GONDWANA UNIVERSITY

GADCHIROLI

SYLLABI AND COURSE OF STUDIES IN

MICROBIOLOGY

FYPG SEMESTER I AND II
UNDER NEP 2020 PROGRAMME

SESSION 2023-ONWARDS

M.Sc. MICROBIOLOGY PROGRAMME

PROGRAM OUTCOMES

By the end of the program the students will be able to:

PO1 - Knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.

PO2 - Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.

PO3 - Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.

PO4 - Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.

PO5 - Exploring the microbial world and analyzing the specific benefits and challenges.

PO6 - Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.

PO7 - Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

PO8 - Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes

PO9 - Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.

PO10 - Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.

PO11 - Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.

PO12 - Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

PROGRAMME SPECIFIC OUTCOME

After completing the graduation in the Bachelor of Science the students are able to:

PSO1 - Demonstrate effectively the applications of biochemical and biological sciences

PSO2 - Inculcating proficiency in all experimental techniques and methods of analysis

PSO3 - Acquire, articulate, retain and demonstrate laboratory safety skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis

PSO4 - Communicate scientific information effectively, especially relating to microbes and their role in ecosystem and health related issues

PSO5 - Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals

PSO6 - Gain and understanding of biochemical and molecular processes that occur in and between cells to expand understanding of biology

NEP 2020
SEMESTER PATTERN
M.Sc. Microbiology (PG) Program
Faculty of Science and Technology
(Affiliated Colleges)
(W.e.f. Academic Year 2023-24)

Scheme of teaching and examination under semester pattern for M.Sc. Program in Microbiology.

SEM	Core Course	Elective	Minor
SEM I	**Major 1- STPG01MCB01** (4 Credits) (4Hours/Week)	**STPG01MCB04 to STPG01MCB08** **Elective Course -** Student shall select any one course. (4 Credits) (4Hours/Week)	**STPG01MCB09** **Research Methodology** (4 Credits) (4Hours/Week)
	Major 2 – STPG01MCB02 (4 Credits) (4Hours/Week)		
	Major 3 – STPG01MCB03 (4 Credits) (4 Hours/Week)		
	Practical – I Based on Major Course and Elective Course (3-8 Hour/Week)		

Total 20 Credits

SEM	Core Course	Elective	Minor
SEM II	**Major 1- STPG02MCB01** (4 Credits) (4Hours/Week)	**STPG02MCB04 to STPG02MCB08** **Elective Course -** Student shall select any one course. (4 Credits) (4Hours/Week)	**STPG02MCB09** OJT/FP (4 Credits) (40Hours/Week)
	Major 2 – STPG02MCB02 (4 Credits) (4Hours/Week)		
	Major 3 – STPG02MCB03 (4 Credits) (4 Hours/Week)		
	Practical – I Based on Major Course and Elective Course (3-8 Hour/Week)		
Total 20 Credits			

Paper wise Marking Distribution Scheme

<table>
<tr><th colspan="7">SEM – I</th></tr>
<tr><th>Major (Mandatory)</th><th>Credit</th><th>Elective</th><th>Credit</th><th>On Job Training /Field Project (OJT/FP)</th><th>Credit</th><th>Total Credit</th></tr>
<tr>
<td>STPG01MCB01
Microbial Diversity and Evolution

Theory = 80 M
Internal = 20 M

STPG01MCB02
Enzymology and Techniques

Theory = 80 M
Internal = 20 M

STPG01MCB03
Commercial Microbiology

Theory = 80 M
Internal = 20 M</td>
<td>(4x3)
12</td>
<td>STPG01MCB04
Microbial Physiology and Metabolism

Theory = 80 M
Practical = 20 M

STPG01MCB05
Principle of Microbiology

Theory = 80 M
Internal =20 M

STPG01MCB06
Pharmaceutical Microbiology

Theory = 80 M
Internal = 20 M

STPG01MCB07
Advanced Microbiology

Theory = 80 M
Internal = 20 M

STPG01MCB08
Agriculture, Dairy and Food Microbiology

Theory = 80 M
Internal = 20 M

Note: Student can select any one elective paper</td>
<td>4</td>
<td>STPG01MCB09

Research methodology

Theory = 80 M
Internal = 20 M</td>
<td>4</td>
<td>20</td>
</tr>
</table>

Practical – I (Based on Major Course)

Total = 50 Marks

One major experiment	10 Marks
Two minor experiments	(5X2) Marks
Viva-Voce	05Marks
Practical Record	05 Marks
Total	**30 marks**

Internal = 20 Marks

Paper wise Marking Distribution Scheme

SEM – II						
Major (Mandatory)	**Credit**	**Elective**	**Credit**	**On Job Training /Field Project (OJT/FP)**	**Credit**	**Total Credit**
STPG02MCB01 **Advance Techniques in Microbiology** Theory = 80 M Internal = 20 M	(4x3) 12	**STPG02MCB04** **Microbial Methods for environment management** Theory = 80 M Internal = 20M	4	**STPG02MCB09** **On Job Training or Field Work** Theory = 80 Internal = 20	4	**20**
STPG02MCB02 **Membrane structure and signal transduction.** Theory = 80 M Internal = 20 M		**STPG02MCB05** **Biosafety and IPR** Theory = 80 M Practical =25M				
		STPG02MCB06 **Microbial Biotechnology** Theory = 80 M Internal = 20 M				
STPG02MCB03 **Microbiological Testing of industrial product** Theory = 80 M Internal = 20 M		**STPG02MCB07** **Microbial Enzyme Technology** Theory = 80 M Internal = 20 M				
		STPG02MCB08 **Microbes in sustainable agriculture and Development** Theory = 80 M Internal = 25M **Note: Student can select any one elective paper**				

Practical – I (Based on Major Course)

Total = 50 Marks

One major experiment	10 Marks
Two minor experiments	(5X2) Marks
Viva-Voce	05Marks
Practical Record	05 Marks
Total	**30 marks**

Internal = 20 Marks

Scheme of teaching and examination under semester pattern for M.Sc. Program

MARKING SCHEME Semester I													
Code	Theory / Practical	Teaching Scheme					Credit	Examination Scheme					
		Theory		Practical		Total		Duration in hrs.	Max. Marks		Total	Marks Minimum	
									External	Internal		Theory	Practical
		UA	CA	UA	CA								
Major - STPG01MCB01	Theory	80	20	**LAB-130**	20	-	4	3	80	20	100	40	40
Major - STPG01MCB02	Theory	80	20				4	3	80	20	100	40	40
Major - STPG01MCB03	Theory	80	20			-	4	3	80	20	100	40	40
Elective – STPG01MCB04	Theory	80	20				4	3	80	20	100	40	40
Minor - STPG01MCB09	Theory	80	20	-	-		3	3	80	20	100	40	40
TOTAL		**400**	**100**	**30**	**20**	**550**	**20**						

MARKING SCHEME Semester II													
Code	Theory / Practical	Teaching Scheme					Credit	Examination Scheme					
		Theory		Practical		Total		Duration in hrs.	Max. Marks		Total	Minimum Marks	
									External	Internal		Theory	Practical
		UA	CA	UA	CA								
Major - STPG02MCB01	Theory	80	20	**LAB-130**	20	-	4	3	80	20	100	40	40
Major - STPG02MCB02	Theory	80	20				4	3	80	20	100	40	40
Major - STPG02MCB03	Theory	80	20			-	4	3	80	20	100	40	40
Elective – STPG02MCB01	Theory	80	20				4	3	80	20	100	40	40
OJT - STPG02MCB09	-	-	-	80	20	-	3	3	80	20	100	40	40
TOTAL		**320**	**80**	**110**	**40**	**550**	**20**						

Assessment and Evaluation		
Suggested Continuous Evaluation Methods:		
Internal Assessment (Theory**)** Continuous Internal Evaluation (CIE)	Class Test, Attendance, Assignment (Charts/Models/Seminar/Rural Service/Report of Excursion/Lab visit/Industrial visit/project or review work)	20
	Total	**20**
External Assessment Practical Exam	Experimentation, *Viva Voce,* Spotting *e*tc.	30
Practical Internal	Practical record and others	20
	Total	**70**
External Assessment University Theory Exam	Section (A) – one Long Question Or Two brief questions	16 X 1=16 8 X 2 = 16
	Section (B) – one Long Question Or Two brief questions	16 X 1=16 8 X 2 = 16
	Section (C) – one Long Question Or Two brief questions	16 X 1=16 8 X 2 = 16
	Section (D) – one Long Question Or Two brief questions	16 X 1=16 8 X 2 = 16
	Section (E) – Four Short Question	4 X 4 = 16
	Total	**80**

General Rules and Regulations regarding pattern of question paper for the semester endexamination:

A) Pattern of Question Paper

1. There will be four units in each paper.
2. Maximum marks of each theory paper will be 80.
3. Question paper will consist of five questions, each of 16 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage andthere will be no internal choice.

B) Practical Examination

1. Each practical carries 100 marks. The scheme of marking shall be as per given in the syllabi of respective subjects.
2. Practical performance shall be jointly evaluated by the External and Internal Examiner. In case of discrepancy, the External Examiner's decision shall be final.
3. Duration of practical examination will be as per given in the syllabi of respective subjects.
4. The Practical Record of every student shall carry a certificate as shown below, duly signed by the teacher-in-charge and the Head of the Department. If the student fails to submit his / her certified Practical Record duly signed by the Teacher-In-Charge and the Head of the Department, he / she shall not be allowed to appear for the Practical Examination and no Marks shall be allotted to the student.
5. The certificate template shall be as follows:

C) On Job Training

1. Students have to do the training at Research Institute/Laboratory/Industry for at least 15 days completing 40hrs/week.

2. Student should prepare hard cover report of the training and should submit with duly signed by HOD.

Paper Title

SEMESTER - I

SEM	Paper Code	Major (Mandatory)	Elective	Paper Code	Minor	Paper Code
I	STPG01MCB01	Microbial diversity and evolution	1 Microbial Physiology & Metabolism	STPG01MCB04	Research Methodology	STPG01MCB09
			2. Principles of Microbiology	STPG01MCB05		
	STPG01MCB02	Enzymology and Techniques	3. Pharmaceutical Microbiology	STPG01MCB06		
			4. Advanced Microbiology	STPG01MCB07		
	STPG01MCB03	Commercial Microbiology	5. Agriculture, Food and Dairy Microbiology	STPG01MCB08		
			Note: - Student shall select any one from above group			
Practicals - Based on Major Course						

SEMESTER - II

SEM	Paper Code	Major (Mandatory)	Elective	Paper Code	Minor	Paper Code
II	STPG02MCB01	Advance Techniques in Microbiology	1. Microbial Methods for environment management	STPG02MCB04	On Job Training/Field Report	STPG02MCB09
			2. Biosafety and IPR	STPG02MCB05		
	STPG02MCB02	Membrane structure and signal transduction.	3. Microbial Biotechnology	STPG02MCB06		
			4. Microbial Enzyme Technology	STPG02MCB07		
	STPG02MCB03	Microbiological Testing of industrial product.	5. Microbes in sustainable agriculture and Development	STPG02MCB08		
			Note: - Student shall select any one from above group			
Practicals - Based on Major Course						

MAJOR COURSE

Semester-I

Paper- STPG01MCB01

Microbial Diversity and Evolution (MDE)

Course Code	Unit	Topic/Title	Credit
01MSCMB01	Unit-I	**Microbial Evolution and Systematic** Evolution of Earth and early life forms. **Primitive life forms:-**RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis. **Methods for determining evolutionary relationships: -** Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phyllogenetic probes, microbial communityanalysis. **Derivation of Microbial Phylogeny:-** characteristics of domainof life, classical taxonomy, chemotaxonomy, bacterial speciation.	04
	Unit-II	**Microbial Diversity: Archea** General Metabolism and Autotrophy in archea **Phylum Euryarchaeota:-**Halophilic archaea, methanogens, thermoplasma. **Phylum Crenarchaeota:-**Energy metabolism, Thermoproteales, sulfolobales, desulfolobales. **Phyllum Nanoarchaeota:-** Nanoarchaeum. Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.	
	Unit-III	**Microbial Diversity: Bacteria** **Phylum Proteobacteria: -**Free living N2 fixing bacteria,purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria. **Phylum prochlorophytes** and cyanobacteria, **Phylum:Planctomyces, Phylum;Verrucomicrobia.**	
	Unit-IV	**Microbial Diversity.** Phylum: Cytophaga, Phylum: Green Sulfur Bacteria. Phylum: Deinococci. Phylum: Green non –sulfur bacteria. Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex. Phylum: Nitrospira and Deferribacter.	

Reference Books

1	Goodfellow, M. and Minnikin, D.E. (eds.), Chemical methods in bacterial systematics, The Society for Applied Bacteriology. Technical Series No.20, Academic Press.
2	Sneath, A.H.P., Mair, S.N. and Sharpe, E.M. (eds.), Bergey's manual of systematic bacteriology Vol.2. Williams & Wilkins Bacteriology Symposium, Series No 2, Academic Press, London/New York.
3	Goodfellow, M., Mordarski, M. and Williams, S.T. (eds.), The biology of the actinomycetes.
4	Barlow, A. (ed.), The prokaryotes: a handbook on the biology of bacteria: ecophysiology, isolation, identification, applications, Volume 1 Springer-Verlag.
5	Kurtzman, C.P., Fell, J.W. and Boekhout, T. (eds.), The yeasts- a taxonomic study.
6	Norris, J.R. and Ribbons, D.W. (eds.), (1971) Methods in microbiology, Vol.18 & 19.
7	Reddy, C.A. (ed.), Methods for general and molecular microbiology
8	Priest, F.G. and Austin, B. Modern bacterial taxonomy, Chapman and Hall.

Semester-I
Paper- STPG01MCB02
Enzymology and Techniques (ET)

Course Code	Unit	Topic/Title	Credit
01MSCMB02	**Unit-I**	**Enzymes kinetics** Overview of Michaelis-Menten equation and its transformation, Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions, kinetics of enzyme inhibition, Classificationof enzymes	04
	Unit-II	**Catalytic mechanisms** Concept of active site, determination of active site, acid –base catalysis, covalent catalysis, metal ion cofactors, proximity and orientation effects, preferential binding. Active site determination and mechanism of ribonuclease, lysozyme, Active site determination and mechanism of serine protease.	
	Unit-III	**Regulation of Enzyme activity** Allosterism, Kinetic analysis of allosteric enzymes Covalent Modification, Feed -back inhibition Membrane bound enzymes, isoenzymes and marker enzymes-LDH, multienzyme complex with mechanism Constituitive and inducible enzymes.	
	Unit-IV	**Techniques** **Enzyme isolation and purification**- Importance of purification, methods of purification and fractionation, crieteria of purity Protein**:** ligand binding studies: association and dissociation constants, co-operative ligand binding MWC or concerted model, sequential model. **Enzyme biosensors**: General concept, Definitions, history and market needs. Glucose biosensor. Industrial applications ofenzymes. Immobilized enzymes, Protein engineering.	

REFERENCES:

1. Advances in Enzymology by Alton Meister (1996), Interscience Publishers.
2. Allosteric enzymes – kinetic Behavior by B.I Kurganov (1982) John Wiley and sons Inc., New York.
3. Biology enzymes in biotechnology by H.J.Rehm and G. Reed Verlag (1983) VCH Publishers. New York.
4. Enzymes as Drugs by John S. Hoilenberg and Joseph Roberts (2001). John Wiley and Sons New York.
5. Enzymes by Dixon, M., and E. C. Webb, 3rd edition, (1980), Academic Press. New York.
6. Enzymology by palmer
7. Hand Book of Enzyme Biotechnology by Wiseman (1985), Ellis Horwood.
8. Methods in Enzymology by W. A. Wood (1980) Academic Press New York.
9. Methods in Enzymology. Volume 22- Enzyme purification and related techniques by William B. Jakoby. Academic press, New York.
10. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer (1974) Verlag Chemie.
11. Topics in enzymes and fermentation biotechnology by L.N.Weiseman, John wiley and Sons.
12. Enzymes: By: Trevor Palmer.
13. Enzyme structure and mechanism By: Alan Fersht.
14.Methods in Enzymology By: S. Berger, A. Kimmel.

Semester-I
Paper- STPG01MCB03
Commercial Microbiology

Course Code	Unit	Topic/Title	Credit
01MSCMB03	Unit-I	**Petroleum Microbiology** Evidence regarding biogenesis of petroleum. Bacterial products as indicators of petroleum biodegradation. Apparatus for the detection of living microbial contaminants in petroleum products. **Exploration**: Microbiological Exploration for Petroleum Deposits; Geomicrobiological Methods of Ore and Petroleum Exploration. **Oil recovery**: Oil Recovery Process using Aqueous Microbiological Drive Fluids; Bacteriological Method of Oil Recovery. **Microbiological Oil Prospecting. Microbial solubilization of coal**	04
	Unit-II	**Cosmetic Microbiology:** Definition**;** Preparations of Skin whitening compositions from microbes like Ascomycetes, Black yeast, enzymes, and Mineral yeast ferments. Microbial Production of Alpha Arbutin; Hyaluronic acid; Kojic acid and their use in Cosmetics preparations. **Space Microbiology**: Monitoring of astronauts' microbial flora: Alterations in the load of medically important microorganisms, ESA STONE experiment. Evaluating the Biological Potential in Samples Returned from Planetary Satellites and Small Solar System Bodies.	
	Unit-III	**Textile Microbiology:** Definitions: Antimicrobial fabrics; Antimicrobial garments; Antimicrobial carpets and tiles, antimicrobial colorants. Bacteriostatic Sanitary napkins and towels. **Paper Microbiology**: Antibacterial Paper and Antibiotic Paper production Antimicrobial papers and Antimicrobial Currency.	
	Unit-IV	**Plastic Microbiology:** definition**,** **Bacteriostatic plastics**: Antimicrobial plastic composition and production. Antiseptic plastics. **Fungistatic plastics**: Definition and production. Production of Plastics Materials from Microorganisms. Methods for Producing Anti-Microbial Plastic Product. Plastic article containing a metallic bactericidal agent Casein Plastic. **Rubber Microbiology**: Definition; Antimicrobial rubbers; Antimicrobial rubber compositions.	

References

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999. Wiley.
3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Biosynthesis by Smith.
7. The Bacteria. Volumes by I.C. Gunsalus and Rogery Stanier, Acadenic Press.
8. Microbial Physiology by Benjam.
9. Metabolic Pathways .By:-David M.Greenberg.
10. Dawes, E. A. Microbial Energetics, New York: Chapman.
11. White, D. The Physiology and Biochemistry of Prokaryotes, Oxford University Press,

ELECTIVE PAPERS

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Paper – STPG01MCB04

Microbial Physiology and Metabolism

Course Code	Unit	Topic/Title	Credit
01MSCMB04	**Unit-I**	**BIOENERGETICS** Basic concept of bioenergetics and metabolism. Carbohydrate metabolism: glycolysis and its regulation, Feeder pathway of glycolysis and carbohydrate–homo and hetero lacticfermentation. Glycogenesis, Glycogenolysis. Gluconeogenesis; pathways and regulation, Pentose phosphate pathway, kreb's cycle and glyoxalate pathway. Substrate level phosphorylation and oxidative phosphorylation, electron transfer reaction in mitochondria, electron carriers andmultienzyme complex I to IV. ATP synthesis: chemiosmotic theory, shuttle system, regulation of oxidative phosphorylation and uncouplers, inhibitors of oxidative phosphorylation.	04
	Unit-II	**PHOTOSYNTHESIS AND LIPID METABOLISM** Photosynthesis: structure of chloroplast, light reaction and dark reaction; Kelvin cycle, C3 and C4 pathway. Mechanism of energy generation in cyanobacteria, green bacteria and purple Sulphur bacteria and chemolithotrophs. Lipid metabolism digestion absorption; oxidation of unsaturated fatty acid and odd chain fatty acid, ketone bodies. Lipid biosynthesis: biosynthesis of fatty acids, triacylglycerol and phospholipids and regulation of fatty acid metabolism.	
	Unit-III	**PROTEIN AND NUCLEIC ACID METABOLISM** Amino acid metabolism: biosynthetic families of amino acids, Breakdown of amino acids into six common intermediates andurea cycle and regulation of amino acid metabolism. Nucleotide metabolism; biosynthesis of purines and pyrimidines nucleotide by de novo and salvage pathways, Degradation of purines and pyrimidines nucleotides.	
	Unit-IV	**NITROGEN METABOLISM** Nitrification, denitrification and pathways of nitrate and ammonia assimilation. Nitrogen cycle, Assimilation of nitrogen: denitrogen fixation- free living and symbiotic, diazotrophic organisms. Biochemistry of nitrogen fixation: nitrogenase complex, function of nitrogenase, regulation of nitrogenase by oxygen and combined nitrogen sources, Genetics of nitrogen fixation; nif genes and their regulation.	

ELECTIVE PAPERS

Paper - STPG01MCB05

Principles of Microbiology

Course Code	Units	Topic/Title	Credit
01MSCMB05	Unit-I	**a.** History and scope of microbiology: Discovery of microorganisms, germ theory of diseases; Major contributions and events in the field of microbiology. Relevance of microbiology. **b.** Microbial taxonomy: Definition and systematics, nomenclature rules, taxonomic ranks and major characteristics used in identification: morphological, physiological, biochemical, ecological, genetic and molecular. Numerical taxonomy. **c.** Recent Trends in exploitation of microbial diversity. Community level physiological profile, fatty acid methyl esterase analysis, G+C ratio, nucleic acid reassociation and hybridization and DNA micro arrays.	04
	Unit-II	**a.** Details of the ultra-structure of prokaryotic cell. Differences between prokaryotic and eukaryotic cells **b.** Types of culture media, isolation, purification and preservation techniques **c.** Microbial growth kinetics, growth measurements, factors effecting the growth.	
	Unit-III	**a.** General characters, thallus organization, cell structure, reproduction and classification of fungi. **b.** Physiology of fungi: Growth, nutrition, reproduction, heterothallism, heterokaryosis, parasexuality, sex hormones, spore dormancy and germination. **c.** General characters, reproduction, life cycles and economic importance of Mastigomycotina- Albugo, Perenospora Zygomycotina- Mucor, Pilobolus Structure, reproduction, molecular and biotechnological aspects of yeasts.	
	Unit-IV	a. General characters, reproduction, life cycles and economic importance of ¾ Ascomycotina – Penicillium, Neurospora ¾ Basidiomycotina- Puccinia, Agaricus ¾ Deuteromycotina- General characters, classification. b. General characters, thallus organization, pigments, reproduction, classification and economic importance of green algae; diatoms, euglenoids. c. Morphology, reproduction and life cycles of Trypanosoma, Leishmania, Plasmodium, Giardia, Entamoeba and Balantidium.	

Reference Books

1. Sneath, P.H.A .and R.R. Sokal 1973 Numerical taxonomy .The Principles and Practice of Numerical Classification, San Francisco. W.H. Freeman
2. Sneath, P.H.A 1989 Analysis and Interpretation of sequence data for bacterial Systematic. The view of a Numerical taxonomist .Syst.Appl.Microbiol.12:15-31
3. Woese,C.R.,Kandler,O. and M.L.Wheelis 1990 Towards a natural System of organisms: Proposal for the Domains Archea, Bacteria and Eucarya. Proc. Nati, Acad, Sci. ,87: 4576- 4570
4. Woese.C,R 1987 Bacterial evaluation, Microbiological Reviews. 51: 221-271
5. Madigan,M.T.,J.M.Mrtinko and J.Parker 2000 Brock Biology of Microbiology IX Ed .Prentice Hall International, Inc.
6. Balows, A.A.G. Thuper, M. Dworker, W. Harder, K.Schleifer 1991 The Prokaryotes , Springer,

Verlog Gunsales and Stainer, The Bacteria I-V vol. Academic press
7. Prescott, L.M., J.P Harley and D.AKlein, 2007 Microbiology VII Ed.Mc Grow Hill,
8. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
9. Stainer General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
10. Schaechter.R. and Ledenberg.J 2004 The desk encyclopedia of microbiology. Elsevier Academic Press California.
11. Cook .T 2002 Microbial Biodiversity saving bacteria to save ourselves, Harvard Sci. Review 26-28.
12. Vandanme,D. B.Pot, M.Gillis, P. Devos, K. Kersters and J. Swimgs.1996 Polyphasic taxonomy, a consensus approach to Bacterial Systematic, Microbiological Reviews. 407-438.
13. Brun,Y.V. and Schinketes 2000 Prokaryotic developments ASM press
14. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
16. Talaro, K.P. and A. Talaro 1999 – Foundations in Microbiology. Mc Graw Hil. Pub.
17. Davies et al.,1990 Microbiology 4thEdition Philadelphia, JB Lippincott
18. Mehrotra RS and KR Aneja. An Introduction to Mycology, New Age Publishers
19. Alexopoulos CJ et al, Introductory Mycology 4th Edition
20. The Fungi: An Advanced treatise I-IV volumes (Ed) Ainsworth & Sussman; Academic Press.
21. Structure and Reproduction of algae FE Fritsch vol I & II
22. Introduction to the algae- Bold H.D and M.J. Wynne, Printice Hall.
23. Introductory Phycology – Trainor, F.R John Wiley, New York.

Practicals – Principles of Microbiology

1. Preparation of culture media (liquid & solid) for bacterial cultivation.
2. Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow.
3. Sterilization of media using autoclave and assessment of sterility.
4. Sterilization of glassware using hot air oven.
5. Sterilization of heat sensitive material by membrane filtration.
6. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
7. Observation of microorganisms - bacteria, cyanobacteria protozoa, fungi, yeasts, and algae from natural habitats.
8. Study of common fungi, algae and protozoan using temporary / permanent mounts.

ELECTIVE PAPERS

Paper - STPG01MCB06

Pharmaceutical Microbiology

Course Code	Units	Topic/Title	Credit
01MSCMB06	Unit-I	Antibiotics and Synthetic antimicrobial agents microbial resistance; therapeutic, prophylactic usage and adverse reactions; Antibiotic and Synthetic antimicrobial agents: Mechanism of action of antibiotics Inhibition of cell wall synthesis, nucleic acid and protein synthesis. ßlactam, aminoglycosides, tetracyclines, macrolides. Antifungal antibiotics: Griseofulvin. Antiviral drugs: Amantidines; Nucleoside analogues, interferons. Peptide antibiotics. Synthetic antibiotics: Sulphonamides Chloramphenicol; Quinolone Bacterial resistance to antibiotics; Penetration of antimicrobial agents (cellular permeability barrier, cellular transport system and drug diffusion).	04
	Unit-II	sources /types of microbial contaminants, assessment of microbial contamination and spoilage. Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations.	
	Unit-III	Classification and mode of action of disinfectants. Factors influencing disinfection, antiseptics and their evaluation. For bacteriostatic and bactericidal actions Evaluation of bactericidal & Bacteriostatic agents. Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.	
	Unit-IV	designing of aseptic area, laminar flow equipment; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification. Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic and testing of antimicrobial activity of a new substance. Safety profile of drugs (Pyrogenicity, Toxicity –hepato, - nephro, -cardio and -neurotoxicity) ;Toxicological evaluation of drug: LD50, Acute, subacute and chronic toxicity; Mutagenicity (Ames test, micronucleus test),Carcinogenicity and Teratogenicity.	

Reference Books

1. A Textbook of Pharmaceutical Microbiology Paperback (2018) by Pulak Mujumder, Sameer Rajan Sahoo Everest Publishing
2. A Textbook of Pharmaceutical Microbiology (2015) Mehra Prahlad Singh IK International Publishing
3. Pharmaceutical Microbiology (2015)by Sheth Z.PCBS Publisher
4. A.V.S.S. Sambamurty .A Textbook of Plant Pathology. IK International Publishing House 2009
5. Nidhi Goel .Pharmaceutical Microbiology: A Textbook .Alpha Science Intl Ltd .2012
6. Prahlad Singh Mehra .A Textbook of Pharmaceutical Microbiology. IK International Publications

Practicals – Pharmaceutical Microbiology

1. Microbial Examination of sterile and Non-Sterile Products
2. Bacterial Endotoxin Testing by Gel Clot Method
3. Test for Confirmation of Labeled LAL Reagent Sensitivity (LAL Test)
4. Antibiotic Potency Testing
5. Bioburden Estimation for Medical Devices
6. Determination of D value, Z value for heat sterilization in pharmaceuticals.
7. Chemical / Microbiological methods for the determination of Penicillin, Streptomycin, Griseofulvin
8. Prediction of binding site of macromolecules using MEDsuMo software

ELECTIVE PAPERS
Paper – STPG01MCB07
Advanced Microbiology

Course Code	Units	Topic/Title	Credit
01MSCMB07	Unit-I	Evolution of Microbial Genomes**:** Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of genome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics	04
	Unit-II	Metagenomics**:** Brief history and development of metagenomics, understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using Metagenomics Basic knowledge of viral metagenome, meta transcriptomics, meta proteomics and metabolomics.	
	Unit-III	Molecular Basis of Host-Microbe Interaction: Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance	
	Unit-IV	Systems and Synthetic Biology: Networking in biological systems, Quorum sensing in bacteria, Coordinated regulation of bacterial virulence factors, Basics of synthesis of polio virus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.	

Reference Books

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson. J.D, Baker. T. A, Bell. S.P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc (2003).
5. David Frifielder, Stanely R. Maloy, Molecular biology and M i c r o b i a l genetics. 2 nd Edition, Jones and Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed.ASM press. (2003).
9. Uldis N. Streips, Ronald E .Yasbin. Modern Microbial Genetics.2 Edition Wiley-Liss, Inc. (2002).
10. Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).

Practicals – Advanced Microbiology

1. Extraction of metagenomics DNA from soil.
2. Understand the impediments in extracting metagenomics DNA from soil.
3. PCR amplification of metagenomics DNA using universal 16s ribosomal gene primers.
4. Case study to understand how the polio virus genome was synthesized in the laboratory.
5. Case study to understand how networking of metabolic pathways in bacteria takes place.

ELECTIVE PAPERS
Paper – STPG01MCB08
Agriculture, Food and Dairy Microbiology

Course Code	Units	Topic/Title	Credit
01MSCMB08	Unit-I	History of Agricultural Microbiology; Microbes and their importance in maintenance of soil, Biogeochemical cycles, role of microbes in maintaining the fertility of soil. Bio fertilizers – Bacterial, - Azotobacter and vermiform compost. Soil microorganism -association with vascular plants- phyllosphere, Rhizobium, Rhizoplane associative nitrogen fixation. Biofertilizers-Cyanobacterial and Azolla.	04
	Unit-II	Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Principles of food preservation: temperature, canning, drying, irradiation, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, citrates, benzoates, nitrite and nitrates etc.	
	Unit-III	Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. Utilization and disposal of dairy by-product – whey.	
	Unit-IV	Food borne diseases (causative agents, foods involved, symptoms and preventive measures)- Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.	

Reference Books

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson. J.D, Baker. T. A, Bell. S.P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc (2003).
5. David Frifielder, Stanely R. Maloy, Molecular biology and M i c r o b i a l genetics. 2 nd Edition, Jones and Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed.ASM press. (2003).
9. Uldis N. Streips, Ronald E .Yasbin. Modern Microbial Genetics.2 Edition Wiley-Liss, Inc. (2002).
10. Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).

Practicals - Agriculture, Food and Dairy Microbiology

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any foodborne bacteria from food products. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
4. Isolation of spoilage microorganisms from bread.
5. Preparation of Yogurt/Dahi.

MINOR COURSE

Paper – STPG01MCB09

RESEARCH METHODOLOGY

Course Code	Units	Topic/Title	Credit
02MSCMB09	Unit-I	**Research Fundamental and Terminology** • Definition and objective of research, criteria of good research study, scientific method. • Study design and variations, basic, applied, historical and exploratory experimental, ex-post-facto, case study, diagnostic research, case control design, cohort study design, multifactorial design.	04
	Unit-II	**Defining Research problem and data collection and analysis** • Hypothesis, theory and scientific law: structure, conditions, sources, formulation, explanation of hypothesis and scientific laws and principle. • Methods and techniques of data collection and analysis of data – types, methods of data collection – Primary (Construction/ experimentation/ questionnaire/ case/ pilot study method.) Secondary data collection (Internal/External)	
	Unit-III	**Sampling and sampling distributions** • Sampling frame, probability sampling, simple/random sampling, systematic sampling, stratified sampling, random sampling, cluster sampling, problems due to unintended sampling, ecological and stratified pollution in the lab. • Variables – Nominal, ordinal, discontinuous, continuous, derived.	
	Unit-IV	**Data collection, analysis and report writing** • **Experimental data collection and data processing:** Data : Method validation, observation, data processing strategies and tools with statistically package (Sigma, STAT, SPSS, for students (t- test, ANOVA etc.) Soft computing in data analysis- computer and its role in research, use of statistic software SPSS, GRETL etc. in research. **Report writing and presentation** • Significance of report writing • Different steps in writing report, • Layout of research report writing • precautions in writing research report. Conclusion and Appendices, Research Ethics, IPR and scholarly publishing- Ethical issue, Ethical committees, IPR law and patent law, copy write, royalty, trade related aspects. • Design of research paper: Citation, acknowledgement, plagiarism, reproducibility and accountability.	

Reference Books

1. Kumar, R. 2005, Research methodology- A step-by-step guide for beginners (2nd edition), Singapore, pearson Eduction.
2. Bhattacharya, D.K., 200^, Research Mehtodoligy (IInd edition) New Delhi, Excek Books.

3. Pannerselvam, R. 2012, Research Methodology, New Delhi, PHI learning.
4. Khan Irfan Ali (2008), Fundamentals of Biostatistics. s Ukaaz publications.
5. Katz, J.M., 2009, Form research on research manuscript: A guide to scientific writing, USA, Springer science.
6. Gargem, B.L., Karadia, R. Agrawal U.K., 2002, An Introduction to Research Methodology, RBSA publishers.
7. Sinha, S.C., and Dhiman, A.K., 2002, Research Methodology, Ess Ess publications, volume-2
8. Wadehre, B.L., 2000, Law relating to patents, trademarks, copy right design and geographical indications. Universal Law Publishing

LAB COURSE

PRACTICALS

Practical – I
Based on Major and Elective Course

1. Isolation of microflora from different ecological niches such as freshwater, mangroves, salt panbed, hot water spring, acid –zone soil, rhizosphere etc. (any two niches)
2. Demonstration microbial Interactions: -competition, syntropy, antagonism and isolation ofnitrogen fixing bacteria.
3. Development of biofilm on metal strips.
4. Isolation and purification of Photosynthetic pigments.
5. Determination of Shannon index as a measure of evenness H/Hmax from garden soil.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.
8. Demonstration of Amination and Deamination
9. Qualitative and quantitative Detection of Amino acid
10. Qualitative and quantitative Detection of fatty acid, triglyceride
11. Determination of acid value of fat
12. Detection of enzyme activity of lipase, Urease, invertase, protease, Tween 80 hydrolysis.
13. Determination of kinetic constant of amylase: -Amylase activity, Vmax.Km.
14. Effect of pH and temperature on amylase activity.
15. Effect of inhibitors on amylase activity.
16. Estimation of protein:
17. Production, isolation and purification of enzyme and determination of fold purification (any one enzyme)
18. Estimation of sucrose in presence of glucose.
19. UV absorption of proteins, DNA and RNA.
20. Estimation of L-leucine by colourimetric method.
21. Determination of pka of an amino acid.
22. To study the decolorization of distillery or textile industrial waste.
23. To study the application of lignocellulolytic enzymes in bleaching of paper pulp.
24. Antibacterial activity assessment of textile materials.
25. Evaluation of antifungal property of treated textile materials.
26. Testing for antibacterial activity and efficacy on textile products, Qualitative and quantitative.
27. Textile fabrics Determination of antibacterial activity Agar diffusion plate test.
28. Microbiological Tests of Cosmetics, Perfumes and Essential Oils.
29. Antimicrobial assessment of finished textiles.

SEMESTER II

Semester-II
Paper-STPG02MCB01
Advance Techniques in Microbiology (ATM)

Course Code	Unit	Topic/Title	Credit
02MSCMB01	**Unit-I**	**Biophysical Techniques-I** Determination of size, shape and Molecular weight of Macromolecules: -by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques.	04
	Unit-II	**Biophysical Techniques-II** Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immune-electrophoresis.	
	Unit-III	**Microscopical Techniques.** Electron Microscopy: SEM, TEM, Staining procedures and microscopy. Fluorescent Microscopy: Staining procedures and Microscopy, FISH. Laser scanning, confocal microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, cryoelectron microscopy.	
	Unit-IV	**Other advance techniques** **Blotting techniques:** Western, southern, northern, Radioimmunoassay. NMR and its biological importance. Site-directed mutagenesis, transcriptional start point mapping.	

References:

1. Methods of General and Molecular Bacteriology, 1993. Edited by Philip. Gerhardt, ASM Publications.
2. Biophysical Chemistry VOL: I,II,III; The conformation of biological macromolecules. By; Cantor and Schimmel. Hans-Peter schmauder, Michael Schweizer, Lilian M. Schweizer.
3. Biophysical Chemistry By: Upadhaya Upadhyaya Nath.
4. Principles and Techniques of Practical Biochemistry by K. Wilson and J. Walker, Cambridge University Press
5. Morrison –Physical Biochemistry (Oxford).
6. Hames, B.D. and Rickwood, D. Gel Electrophoresis A practical Approach, Oxford University Press, New York.
7. Cotterill, R.M J. Biophysics An Introduction, John Wilely and Sans England.
8. Nolting, B. Methods in Modern Biophysics II Ed. Springer, Germany.
9. Narayana .P. Essentials of Biophysics New Age International Pub. New Delhi.
10. Keeler, J. Understanding NMR spectroscopy. John Wiely and Sons England.
11. Holler, F.J.,D.A. Skoog and S.R. Crouch, Principles of Instrumental Analysis IV ED.Thomson, Brooks/Cole Pub. US

Semester-II
Paper-STPG02MCB02
Membrane structure and Signal Transduction (MSST)

Course Code	Unit	Topic/Title	Credit
02MSCMB02	**Unit-I**	**Structure and organization of membranes** Mitochondria, endoplasmic reticulum, prokaryotic membrane, membrane junctions (Gap & tight junctions), techniques for membrane study: electron microscopic method, membrane vesicles, differential scanning colorimetry, fluorescence photobleaching recovery, flow cytometry.	04
	Unit-II	**Membrane Transport** Active and Passive transport, uniport, ATP powered pumps, non-gated ion channels, cotransport by symporters and antiporters, transepithelial transport.	
	Unit-III	**Signal Transduction** General concept of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases. Down regulations of pathways. Cytokine receptors and their mechanism (JAK-STAT pathway).	
	Unit-IV	**Bacterial signal transduction** Basic two component system. Histidine kinase pathway Sporulation as a model of bacterial signal transduction. Osmoregulatory pathways. Heat shock proteins. Mating types of yeast.	

References:

1.The Biochemistry of copper By: Jack Peisach, Phillip Aisen.
2, Biochemistry:-By:Rex Montgomery.
3.Lehninger Principles of Biochemistry By:-David L. Nelson and Cox 4.Principles of Biochemistry. By: Donald J. voet, Judith G. Voet, Charlotte W.Pratt.
5. Getzen berg, R.H. and E.E. Bittar, Cell Structure and Signalling, Elsevier Science.
6. Ernet, J.M. Helmreich, The Biochemistry of Cell Signalling, Oxford Press.
7. Boyer,P. D. The ATP synthase- A splendid molecular machine. Ann. Rev.
8. Cossart et al., Cellular Microbiology
9. S. Ram Reddy and S.M. Reddy, Microbial Physiology, Scientific Pub, Jodhpur.
10. Dawes, I.W., Sutherland ,I.W Microbial Physiology 2nd ed London: Blackwell scientific Publishers

Semester-II
Paper-STPG02MCB03
Microbiological Testing of Industrial Products (MTIP)

CourseCode	Unit	Topic/Title	Credit
02MSCMB03	**Unit-I**	**A) Mineral water industry**: i) Stages of mineral water production. ii) Analysis of water quality – pH, salinity, alkalinity, dissolved oxygen, carbonates, nitrate, silicate, phosphate, COD and BOD. **B) Determination of microbial load in water :** Faecal indicator organisms – coliform bacteria, faecal enterococci, Clostridium perfringens, yeast, moulds and sulphide reducing anaerobes, viruses and bacteriophages, fungi and Yeasts, protozoa and helminths. **C)** Methods of mineral water quality assessment – MPN test, membrane filtration technique.	04
	Unit-II	**A) Microbial Analysis of Food products:** i) Conventional and Automated methods. ii) Application of light pulse technology – principles of light pulse generation, mode of action, Instrumentation. iii) Effect of light pulses on foods and microorganisms, Advantage and limitation of light pulse treatment. B) **Quality control in fruits and vegetable processing.** C) **Risk assessment in food Industry** – Physical, Chemical and Biological hazards.	
	Unit-III	**A) Assessment of microbial quality of marine foods**: i) Conventional and recent developed methods: Flow cytometry, ATP estimation, Radiometric, Reflective Colorimetry, LAL test, Immunoassay. ii) Application of additives in food. Food safety and standard act for adulteration. iii) Significance of barcode and its uses in food industry. **B) Endotoxin test methods: i)** Gel clot assay, Turbidometeric assay and Chromogenic methods. ii) Biological assay: Vitamin assay, Antibiotic susceptibility testing by Disc diffusion and well diffusion method. iii) Mycoplasma testing. **C) Endotoxin activity risk Assessmen**t in parenteral manufacture by Pyrogen test and de-Pyrogenation test.	
	Unit-IV	**A) Microbial Enumeration Tests of Pharmaceuticals:** i) Finished product test, tests for specified microorganisms. ii) Sterility testing – Antimicrobial effectiveness testing. iii) Sterility assurance- Biological indicators, sterilization validation process. **B) Preservation of Pharmaceutical Products:** i) Chemical preservatives, Raw materials, Equipment, Role of preservatives. ii) Microbial Risk Assessment through HACCP plan.	

Reference:

1. Ashutosh, K. (2008). Pharmaceutical Microbiology. New Delhi: New Age International Publishers.
2. Kevin, W. (2007). Endotoxins – Pyrogens, LAL Testing and Depyrogenation (3rd ed). Informa Press.
3. Manivasakam, N. (2001). Chemical and Microbial analysis of mineral and packaged drinking waters. Coimbatore: Sakthi Book Service.
4. Trivedy, R.K., Goel, P.K. and Trishal, C.L. (1987). Practical methods in Ecology and Environmental science. Environmental publishers.
5. John A. J. Barbara, Fiona A. M. Regan, Marcela Contreras. (2008). Transfusion Microbiology, United Kingdom: Cambridge University Press.
6. Joseph, A. Bellanti. (2016). Immunology IV: Clinical Applications in Health and Disease.
7. Washington, DC: Georgetown University School of Medicine.
8. Michael J. Day, Ronald D. Schultz. (2014). Veterinary Immunology: Principles and Practice (2nd ed). CRC Press.
9. Raif Geha, Luigi Notarangelo. (2016). Case Studies in Immunology. A Clinical Companion (7th ed). ASM Press.
10. Rao, C. V. (2013). Immunology (2nd ed). New Delhi: Narosa Publishing House.
11. Richard Coico and Geoffrey Sunshine. (2015). Immunology: A Short Course, (7th ed). Wiley-Blackwell.

ELECTIVE PAPERS

ELECTIVE PAPERS

SEM II– STPG02MCB04

Microbial Methods for Environment Management

Course Code	Unit	Topic/Title	Credit
02MSCMB04	Unit-I	**Eutrophication, Biodeterioration and Biomagnification** **Eutrophication:** Microbial changes induced by organic and inorganic pollutants, factors influencing eutrophication process and control of eutrophication. **Biodeterioration:** Definition and concept of biodeterioration, biodeterioration of woods and pharmaceutical products. **Biomagnification:** concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides.	04
	Unit-II	**Biotransformation and Bioleaching, Biodegradation** **Biotransformation:** metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene. **Bioleaching:** Bioleaching of ores, leaching techniques and applications. **Biodegradation:** Biodegradation of plastics.	
	Unit-III	**Pollution Management** Waste water management using activated sludge, aerated lagoons, trickling filter, rotary biological contractors, fluidized bed reactors, stabilization ponds. Concept of phytoremediation and applications.	
	Unit-IV	**Global Environmental Problems** Ozone depletion, UV-B, greenhouse effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems. Global warming and climate change.	

Reference Books

1. Environmental Microbiology By: Ralph Mitchell, John Wiley and Sops. Inc.
2. Environmental Biotechnology By: C.F. Froster and D.A. John Wase, Elis Horwood.
3. A manual of environment Microbiology. By: Christon J. hurst, ASM publication.
4. Environmental Microbiology By: R.M. Maier, I.C. Papper and P. Gerba.
5. Experimental Microbial Ecology. By: Arosison Academic Press.
6. Microbiology of Extreme environments, edited by Clive Edward, Open University press, MiltonKeynes.

Elective Paper
SEM II - STPG02MCB05
Biosafety and IPR

Course Code	Units	Topic/Title	Credit
02MSCMB04	Unit-I	**Biosafety:** Introduction; biosafety issues in biotechnology; Biological Safety Cabinets &their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.	04
	Unit-II	**Biosafety Guidelines**: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol	
	Unit-III	**Grant of Patent and Patenting Authorities:** Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	
	Unit-IV	**Agreements and Treaties:** GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

Reference Books

1. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan K. Sell Cambridge University Press, 2000
2. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition
3. M K Sateesh. Bioethics and Biosafety . Kindle Edition
4. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013

Practicals – Biosafety and IPR

1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

Elective Paper
SEM II - STPG02MCB06
Microbial Biotechnology

Course Code	Units	Topic/Title	Credit
02MSCMB06	Unit-I	Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial applications: Bacteria and yeast	04
	Unit-II	Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors	
	Unit-III	Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization. RNAi and its applications in silencing genes, drug resistance, therapeutics, and host pathogen interactions	
	Unit-IV	Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents	

Reference Books

1. Richard H. Baltz. Julian E Davies and Arnold L. Demain Manual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).
2. Daniel Forciniti. Industrial Bioseperation: Principles and practice. 1st edition, Wiley-Blackwell (2008).
3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
5. EL Mansi. E.M. T., Fermentation Microbiology and Biotechnology. 2ndEdition, CRC Taylor Francis (2007).
6. Waites, M.J., Morgan, N. L., Rockey, J.S. and Higton, G. Industrial Microbiology: An introduction. Blackwell Science Publishers (2002).
7. Casida LE, Industrial Microbiology, J. Wiley, (1968).
8. James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
9. Jayanta Kumar Patra Giti Shree Das Han-Seung Shin. Microbial Biotechnology. Springer

Practicals – Microbial Biotechnology

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* /*Penicillium*)
4. Isolation of xylanase or lipase producing bacteria

Elective Paper
SEM II - STPG02MCB07
Microbial Enzyme Technology

Course Code	Units	Topic/Title	Credit
02MSCMB07	Unit-I	Basic concepts of enzymes**:** Nomenclature, classification, methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Michaelis-Menten equation, effect of pH, substrate concentration, temperature and inhibitors. Isoenzymes and allosteric enzymes. Enzyme inhibition- competitive and non-competitive inhibition	04
	Unit-II	Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors.	
	Unit-III	Immobilized enzymes: Physical and chemical methods of immobilization immobilization support, kinetics of immobilized enzymes. Enzyme catalysis in polar medium, reverse micellar entrapment of enzymes and its applications.	
	Unit-IV	Application of enzymes: synthesis of chemicals using enzymes, food technology and medicine. Enzymes in diagnostic assays. Enzyme electrodes, immunoenzyme techniques. Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti-inflammatory compounds.	

Reference Books

1. Berg JM, Tymoczko JL, Stryer L., Biochemistry. 6 th Edition. Freeman (2006).
2. Prakash Singh Bisen, Anjana Sharma, Introduction to Instrumentation in Life Sciences, Taylor and Francis, (2012).
3. James Bailey and David Ollis, Fundamentals of Biochemical Engineering, 2nd edition, McGraw-Hill, (1986).
4. Casida LE, Industrial Microbiology, J. Wi ley, (1968).
5. Chisti. Y.Encyclopedia of Bioprocess Technology, Vol-5, John Wi ley and Sons, New York.
6. Michael L. Shuler and Fikret Kargi. Bioproccess Engineering: Basic Concepts, 2nd Edition. Prentice Hall. (2001).
7. Fogarty, W.M., Kelly, C.T. Microbial Enzymes and Biotechnology
8. Goutam Brahmachari .Biotechnology of Microbial Enzymes .Academic Press (2016)

Practicals – Microbial Enzyme Technology

1. Isolation Purification of amylase from suitable culture: assay, Purification at least three steps,
2. Determination of Km., Line Weaver Burk plot
3. Isolation Purification of cellulase from suitable culture: assay, Purification at least three steps,
4. Determination of Km., Line Weaver Burk plot Factors affecting enzyme activity (pH,
5. Temperature) Immobilization of enzyme using calcium alginate
6. ELISA(demonstration)

Elective Paper
SEM II - STPG02MCB08
Microbes in sustainable agriculture and Development

Course Code	Units	Topic/Title	Credit
02MSCMB08	Unit-I	Soil Microbiology**:** Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Microbial Activity in Soil and Green House Gases- Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control	04
	Unit-II	Mineralization of Organic & Inorganic Matter in Soil: Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium. Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	
	Unit-III	Biofertilization, Phyto stimulation, Bioinsecticides: Plant growth promoting bacteria, biofertilizers–symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs	
	Unit-IV	Secondary Agriculture Biotechnology**:** Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters. GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.	

Reference Books

1. K. S. Bilgrami, H. C. Dube. A textbook of modern pathology. 6th reprint (2006). Edition,Vani Educational Books,
2. Mehrotra R S and Ashok Agrawal. Plant Pathology. Tata Mc Graw Hill ,6
3. EldorA. Paul. Soil Microbiology. Ecology and Biochemistry. VI Edition: Academic Press, (2007).
4. Agrios, G.N. Plant p a t h o l o g y . Harcourt Asia Pvt. Ltd. (2000).
5. Buchanan.B.B., Gruissem, W.and Jones,R. L Biochemistry and Molecular Biology of Plants. I.K. International Pvt.Ltd. (2000).
6. K.R. Aneja .Experiments in Microbiology, Plant Pathology and Biotechnology . New Age Publications.2017

Practicals - Microbes in sustainable agriculture and Development

1. Isolation and purification of cyanobacteria, actinomycetes, fungi
2. Methods of isolation and identification of fungi by traditional methods Study of soil fungi
3. Staining and observation of plant pathogenic fungi.
4. Isolation of amylase producing microorganisms from soil
5. Isolation of protease producing microorganisms from soil
6. Isolation and Rhizobium and Azotobacter Nitrogen bacteria from soil.
7. Laboratory scale production of biofertilizers.
8. Isolation and characterization of plant growth promoting bacteria.
9. Splash liberation of fungal spores from diseased tissue.

LAB COURSE

PRACTICALS

PRACTICAL - I

Based on Major and Elective Course

1. Separation of DNA by agarose gel electrophoresis and estimation of DNA by Diphenylamine method.
2. Estimation of RNA by Orcinol method.
3. Separation of amino acids by paper chromatography.
4. Separation of serum proteins by paper electrophoresis.
5. Thin layer chromatography of mycotoxins
6. SDS-Page of proteins.
7. Performance of affinity chromatography.
8. Performance of Gel filtration chromatography.
9. Demonstration of blotting technique. [any one].
10. Ion exchange chromatography
11. Analysis of water quality – pH, salinity, alkalinity, dissolved oxygen, carbonates, nitrate, silicate, phosphate, COD and BOD.
12. Determination of microbial load in water- Faecal indicator organisms (IMVIC Test).
13. Methods of mineral water quality assessment - MPN test, membrane filtration technique.
14. Sterility testing – antimicrobial effectiveness testing (AET)
15. Gel Clot assay
16. Turbidimetric assay for toxin detection
17. Biological assays - vitamin assay
18. antibiotic susceptibility testing-Disc diffusion and well diffusion assay
19. Pyrogen test
20. Checking adulteration in food
21. Isolation of Yeast.
22. Isolation of Actinomycetes.
23. Membrane disruption and separation subcellular organelles.
24. Production of microbial pigments using any pigment producing organism.
25. Biotransformation of toxic chromium (+6) into nontoxic (+3) by Pseudomonas species.