechnology for the students to perceive various nanomaterial syntheses and characterization.

The bioinformatics provides the introductory knowledge concerning genomics, proteomics and their applications, including the primary tools used for the structural elucidation and characterization of the biomolecules.

Expected Course Outcomes:

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

1	To acquire the theory and practical experience of the use of common computational tools, AI &ML and databases which facilitate investigation of molecular biology concepts.	K3
2	To acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.	K6
3	To acquire basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	FUNDAMANTALS OF BIOINFORMATICS	12 hours

Bioinformatics - Definition, History, Web servers, computer systems, languages, - machine, high level and assembly. Internet basics – internet connection, web browsing and URL. Introduction to biological databases - Sequence databases, structural databases, specialized databases, sequence retrieval system from net - SRS, Entrez,

Unit:2	TOOLS IN BIOINFORMATICS	8 hours

Structure prediction –similarity and database structure tools, FASTA, BLAST - Sequence and similarity – sequence alignment – local, global pairwise and multiple sequence, introduction to phylogenetic trees.

Unit:3	GENOMICS & PROTEOMICS	12 hours

Genomics: Types of genomics-structural, functional, comparative and environmental genomics. Metagenomics–study on Uncultivable microbes. SNPs-EST- Strategies for Whole Genome Sequencing – Hierarchical and Whole Genome Shotgun Sequencing- De novo and reference based assembly. DNA microarray.

Proteomics: Protein sequencing; Protein modifications, Protein engineering; Protein chips, Types of proteomics - expression proteomics, structural proteomics and functional proteomics. Protein microarrays. Infectomics: Introduction and definitions of Infectomics. Types of Infectomics - ecological, immuno-and chemical Infectomics. Future of Infectomics.

Unit:4	FUNDAMENTALS OF NANOTECHNOLOGY	15 hours

Nanoscience basics: Definition, Nanotechnology- Nano biotechnology Nanomaterial- Nano

composites- Classification of nanostructure- Top down & Bottom-up approach- Quantum dots- Bio inspired nanomaterials; Nanomaterial synthesis, Physical methods (Plasma, Laser), Chemical method (Sol-gel, Co-precipitation) & Biological method (Microbes, plant)..		
Unit:5	**NANOMATERIAL CHARACTERIZATION**	**13 hours**
Nanomaterial characterization: Electron microscopy – TEM, SEM & AFM – For particle imaging, XRD and FTIR for analyze the size, shape, structure, chemistry and crystallography. Drug delivery nanoparticles in cancer therapy, military application of nanotechnology- Future perspectives.		
Unit:6	**AI IN BIOINFORMATICS & NANOBIOTECHNOLOGY**	**8 hours**
Expert lectures, online seminars – webinars		
Qualitative discussions on Machine Learning Tools (Artificial Intelligence, Genetic algorithm and neural networks). Applications of AI &ML in Nanotechnology-AI in scan probe microscopy (SPM)- Classification of material properties at the nanoscale using artificial neural network (ANN)- Designing nanosystems-AI in Nanoscale Simulations-Nanocomputing and artificial intelligence		
E-Learning		**2 hours**
http://thesciencepublishers.com/biomed_lett/files/v5i2-8-BML201912102.pdf https://www.researchgate.net/publication/261062123_ARTIFICIAL_INTELLIGENCE_IN_BIOINFORMATICS https://www.frontiersin.org/research-topics/9029/artificial-intelligence-bioinformatics-development-and-application-of-tools-for-omics-and-inter-omic		
	Total Lecture hours	**70 hours**

Text Book(s)	
1	Introduction to bioinformatics by T.A Atwood
2	Introduction to computers by Alexis Leon and Mathews Leon
3	Genomics: The Science and Technology Behind the Human Genome Project (2000). Edited by C.Cantor and C.L.Smith, Wiley -Interscience, New York
4	J.W. Dale. (1998). Molecular Genetics of Bacteria, 3rd Edition. Wiley Publishers.
5	Singer M and Berg P. (1991). Genes and Genomes. University Science Books.
6	Lewin B. (2005). Genes IX. Oxford University press.
7	A. Pandey and M. Mann. (2000). Proteomics to study genes and genomes Nature.
8	Sheng-He Huang, Timothy Triche, Ambrose Y. Jong. (2002). Infectomics: genomics and proteomics of microbial infections. Springer-Verlag publications.
9	Fundamentals of Nanotechnology. Gabor L. Hornyak, John J. Moore, H.F. Tibbals, Joydeep Dutta. December 22, 2008 by CRC Press. Textbook - 786 Pages.
10	Introduction to Nanoscience. Stuart Lindsay. Oxford University press. Textbook – 448 pages.

Reference Books	
1	Genome Mapping – A Practical Approach (1997) by P.H. Dear, Oxford University Press, Oxford.
2	Reviews and Articles from Journals such as Nature, Science, PNAS (USA), Nucleic Acids Research, Trends Series & Current Opinion Series.
3	Protein Research: New Frontiers in Functional Genomics (1997). Edited by M.R. Wilkins, K.L. Williams, R.D. Appel and D.F. Hochstrasser, Springer – Verlag, NewYork2-D Proteome Analysis Protocols (1998). Edited by A.L. Link, Humana Press, Totowa, NJ.
4	Proteins and Proteomics. 2002. R.J. Simpson. Cold Spring Harbor Lab. Press. New York.
5	Cantor and Smith, Genomics. John Wiley & Sons, 1999.

6	Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
7	R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
8	P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.
9	L.Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007.
10	Introduction to Nanoscience and Nanotechnology 1st Edition by Chris Binns. Wiley publishers. 320 Pages.
11	Nanotechnology: A Gentle Introduction to the Next Big Idea by Mark A. Ratner; Daniel Ratner. Pearson Education (US). 208 Pages.
12	12. Textbook of Nanoscience and Nanotechnology. Authors: Murty, B.S., Shankar, P., Raj, B., Rath, B.B., Murday, J. Springer, 2013. 244 Pages.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	**2 hours**
	https://www.researchgate.net/publication/222834503_Applications_of_artificial_intelligence_in_bioinformatics_A_review
	https://nptel.ac.in/courses/102/106/102106065/
	https://nptel.ac.in/courses/102/103/102103044/
	https://swayam.gov.in/nd1_noc20_bt10/preview
	https://nptel.ac.in/courses/118/107/118107015/
	https://nptel.ac.in/courses/102/107/102107058/
Course Designed By: **Dr.G.KAPILDEV**	

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	M	L	L	S	S	L	L	M
CO2	L	M	M	M	M	S	S	M	L	M
CO3	M	L	M	M	L	S	S	M	M	L

*S-Strong; M-Medium; L-Low

Course code	20MBTME14B	GOOD MANUFACTURING PRACTICES AND QUALITY ASSURANCE	L	T	P	C
Elective Paper			4	-	-	4
Pre-requisite		Basic knowledge on practices in bio process industry	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Provide the student with an understanding of the principles and practice of GMP
Enable them to realize the importance and compliance of GMP.
Impart Expertise on the Administrative structure in the Industries
Will be taught about the designing an Industry and construction of SOPs
Learning on Artificial Intelligence role in Industry 4.0

Expected Course Outcomes:

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

1	Design the rules and regulation to be followed in an Industry	K3
2	Prepare SOPs for a product in an Industry	K6
3	Perform quality check for the raw materials and products	K4
4	systematize the arrangement of equipment in the Industry	K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Principles and Importance of GMP, Public Health Protection and Premises	9-- hours

Principles and Importance of GMP – Definition of GMP, Quality management, Personnel, Risk management, Quality control, Documentation, Inspections, GDP, GLP. **Public Health Protection** - adulteration definition - approved chemicals (lubricants, steam additives, etc.) - toxic chemical control and storage - hazard review: chemical, physical, biological - potential sources (humans, animals, environment) and controls

Premises - Design, construction, and maintenance of the production and staff areas in the facility, Layout (design) of the facility - separation from farm/animals/pets (small scale) - perimeter, entrances, drainage - construction, heating/ventilation, humidity control - separation raw versus. pasteurize; product flow - equipment / pipe layout / drainage - water source (treatment, hardness) monitoring

Unit:2	Equipment and Personnel Management	8-- hours

Equipment - Design, construction, and maintenance of equipment, Equipment arrangement and operation, cleaning-in-place process.

Personnel - Ensuring facility personnel are qualified for their job responsibilities, personal health and disease control, personal hygiene; clothing, habits, hand wash, restrooms, plant traffic control.

Unit:3	Sanitation	8-- hours

Sanitation - Sanitation programs: Cleaning and sanitation compounds and their uses – for process equipments - for environmental cleaning (drains, coolers, etc.) - influence of water quality, formulation control - concentrations and time. Environment sanitation and monitoring - environmental monitoring / pathogen testing - pest control programs

Unit:4	Raw Material Testing, Good practices in production and control and Process Control	12-- hours

Raw Material Testing - Testing raw materials - Identifying when product or raw materials must

be tested - Accepting raw materials from a vendor without additional regular testing - Supplier certification. **Good practices in production and control** - Controlling the manufacturing process - Stages in the production cycle – contracting quality tools – R & D - Self-inspection programs for fabricators, packagers/labelers - Testing requirements for packaging materials including supplier certification. **Finished Product Testing** - Finished product testing - Writing product specifications - Conditions and options for finished product testing, distributors - product storage - packaging, distribution. **Process Control** - refrigeration (potential hazardous compounds), pasteurization - culture, pH, incubation temperature, aging temperature.

Unit:5	**Quality Control Department and Audits**	**15-- hours**

Quality Control Department and Audits - Establishing a QC department - Investigating product quality. Audits- Records -Maintaining accurate, clear, and precise documents - Identifying individuals responsible for maintaining documents. Validation -- Definition – PQ, DQ, OQ, IQ Qualification, Process validation, Cleaning validation and Computer validation. GMP regulations - US-FDA, Europe, Japan, ICH, PICS/S, WHO

Unit:6	**Contemporary Issues**	**2 hours**

Expert lectures, online seminars – webinars

AI/ML in Warehouse Logistics
Machine Learning in Load forecasting and vehicle scheduling
ML in Supply chain Management
AI in Supplier Management

	Total Lecture hours	**54 hours**

Text Book(s)

1	Compendium of Good Practices in Biotechnology, BIOTOL series

Reference Books

1	.A WHO guide to good manufacturing practice (GMP) requirements: Volume 1,2,3,4,5. Part 2-Validation, by Gillian Chaloner-Larsson, Ph.D, GCL Bioconsult, Ottawa
2	Good Manufacturing Practices for Pharmaceuticals, Sixth Edition by: Graham Bunn Publisher: Informa Healthcare; 6 edition | 424 pages (2007) http://ebookee.org/Good-Manufacturing-Practices-for-Pharmaceuticals-Sixth-Edition_859976. html#uPYoXd8huFeqqXB9.99
3.	A Primer – Good Laboratory Prcatices and current manufacturing practice, by Ludwig Huber, Published by Agilent Technologies, Germany (2002) http://www.chem.agilent.com/Library/primers/Public/59886197.pdf.
4.	GMP manual: Good manufacturing practices and implementation, http://www.gmp-publishing.com/media/ebooks/flyer/files/gmpmanual_eu_4c_online.pdf.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Inspection and Quality Control in Manufacturing- https://swayam.gov.in/nd1_noc20_me27/preview
2	Product design and Manufacturing-https://swayam.gov.in/nd1_noc20_me12/preview
3	Design for quality manufacturing and assembly- https://swayam.gov.in/nd1_noc19_me48/preview
4.	Quality Design and Control-https://swayam.gov.in/nd1_noc20_mg18/preview

Course Designed By:Dr. V. Brindha Priyadarisini

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	L	L	S	L	L	L	L	L	L
CO2	L	L	L	S	L	L	L	L	S	L
CO3	L	S	L	S	L	S	L	L	L	L
CO4	L	L	L	S	L	L	L	L	L	L

*S-Strong; M-Medium; L-Low

Fourth Semester

Course code	20MBTME15A	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
Elective Paper			2	-	-	2
Pre-requisite		Basic knowledge about Entrepreneur	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
To enable the students to acquire knowledge about the various concepts of Entrepreneurship
To develop and enhance entrepreneurial competency and drive to startups.
To know start up grants from government agencies

Expected Course Outcomes:

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

1	Should able develop idea generation and innovative skills for Entrepreneurship	K2
2	Have the ability to discern distinct entrepreneurial traits	K2
3	Know the parameters to assess opportunities and constraints for new business ideas	K2
4	design strategies for successful implementation of ideas	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Introduction	5 hours

Entrepreneurship – Meaning, Definition and concepts – Evolution of Entrepreneurship – Theories of Entrepreneurship – Role of Entrepreneurship in Economic Development, Factors affecting Entrepreneurship - Entrepreneur – Qualities, nature, types and traits – Entrepreneur Vs. Intrapreneur – Entrepreneur Vs. Manager – Entrepreneurship Development – meaning and importance.

Unit:2	Entrepreneurial mobility and motivation	6 hours

Entrepreneurial mobility, Factors affecting Entrepreneurial mobility, types of Entrepreneurial mobility – Meaning and concept of Entrepreneurial competency, developing Entrepreneurial competencies and Culture – Entrepreneurial Motivation – meaning and concept of motivation – motivation theories – Entrepreneurship Development Programs (EDPs) – Needs and objectives – phases of EDPs and evaluation of EDPs.

Unit:3	Entrepreneurship Development and Government	6 hours

Role of Government in promoting Entrepreneurship, MSME policy in India – District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship Development Board (NEDB) – Recent initiatives by the Central and State Governments to boost startups and entrepreneurship in India , Startup India, Skill India, MSDE and NSDC– Financial Support System for entrepreneurship development.

Unit:4	Business sectors and forms	6 hours

Business Sectors, Meaning and classifications - primary, secondary and tertiary sectors - Business Organisation – Forms of business organization, Sole Proprietorship, Partnership firms, Joint stock companies, Co-operative Society – their features, relative merits, demerits & suitability – Concept of Social Enterprise and Social Entrepreneurship, Social Entrepreneurs, Sustainability issues in Social Entrepreneurship – Entrepreneurial failure, issues, reasons and revamps.

Unit:5	Project Management	5 hours

Project Management, Concept, features, classification of projects, issues in Project Management – Project identification, Formulation, design and evaluation, Project appraisal, Project Report Preparation, Specimen of a Project Report – Starting a small scale unit, Procedure and legal formalities, Steps in setting SSI unit, incentives and subsidies – Evaluating entrepreneurial performance.	
Expert lectures, online seminars – webinars	
E learning	**2 Hours**
http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000023MA/P001403/M016027/ET/1465203437Module-7Entre.pdf **http://ecoursesonline.iasri.res.in/course/view.php?id=303**	
Total Lecture hours	**30 hours**

Text Book(s)	
1	**Drucker, P. Innovation and Entrepreneurship. 2Rev Ed edition. Butterworth-Heinemann, 2010.**
2	**Hopkins, Bruce. A Legal Guide to Starting and Managing a Nonprofit Organization. 3rd edition. Wiley, 2000.**
3	**Jensen, Bill. Simplicity: The New Competitive Advantage in a World of More, Better, Faster. Perseus, 2001.**
4	**Reinhardt, Forest. Down to Earth. Harvard Business School Press, 2000.**
Reference Books	
1	P. Saravanavelu, "Entrepreneurship Development", Eskapee Publications.
2	N.P. Srinivasan & G.P.Gupta, "Entrepreneurship Development", Sul tanchand & Sons.
3	Satish Taneja, Entrepreneur Development", New Venture Creation.
4	Barringer M.J. "Entrepreneurship", Prentice-Hall, 1999
5	Robert D. Hisrich, Michael P. Peters, "Entrepreneurship Development", Tata McGraw Hill
6	Vasanth Desai, "Dynamics of Entrepreneurial Development and Management", Himalayas Publishing House
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	**https://onlinecourses.swayam2.ac.in/cec20_mg19/preview**
	https://onlinecourses.swayam2.ac.in/cec19_mg39/preview
Course Designed By: Dr. N. Uma Devi Assistant Professor, BSMED, Bharathiar University.	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	S	L	S	L	L	L	L	L	L
CO2	L	L	L	S	L	L	L	L	L	L
CO3	L	L	L	S	L	L	S	L	L	L
CO4	L	L	L	S	L	L	L	L	L	S

*S-Strong; M-Medium; L-Low

Course code	19MBTGE15B	TEACHING TECHNIQUES IN SCIENCE	L	T	P	C
Elective Paper			2	-	-	2
Pre-requisite		Aware of Teaching Methodology	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Acquire knowledge about teaching- learning process and techniques.
Comprehend different methods of teaching science.
Acquire knowledge about various skills of Microteaching.
Understand and apply the concept of unit plan and lesson plan in teaching science

Expected Course Outcomes:

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

1	Able to disseminate up-to-date knowledge	K2
2	Able to develop the capability to use ideas and information	K3
3	Able to develop the student's ability to test ideas and evidence	K2
4	Capability to plan and manage own learning	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Teaching Learning Process	6 hours

Teaching: Meaning, Scope, Importance. Learning: Meaning, Scope, Importance. Teaching Learning Process. Bloom's Taxonomy of Learning objectives in Science.

Unit:2	Methods of Teaching Science	6 hours

Pedagogy: Meaning, concept. Different pedagogy of teaching Science: Seminar, Conference, Symposium and Workshop. Methods of Teaching in Science: Lecture-cum-Discussion Method, Laboratory Method, Observation Method, Project Method and Problem Solving Method.

Unit:3	Micro-teaching skills in Science	6 hours

Micro-teaching: Meaning, Importance, Steps and Cycle. Skills of Micro-teaching: Set Induction, Explaining, Stimulus variation, reinforcement and Closure.

Unit:4	Teaching of Science	5 hours

Formulation of Instructional Objectives. Unit Planning: Meaning and Steps. Lesson Planning: Meaning and Steps. Improvised of teaching aids in general science.

Unit:5	Evaluation in Science	5 hours

Evaluation: Definition and Objectives. Types of Evaluation: Formative and Summative. Achievement test: Development and Construction.

E learning	2 Hours

https://bit.ly/2GNBaSW
https://files.eric.ed.gov/fulltext/ED532172.pdf
https://bit.ly/3iOH97H

Total Lecture hours	30 hours

Text Book(s)	
1	Ahuja, M & Bhushan, A .2012: *Educational Technology: Theory and Practice Teaching Learning Process*, Bawa Publications, Patiala.
2	Kochar, S.K. 1985: *Methods and Techniques of Teaching*, Sterling Publishers Private Limited, New Delhi.
3	Mehra,V. 2010: *A Textbook of Educational Technology*, Sanjay Prakashan Publishers, New Delhi.
4	Sachdeva, M.S. 2006: *Essentials of Educational Technology and Management,* Twenty First Century Publications, Patiala.
Reference Books	
1	Kumar, K.L. (1996). Educational technology. New Delhi: New Age International Publishers.
2	Srivastava, A.P. (1987). Teaching and learning in 21st century. New Delhi: Indian Books Centre.
3	Vedanayagam, E.G. (1989).Teaching technology for college teachers. New York: Sterling Publishers.
4	Sharma, S.R. (2003). Effective classroom teaching modern methods, tools & techniques. Jaipur: Mangal Deep.
5	Neel A, GlasGow, Cathy & Hicks. What successful teachers do. Chennai: Tamil Nadu Book House.
6	Sampath, K., Panneerselvam, A. &Santhanam, S. (1984). Introduction to educational technology. II revised Edition. New Delhi: Sterling Publishers.
7	Witch, W.A. &Schulles, C.F. (1973). Instructional technology: Its nature and use New York: Harpu& Row.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://onlinecourses.swayam2.ac.in/nou20_ed04/preview
2	https://onlinecourses.swayam2.ac.in/cec19_ed08/preview
Course Designed By: Dr. G. Singaravelu, Professor & Head, Dept. of Education Technology, Bharathiar University	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	L	L	L	L	L	L	L	L	S
CO2	L	L	L	L	L	L	L	L	L	S
CO3	L	L	L	L	L	L	L	L	L	S
CO4	L	L	L	L	L	L	L	L	L	S

*S-Strong; M-Medium; L-Low

Supportive Course

SUPPORTIVE PAPERS

Course code	10MBTS1	MICROBIAL BIOTECHNOLOGY	L	T	P	C
Supportive Paper			2	-	-	2
Pre-requisite		Aware of Biological Sciences	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:
Give insights on the Components and units of a bioprocess industry
Impart knowledge on the various industrial bioproducts
Familiarize with various sectors of industrial biotechnology

Expected Course Outcomes:

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

1	Isolation and maintenance of industrial microbes	K2
2	Production of various industrial bioproducts from industrially relevant microbes	K1
3	Design a fermentor and its unit	K2
4	Potential applications of bioprocessing in various fields	K3

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Title of the Unit (Capitalize each Word)	5-- hours

Isolation, Preservation and Maintenance of Industrial Microorganisms. Fermenter parts and components; Media for industrial fermentation; Sterilization.

Unit:2	Title of the Unit (Capitalize each Word)	7-- hours

Industrial Bioproducts– microbial synthesis of organic acids (Citric acid), alcohol (ethanol), antibiotics production (penicillin), vitamin(B12) and amino acid(Tryptophan), beverage (wine) , food (soy sauce/cheese).

Unit:3	Title of the Unit (Capitalize each Word)	5-- hours

Agricultural Microbiology: Microbial herbicides, Agricultural antibiotics, Bio-fertilizers and Bio-insecticides

Unit:4	Title of the Unit (Capitalize each Word)	5-- hours

Medical Microbiology – Methods of isolation of pathogenic organisms; Production of vaccine, Hormones, Pharmaceuticals.

Unit:5	Title of the Unit (Capitalize each Word)	5-- hours

Environmental Biotechnology – Microbes in waste water treatment, microbial ore leaching and mineral recovery, oil recovery.

Unit: 6	Contemporary Issues	3 – hours

Online Industry video tours, Seminars/Webinars

	Total Lecture hours	30-- hours

Reference Text Book(s)

Peter F Stanbury, Allan Whitaker, Steohen J Hall, 2013, Principles of Fermentation Technology, Elsevier Science Ltd, Second Edition.
Manual of Industrial Microbiology and Biotechnology, III edition, Arnold. L. Demain and Julian

Davies, ASM press, Washington DC, 2010.
Handbook of Downstream processing, Edin Goldberg, Blackie and Academic Professional, 1997.
Medical Microbiology – Ananthanarayanan and Panicker, Orient Blackswan, 2006
Bio-fertilizers in Agriculture and Forestry, 1993, by N.S. Subba Rao.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	Industrial Biotechnology https://online-learning.tudelft.nl/courses/industrial-biotechnology/
2	Recent Technology biogas industry - https://www.bioprocesscontrol.com/academy/online-courses/
3	Microbes in waste water treatment - https://www.open.edu/openlearn/nature-environment/microbes-friend-or-foe/content-section-2
4	Microbial Leaching - https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/16%3A_Microbial_Ecology/16.6%3A_Microbial_Bioremediation/16.6A%3A_Microbial_Ore_Leaching
5	Vaccine production -https://www.chop.edu/centers-programs/vaccine-education-center/making-vaccines/how-are-vaccines-made
6	Insulin production - https://www.youtube.com/watch?v=OYvav8aDGCc

Course Designed By: Dr.Sentila Rajan

Course code	09MBTS2	CLINICAL MICROBIOLOGY	L	T	P	C
Supportive Paper			2	-	-	2
Pre-requisite		Basics of Microbiology	Syllabus Version		2021-22	

Course Objectives:

The main objectives of this course are to:

ing information on types of infections and their epidemiology

s knowledge on host defense and immune system

standing the preventive measures towards infection

Expected Course Outcomes:

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

1	Able to predict the epidemiology of disease	K2
2	Identify proper diagnosis and treatment of various infections caused by pathogens	K2
3	Make appropriate and effective on-the-job professional decisions in the processing of clinical samples.	K2
4	Differentiate the proper and inappropriate sample for analysis	K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	Infection and immunity	3 hours

Infection and immunity: General principles of infection, antigens, antibodies, antigen – antibody reactions, complement system.

Unit:2	Pathogenic/Parasitic organisms	6 hours

Pathogenic/Parasitic organisms: Bacterial, viral and protozoal infections of the gastrointestinal system, nervous system, lung, liver, and eye; sexually transmitted diseases, skin infections, zoonoses, arthropod borne diseases. Transmission and spread of diseases – disease epidemiology

Unit:3	Control and prevention of infections	6 hours

Control and prevention of infections: Drugs and antibiotics, drug resistance, mycobacteria, leprosy and malarial parasite – importance, life cycle, spread and control. Control of vectors – mosquito control – biotechnological approaches.

Unit:4	Vaccines	4 hours

Vaccines : Types and methods of action. Biotechnological approaches to disease control and vaccine production. Genetic disorders and gene therapy.

Unit:5	Biochemical changes due to infections	4 hours

Biochemical changes due to infections: Blood test and tissue analysis. Isolation and identification of organisms from tissue samples. Disease detection – conventional and molecular techniques.

Unit:6	AI in Clinical Microbiology	5 hours

Expert lectures, online seminars – webinars

Use of artificial intelligence in infectious diseases
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7153335/

Deploying Artificial Intelligence Against Infectious Diseases https://www.uspharmacist.com/article/deploying-artificial-intelligence-against-infectious-diseases Image analysis and machine learning for detecting malaria. https://europepmc.org/article/med/29360430 **The potential for artificial intelligence in healthcare** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/	
E learning	**2 Hours**
Immunity to pathogens https://nptel.ac.in/content/storage2/courses/102103038/download/module5.pdf Cellular and Molecular Immunology https://nptel.ac.in/content/storage2/courses/102103038/download/module1.pdf Mechanism of immune response https://nptel.ac.in/content/storage2/courses/102103038/download/module4.pdf Essentials in Immunology https://nptel.ac.in/courses/104/108/104108055/ **Basic Vaccinology: Why Vaccines Work or Don't Work** **https://youtu.be/iCej1gMWD4o**	
Total Lecture hours	**30 hours**

Text Book(s)	
1	Text book of microbiology, C.J.K. Panicker.
2	Immunology, Roitt,I.M., Brestoff and Male D.K., 1996.
Reference Books	
1	Molecular biotechnology, Glick.
2	Clinical microbiology, Ananthanarayanan.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Medical Microbiology: http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/248
Course Designed By: Dr. M. Gnanadesigan	

Course code	09MBTS3	FOOD BIOTECHNOLOGY	L	T	P	C
Supportive Paper			2	-	-	2
Pre-requisite		Aware of microorganism and its importance in food	Syllabus Version		2020-21	

Course Objectives:

To give an insight on the role of microorganism in food industries
2. Categorize harmful and beneficial microorganism in food industries

Expected Course Outcomes:

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

1	Explain importance of different types of food in balanced diet and diet planning	K3
2	Differentiate between different nutrient components in food and their role in processing and consumption	K4
3	Able to identify the characteristics of foodborne, waterborne and spoilage microorganisms	K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Unit:1	**Introduction**	**6- hours**

Nutritive factors of food constituents – protein, carbohydrates, fats in nutrition, bioavailability of nutrients and stability of nutrients. Microbes as direct food (Single cell protein and Baker's yeast); mycoprotein and yeast extract.

Unit:2	**Fermentation product**	**5-- hours**

Dairy products: General principles of manufacture of Cheese and Yogurt; Fermented foods: Soy sauce and Miso; Fermented vegetable: Sauer Kraut and pickles. Fermented sausages.

Unit:3	**Distilled beverages & Food additives**	**6-- hours**

Alcohol, wine, brandy and beer;
Production of additives - organic acid (acetic acid), amino acid (glutamic acid), food flavourants and pigments.

Unit:4	**Food spoilage and public health & Food preservation**	**5-- hours**

Staphylococcal, Salmonellosis, E.coli, Botulism, aflatoxin.
Principles of food preservation – methods of preservation: Physical (irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere); Chemical (Sodium benzoate Class I & II); Biological: Probiotics and bacteriocins.

Unit:5	**Food process technology**	**6-- hours**

Canning, Microwave heating, thermal inactivation of microorganisms, freezing and thawing of foods. Food process operations: Evaporation - single and multi effect evaporation, dehydration, psychomatric charts; drying-tunnel, tray, spray, drum, freezeing; distillation; food processing aid through biotechnology.

Unit:6	**Contemporary Issues**	**1 hour**

Expert lectures, online seminars – webinars

Examples of AI application in food industry
https://foodindustryexecutive.com/2018/04/6-examples-of-artificial-intelligence-in-the-food-industry/

Application of Machine Learning in Microbiology https://www.frontiersin.org/articles/10.3389/fmicb.2019.00827/full		
E-learning		**1 hour**
https://www.studocu.com/row/document/egerton-university/food-nutrition-and-dietetics/lecture-notes/food-science-and-technology-module-pdf/5275169/view http://ecoursesonline.iasri.res.in/course/view.php?id=131		
	Total Lecture hours	**30 hours**

Text Book(s)	
1	Industrial Microbiology, 1983, 4th Edition, Prescott and Dunn's, Gerald Reed, AVI Publishing Company Inc. Conneticut.
2	Food Microbiology- Frazier, 1987, Tata McGraw-Hill Education
Reference Books	
1	Food Biotechnology. 1982. by Knorr, D. Marcel Dekker, New York
2	Biotechnology, 1983, VI-VIII, Rehm, H.J. and Reed,G, Verlag Chemie,Wainheim
3	Genetic Engineering Applications for Industry, 1981, Paul,J.K.,Noyer Corporation, New Jersey
4	Fundamentals of Food Process Engineering, 1980, Toledo,R.T., AVI Publishing Co., USA.
5	Food Engineering Operations, 1979, 2nd Edition, Brennan,J.G., Bulters,J.R., Gowelx,N.D and Lilly, A.E.V., Applied Science Publishers
6	Food Process Engineering, 1977, 2nd Edition, Heldman, D.R., AVI Publishing
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Food Science and Processing https://swayam.gov.in/nd2_cec19_ag05/preview
2	Food Microbiology and Food Safety https://swayam.gov.in/nd2_cec20_ag13/preview
3	Food Preservation Technology https://swayam.gov.in/nd2_cec19_ag01/preview
4	Introduction to food Microbiology https://nptel.ac.in/courses/126/103/126103017/
Course Designed By: Dr.M.Thandeeswaran	

Annexure

SCHOOL OF BIOTECHNOLOGY & GENETIC ENGINEERING
DEPARTMENT OF MICROBIAL BIOTECHNOLOGY

Syllabus
M.Sc., Microbiology (CBCS –UD)
2021ONWARDS

Bharathiar University: Coimbatore-641 046
(A State University, Accredited with "A" Grade by NAAC and 13th Rank among Indian Universities by MHRD-NIRF)
Coimbatore 641 046, INDIA

BHARATHIAR UNIVERSITY: COIMBATORE 641046
DEPARTMENT OF MICROBIAL BIOTECHNOLOGY

MISSION

To empower young minds with scientific knowledge facilitating the grandaunts to have an array of career options allowing them to emerge as either a scientist or an entrepreneur commercializing microbial product or an entrepreneur establishing diagnostic laboratory or an Industrial expert in quality control. Education process is aimed at creating manpower with not only scientific knowledge but also with moral values and social responsibilities.