Course Name: Bachelor of Science
Discipline : Microbiology
CHOICE BASED CREDIT SYSTEM
(For those who joined in June 2022 and after)

Course Scheme:

III year B.Sc. MICROBIOLOGY

I- SEMESTER

Part	Course Code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Part I		Tamil	6	3	25	75	100	
Part II		English	6	3	25	75	100	
Core 1		General Microbiology	5	4	25	75	100	Skill Development
Core 2 Lab		Lab: General Microbiology	5	3	40	60	100	Focus on Employability
Allied 1		General Chemistry I	4	4	25	75	100	Skill Development
Allied 2 Lab		Lab: Volumetric Analysis	2	--	--	--	--	Focus on Employability
SEB1		Basic Bioinstrumentation	2	2	25	75	100	Entrepreneurship
SLC*		Value Education		3	25	75	100	Skill Development
Total			30	22				

SLC*- Compulsory Self learning course

II- SEMESTER

Part	Course code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Part I		Tamil	6	3	25	75	100	
Part II		English	6	3	25	75	100	
Core 3		Microbial Physiology	5	4	25	75	100	Skill Development
Core 4 Lab		Lab: Microbial Physiology	5	2	40	60	100	Focus on Employability
Allied 3		General Chemistry II	4	4	25	75	100	Skill Development
Allied 4 Lab		Lab: Volumetric Analysis	2	2	40	60	100	Focus on Employability
SEB2		Biochemistry	2	2	25	75	100	Skill Development
SLC*		Environmental Studies	-	2	25	75	100	Skill Development
Total			30	22	230	570	800	

III- SEMESTER

Part	Course Code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Part I	U22PT31/ U3PT3	Tamil	6	3	25	75	100	
Part II	U22PE31	English	6	3	25	75	100	
Core 5	U1MBC31/ U22MBC31	Immunology	4	4	25	75	100	Skill Development
Core 6 Lab	U2MBC3P/ U22MBCP31	Lab: Immunology	2	2	40	60	100	Focus on Employability
Allied 5	U2CHA3Y/ U22CHAY31	General Chemistry III	4	4	25	75	100	Skill Development
Allied 6 Lab	-	Lab: Organic Qualitative Analysis	2	--	--	--	---	Focus on Employability
Allied 7	U2MBA3/ U22MBA31	Biology-Plant Science	4	4	25	75	100	Skill Development
Allied 8 Lab		Lab: Biology	2	--	--	--	---	Focus on Employability
Total			30	20				

IV- SEMESTER

Part	Course Code	Course Title	Hours	Credit	Marks			Focus on Employability/ Entrepreneurship/ Skill Development
					I	E	Total	
Part I	U2PT4/ U22PT41	Tamil	6	3	25	75	100	
Part II	U22PE41	English	6	3	25	75	100	
Core 7	U3MBC4/ U22MBC41	Microbial Genetics and Molecular biology	4	4	25	75	100	Skill Development
Core 8 Lab	U22MBCP41	Lab: Microbial Genetics and Molecular biology	2	2	40	60	100	Focus on Employability
Allied 8	U2CHA4Y/ U22CHAY41	General Chemistry IV	4	4	25	75	100	Skill Development
Allied 9 Lab	U2CHA4YP/ U22CHAYP41	Lab: Organic Qualitative Analysis	2	2	40	60	100	Focus on Employability
Allied 10	U3MBA4/ U22MBA41	Biology-Animal Science	4	2	25	75	100	Skill Development
Allied 11 Lab	U2MBA4P/ U22MBAP41	Lab: Biology	2	2	25	75	100	Focus on Employability
Total			30	22				

Year	**Part**	**Subject**	**Credit**	**Internal=Total**	**Code**
I & II	Part V	NSS/NCC/Physical Education – Sports/ YRC/RRC	3	100=100	U22NS4/U22NC4/U22PS4/ U22YR4/U22RR4

III year B.Sc. MICROBIOLOGY

Semester	Part	Subject Name	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of Revision
V	Core 9	**Medical Microbiology**	4	4	25+75=100				✔					✔			U24MBC51	10 % Revised
	Core 10	**Environmental and Agricultural Microbiology**	4	4	25+75=100			✔						✔			U24MBC52	10 % Revised
	Core 11	**Bioinformatics**	4	4	25+75=100			✔								✔	U24MBC53	New
	Core 12	**LAB: Medical, Environmental and Agricultural Microbiology**	6	5	40+60=100			✔						✔			U24MBCP51	Title Change
	Allied 12	**Introduction to Pharmacognosy**	4	4	25+75=100		✔									✔	U24MBA51	10 % Revised
	Allied 13 Lab	**LAB**: Pharmacognosy and Pharmacology	2	-	-		✔									✔	---	--
	SBE 3	**Cell Biology**	2	2	25+75=100			✔								✔	U24MBS51	New
	SBE 4	**Employability Skills**	2	1	25+75=100									✔			U24PS51	Revised 50%
	NME	**Introduction to Microbiology**	2	2	25+75=100		✔									✔	U24MBN51	10 % Revised
	Total		**30**	**26**														
	Internship Programme (Extra Credit)		**60**	**2**													U24IP51	New
VI	Core 13	**Recombinant DNA (rDNA) Technology**	4	4	25+75=100			✔						✔			U24MBC61	10 % Revised
	Core 14	**Food & Industrial Microbiology**	4	4	25+75=100			✔						✔			U24MBC62	10 % Revised
	Core 15	**Research Methodology and Biostatistics**	4	4	25+75=100			✔								✔	U24MBC63	90% Revised
	Core15 Lab	**LAB: Recombinant DNA (rDNA) Technology, Food and Industrial Microbiology**	6	4	40+60=100			✔						✔			U24MBCP61	50% Revised
	Allied	Basic concept of Pharmacology	4	4	25+75=100		✔									✔	U24MBA61	Credit change

	15																	
	Allied 16	**LAB:** Pharmacognosy and Pharmacology	2	2	40+60=100		✔									✔	U3MBA6P/ **U24MBAP61**	No change
	SBE 6	Project	4	4	40+60=100			✔								✔	U1MB6PR/ **U24MB6PR**	No change
	NME 2	**Applied Microbiology**	2	2	25+75=100		✔									✔	**U24MBN61**	**10 % Revised**
		Total	**30**	**28**														

SEMESTER - V

Course Title : Medical Microbiology	**Total Hours : 60**
Course Code : U24MBC51	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Collect, transport and process of various kinds of clinical specimens.
CO2	Analyze various pathogenesis and treatment methods for bacterial disease.
CO3	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents.
CO4	Investigate the symptoms of viral infections and presumptively identify the viral disease.
CO5	Diagnose various protozoan diseases by different methods (serological, conventional and molecular).

Unit I **(12 hours)**

Normal microbial flora of Human body:- Skin, upper respiratory tract and intestinal tract. Nosocomial infections:- Definition, impact and their control (*Pseudomonas aeruginosa).* Specimen collection, transport and Laboratory examination of pus, throat swab, Urine and CSF samples.

Unit II **(12 hours)**

General characteristics, pathogenesis, diagnosis, treatment and preventive measures of *E. coli, Staphylococcus aureus, Streptococcus pyogenes, Mycobacterium tuberculosis, Treponema pallidum* and *Salmonella typhi.*

Unit III **(12 hours)**

Morphology, cultural characteristics, Pathogenesis, Laboratory diagnosis, Treatment of fungi - *Cryptococcus, Candida, Aspergillus Mucormycosis, Histoplasma, Coccidioides, Blastomyces.*

Unit IV **(12 hours)**

General characteristics, Pathogenesis, Laboratory Diagnosis and Treatment - Ebola virus, HIV, Dengue virus (DENV), SARS (CoV-2) and Hepatitis B virus (HBV).

Unit V **(12 hours)**

General characteristics, life cycle, diagnosis, treatment and preventive measures of *Entamoeba histolytica*, *Giardia lamblia*, *Leishmania donovani*, *Trichomonas vaginalis*, *Plasmodium falciparum*.

Text books:

1. Prescott, Harley and Klein. 2006. Microbiology (6th Edition). The McGraw-Hill Publishing Co., Ltd., New Delhi.
2. Ananthanarayanan, R. and Jayaram Panicker, C.K. 2005. Text book of Microbiology, orient Long man, London.

Reference Books:

1. Salle A. J. (2007). Fundamental Principles of Bacteriology. (4th Edition). Tata McGraw-Hill Publications.
2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartney Practical Medical Microbiology. 14th edn, Churchill Livingston.
3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries. - Part 22ndedn.Cambridge University Press.
4. Topley and Wilson's. (1998). Principles of Bacteriology. 9thedn. Edward Arnold, London.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. P. faller. 7th edn. Elsevier, Mosby Saunders.

Course Title : Environmental and Agricultural Microbiology	**Total Hours : 60**
Course Code : U24MBC52	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Understand the distribution and interactions of microbial population in soil
CO2	Analyze the various roles in biogeochemical cycles.
CO3	Evaluate the application of microbes in wastewater management.
CO4	Learn the beneficial application of microbes in agriculture.
CO5	Study the microbes as plant pathogens

Unit I **(12 hours)**

Distribution of microorganisms in soil – Factors influencing the soil microflora – Role of microorganisms in soil fertility – Interactions among microorganisms: mutualisms, commensalism, competition, amensalism, parasitism and predation – Positive interactions between microbes and plants: rhizosphere, phyllosphere and mycorrhizae.

Unit II **(12 hours)**

Biogeochemical cycles: Carbon cycle – Nitrogen cycle – Nitrogen fixation: symbiotic, asymbiotic and associative symbiotic relationships – Phosphorous cycle – Sulfur cycle.

Mycorrhizae – Types and Uses - VAM

Unit III **(12 hours)**

Microbes in waste treatment: Solid waste management: Saccharification, gasification and composting – Liquid wastes – Sewage treatment (Primary, secondary and tertiary treatments). Microbial assessment of water – Most Probable Number (MPN) technique, membrane filtration – Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) – Biodegradation of xenobiotics (Chlorinated pesticide 2,4-D).

Unit IV **(12 hours)**

Microbes for sustainable agriculture: Rhizobium, Azotobacter and Blue-green algae - Mass production, field applications and significance of biofertilizers – Mode of action and Applications of Biopesticides:- Bacterial: *Bacillus thuringiensis*, Viral:- Nuclear polyhedrosis virus and Fungal:- Trichoderma.

Unit V **(12 hours)**

Study of microbes as plant pathogens – Bacterial pathogens: *Xanthomonas*, *Mycoplasma* – Fungal pathogens: *Cercospora*, *Fusarium* – Viral pathogen: *Tobacco Mosaic Virus*, *Cucumber Mosaic Virus*. Role of the Environmental Protection Agency (EPA).

Text books:

1. Subbarao, 1995, Soil microorganisms and plant growth, 4/e, Oxford and IBH, New York.
2. Ronald M. Atlas and Richard Bartha, 1997, Microbial Ecology, 4/e, Benjamin CummingsPublishing Company.
3. Mehrotra and Ashok Agarwal, 2005, Plant Pathology, 2/e, Tata McGraw-Hill PublishingCo. Ltd., Delhi.

References Books:

1. Michael T. Madigan *et. al*., 1997, Brocks's Biology of Microorganisms, 8/e, Prentice, Hall Internation Inc.
2. Dubey and Maheshwari, 1999, A text book of Microbiology, 1/e, Chand publications, New Delhi.

Course Title : Bioinformatics	**Total Hours : 60**
Course Code : U24MBC53	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Relate the basic parts of computer and its significance in data abstraction from biological data bases
CO2	Explain the type's biological database, tools used to integrate the alignments and data interpretation for macromolecules

CO3	Predict the methodologies used in bioinformatics and its application in recent day's research activities.
CO4	Compare the structure related prediction as well as the evolutionary aspects of analysis for interpreting the results in an accurate and meaningful way
CO5	Compile the overall techniques for the betterment of human survival and also develop skills about creating new bioinformatics tools

Unit-I **(12 hours)**

History and development of computers; generations of computers, Input devices: Keyboard and mouse. Output devices: Visual display unit - LED, LCD. Storage devices: Primary memory - RAM, Secondary memory: Magnetic storage -Hard disk.

Unit-II **(12 hours)**

Internet basics: World Wide Web, HTTP, HTML, Electronic mail and Intranet. Introduction to Bioinformatics – Scope and Applications of Bioinformatics. Introduction to Triple letter and single letter code for aminoacid, Symbols used in nucleotides.

Unit-III **(12 hours)**

Nucleotide sequence databases: NCBI - GenBank, EMBL and DDBJ, Sequence submission methods and tools - Bankit, Useful programs: BLAST, FASTA and Clustal-W, Significance of multiple sequence alignments.

Unit-IV **(12 hours)**

Protein databases: Sequence file formats: PIR, Swiss Prot. Derived databases: Prosite and Pfam. Protein structural databases: PDB, Protein structural classification databases: CATH and SCOP.

Unit-V **(12 hours)**

Carbohydrate structure database: CCSD. Metabolic databases: KEGG, Specialized database: EST. Evolutionary analysis: Cladistic methods (Maximum parsimony and Maximum likelihood) and Phylogenetic methods (UPGMA and Neighbor Joining). Phylogenetic analysis tools - Phylip.

Text books:

1. Sundaralingam, R., and Kumaresan, V. 2008. Bioinformatics, 1st edition. Nagarcoil: Saras Publication.
2. Ignacimuthu, S.J. 2009. Basic Bioinformatics, 1st edition. New Delhi: NarosaPublishing House.
3. Rajaraman,V. 2010. Fundamentals of computers, 5th edition. New Delhi: PHI Learning Pvt Ltd

Reference books:

1. Teresa Attwood, K., & David parry smith, J. 2006. Introduction to Bioinformatics,1stedition. London: Dorling Kindersley Pvt, Ltd.
2. Kuppuswamy, C. 2006. Bioinformatics, 1st edition. New Delhi: Dominant Publishers.
3. Subramanian, C. 2006. A textbook of bioinformatics, 8th edition. New Delhi:Dominant Publishers.

4. Srinivasa Rao, D. 2010. Bioinformatics, 1st edition. Hyderabad: Biotech Pharmapublications.
5. Ignacimuthu, S.J. 2009. Basic Bioinformatics, 1st edition. New Delhi: NarosaPublishing House.

e- Resources:

1. https://www.hsls.pitt.edu/obrc/
2. https://www.hsls.pitt.edu/obrc/index.php?page=dna
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4. https://www.ebi.ac.uk/
5. https://www.kegg.jp/kegg/kegg2.html

Course Title : Lab: Medical, Environmental and Agricultural Microbiology	**Total Hours : 90**
Course Code : U24MBCP51	**Total Credits : 5**

Course Outcomes:

Cos	CO Statement
CO1	Get a platform that involves working knowledge of scientific research and academics, health clinics and industries.
CO2	Know about microorganisms including their environmental, agricultural and medical microbiology.
CO3	Learn about laboratory isolation and identification of microorganisms that will help them to understand the application of microbes in clinical microbiology.
CO4	Demonstrate an understanding and competency in laboratory safety and specialized microbiological laboratory skills including observation, creative and analytical thinking and data interpretation.
CO5	Observe the infected roots of Mycorrhizae

List of Experiments:

1. Isolation and Identification of microorganisms from Urine, pus, sputum and throat samples.
2. Isolation and identification of fungi from skin scraping, Dandruff.
3. Enumeration of microorganisms from soil.
4. Enumeration of microorganisms from water.
5. Enumeration of microorganisms from air (Open plate method).
6. Microbiological analysis of water by Most Probable Number (MPN) technique.
7. Isolation of *Rhizobium* sp from root nodules.
8. Isolation of *Pseudomonas* sp and *Azotobacter* from soil.
9. Staining and observation of Mycorrhizae from infected roots.
10. Demonstration / observation of microalgae and diatoms.
11. Visit Tamilnadu Agricultural University, Coimbatore and submit the report.

References:

1. Dubey, R.C. and O.K. Maheshwari, 2005, Practical Microbiology, 1/e, S. Chand & Co. Ltd., New Delhi.
2. Aneja, K.R. 2003, Experiments in Microbiology, Plant Pathology and Biotechnology, 4/e, New Age International, New Delhi.
3. Cappuccino and Sherman, 2007, Microbiology: A Laboratory Manual, 7/e, Pearson Education, New Delhi.

Course Title : Introduction to Pharmacognosy	**Total Hours : 60**
Course Code : U24MBA51	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Develop the knowledge about history and applications of Pharmacognosy
CO2	Improve the knowledge Conservation of medicinal plants.
CO3	Know about the functions various systems of medicine.
CO4	Discuss the properties of primary metabolites
CO5	Analyze the Applications of plant tissue culture

Unit I **(12 hours)**

Pharmacognosy-Introduction and History; Scope and develop of Pharmacognosy; Sources of Drugs – Medicinal plants, marine sources and Tissue culture. Structural Classification of medicinal plants.

Unit II **(12 hours)**

Cultivation and Collection of drugs of natural origin; Factors influencing cultivation of medicinal plants; Conservation of medicinal plants; Applications of plant hormones: Auxin, Gibberlin, Cytokynin and Abcissic acid.

Unit III **(12 hours)**

Introduction and properties of primary metabolites: Carbohydrates – Beta Glucose, Agar, Enzymes - Gelatinase, caseinase; Lipids – Castor oil, bees wax. Introduction to secondary metabolites: Test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Essential oil and Resins.

Unit IV **(12 hours)**

Plant tissue culture: Historical development of plant tissue culture; Types of cultures; Nutritional requirements; growth and their maintenance. Applications of plant tissue culture in pharmacognosy.

Unit V **(12 hours)**

Applications of Pharmacognosy in various systems of traditional medicine: Allopathy; Ayurveda; Unani; Siddha; Homeopathy systems of medicine.

Text Books:

1. Biren shah, 2013. Text book of Pharmacognocy and Phytochemistry, 2nd edition, Elsevier india.
2. Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edition, W.B. Sounders & Co.,London,
3. Tyler, V.E., Brady, L.R. and Robbers, J.E., 1988. Pharmacognosy, 9th edition, Lea and Febiger, Philadelphia,
4. Text Book of Pharmacognosy by T.E. Wallis, Published by Elsevier Inc.
5. Mohammad Ali., 2011. Pharmacognosy: Pharmacognosy and Phytochemistry, Volume 1, Published by CBS Publishers & Distributors Pvt. Ltd.
6. Kokate, C.K., Purohit, Gokhlae, 2007. Text book of Pharmacognosy, 37th edition, Nirali Prakashan, New Delhi.

References:

1. Herbal drug industry by R.D. Choudhary (1996), Ist Edn, Eastern Publisher, New Delhi.
2. Essentials of Pharmacognosy, Dr.SH.Ansari, IInd edition, Birla publications, New Delhi, 2007.

Course Title : Cell Biology	**Total Hours : 30**
Course Code : U24MBS51	**Total Credits : 2**

Course Outcomes:

Cos	CO Statement
CO1	Understand the basic knowledge about the structure and function of cells and cellular components
CO2	Examine different areas of cellular biology including structure and function of prokaryotic and eukaryotic cells, membrane and organelle structure and function, chemical composition of the cell, cell organelles and cellular communication
CO3	Examine the methods to fractionate cells and cellular components
CO4	Discuss the mechanisms behind organelle transport and secretion, the structure and function of enzymes and kinetics of enzyme reactions.
CO5	Analyze the signals over the plasma membrane, receptors, and cell signaling; the organisation and structure of the cell nucleus, chromatin and chromosomes

Unit I **(6 hours)**

Study of Prokaryotic and Eukaryotic cells, Plant and animal cells, Chemical components of biological membranes organization and Fluid Mosaic Model.

Unit II **(6 hours)**

Eukaryotic Cell organelles: Structure and functions of Mitochondria, Chloroplast, ribosomes and nucleus, Endoplasmic Reticulum, Golgi apparatus.

Unit III **(6 hours)**

Nucleus: Structure and Function, Chromosomes and their structure Cell division: Comparison between Mitosis and Meiosis and crossing over, Symmetric and asymmetric cell divisions.

Unit IV **(6 hours)**

Cell Cycle and its regulation, Regulation of DNA replication, Cell differentiation and stem cells, Tumor Suppressor Genes and Oncogenes.

Unit V **(6 hours)**

Cell viability assay, Study of mitosis in onion root, Preparation of Nuclear, Mitochondrial & cytoplasmic fractions

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, Keith; Walter, P., (eds) c2002: *Molecular Biology of the Cell*, Garland Science, New York and London.
2. Copper, G.M., & Hausman, R.E., 2004: *The Cell: A Molecular Approach*, 3rd ed., Sinauer Associates, Inc, Sunderland, Massachusetts.
3. Lodish, H. Berk A, Zipursky SL, et al., 2000: *Molecular Cell Biology*, 4th edition., W.H. Freeman, New York.

EMPLOYABILITY SKILLS

Course Title : Employability Skills	**Total Hours : 30 Hours**
Course Code : U24PS51	**Total Credits : 1**

COURSE OUTCOMES:

On completing this course, students can/are able to

Cos	CO STATEMENT
CO1:	enhance their skills in solving quantitative aptitude problems
CO2:	expertise themselves in solving verbal and non-verbal reasoning problems.
CO3:	prepare for various public and private sector exams and placement drives.
CO4:	interpret the concepts of LOGICAL REASONING Skills.
CO5:	analyze the problems logically and approach the problems in a different manner

Unit I: Quantitative Aptitude – I **6 Hours**

H.C.F. and L.C.M. of Numbers - Average - Percentage - Profit and Loss - Ratio and Proportion - Time and Work - Time and Distance - Train Speed.

Unit II: Quantitative Aptitude – II **6 Hours**

Area related problems - Problems on Ages - Boat and Stream - Simple Interest - Compound Interest – True discount – Calendar – Clocks - Data Interpretation - Bar Graphs - Pie Chart.

Unit III: Verbal Reasoning – I **6 Hours**

Analogy - Classification – Series - Coding & Decoding - Coded inequality - Blood relations - Direction sense test.

Unit IV: Verbal Reasoning – II **6 Hours**

Number Test - Ranking and Time Sequence Test - Seating arrangements - Alphabet Test - Logical Venn Diagram.

Unit V: General Knowledge **6 Hours**

Abbreviations & Acronyms - Famous Personalities - Important Days (National & International) - Capital Cities and Currencies – Current affairs - Sports – RBI & Banking Terms – Basics of Computers and Internet.

Reference Books:

1. R.S.Agarwal, Quantitative Aptitude for Competitive Examinations, S Chand Publishing company; Revised edition (21 February 2017).
2. R.S.Agarwal, A modern approach to logical reasoning, S Chand Publishing company; August 2022.
3. R.S.Agarwal, A Modern Approach To Verbal Reasoning (Old Edition), S Chand Publishing company.
4. R.S.Agarwal, Advanced objective general knowledge revised edition, S Chand Publishing company, 2017.

e-Resources:

1. https://www.cuemath.com/numbers/hcf-and-lcm/
2. https://www.geeksforgeeks.org/speed-time-distance-formula-and-aptitude-questions/
3. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cdn1.byjus.com/wp-content/uploads/2020/06/Boat-Stream-Sample-Questions.pdf
4. https://www.hitbullseye.com/Simple-Interest-and-Compound-Interest.php
5. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://examsdaily.in/wp-content/uploads/2018/09/br.pdf
6. https://testbook.com/objective-questions/mcq-on-direction-and-distance--5eea6a0e39140f30f369e42a
7. https://unacademy.com/content/cat/study-material/data-interpretation-and-logical-reasoning/ranking-and-time-sequence/
8. https://www.toppr.com/guides/computer-aptitude-and-knowledge/basics-of-computers/basic-computer-terminology/

Course Title : NME - Introduction to Microbiology	**Total Hours : 30**
Course Code : **U24MBN51**	**Total Credits : 2**

Course Outcomes:

Cos	CO Statement
CO1	Evaluate the importance of the contributions to microbiology
CO2	Provide an idea about the major types of microbes
CO3	List the characteristics originally used to describe prokaryotic cells
CO4	Describe the characteristics of Eukaryotic cell
CO5	Develop the basic awareness of microbiology

Unit I (**6 Hours)**

Introduction to Microbiology - History of Microbiology – Contributions of Antonie von Leeuwenhoek, Louis Pasteur and Robert Koch. Spontaneous generation theory – Biogenesis.

Unit II (**6 Hours)**

Bacteria: Ultra structure, Shape -Salient features of bacteria: Gram positive (*Methanobacterium*) and Gram negative (*E. coli*). Economic importance of bacteria.

Unit III (**6 Hours)**

Algae: General features of algae: Structure and reproduction of *Chlamydomonas* and *Sargassum*. Economic importance of algae.

Unit IV (**6 Hours)**

Fungi: General features of fungi, structure of *Yeast*, *Aspergillus* and *Penicillium*. Economic importance of fungi.

Unit V (**6 Hours)**

Protozoa: Structure of *Plasmodium*. Virus general characteristics of viruses – Transmission and Treatment of HIV and COVID-19.

Text Books:

1. Dubey, R.C. and Maheswari, D.K. 2010. A Text Book of Microbiology. S Chand publications, NewDelhi.
2. Mani , A., Selvaraj , A.M., Narayanan , L.M. and Arumugam, N. 2014. Microbiology – General and Applied . Saras Publication, Nagercoil, Tamil Nadu.

Reference Books:

1. Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw Hill, New York.
2. Prescott, Harley and Klein.2006.Microbiology 6/e. The McGraw-Hill companies.
3. Kumaresan, V. 2015. Biotechnology. Saras Publication, Nagercoil, Tamil Nadu.
4. Tauro, P., Kapoor, K.K. and Yadav, K.S.1989. An Introduction to Microbiology. Willey Publications. New Delhi.
5. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5th Edition., MacMillan Press Ltd.
6. Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11th Edition., Benjamin Cummings.

e- Resources:

1. https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-tomicrobiology/a-brief-history-of-microbiology
2. https://byjus.com/question-answer/methanobacterium-is-a-genus-of/
3. https://microbenotes.com/escherichia-coli-e-coli/
4. https://www.embibe.com/exams/economic-importance-of-bacteria/
5. https://byjus.com/neet/chlamydomonas/#:~:text=Chlamydomonas%20is%20a%20green%20alga,is%20studied%20in%20molecular%20biology.
6. https://www.vedantu.com/neet/economic-importance-of-algae
7. https://collegedunia.com/exams/economic-importance-of-fungi-definition-examples-sample-question-biology-articleid-2389

VI- SEMESTER

Course Title : Recombinant DNA (rDNA)Technology	**Total Hours : 60**
Course Code : U24MBC61	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Gain knowledge about the various techniques used for gene transfer mechanisms.
CO2	Understand the various enzymes and vectors involved in recombinant DNA technology.
CO3	To analyze the Extraction, purification and estimation of nucleic acids

CO4	Understand the blotting techniques and construction of cDNA
CO5	To know the applications of rDNA technology

Unit I **(12 hours)**

Introduction to rDNA technology – Mode of action and application of Enzymes: Restriction endonucleases (Types I, II and III), DNA polymerase, DNA ligase, Alkaline phosphatase, Methyl transferases, Topoisomerase. Uses of Linkers and adapters.

Unit II **(12 hours)**

Structural properties and applications of Vectors (Plasmid vectors):- Artificial Vectors: pBR322 and pUC19 – Phage Based vectors: lambda Vector – Cosmids – Phagemids – Bacterial Artificial Chromosome (BAC) and Yeast Artificial Chromosome (YAC).

Unit III **(12 hours)**

Artificial Gene transfer methods:- Calcium chloride induction, Electroporation and Microinjection – Gel electrophoresis:- AGE and PAGE – DNA sequencing: Maxam – Gilbert (Chemical) and Sanger – Nicholson (dideoxy/enzymatic) sequencing method.

Unit IV **(12 hours)**

Construction of Genomic library and cDNA library – Principle and applications in analysis of recombinants: Selection and screening of recombinants (Colony hybridization, Insertional inactivation and Blue and white colony selection) – Blotting techniques (Northern, Southern and Western) – Polymerase chain reaction (PCR).

Unit V **(12 hours)**

Applications of r-DNA technology: Medicine (Production of Insulin) – Gene therapy;- *Ex vivo*: Serve Combined Immuno Deficiency (SCID) and *In vivo*: Cystic Fibrosis Transmembrane Regulator (CFTR) – Transgenic animals (sheep and mice) – Transgenic plants – Bt cotton and Golden rice.

Text books:

1. Brown .T.A, 2006, Gene Cloning and DNA Analysis – An Introduction, 5/e, Wiley-Blackwell, UK.
2. 2. Dubey. R.C, 2013, A Textbook of Biotechnology, 5/e, S. Chand & Co. Ltd., New Delhi.
3. Primrose S. B. and Twyman R. M., 2006, Principles of Gene Manipulation and Genomics, 3/e, Blackwell Publishing Company, Oxford, UK.
4. Brown T. A. and Gene Cloning, 2006, DNA Analysis: An Introduction, 5/e, Wiley Blackwell, UK.
5. Glick B.R. and Pasternak J. J., 2003, Molecular Biotechnology, 3/e, ASM press, Washington.

Reference Books:

1. Kumaresan, V., 2003, Biotechnology, 3/e, Saras Publication, Nagercoil, Tanilnadu.
2. Joseph Sambrook and David William Russell, 2001, Molecular cloning, 3/e, CSHL Press, New York.
3. Brown .T.A, 2006, Gene Cloning and DNA Analysis – An introduction, 5/e, Willey-Blackwell, UK.

Course Title : Food and Industrial Microbiology	**Total Hours : 60**
Course Code : U24MBC62	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	To obtain information on the basic principles of the food borne microbes
CO2	To understand the role of varied microbes in food preservation.
CO3	To understand various kinds of preservation and spoilage of food products
CO4	To know about the different types and microorganisms that causes food borne illness
CO5	To acquire fundamental knowledge about industrial microbes

UNIT I **12 Hours**

Food as a substrate for microorganisms – pH, Moisture requirement, Oxidation-Reduction Potenial and Nutrient content; Contamination of foods – From Green plants & fruits, Animals and Air; Factors affecting the growth of microorganisms in foods.

UNIT II **12 Hours**

Principles of food preservation – Asepsis, High temperature, Low temperature, Drying Radiation: UV, Ionizing and Food additives.

UNIT III **12 Hours**

Spoilage and Preservation of Cereals and Cereal Products, Vegetables and Fruits, Meat and Meat products, Milk and Milk Products.

UNIT IV **12 Hours**

Food-borne illness: Bacterial – Botulism, *Staphylococcus*. Food intoxication;- Salmonellosis; *E.coli, Shigella sp., Aspergillus niger*, Hepatitis A. Mycotoxin – Aflatoxin and Patulin.

UNIT V **12 Hours**

Fermentor: Basic design and its functions – Types of Fermentor – Air lift, continuous stirred Tank and Tower. Fermented dairy products: Yoghurt and cheese. Industrially important of Microbial products:- Antibiotics: Production of Penicillin, Enzyme- amylase, Beverage - wine production; Single Cell Protein (SCP). Difference between prebiotics and probiotics.

Text Books:

1. Frazier, W. C. and Westhoff, D.C., 2014, Food Microbiology, Tata Publishing Company Limited, New Delhi.
2. Patel. A.H. (2012). Industrial Microbiology. 2nd Edition, Published by Pan Macmillan India, limited
3. Adams, M.R. and Moss, M.O., 2000, Food Microbiology, New Age International (P) Ltd., New Dehli.
4. Moshrafuddin Ahamed and Basumatary, S.K., 2008, Applied Microbiology, MJP Publishers, Chennai.

Reference Books:

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

e-Resource:

1. https://www.fda.gov/food/laboratory-methods-food/bam-chapter-18-yeasts-molds-and-mycotoxins#:~:text=Both%20yeasts%20and%20molds%20cause,processed%20foods%20and%20food%20mixtures.
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=111435
3. https://nofima.com/worth-knowing/foodpreservation/#:~:text=Temperature%20preservation,-Canned%20food%3A%20The&text=Sterilized%20food%20is%20heated%20to,pathogenic%20bacteria%20in%20the%20food.
4. https://www.pdfdrive.com/food-microbiology-e1079759.html
5. https://www.foodstandards.gov.au/consumer/safety/foodborne-illness/Pages/Toxins-in-seafood.aspx

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Course Title : Research Methodology and Biostatistics	**Total Hours : 60**
Course Code : U24MBC63	**Total Credits : 4**

Course Outcomes:

Cos	CO Statement
CO1	Understand the principles of research and various research methods and their applications
CO2	Analyze the guidelines for writing a manuscript for a journal.
CO3	Know the citation index and search engines
CO4	Understand the basic statistics methods
CO5	Analysis the classification of ANOVA

Unit I **(12 hours)**

Introduction to Research: Objectives of Research - Important Ingredients for Research: componential theory of individual creativity – Types of Research: Basic, Applied, Qualitative and Quantitative Research. Features of a good research study.

Unit II **(12 hours)**

Conducting Background Research: Need for Background Research Study, Resources of Literature Survey, Reputed Journals/Impact Factor Journals: SCOPUS, Science Direct and Springer - Phases of Research.

Unit III **(12 hours)**

Presenting and Publishing the Research Findings: Contents of Research Paper and Theses - Review System: Types of Peer Review, General Guidelines of selecting the research Journal, Citation Index. Plagiarism software – iThenticate and Urkund

Unit IV **(12 hours)**

Introduction to Statistics – Collection of data: Primary and Secondary data – Classification and Tabulation of data – Diagrammatic representation: General rules for Constructing diagrams, Types of Diagram: line, Bar, Pie. Measures of Central Tendency: Merits and Limitations of mean, median, mode.

Unit V **(12 hours)**

Correlation – Types and Merits. Chi-square test: Procedure and applications. Student's t-test: Procedure and applications. Analysis of Variance (ANOVA): Principles, classification and applications of ANOVA.

Text Books:

1. Vinayak Bairagi and Mousami V. Munot., 2019, Research Methodology, A Practical and Scientific Approach, CRC Press, Taylor & Francis Group, New York, ISBN 13: 978-0-8153-8561-5.
2. S. Palanichamy., M. Manoharan., 2005, Statistical Methods for Biologists (Biostsistics), Palani Paramount Publications, Palani, ISBN 81-85517-53-3.

REFERENCES:

1. Kothari, C.R., 2007, Research Methodology – Methods and Techniques, New Age International Publishers, New Delhi.
2. Montgomery, Douglas C, 2007, 5/e, Design and Analysis of Experiments, (Wiley India)
3. Jin Xiong: Essential Bioinformatics, Cambridge University Press Tramontano: Introduction to Bioinformatics, Chapman and Hall Series.
4. Prem S. Mann, 2004. Introductory Statistics. 5/e. John Wiley sons.
5. Sokal and Rohif, 1973 Introduction to Biostatistics - Toppan Co. Japan.
6. Gurumani, N, 2004, An Introduction to Biostatistics, 1/e, MJP Publishers, Chennai.
7. Attwood T.K. and D.J. Parry-Smith, 2001, Introduction to Bioinformatics Pearson Education, Asia.

Course Title : LAB: Recombinat DNA (rDNA) Technology, Food and Industrial Microbiology	**Total Hours : 90**
Course Code : U24MBCP61	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Understand about the isolation of microorganisms from various spoiled foods
CO2	Gain the knowledge on isolation of microorganisms from fermented foods
CO3	Applying the skills gained through the production of beverages and ethanol by using microorganisms
CO4	Determine of quality of milk sample
CO5	Gain the technical skills about immobilization technique using yeast.

1. Estimation of DNA using colorimeter (Diphenylamine reagent)
2. Estimation of RNA using colorimeter
3. Screening and isolation of phages from sewage
4. SDS- PAGE (Demonstration)
5. Enumeration of microorganisms from Spoiled fruits, vegetables and Milk
6. Isolation and Identification of fungi from contaminated foods – Bread
7. Determination of quality of milk sample by methylene blue reductase test.
8. Immobilization technique using yeast.
9. Wine production by yeast using Red Grapes - Demonstration
10. Beer production by yeast using Barley – Demonstration
11. Ethanol production by yeast using sugarcane molasses – Demonstration.
12. Industrial visit and Submission of Report – Dairy or sugar industries.

References Books:

1. Cappuccino, J.G. and Sherman, N. 2002. Microbiology: A laboratory manual (7th Edition), Addison Wesley, New York.
2. Patel. A.H. (2012). Industrial Microbiology. 2nd Edition, Published by Pan Macmillan India, limited.
3. Cappuccino, J.G. and Sherman, N., "Microbiology: A laboratory manual" Additon Wesley, Europe, 2002.
4. Harley and Prescott (1996), Laboratory Exercises in Microbiology, McGraw Hill Higher Education, 5th Edition.

Course Title : Basics Concepts of Pharmacology	**Total Hours : 60**
Course Code : **U24MBA61**	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Develop the knowledge of pharmacology.
CO2	Understand the anatomy and microbial infections of human.
CO3	Create the awareness about the adverse effects of drugs.
CO4	Discuss the effects antibiotics and antiseptics
CO5	Analyze the measurement of drug levels in different body fluids

Unit I **(12 hours)**

Drugs- Introduction, Route of administration, concept Pharmacokinetics, Pharmaco-dynamics and adverse drug reactions. Drug discovery and clinical evaluation of new drugs – Drug discovery Phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials.

Unit II **(12 hours)**

Measurement of Drug levels in different body fluids and significance. Drugs acting on digestive system- Antacids and drugs used in peptic ulcer, purgatives, and laxatives, Antidiarrohoeals, Emetics, Anti-emetics and Analgesics.

Unit III **(12 hours)**

Mode of action of Anti-Protozoan Drugs (*Plasmodium falciparum* & *Entamoeba histolytica*), Antifungal Drugs (*Aspergillus niger* & *Candida albicans*), Anti-Bacterial Drugs (*Salmonella typhi* & *Mycobacterium tuberculosis*), Anti-Cancer Drugs. Anti-Viral drugs (HIV, Hepatitis B virus).

Unit IV **(12 hours)**

Antibiotics in role of action - Penicillin, Tetracyclines, Streptomycin, Sulphonamides. Antitubercular agents, Anti-leprotic drugs. Disinfectants and antiseptics.

Unit V **(12 hours)**

Drugs affecting the Gastro Intestinal System, Respiratory System, Cardiovascular System, Central nervous system, Urine and renal functions. Excretion of drugs in stool and bile.

Text books:

1. Rang H. P., Dale M. M., Ritter J. M., Flower R. J. 8th Edition 2015. Rang and Dale's Pharmacology,.Churchil Livingstone Elsevier
2. Katzung B. G., Masters S. B., Trevor A. J. 2012. Basic and clinical pharmacology, Tata McGrawHill

Reference Books:

1. Goodman and Gilman's, The Pharmacological Basis of Therapeutics, 2006. Page 81 of 161
2. Marry Anne K. K., Lloyd Yee Y., Brian K. A., Robbin L.C., Joseph G. B., Wayne
3. A.K., Bradley R.W. 2009. Applied Therapeutics, The Clinical use of Drugs, 9th
4. edition, The Point Lippincott Williams &Wilkins.
5. Mycek M.J, Gelnet S.B and Perper M.M. 2014. Lippincott's Illustrated Reviews-Pharmacology, 6th edition, Wolters Kluwer(India) Pvt.Ltd - New Delhi.

Course Title : LAB: PHARMACOGNOSY AND PHARMACOLOGY	**Total Hours : 30**
Course Code : U3MBA6P/ **U24MBAP61**	**Total Credits : 2**

Course Outcomes:

COs	CO Statement
CO1	Learn and get experiences about herbs and their science
CO2	Define principle procedure of general formulations of drugs.
CO3	Recognize route of drug administration and classification of Pharmaceutical dosage
CO4	Learn the collection of blood and separation of plasma techniques
CO5	Understand preliminary phytochemical Screening of some ethno medicinal plants

List of experiments:

1. Cross anatomical studies (T.S. of stem) of *Azadiracta indica* L.
2. Morphological characteristics of plant families – Tridax procumbens L., *Catharanthus roseus* (L.) G.Don
3. Maintenance of laboratory animals as per CPCSEA guidelines (record work only).
4. Blood collection, serum and plasma separation
5. Study of different routes of drugs administration in mice/rats (record work only)
6. Preliminary Phytochemical Screening of *Phyllanthus niruri* L.
7. Preliminary Phytochemical Screening of *Vitex negundo* L.
8. Preliminary Phytochemical Screening of *Pedalium murex* L.
9. Preliminary Phytochemical Screening of *Tribulus terrestris* L.
10. Preliminary Phytochemical Screening of *Moringa oleifera* Lam.

Reference Books:

1. Bikash Medhi and Ajay Prakash, 2010. Practical Manual of Experimental and ClinicalPharmacology, jaypee brothers medical publishers (p) ltd.

2. Biswas.C and Johri, B.M.I999, The Gymnosperms. Narosa publishing house, New Delhi.
3. Harborne, J. B. practical manual of Phytochemical Methods (A Guide to Modern Techniques of Plant Analysis), Thirde dition 1998. Published by chapman & Hall, an imprint of Thomson Science, 2-6 Boundary Row, London SE1 8HN, UK.

Course Title : PROJECT WORK	**Total Hours : 60**
Course Code : U1MB6PR/ **U24MB6PR**	**Total Credits : 4**

The aim of project work (lab work) is to inculcate students to learn adequate knowledge on research methodology in the subject and prepare them for pursuing research in experimental or computational areas of the subject. Student's allotment is done by lot system. The project work study is to be undertaken under the guidance of a Teacher of the Department. The guiding teacher will make continuous internal assessment of the Project Work. No teacher shall be permitted to guide more than eight students in a semester for Project Work under his/her supervision. The project work will be evaluated by the external examiner.

1. Project will be done by the final year students in the sixth semester under the guidance of respective guides.
2. For projects internal marks (max 40) will be awarded by the respective guide and external marks (max 60) will be awarded in the external examinations.
3. Minimum number of pages for B.Sc. Project thesis shall be 30.

NME - 2

Course Title : APPLIED MICROBIOLOGY	**Total Hours : 30**
Course Code : U24MBN61	**Total Credits :2**

Course Outcomes:

COs	**CO Statement**
CO1	Learn the application of microbes in various fields.
CO2	Understand the basic ideas about beneficial role of microorganisms.
CO3	Develop the knowledge about the role of microorganisms on the food.
CO4	Study the role microorganisms in dairy products
CO5	Learn the importance of normal microflora of human body

Unit I **(6 hours)**

Introduction to applied microbiology :- Scope of Microbiology - Role of microorganisms in agriculture (Plant Growth Promoting Bacteria) food (dairy and alcoholic beverages) and medicine (antibiotics and vaccine).

Unit II **(6 hours)**

Agricultural microbiology (Role and applications): Microbes as Biofertilizers – *Rhizobium* (Symbiosis), Azotobacter, Azospirillum, Blue green algae (BGA), Azolla.

Unit III **(6 hours)**

Food microbiology: common food items – purpose of microbial examination in foods – methods of food preservation: pickling, salting, canning and refrigeration.

Unit IV **(6 hours)**

Dairy microbiology: composition of milk. Role of microorganisms in Dairy products: curd, yogurt, cheese and kefir (introduction only).

Unit V **(6 hours)**

Medical microbiology: Normal microflora of Human body (skin infection). Causes, symptoms, treatment and prevention of diseases: Bacterial – Typhoid, Viral: Dengue fever, COVID 19.

Text books:

1. Mani , A., Selvaraj , A.M., Narayanan , L.M. and Arumugam, N. 2014. Microbiology – General and Applied . Saras Publication, Nagercoil, Tamil Nadu.
2. Kumaresan, V. 2015. Biotechnology. Saras Publication, Nagercoil, Tamil Nadu.
3. Dubey, R.C. and Maheswari, D.K. 2010. A Text Book of Microbiology. S Chand publications, NewDelhi.
4. Ananthanarayanan, R. and Jayaram Panicker, C.K. 2005. Text book of Microbiology, orient Long man, London.

References:

1. Swaminathan, M. 1990. Food and Nutrition, Bappco. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
2. Kannaiyan, S. 2002. Biotechnology of biofertilizers, Narosa publishing house, New Delhi.
3. Subba Rao, N.S. 2002. Soil microorganisms and plant growth. 4th edition. Oxford and IBH publishing co Pvt. Ltd, New Delhi.
4. Adams, M.R. and Moss, M.O. 2006.Food microbiology, New Age international (P) Ltd., New Delhi.
5. Greenwood, D. Richard C.B. Salk, John, F. and Peutherer. 2003. Medical Microbiology (5th Edition). Churchill Livingstone, USA.
