MOTHER TERESA WOMEN'S UNIVERSITY

KODAIKANAL - 624 101
Tamil Nadu.

Curriculum Framework and Syllabus for

M.Phil. – Microbiology
(For the candidates to be admitted from the academic year 2021-2022 onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL

M.Phil. – Microbiology

Eligibility : Master degree in the relevant discipline with 55% marks

Common Entrance Exam : University conduct a Common Entrance Test (CET) for M.Phil admission

M.Phil Microbiology syllabus 2021-2023

No	Paper Code	Course Title	Hours	Credits	CIS	ESE	Total
1.	M21MBT11	Core I (Theory)- Research Methodology	10	4	40	60	100
2.	M21MBT12	Core II (Advance Microbiology)	10	4	40	60	100
3.	M21PST13	Core III (Theory)- Common Paper Professional Skills	10	4	40	60	100
		Total	30	**12**			**300**
SEMESTER II							
4.	M21MBT21	Core IV (Theory)- Special Paper	10	4	40	60	100
5.	M21MBD21	Dissertation + Viva-voce	20	14 (12+2)	-	-	200
		Total	**30**	**18**			**300**
Total			**60**	**30**			**600**

Special Paper related to Projects

Sl.No.	Course
1.	Special Paper I –Advanced Microbiology
2.	Special Paper II – Area Paper IV- Agricultural and Environmental Microbiology
3.	Special Paper III- Area Paper V- Clinical Microbiology
4.	Special Paper IV- AREA PAPER VI- Nanotechnology
5.	Directed Study[#]
6.	Any UGC approved online course related to research(equal credit)

[#] Any new course can be added as special paper by getting permission from BoS and Academic council.

The M.Phil course consists of four theory papers. Paper III is common for all the programmes. Area Paper (IV) is pertaining to the area of specialization chosen by the candidate with the approval of guide. Area paper is purely internal (framing syllabus, question setting and evaluation) whereas the external exam will also be conducted for area paper.

Each candidate will submit a dissertation on a topic in the relevant discipline after carrying out the project work under the supervision of a guide. The duration of the project work will be for six months.

The dissertation will be evaluated by an external examiner and viva voce will be conducted for the candidate.

The examination will be for 100 marks in each of the theory papers. The question paper will cover the entire syllabus. The duration of the examination is 3 hours.

M.PHIL. – MICROBIOLOGY

Programme Educational Objectives (PEO)

On completion of this program, students will be able to

PEO1: pursue their Ph.D., in their chosen fields.
PEO2: Develop teaching skills and their academic knowledge.
PEO3: Acquire necessary experience on theoretical and practical in all divisions of microbiology to become an effective professionalist.
PEO4: Develop their professional ethics in order to address global and societal issues for sustainable development.
PEO5: Develop lifelong learning skills to meet the ever evolving professional demands.

Programme Outcome (PO)

On completion of M.Phil. Microbiology, graduates will be able to

PO1: understand to prepare a research project.
PO2: acquire basic knowledge of research data collection, processing and presentation of data and application of research tools. .
PO3: write research articles, review articles, chapters and books.
PO4: apply their skills and techniques gained to reform the modern needs and make welfare for the society through the beneficial microbes.
PO5: demonstrate the basic and advanced knowledge in microbiology disciplines.
PO6: communicate effectively and demonstrate professional and ethical responsibilities.
PO7: understand the relationship between science and society by recognizing and discussing logical, scientific and ethical issues in microbiology.
PO8: acquire first-hand experience in working on projects at individual level and exposure to industrial and research environment.

Programme Specific Outcome (PSO)

On completion of M. Phil. Microbiology program,

PSO1: Problem Solving Skills: Students will be able to explain about various applications in the Microbiology field.
PSO2: Research Skills: Students will developed their research thought and ideas to develop the innovative projects.
PSO3: Successful career: Students will be able to take up a suitable position in academia or industry, and to pursue a career in research field.
PSO4: Entrepreneurship: Students will be aware of the importance of entrepreneurship opportunities available in the society.
PSO5: Sustainable Development: Students will be able to design and execute experiments related any field of microbiology.

<table>
<tr><td>Course Title & Code</td><td colspan="4">Core -1 (Theory)
RESEARCH METHODOLOGY- M21MBT11</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- I</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">• Acquire wide knowledge on basic aspects of research
• Learn the different types of instruments and their application
• Understand the process of fermentation and types of fermentors
• Know about various statistical analysis in research.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td>Understand the concept of research articles, citation and index.</td><td>K2</td></tr>
<tr><td>CO2</td><td>Impart knowledge on instrumental techniques and its applications.</td><td>K3</td></tr>
<tr><td>CO3</td><td>Get familiarity on various techniques of molecular biology.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Understand the basic concepts of fermentor and its working principles.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Get familiar with basics of computer and analyse & publish data using biostatistics and other related techniques.</td><td>K3</td></tr>
<tr><td>Unit I</td><td colspan="4">Meaning and importance, review of literature-survey/Net/Data collection-questionaire and synopsis presentation. Research designs- experimental and non-experimental. Selection and formulation of research problems. Guidelines for preparing an article and research report. Search engines, citation index, online submission of papers, plagiarism. Computers in biological research. MS-Word, MS-Excel, Powerpoint. Thesis writing, Reference style: Havard & Vancover; biosafety, ethics of research and IPR. Project proposals and fund generations.</td></tr>
<tr><td>Unit II</td><td colspan="4">pH meter, polarography, UV, Visible, Fluorescent, Atomic Absorption, NMR & Mass spectroscopy including ESI MS and MALDI-TOF MS and Applications. XRD. Measurement of Radioactivity: GM-Counter and Scintillation counter. Thin layer chromatography, Column Chromatography, GLC, HPLC, HPTLC, Ion exchange chromatography, GC-MS, Gel filtration, Adsorption and Affinity, Electrophoretic techniques, SDS PAGE, PFGE, Immuno-electrophoresis, Counter immuno-electrophoresis, Agarose Gel Electrophoresis.</td></tr>
<tr><td>Unit III</td><td colspan="4">Isolation and quantification of genomic DNA, Plasmid DNA & total soluble Proteins. Blotting & Hybridization. Polymerase Chain Reaction-Principles, types and applications, PCR based DNA finger printing, VNTR finger printing, RAPD & RFLP analysis. Restriction mapping. Cloning strategies, DNA sequencing-Manual and automated methods. Metagenomics</td></tr>
<tr><td>Unit IV</td><td colspan="4">Fermentors - design, types, sterilization of fermentors, production of primary and secondary metabolites with examples- Instrumentation for monitoring bioreactor and fermentation processes. strain improvement of industrially important organisms. Development and application of immobilized cells with examples.</td></tr>
</table>

	Upstream & downstream processes. Optimization of growth condition.
Unit V	Collection, classification, sampling techniques, analysis, presentation of data-measures of central tendency-mean, median & mode, correlation coefficient, standard deviation, F-test, student 't' & Chi square test. Analysis of Variance (ANOVA) & SPSS package and its uses. Internet basics-World Wide Web (WWW), gene bank sequence data bases – NCBI, EMBL, DDBJ – protein sequence databases – PIR, SWISS PROT-retrieving database entries, sequence alignment and database searching - FASTA, BLAST, Phylogenetic analysis. Secondary and 3D structure. Prediction using DNA and Protein sequences. Data processing and publishing.
Text Books	1. Bajpai S (Ed.). 2006. Biological Instrumentation and Methodology. Chand & Company Ltd., New Delhi2. John G. Webster (2004) Bioinstrumentation. Student Edition, John Wiley and Sons Ltd., 2. Keith Wilson and Jon Walker. 2003. Practical Biochemistry Principles and Techniques, 5th Edition, Cambridge University Press. 3. N. Gurumani .2006. Research Methodology for Biological Sciences. 1st edition, MJP Publishers. A unit of Tamilnadu Book house, Chennai.
References	1. Marcello Pagano Kimberlee Gauvreau, Brooks Cole. 2000. Principles of Biostatistics (2nd Edition). 2. Stanton A. Glantz, MccGraw-Hill .2001. Primer of Biostatistics. 3. Bernard Rosner.1999. Fundamentals of Biostatistics. Duxbury Press. 4. Beth Dawson Robert G. Trapp .2004. Basic & Clinical Biostatistics (LANGE BASIC SCIENCE), McGraw-Hill. 5. Harvey Mtulsky .1995. Intuitive Biostatistics. Oxford University Press. 6. David W. Mount .2001. Bioinformatics, Sequence and Genome Analysis,Cold spring Harbor Laboratory Press. 7. D. Higgins and W. Taylor (Eds). 2000. Bioinformatics, Sequence, Structure and database- A Practical approach, Oxford University Press. 8. Jeffrey A. Witmer, Myra L. Samuels Prentice Hall. 2002. Statistics for the Life Science (3rd Edition) 9. A.D. Baxevanis and B.F. Francis Ouellette (Eds.) .2001. Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins . Wiley-Interscience. 10. G. Gibson and S.V Muse, Sinauer Associates .2002. A Primer of Genome Science. Inc Publishers. 11. S. Misener and S.A Krawetz (Eds.) .2000. Methods in Molecular Biology (Vol. 132)- Bioinformatics Methods and Protocols. Humana Press. 12. J.M Claverie and C. Notredame. 2003. Bioinformatics for Dummies, Wiley Publishing Inc.
E-References	1. http://www.anest.ufl.edu/computer/index.html 2. http://www.jegsworks.com/Lessons/index.html 3. http://www.bettycjung.net/statsites.html 4. http://www.biostat.harvard.edu/links/ 5. http://www.ped.mod.utah.edu/genpedscrr/Epibio.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	M	S	S	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">Core –II (Theory)
ADVANCED MICROBIOLOGY- M21MBT12</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- I</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">• Acquire wide knowledge on microscopy.
• Understand the mechanism and growth of microorganisms.
• Learn the advances in the field of microbiology.
• Know about various drug delivery systems.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Understand the concept of microscopy and its types.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Get familiarity on ecological succession.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Impart knowledge on various techniques of recombinant technology.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the basic concepts of nanotechnology.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Get familiar with basics of drug design and single cell proteins.</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">All types of microscopes including atomic force microscope, scanning tunneling microscope; cultivation & preservation methodology for microbes, development of DNA microarray for comparative and evolutionary genomics. Principles and applications of Flow cytometry, photo and video micrography & autoradiography.</td></tr>
<tr><td>Unit II</td><td colspan="4">Ecological hierarchy – Ecological succession of microorganism – Homeostasis – Adaptive mechanism among microorganisms and factors affecting the growth of microorganisms Nutritional requirements of microorganisms and nutrition types- Exploration of bioactive compounds from extremophiles.</td></tr>
<tr><td>Unit III</td><td colspan="4">Laboratory and hospital acquired infection, hospital waste management, MDR & XDR microbes. Automated diagnostic methods. Bio-weapons, recombinant vaccines. Environmental aspects of emerging diseases.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Microbes in nanotechnology – nanobio-analytics, biopolymerase, biosurfactants, biofertilizers, biopesticides, bioremediation, bioaccumulation, bioluminescence, biofuel, biofilm biosensors - remote sensing microbiology- genetically modified microorganisms, microbial diversity analysis using PCR.</td></tr>
<tr><td>Unit V</td><td colspan="4">Drug discovery & design including docking techniques, marine microbial antibiotics, microbial therapeutic enzymes, microbial pigments, single cell proteins.</td></tr>
<tr><td>Text Books</td><td colspan="4">1. P. Asokan. 2001. Analytical Biochemistry (Biochemical Techniques), 1st Edition, 2nd Reprint, Published by CHINN Publications, Malvisharam, Vellore, Tamilnadu.
2. Bernard D. Davis, Renato Dulbecco, Herman N. Eisen, Harold S. Ginsberg, W. Barry wood, Jr. Maclyn McCarty. Microbiology, Second Edition, Harper International Edition.</td></tr>
</table>

	3. Bernard R Glick. 2003. Molecular Biotechnology. Principles and Applications of Recombinant DNA. Third edition ASM Press. Washington DC.
References	1. Chakraborthy.2003. A text book of Microbiology, 2nd Edition, Published by New Central Book Agency (P) Ltd. Kolkata. 2. Donald P. Albert, Wilbert M. Gaster and Barbara Lever Good. 2002. Spatial Analysis, GIS and Remote Sensing, Applications in the Health Sciences, Sleeping Bar Press. 3. E.M.T.E.L Mansi and C.F.A Bryle. 2002. Fermentation Microbiology & Biotechnology, Taylor & Francis Ltd, UK. 4. Ellen K, Cromby, Sara L. Mclafferty. 2002. GIS and Public Health, The Gullford Press, Newyork. 5. J.E Casida, JR .1995. Industrial Microbiology, New Age International Publishers. 6. E. Jawetz, J.L. Melnick, and E.A Adelberg. 1998. Review of Medical Microbiology. 19th Edition. Lange Medical Publications. ELBS. London. 7. M.M Young .2004. Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Volume 1, 2, 3 & 4. Reed Elsevier India Private Ltd. India. 8. S.N Ognand. 2004. Gene Biotechnology. Himalaya Publishing house, Mumbai. 9. P. Rajendran and P. Gunasekaran. 2006. Microbial Bioremediation, MJP Publishers, Chennai. 10. P. Prave, U. Faust, W. Sittig and D.A Sakatsch. 2004. Fundamentals of Biotechnology, Panima Publishing Corporation, India. 11. P.F Stanbury, A.Whitaker and S.J Hall. 1997. Principles of Fermentation Technology, Aditya Books Pvt. Ltd, India.
E-References	1. http://gsbs.utmb.edu/microbook/toc.html 2. http://www.biosciohio-state.edu/-mgonzalez/micro521.html 3. http://bioweb.uwiax.edu/Genweb/Microbiology/General/general.html 4. http://www.medunich.edu/TAMC/LINKS.HTML 5. http://acs.ucalgary.ca/-browder/transgeni.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	M	S	S	S	S	S	S	M	M	S
CO3	S	M	M	S	S	S	S	S	S	S	S	M	S
CO4	S	M	M	S	S	S	S	S	S	S	S	S	M
CO5	S	M	S	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE III – Professional Skills- M21MBT13</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- I</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● Develop skills to ICT and apply them in teaching, learning contexts and research.
● Acquire the knowledge of communication skills with special reference to its elements, types, development and styles.
● Understand the terms: Communication technology, Computer Mediated Teaching and develop Multimedia/E-contents in their respective subjects.
● Develop different teaching skills for putting the content across to targeted audience.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Learn the computer basics and its application in science field.</td><td>K1</td></tr>
<tr><td>CO2</td><td colspan="2">Develop the communication skills in both English and tamil.c</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Impart knowledge on computer mediated teaching.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the basic concepts of micro teaching skills.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Get familiar with basics of industrial technology</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">Computer Application Skills: Fundamentals of Computers and windows, Operating System – MS – Office Components; Word: Equation editor, Table Manipulation – Formatting Features – organizational Chart. MS – EXCEL: Statistical Functions – Number Manipulation – Chart Preparation with various types of graphs. MS Powerpoint: Powerpoint presentation with multimedia features. Internet and its applications: E-mail and attachments – working with search engines.</td></tr>
<tr><td>Unit II</td><td colspan="4">Communication Skills (English/Tamil/Both): English: Skills of Communication: Listening, Speaking, reading and Writing – Writing Synopsis, Abstract and proposals. Developing good language asbilities – Public speaking – Writing Skills. Tamil: gapw;Wtpf;Fk; jpwd; - Ngr;Rj;jpwd; - ntspg;ghl;Lj; jpwd; - Ma;Tj;jpl;lk; - Ma;Tr;R&f;fk; jahhpj;jy;.</td></tr>
<tr><td>Unit III</td><td colspan="4">Communication technology: Computer Mediated Teaching: Multimedia, E – Content, Satellite Based Communication – EDUSAT and ETV channels. Web: Internet I Education.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Pedagogical Skills: Micro teaching Skills: Skill of Induction, Skill of Stimulus Variation. Skill of Explaining, Skill of Probing Questions, Skill of Blackboard, Writing and Skill of Closure – Integration of Teaching Skills – Evaluation of Teaching Skills – Research Extension and Consultancy.</td></tr>
<tr><td>Unit V</td><td colspan="4">Industrial Technology: Lecture Techniques: Steps, Planning of a lecture, Lecture Notes, Updating, Delivery of Lecture. Teaching – Learning Techniques: Team teaching, Group Discussion. Seminar, Workshops, Symposium and Panel Discussion – Games and Simulations – Web Based Instructions.</td></tr>
</table>

Text Books	1. Micael D. and William (2000). Integrating Technology into Teachnig and Learning: Concepts and Applications, Prentice Hasll, New York. 2. Information and Communication Technology in Education: A Curriuculum for Schools and Programme of Teacher development. Jonathan Anderson 3. Pandey S.K.(2005). Teaching communication. Commonwealth publisher, Delhi 4. Sharma. R.A.(2006), Fundamentals of education technology, Surya publication, Meerut
References	1. Kum Babu A. and Dandapani S. (2006), Microteaching, Neelkamal Publications, Hyderabad 2. Vanaja M and Rajasekhar S. (2006), Computer Education, Neelkamal Publications, Hyderabad

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	M	S	M	S	S	S	S	S	S	S
CO2	S	S	S	S	M	S	S	S	S	M	S	S	S
CO3	S	S	S	M	M	S	S	S	S	S	S	S	S
CO4	S	S	S	M	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER –I
BIOREMEDIATION- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● To provide a wide knowledge on basic aspects of research
● To learn the different types of instruments and their application
● To understand the process of fermentation and types of fermentors
● To know about various statistical analysis in research.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Learn the efficacy of bioremediation and environmental modifications.</td><td>K1</td></tr>
<tr><td>CO2</td><td colspan="2">Impart knowledge on diversity and criteria of bioremediation.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Impart knowledge on biodegradation in air pollutants.</td><td>K2</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the basic concepts of xenobiotics.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Get familiar with basics of composting</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">Bioremediation-definition-Efficacy testing-side effects testing. Approaches to bioremediation. Environmental modification. Microbial seeding. Bioengineering approaches to the bioremediation of pollutants. Plant based and microbial based bioremediation.</td></tr>
<tr><td>Unit II</td><td colspan="4">Bioremediation of contaminated soils –Diversity and magnitude of soil contaminants-criteria for bioremediation-biological mechanism of transformation-strategies for bioremediation- case studies of bioremediation strategies.</td></tr>
<tr><td>Unit III</td><td colspan="4">Bioremediation of various ecosystem-contaminated aquifers-Bioremediation of oil pollutants -Biodegradation enhancement – stimulation of oil spills degradation. Bioremediation of air pollutants.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Xenobiotics- cometabolism and detoxification reactions. Biochemistry of xenobiotic metabolism. Bioleaching- Recovery of metals from ores- oxidation of minerals- testing for biodegradability- biomagnification. Bioaccumulation-removal of heavy metals from effluents.</td></tr>
<tr><td>Unit V</td><td colspan="4">Composting of organic wastes- substrates suitable for composting-properties of compostable wastes- microbial characteristics of the composting process-progression-compost systems-Batch, continuous. Vermicomposting. Waste water use in farming</td></tr>
<tr><td>Text Books</td><td colspan="4">1. Atlas and Bartha. 1992. Microbial Ecology.
2. Fundamental and applications. Benjamin/Cumming. Red wood city J.J.Glick and Pastener J.J.1994.
3. Molecular biotechnology ASM press Washington DC Josdand,S.N. 1995.</td></tr>
<tr><td>References</td><td colspan="4">1. Environmental Biotechnology. Himalaya Publishing House, Bombay. Soli J Arceivala. 1998.
2. Waste water treatment for pollution control. 2nd edition. Tata McGraw Hill publishing company Ltd.</td></tr>
</table>

E-reference links	1. https://www.pdfdrive.com/environmental-biology-the-conditions-of-life-environmental-selection-extinction-creation-e116415545.html 2. https://www.pdfdrive.com/environmental-biotechnology-biodegradation-bioremediation-and-bioconversion-of-xenobiotics-for-sustainable-development-e158141796.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER –II
Bioenergy & Microalgae- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● Acquire wide knowledge on characteristics of algae.
● Learn the importance of Cyanophyta and Chlorophyta.
● Understand the process of bioenergy synthesis
● Know about various advancements in bioenergy using microalgae.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Learn the general characters of ecology and its classification.</td><td>K1</td></tr>
<tr><td>CO2</td><td colspan="2">Understand the overall about the marine algae, freshwater algae.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Gain idea about the microbial fuel cell.</td><td>K1</td></tr>
<tr><td>CO4</td><td colspan="2">Clear knowledge about the culturing of microalgae.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Get familiar with Microalgal genetics.</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">General Characteristics: General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups).</td></tr>
<tr><td>Unit II</td><td colspan="4">Cyanophyta & Chlorophyta : Ecology of freshwater, brackish water and marine algae and distribution; thallus organization; cell structure; chromatic adaptation; physiology; reproduction; economic importance; role in biotechnology; morphology and life cycle of Spirulina, Scendesmus, Nanochloropsis, Nanochlorsis, Chlorella & Botryococcus.</td></tr>
<tr><td>Unit III</td><td colspan="4">Introduction to biofuels & MFC : Biofuels overview – Conventional Biomass – Aquatic Biomass. Fuel products – Hydrogen fuel cells. Biomass conversion to biofuel: chemical conversion. Microbial fuel cells – overview – types – electrical generation process - construction – operation and control methods.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Culturing of microalgae: Culturing of microalgae – Environmental conditions – Open pond system – Close loop system – Photobioreactors. Microalgal photosynthesis – microalgal biochemistry. Artificial photosynthesis.</td></tr>
<tr><td>Unit V</td><td colspan="4">Microalgae & Bioenergy: Bioenergy – biomass used as energy – Biodiesel - Chemical processes – Thermochemical processes. Biochemical processes – Bioethanol, Biobutanol, Biomethanol, Biohydrogen. Microalgal Genetics – Genetic Engineering in microalgae.</td></tr>
<tr><td>Text Books</td><td colspan="4">1. Microalgae as a Feedstock for Biofuels – Luisa Gouveia, Springer Science & Business Media, 2011.
2. Biofuels from algae – Ashok Pandey, Duu – Jong Lee, Yusuf Chisti, Carlos R.Soccol, 2013</td></tr>
</table>

References	1. The Science of Algal Fuels – Richard Gordon, Joseph Seckbach, 2013 2. CRC Handbook of Microalgal mass culture – Amos Richard, 2013 3. Microalgae: Biotechnology & Microbiology – E.W.Becker, 1996, Cambrigde University Press. 4. Microbial Fuel Cells – Bruce E.Logan, John Wiley & Sons, 2008
E-References	1. https://www.nature.com/subjects/microbiology#:~:text=Microbiology%20is%20the%20study%20of,host%20response%20to%20these%20agents. https://www.moscmm.org/pdf/Ananthanarayan%20microbio.pdf

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	M	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S	S	S	S
CO4	M	S	S	S	M	S	S	S	S	M	S	S	M
CO5	S	S	S	S	S	S	S	S	S	M	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER III
Industrial Microbiology- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● Acquire wide knowledge on bioprocess technology
● Learn the different types of fermenters and fermentation.
● Understand the process of extraction of products.
● Know about various applications of industries.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Learn the technology of bioprocess.</td><td>K1</td></tr>
<tr><td>CO2</td><td colspan="2">Impart knowledge on diversity and fermentor and its types.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Impart knowledge on downstream processing.</td><td>K2</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the applications of industrially importance microbes.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Get familiar with basics of biofuel and biogas production.</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">Introduction to bioprocess technology – Isolation, cultivation, preservation and improvement of industrially important organisms.</td></tr>
<tr><td>Unit II</td><td colspan="4">Fermentation – Types, Fermentors – Basic unit, design, components, asepsis, containment requirement, body construction, temperature control, aeration, agitation and function, types. Sterilization of fermentors – aseptic inoculation method – sampling method – air & media supply, monitoring and control devices.</td></tr>
<tr><td>Unit III</td><td colspan="4">Downstream processing – foam separation, precipitation methods, filter devices and filter aids. Industrial scale configuration – cell disruption methods. Physico-chemical basis of bio-separation processes, techniques for purification of end products –electrophoresis, distillation.Chromatography – two face aqueous extraction – super critical fluid extraction – ultra filtration – drying devices – crystallization and whole broth processing.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Industrially important microbial products: Vitamins – Vitamin B_{12}; organic acids –citric acid; alcohol production –ethanol; aminoacid – L-glutamate; Growth regulators –IAA; antibiotics – penicillin.</td></tr>
<tr><td>Unit V</td><td colspan="4">Production of biofuels and its application: Biogas production – Steps involved, factors affecting, substrates used, advantages. Biodiesel production – steps involved, factors affecting, and substrates used, applications.</td></tr>
<tr><td>Text Books</td><td colspan="4">1. Stanbury PF., Whittakar A., and Hall SJ. 1995. Principles of Fermentation Technology.
2. Casida L.E 1989. Industrial Microbiology.
3. Wulf Cruger, Biotechnology: A textbook of Industrial Microbiology.</td></tr>
<tr><td>References</td><td colspan="4">1. McNeil and Harvey. 1990. Fermentation – A practical approach.
2. Arnold L. Dermain and Nadine A .Solomon. 1986. Industrial Microbiology and Biotechnology.</td></tr>
<tr><td>E-references</td><td colspan="4">1. https://bioprocessing.weebly.com/upstream-processing.html</td></tr>
</table>

Mapping of COs with POs &PSOs:

CO	POs								PSOs				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	M	S	M	S	S
CO4	S	S	M	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	M	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER IV
Agricultural & Environmental Microbiology- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● Acquire wide knowledge on ecology and microbial diversity
● Learn the environmental impact of microbes.
● Understand the mechanisms of microbes in soil
● Know about biofertilizers and biocontrol agents</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Realise and understand the interaction of microbes.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Acquire information about the environemtal microbiology.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Recognise and realise the evolutionary role of microbes in biosphere.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the role of microbes in soil.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Empathize microbiological knowledge in fertilizers</td><td>K3</td></tr>
<tr><td>Unit I</td><td colspan="4">Ecology and Microbial Diversity: Various environments and its components – Extreme environments – hot springs, acid springs and lakes. Microbial communities and its interaction – Interaction between microbes and environment –commensalism, parasitism, mutualism, colonization, succession – Interaction of microbes with plants – Rhizosphere, Phyllosphere – Interaction of microbes with animals – rumen microbiology.</td></tr>
<tr><td>Unit II</td><td colspan="4">Environmental Microbiology: Biogeochemical cycle – Carbon, Nitrogen, Phosphorus, Sulfur and other cycles – Microbes in fresh water and marine water.</td></tr>
<tr><td>Unit III</td><td colspan="4">Biotransformation and Biodegradation: Evolutionary role of microorganisms in biosphere. Biodegradation, Bioremediation of xenobiotic components- sources of heavy metal pollution, microbial interaction with heavy metal pollutants. Principles of measuring Biodegradability – Design and implementation of Biodegradation assays – management of organic contaminants in filed site – verification of Bioremediation in the field site. Biopolymer and its application.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Soil Microbiology: Geomicrobiological process. Significant development in Soil microbiology – Soil microorganisms –methods used in soil microbiological studies. Isolation of bacteria (Rhizobium, Azotobacter, Azospirillum) - Fungi (VAM) – Algae (Cyanobacteria, Nostoc, Oscillatoria) – Actinomycets (Frankia).</td></tr>
<tr><td>Unit V</td><td colspan="4">Biofertilizers and Biocontrol agents: Rhizobium and legume root nodulation – free living N_2 fixing bacteria (Azotobacter and Azospirillum) – Nitrogen fixation (Blue green algae) – Phosphorous solubilizing bacteria – Phosphorus mobilization. Biofertilizer production, Mass cultivation, Quality Control Analysis – Packaging.</td></tr>
<tr><td>Text Books</td><td colspan="4">1. Ronald M. Atlas & Richard Bartha. 1991. Microbial Ecology,</td></tr>
</table>

	Fundamentals and application. 2. Thomas D. Brock and M.T Madigan. 1991. Biology of Microorganisms. 3. Alexander 1977. Introduction to soil microorganisms and plant growth.
References	4. N.S. Subba Rao – Soil Microorganisms and Plant growth. 5. N.S. Subba Rao – Biofertilizers. 6. Dasgupta R.S – Plant Pathology. 7. George N. Agriosis – Plant diseases.
E-references	1. https://www.routledge.com/Microbiology-for-Sustainable-Agriculture-Soil-Health-and-Environmental/Verma/p/book/97817746

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	M	S	S	M
CO4	M	S	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER V
Clinical Microbiology- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">● Acquire wide knowledge on microbe interaction in host.
● Learn the different types of immunity in disease control.
● Understand the various diseases caused by microorganisms
● Know about various treatment measures.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Acquire knowledge in the microbes and their host interactions.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Gain knowledge on overall microbial diseases.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Recognise the infection of individual microbes in diseases causing.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the comparison of Siddha, Ayurvedha, Unnani.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Empathize on chemotheraphy and its action.</td><td>K3</td></tr>
<tr><td>Unit I</td><td colspan="4">Microbes and their host interaction – normal flora of human – host pathogen interactions – viral, bacterial, fungal and parasites – protozoans & nematodes. Various associations – pathogenic, opportunistic, nasocomial, asymptomatic carriage, symbiotic, commensalism, mutualism etc.</td></tr>
<tr><td>Unit II</td><td colspan="4">Virulence factors, pathogenicity & toxigenicity
Virulence factors – various types with reference to viral, bacterial, fungal, protozoans & nematode pathogens. Toxins – types – mode of action. Epidemiology and control measures. Community infection, Host defence mechanism - Immunity</td></tr>
<tr><td>Unit III</td><td colspan="4">Bacterial, Fungal, Viral and Protozoan diseases – Pathogenesis, Laboratory Diagnosis, Epidemiology and Control of Bacterial diseases. Bacteriology – Morphology, Pathogenesis and laboratory diagnosis of Staphylococcus, Bacillus anthrax, Corneybacterium, Clostridium, Streptococci, Mycobacterium,, E. Coli, Salmonella, Shigella, Pseudomonas and Vibrio cholera. H.pylori Parasitology – Ascaris, Giardia, Plasmodium, Taenia solium, E.histolytica. Zoonotic disease – Rabies, Filariasis. Fungal disease – Candidasis, Aspergiloosis, Superficial Mycoses. Viral disease – Hepatitis, Influenza, Pox, HIV, Polio.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Diagnosis, treatment and prevention of diseases
Diagnosis – micro, macro, biochemical, serological & molecular. Treatment – chemical, chemotherapy and alternative therapy – Siddha, Ayurvedha, Unnani and Naturopathy Prevention – Natural & artificial vaccine, Active & Passive</td></tr>
<tr><td>Unit V</td><td colspan="4">Chemotherapy – Antimicrobics – Antibacterial, Antifungal, Antiviral –m Drugs and Mode of action – Selection – Kirby Bauer Test, MIC – Drug resistance</td></tr>
<tr><td>Text Books</td><td colspan="4">1. David Greenwood, Richard CD, Slack, John Forrest Peutherer, (1992) Medical Microbiology.
2. Charttejee K.D. 1980. Parasitology & Helminthology
3. Jawetz and Melnich. 1986. Review of medical microbiology</td></tr>
</table>

References	1. Chaechter M. Medof G. Eisenstein BC (1993). Mechanism of Microbial diseases. 2. Joans Stokes E, Ridgway GL and Wren MWD (1993). Clinical Microbiology 3. Principles of Bacteriology, Virology and Immunity – Topley & Wilsons (1990).
E-references	1. https://idp.my.vccs.edu/authenticationendpoint.com

Mapping of COs with POs &PSOs:

CO	**POs**								**PSOs**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	S	S	M	S	S	S	M	S
CO3	S	S	S	S	M	S	S	S	S	M	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	M	S	S	S	S	S	S	M	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

<table>
<tr><td>Course Title & Code</td><td colspan="4">CORE IV-SPECIAL PAPER VI
Nanotechnology- M21MBT21</td></tr>
<tr><td>Semester</td><td colspan="2">Semester- II</td><td>Credits:4</td><td>Hours/weeks: 10</td></tr>
<tr><td>Cognitive Level</td><td colspan="4">K1: Recall
K2: Understand
K3: Apply
K4:Analyze</td></tr>
<tr><td>Learning Objective</td><td colspan="4">• To familiarize the biological nanomaterials
• To understand the Spectroscopic techniques
• To know about the Nanocarriers</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="4">Upon completion of this course the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Acquire knowledge in the biological nanotechnology.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Gain knowledge on spectroscopic techniques.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Learn the theory of advanced drug delivery.</td><td>K1</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the microbes and antibody based nanocarriers.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Gain the basics of nanocomposites.</td><td>K2</td></tr>
<tr><td>Unit I</td><td colspan="4">Biological nanomaterials: Overview of biological nanomaterials, Ferritins and Related Protiens – Superparamagnetic model systems – Native forms – Magnetoferritin, Magnetotactic Bacteria – Magnetic direction finding – Magnetosomes, Molluscan Teeth – Biomineralization.</td></tr>
<tr><td>Unit II</td><td colspan="4">Spectroscopic techniques : Introduction to Molecular Spectroscopy and Differences-With Atomic Spectroscopy-Infrared (IR) Spectroscopy and Applications- Microwave Spectroscopy- Raman Spectroscopy and CARS Applications-Electron Spin Resonance Spectroscopy; NMR Spectroscopy; Dynamic Nuclear Magnetic Resonance; Dynamic light scattering (DLS), Double Resonance Technique.</td></tr>
<tr><td>Unit III</td><td colspan="4">Theory of advanced drug delivery: Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Microbes and antibody based nanocarriers: Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibodybioconjugates. Devices for drug delivery Fabrication and Applications of Microneedles, Micropumps, microvalves. Implantable microchips.</td></tr>
<tr><td>Unit V</td><td colspan="4">Basics of nanocomposites: Nomenclature. Properties, features and processing of nanocomposites.Sample Preparation and Characterization of Structure and Physical properties.Designing, stability and mechanical properties and applications of Super hard nanocomposites.</td></tr>
<tr><td>Text Books</td><td colspan="4">1. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
2. R.M.Rose, L.A.Shepard and J.Wulff, “The Structure and Properties of Materials”, Wiley Eastern Ltd, 1996.
3. Drug Delivery and Targeting, A.M. Hillery, CRC Press, 2002.</td></tr>
</table>

References	1. Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman, Oxford University Press, 2001. 2. Drug Delivery: Principles and Applications, B. Wang, Wiley Intersceince, 2005. 3. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.
E-References	1. https://www.pdfdrive.com/cancer-nanotechnology-methods-and-protocols-d158801917.html 2. https://www.pdfdrive.com/nanotechnology-and-nanosensors-introduction-to-nanotechnology-d187619895.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	M	S	S	M	S	S	S	S	S	M
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S	S	S	M
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	M	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark