।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
ACADEMIC (1-BOARD OF STUDIES) SECTION
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संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे **CBCS Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७–२०२०**च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्यात येत आहेत.

1. M.Sc.-II Year-Botany
2. M.Sc.-II Year-Herbal Medicine
3. M.Sc.-II Year-Analytical Chemistry
4. M.Sc.-II Year-Biochemistry
5. M.Sc.-II Year-Organic Chemistry
6. M.Sc.-II Year-Physical Chemistry
7. M.Sc.-II Year-Computer Management
8. M.Sc.-II Year-Computer Science
9. M.Sc.-II Year-Information Technology
10. M.C.A. (Master of Computer Applications)-II Year
11. M.Sc.-II Year-Software Engineering
12. M.Sc.-II Year-System Administration & Networking
13. M.Sc.-II Year-Dairy Science
14. M.Sc.-II Year-Environmental Science
15. M.Sc.-II Year-Applied Mathematics
16. M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.Sc.-II Year-Bioinformatics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक–१/परिपत्रक/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०२०–२१/**३३५**

दिनांक : १६.०७.२०२०.

स्वाक्षरित/–
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure (New scheme)

Faculty of Science and Technology

Subject: Microbiology

M.Sc. Second Year Semester – III & IV

(Affiliated Colleges W.E.F. JUNE – 2020)

Name of the Faculty	Total credit	Average credits per semester
Science and Technology	**100**	**25**

- **Note:**
  - Assessment shall consist of Continuous assessment **(CA)** and End of Semester Examination **(ESE).**
  - **Weightage:** 75% for ESE & 25% for CA
  - **Paper- (Elective):** Transfer of Credit as per Student choice

Distribution of Credits for M. Sc. IInd Year Microbiology under Science & Technology faculty (All Affiliated Colleges)

Semester	Paper No. & Code	Title of the subject	External (ESE)	Internal (CA)	Total
Sem. III	Paper-XI: MB-301	Molecular Immunology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper-XII: MB-302	Recombinant DNA Technology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper-XIII: MB-303	Microbial Diversity and Extremophiles	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	*Paper-XIV (Elective): MB-304	Biostatistics, Computer Applications and Research Methodology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper –XV (Seminar)	Based on theory paper MB-301, 302, 303 & 304	(25 marks)		Credit: 1
				Total for Sem: III	**Credit: 17**
Sem. IV	Paper-XVI: MB-401	Fermentation Technology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper-XVII; MB-402	Medical and Pharmaceutical Microbiology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper-XVIII: MB-403	Environmental Microbiology	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	*Paper-XIX (Elective): MB-404	Microbial Bioinformatics, Genomics and Proteomics	(75 marks)	(25 marks) (2Test: 15 marks+ Assignments :10 marks)	Credit: 4 (100 marks)
	Paper –XX (Seminar)	Based on theory paper MB-401, 402, 403 & 404	(25 marks)		Credit: 1
				Total for Sem: IV	**Credit: 17**
Lab Course Work (Annual Practical)	LAB –V	Based on theory paper MB-301 & MB-302	(75 marks)	(25 marks)	Credit: 4 (100 marks)
	LAB –VI	Based on theory paper MB-303 & MB-304	(75 marks)	(25 marks)	Credit: 4 (100 marks)
	LAB –VII	Based on theory paper MB-401, 402, 403 & 404	(75 marks)	(25 marks)	Credit: 4 (100 marks)
	LAB –VIII (Dissertation) *(Elective)	----	(75 marks)	(25 marks)	Credit: 4 (100 marks)
	Total for Lab Course work (Annual)				**Credit: 16**
	Total for M.Sc. II Year: Sem. III + Sem. IV + Lab Course work (Annual)				**Credit: 50**
	Total for M. Sc. (I Year + II Year):				**Credit: 100**

Outline and Salient Feature:

M. Sc. Microbiology syllabus is designed to serve the need of choice based credit system course structure to orient and practically train students in the field of Microbiology. The course is specifically bringing Core courses dealing additional domain of knowledge in this field of study including molecular immunology, Recombinant DNA technology, Microbial Diversity and Extremophiles, Fermentation Technology, Medical and Pharmaceutical Microbiology, and Environmental Microbiology where in elective course based on Biostatistics, Computer Applications and Research Methodology is mainly concerned with application of biostatistics, computers and research methodology in the field of microbiology while Microbial Bioinformatics, Genomics and Proteomics as elective course gives additional knowledge of applications of bioinformatics. Internet and bioinformatics, Database management system (DBMS), Sequence alignment, searching sequence databases using BLAST and FASTA, Principles of microbial genomics such as sequencing, assembly, annotation of microbial genomes and its application to cultured and uncultured microbial community, methods for gene sequence analysis, Types of proteomics, tools for proteomics- separation and isolation of proteins, methods of studying proteins.

The seminar based on these syllabi gives boost to the student to face the interviews which help them to get placements in different industries.

The syllabus of M. Sc. microbiology course will orient and train the students in view of microbial genetics and molecular biology, occurrence of metabolic events and its relation to environment and agriculture, to understand and apply this knowledge for carrier orientation.

Learning Objectives:

The learning objectives of lab course plays essential role for students to have handling knowledge and practice of different instruments through various practicals included in lab course V, VI, VII, and VIII.

Prerequisite:

The course is offered for a student registered for undergraduate programme in the faculty of Science and technology who had primary training in the field of microbial sciences and also likes to gain additional advanced knowledge in this field of science.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Paper Name: MOLECULAR IMMUNOLOGY
Paper Number: MB-301

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student will be able to explain and categorize different types of lymphoid organs as primary and secondary lymphoid organs, immunogen and immunoglobulin, Organization and Expression of Immunoglobulin genes, and Major, Minor Histocompatibility Complexes and Clinical immunology.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Organs and Cells of Immune System	1. Primary lymphoid organs - thymus, bone morrow - structure and function. Lymphatic system - transporter of antigen - introduction. Secondary lymphoid organs – spleen and lymph nodes structure and functions. Mucosal associated lymphoid tissue, (MALT) - tonsils. Cutaneous associated lymphoid tissue - keratinocytes and Langerhans cells - Location and immunological functions. 2. Lymphoid cells - B-lymphocytes and T-lymphocytes - maturations, activation and differentiation. Receptor on B and T cells. Null cells. γ δ T cells - Intraepithelial lymphocyte (IEL)- function, Mesangial cells, Microglial cells - Structures and secretions - interleukin I, hydrolytic enzymes, complement proteins, α-	Appraise the students for knowledge of structure and function of bone marrow, lymphatic system, lymphoid organs, spleen and lymph nodes,. Functions of T and B lymphocytes. T and B lymphocytes maturations, activation.	**11**

	Interferon, Tumor necrosis factor α (TNF-α) (IL-6, GM-CSF, G-CSF, M-CSF). 3. Growth factors associated in haematopoiesis, Granulocytes - Neutrophile, Basophile, Eosinophile - immune response generated against parasite by granulocytes. 4. Mast cell - Structure, function in innate immunity and acquired immunity. Dendritic cell - structure and function.		
Unit-II Immunogens and Immunoglobulins	1. Types of antigens - Exogenous, Endogenous, Autologus, Xenogenic and Allogenic. General properties of antigens - Molecular size, chemical composition, foreignness, specificity, Haptens, Supera antigens and Adjuvants: Freund, complete and incomplete adjutants, Depot effect, Macrophage activation, Effect of lymphocyte, antitumor action, **2.** Epitopes: A.A.sequence /structure. Immunoglobulins: Classes, Structure, distribution and function. Isotypic, Allotypic, Idiotypic determinants. Idiotype network. Antibody production theories.	Student able to Differentiate between exogenous ,endogenous, autologous, Xenogenic and allogenic antigen. Hapten, superantigen and adjuvants ,types ,and properties of antigen.	**09**
Unit- III Organization and Expression of Immunoglobulin genes	1. Genetic model for Ig structure, Germ line and somatic variation models, Dryer and Bennett two gene models, K chain genes, λ chain genes, Heavy chain genes, VH gene segments, 2. Gene rearrangement in VH region - In light chain, In heavy chain, Mechanism of variables region DNA rearrangement, 3. Generation of antibody diversity, Regulation of Ig gene transcription	Analyse the genetic model for Ig structure germ line and somatic variation models DNA rearrangement in VH gene segment. Generation of antibody diversity	**10**
Unit-IV Major, Minor Histocompatibility Complexes and Clinical Immunology	1. MHC class-I, MHC class-II - Structure of molecules, gene organization. Genetic polymorphism of molecule, Peptide interaction with molecule, MHC and immune responsiveness, MHC and susceptibility to infectious diseases, Minor MHA - structure, role and genetics, HLA system, Antigen processing and presentation. **2.** Hypersensitivity, Immunology of Tumors, Immunodeficiency diseases, autoimmune diseases, Immunomodulation / Immunological tolerance.	Differentiate between MHC class I and class II structure of molecules Role of MHC in susceptibility of infection. Students will understand hypersensitivity, immunology of tumours, immunodeficiency diseases etc	**15**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Practical Paper Name: MOLECULAR IMMUNOLOGY
Paper Number: PRACTICAL LAB-V MB-301

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Acquire skills to perform practical by Comparing various parameters according to different immunological techniques.

1. Ag – Ab reaction
    a. Agglutination - Slide – Widal test
        i. Tube - Dreyer's technique
        ii. Bordet Durham's technique
        iii. Quantitative Widal test.
    b. Precipitation - Slide - VDRL, RPR, RA
    c. Complement fixation test - Coomb's test (demonstration)
2. Radial Immunodiffusion
3. Immunohaematology.
    a. DLC, TLC, RBC count
    b. Blood grouping –
        i. ABO system
        ii. Rh grouping
4. Separation of serum proteins by electrophoresis.
5. Preparation of 'H' antigen of S. typhi by Craigies tube method.
6. Preparation of 'O' antigen of S. typhi by phenol agar method.

REFERENCES -

1. A handbook of practical immunology by G. P. Talwar, Vikas Publishing House, New Delhi.
2. Genes VII by Benjamin Lewin, Oxford University Press.
3. Immunology (2^{nd} edition) by C. Vaman Rao, Narosa publication.
4. Immunology (2^{nd} edition) by Janis Kuby, W. H. Freeman and company.
5. Immunology (8^{th} Edition) by D. M. Weir, Churchill Livingstone.
6. Roitt's Essential Immunology (9th edition) by Ivan Roitt, Blackwell Sciences.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Paper Name: RECOMBINANT DNA TECHNOLOGY
Paper Number: MB-302

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student will be able to understand and explain the recombinant DNA technology, explain steps and tools in genetic engineering and apply recombinant DNA technology in medicine agriculture and veterinary sciences.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I **Basic tools of rDNA Technology**	1. Enzymes used with their types, mode of activity and examples: Nucleases- Exonucleases (BAL 31 nuclease, Exonuclease I, III), Endonucleases- Restriction endonucleases type I, II, III, restriction modification system: nomenclature and classification of type II endonucleases (S1 nuclease). DNA polymerase (*E. coli* DNA pol. I, T7 DNA Pol., Klenow fragments, Thermostable DNA Pol., Terminal Transferase and Reverse Transcriptase). DNA ligation (Linkers and Adaptors). DNA Manipulating enzymes (Polynucleotide kinase, Phosphatase, Methylase, Topoisomerase and Ribonucleases). 2. Cloning Vectors (their structure, genealogy and derivatives): Plasmids (pBR 322 and pUC18). Bacteriophage lambda (λ), Cosmids, Phasmids and Phagemids as vectors. Artificial chromosome vectors (YACs, BACs, PACs,	Able to demonstrate techniques gene cloning and categorize essential enzymes in genetic engineering and hybridization techniques. Also, able to classify cloning vectors and describe their properties. Explain derivatives of plasmid. Construction of vectors.	**12**

	and MACs). Animal virus derived vectors, SV40vaccina/bacculo and retroviral vectors. Expression vectors, Shuttle vectors, Integrative vectors. 3. Gene probes: development and labeling of DNA and RNA probes		
Unit-II Nucleic acid amplification, Sequencing and Hybridization Techniques	1. Polymerase Chain Reaction (PCR) - Primer design, fidelity of thermal enzymes, DNA polymerase, variations in PCR and its applications. PCR in gene recombination, deletion, addition, overlap extension and SOEing, site specific mutagenesis, PCR based mutagenesis, PCR in molecular diagnostics, viral and bacterial detection. 2. Methods of nucleic acid detection, sequencing methods (enzymatic DNA sequencing, chemical DNA sequencing, principles of automated DNA sequencing, RNA sequencing, thermal cycle dideoxy DNA sequencing, and pyrosequencing). 3. Methods of nucleic acid hybridization (Southern blotting, Northern blotting, in situ hybridization). DNA fingerprinting, chromosome walking and jumping.	Student able to Compose polymerase chain reaction. Tell PCR in molecular diagnostic viral bacterial detection explain PCR based mutagenesis.	**12**
Unit- III Cloning and Screening methodologies	1. Insertion of foreign DNA into the host cells: transformation, transfection: chemical and physical method, liposomes, microinjection, electroporation, biolistic, somatic cell fusion, gene transfer by pronuclear microinjection 2. Cloning and expression in yeast (*Saccharomyces*, and pichia), animal and plant cells. Plant transformation technology: Basic of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence gene, use of Ti and Ri as plasmids vectors. Factors affecting expression in plants and animal cells, strategies to create knockout (KO) cells and transgenic animals. 3. cDNA and genomic cloning, expression cloning, jumping and hopping libraries, phage display. Construction of cDNA and genomic DNA libraries. Screening libraries with gene probes, colony hybridization, plaque hybridization, screening by gain of function, immunological screening.	Able to describe methods of DNA insertion into host cell and construction of c DNA. Apply plant transformation technology.	**11**
	1. Molecular Markers- types and applications. Construction of molecular maps (genetic and physical maps). DNA chip Technology and Microarrays (a brief account).	Able to understand the application of r DNA technology in construction of molecular maps,	**10**

Unit-IV Applications of rDNA technology and Legal issues	2. Applications of recombinant DNA technology in medicine, agriculture, Forensic and veterinary sciences. 3. Engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies etc. Human genetic engineering and Gene therapy- methods of gene therapy, gene therapy in treatment of diseases, Stem cell therapy, Future of stem cell therapy, gene targeting. Gene silencing in bacteria. CRISPR-Cas systems for editing and targeting genome. 4. Science and the constitution- ethical, legal and environmental issues associated with rDNA Technology.	medicine, agriculture, forensic and veterinary sciences. Also, in production of antibiotics, enzymes and growth hormones, and gene therapy	

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Practical Paper Name: RECOMBINANT DNA TECHNOLOGY
Paper Number: PRACTICAL LAB-V MB-302

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Acquire skills to perform practicals of isolation, restriction digestion, ligation, amplification, gene mapping and gene cloning required for recombinant DNA technology.

1. Isolation of pBR 322/ pbluescript by alkaline detergent method - A mini prep procedure
2. DNA fingerprinting.
3. DNA ligation by T4 DNA ligase.
4. DNA molecular size determination.
5. Isolation of genomic DNA and it's confirmation by Southern blotting
6. Isolation of plasmid DNA and its Restriction digestion.
7. PCR amplification from genomic DNA and analysis by agarose gel electrophoresis.
8. RAPD application.
9. Restriction mapping.
10. Demonstration of gene cloning,
11. Selection of transformed cells by blue white selection techniques

REFERENCES:

1. DNA cloning: A practical approach by D.M. Glover and D.D. Harmes, RL press, Oxford 1995.
2. Essentials of molecular biology vol. I (A Practical Approach) by Brown T.A., IRL press Oxford. 1995.
3. From Gene to Clone by E. L. Winnacker.
4. Genetic engineering, principles and practice, by Sandhya Mitra. Macmillan India Ltd.
5. Genome mapping and sequencing by Ian Dunham. Horizon Scientific press.
6. Manipulation and expression of Recombinant DNA. Robertson.
7. Methods in enzymology gene expression technology by D.A Godgel. Academic press Inc, San Diego.
8. Methods in enzymology guide to molecular cloning techniques, vol. 152 S. L. Berger. Academic press .Inc, san Diegn, 1996.
9. Molecular biotechnology (2nd edition), by S.B. Primrose, Blackwell Scientific publishers, Oxford.
10. Molecular biotechnology: principles and application of Recombinant DNA II by Bernard R. Glick and J. Pastemak, ASM publication.
11. An introduction to genetic engineering (2nd edition) by Nicholl D.S.T., Cambridge University press, Cambridge, U.K.
12. PCR application. Protocol for functional genomics by Michael A. Innis. David H., Gelfand John J. Sninsky, Academic Press.
13. PCR technology- principles and application for DNA amplification by Henry A Erilch (Ed) Stockton Press. 1989.
14. Route maps in gene technology by M.R. Walker and R. Rapley, Blackwell science, Oxford.
15. Molecular cloning by Sambrook J, Fritsch E.F and Maniatis, cold spring harbor laboratory press, New York.
16. Principles of Gene Manipulation and Genomics, Third Edition. S.B. Primrose, S.B. and R.M. Twyman, Blackwell Publishing Company, Oxford, UK. 2006
17. Gene Cloning and DNA Analysis: An Introduction. Fifth Edition. T.A. Brown, Wiley-Blackwell, UK. 2006.
18. Ethics of Emerging Technologies: Scientific Facts and Moral Challenges. John Wiley and Sons Inc. Thomas F. Budinger and Miriam D. Budinger. 2006.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Paper Name: MICROBIAL DIVERSITY AND EXTREMOPHILES
Paper Number: MB-303

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student will be able to understand and explain the microbial diversity present in different extreme environmental conditions in terms of their distribution, abundance, classification, structure and applications of their products.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Biodiversity and Thermophiles	1. Introduction to microbial diversity- Distribution, Abundance, Ecological Niches. Types- Bacterial, Archael, Eucaryal, Characteristics and Classification of Archae (Methanogens). 2. Classification, Hyper-thermophilic habitat and ecological aspects. Molecular basis of thermo-stability, Heat stable enzymes and metabolism, Genetics of thermophiles, Minimal complexity model systems. 3. Commercial aspects of thermophiles and application of thermoenzymes.	Able to understand and explain distribution, abundance and ecological niches of microbes, Construct, & Demonstrate Phylogenetic relationship between Bacterial, Archael, Eucaryal. Illustrate Classification of thermophile on the basis of their habitat. Comparative, study of thermophilic enzymes.	**18**
Unit-II Acidophiles and Alkalophiles	1. Acidophiles- Classification, life at low pH, acido-tolerance, applications. 2. Alkalophiles- Isolation, Distribution and Taxonomy. Cell structures-Flagella, Cell wall, Cell membrane. Physiology- Growth conditions, Mutants, Antiporters and alkaliphily. Intracellular enzymes.	Student able to understand and explain Classification of Acidophiles & Alkalophiles. Compare different Cell structures of	**09**

	Molecular biology- Alkalophiles as DNA sources, secretion vectors, promoters 3. Enzymes of alkaliphiles and their applications	Alkalophiles with mesophilic organisms.	
Unit- III Psychrophiles	1. Conditions for microbial life at low temperature Climate of snow and ice, limits for life at subzero temperature. 2. Microbial diversity at cold ecosystem – snow and glaciers ice, subglacial environments, psychropiezophiles, permafrost, anaerobic and cyanobacteria in cold ecosystem, microalgae in Polar Regions. 3. Molecular adaptations to cold habitats – Membrane components and cold sensing, cold adapted enzymes, cryoprotectants and ice binding proteins, role of exopolymers in microbial adaptations to sea ice	Able to differentiate Microbial diversity at different climatic conditions. Appraise Molecular adaptations to cold habitats – Membrane components and cold sensing.	**09**
Unit-IV Halophiles and Barophiles	1. Halophiles- Classification, Halophilicity and Osmotic protection, Hypersaline Environments, Eukaryotic and prokaryotic halophiles Halobacteria – cell wall. Membranes, compatible solutes, osmo-adaptations or halotolerance, Applications of halophiles and their extremozymes. **2.** Barophiles- Classification, high pressure habitat, life under pressure, barophily, death under pressure.	Able to explain and understand microbes in Hyper saline and high pressure Environments in terms of their structure, classification. Applications of halophiles and their extremozymes.	**09**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Practical Paper Name: MICROBIAL DIVERSITY AND EXTREMOPHILES
Paper Number: PRACTICAL LAB-VI MB-303

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students are enabled to isolate thermophiles, halophiles by studying different parameters. Isolation of thermophiles from hot water spring (Study at least one thermostable enzyme).

1. Studies on halophiles isolated from high salt habitat. (Study its pigmentation and salt tolerance phenomenon).
2. Studies on alkalophiles and its enzymes (any one) isolated form extreme alkaline environment.
3. Biogenic methane production using different wastes.
4. Isolation of *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans* culture from metal sulfides, rock coal and acid mine water.

REFERENCES:

1. Advances in applied microbiology. Vol.X, by Wayne W. Umbreit and D. Pearlman Academic Press.
2. Brock biology of Microorganisms. XI by Michael T. Madigan, John M. Martinko. Pearson Education International.
3. Extreme environment. Metabolism of microbial Adaptation by Milton R., Heinirich Academic Press.
4. Microbial ecology. Fundamental and applications by Ronald M. Atlas and Richard Bartha. II and IV edition.
5. Microbial Ecology. IInd edition by R. Campbell. Blackwell scientific publication.
6. Microbial life in extreme Environment by D.J. Kushner. Academic Press.
7. Microbiology of extreme Environment and its potentials for Biotechnology by N. S. Da Coasta, J. C. Duarata,, R.A.D. Williams. Elsisver applied science, London
8. Thermophiles. General, Molecular and applied Microbiology by Thomas D.Brock. Wiley Interscience publication.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Paper Name: BIOSTATISTICS, COMPUTER APPLICATIONS AND RESEARCH METHODOLOGY
Paper Number: MB-304 (Elective)

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student will be able to understand explain and apply the biostatistics, computer and research methodology during his further studies.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Introductory biostatistics and Measures of Central Tendency	1. Introductory biostatistics: Sampling. Data collection and presentation: Types of data, Methods of data collection. Graphical (Histogram, frequency polygon and o give curves, Box plot, Scatter plot, survival curves) and diagrammatic (Simple bar diagram, percentage bar diagram, multiple bar diagram, sub-divided bar diagram and pie diagram) representation of data. 2. Measures of central tendency: Arithmetic mean, mode, and median. Empirical relationship between mean, median and mode. Quartile and percentile. 3. Measures of Dispersion: Range, Standard deviation, variance and coefficient of variance. Standard Error and its significance. 4. Measures of Skewness and Kurtosis.	Able to understand and explain basic of biostatistics, like mean, mode, standard deviation etc.	**13**

Unit-II Tests of Significance and Designing of Experiment	1. Tests of Significance: The concept of Null and alternative hypothesis. Parametric and non-parametric tests of significance (Chi-square, t-test, F-test, H test, U test, and Z test). Correlation and Regression: Bi-variate data and scatter diagram, Simple (linear) correlation and regression, Coefficient of correlation and regression and their properties. 2. Probability: Definition, Elementary properties, Types, Rules of probability. Its applications to biological problems. Probability distributions- Binomial, Poisson, Normal (Only definitions and problems). 3. Analysis of Variance: ANOVA. Experimental designs- Completely Randomized Design, Randomized Block Design. Latin square design. Factorial designs.	Student able to understand and apply the biostatistics for analysis of data.	**10**
Unit- III Computer: Introduction and applications	1. Introduction: Organization of computers. Classification of computers. Concept of hardware and software. Operating System (command line and WIMP). Elementary ideas about programming languages and application packages for microbiologists. LIMS. 2. MS Office softwares and their applications: MS word, MS PowerPoint, and MS excel. Applications of these softwares in Microbiology. 3. Computer based statistical techniques and statistical packages (Basics and Introduction in Short): Features of statistical softwares (free open source) Examples: SAS University Edition, Scilab, Statistical Lab, Dataplot and SOFA (Statistics Open For All) for various applications in Bioresearch.	Students have the knowledge of computer and apply this knowledge in research and day to day life.	**12**
Unit-IV Research Methodology	1. Introduction: Definition, Importance and meaning of research. Qualities of a good researcher. Characteristics of research. Types of research. Steps in research. Identification and selection of research problems. Formulation of hypothesis. Literature search: Information sources. 2. Scientific writing: Basic concepts of scientific writing. Scientific Documents:	Able to explain and understand the different methods that has been used in research like framing of hypothesis, research paper formulation, types of research papers etc.	**10**

	Definition and types-Research papers, review papers, conference reports and proceedings, project reports, theses, book reviews, research proposal, and dissertation. Basic structure of a Research Article: IMRAD format. Essentials features of abstract, introduction, review of literature, materials, methods, results and discussion, conclusion and outcome. Effective illustration- tables and figures. Reference styles- Harvard and Vancouver systems. Citation tools used in research (e.g. Mendeley). 3. Legal aspects of scientific authorship: Copyright considerations, Plagiarism and plagiarism detection softwares. Presenting and publishing research. Bibliometric measures (Impact factor & h-index).		

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Practical Paper Name: BIOSTATISTICS, COMPUTER APPLICATIONS AND RESEARCH METHODOLOGY
Paper Number: PRACTICAL LAB-VI MB-304

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students develop skill to apply statistical knowledge and to correlate statistically extracted value by performing knowledge based practical. Also acquires skill to represent data by using the computer knowledge of MS Word, Excel and power point presentation.

1) Representation of statistical data by
    a) Histogram b) Ogive curve c) Pie diagram.
2) Determination of statistical averages/central tendencies.
    a) Arithmetic mean
    b) Median
    c) Mode.
3) Determination of measure of dispersion.
    a) Mean deviation.
    b) Standard deviation and coefficient of variation.
    c) Quartile deviation.
4) Tests of significance-Applications of following.
    a) Chi-square test.
    b) t-test
    c) Standard error
5) Find out the Karl Pearson coefficient of correlation for the problem given by your subject expert.
6) Creating files, folders and directories.
7) Application of computers in biology using MS-office.
    a) MS-word

b) Excel
c) Power point.

8) Data presentation and analysis using MS Excel/Open Source free Statistical Packages:
   a) Plotting graphs – bar charts, line graphs, pie charts, adding error bars
   b) Statistical analysis of data – Students t test, ANOVA, Chi square test, F test
9) An introduction to Internet, search engines, websites, browsing and downloading.
10) Writing any of the scientific document with standard format.
11) Make extensive literature review/survey of any topic of your interest.

REFERENCES:

1. Biostatistical methods by John M. Lachin. John Wiley & Sons.
2. Biostatistics- 7th edition by Wayne W. Daniel. John Wiley & Sons.
3. Sampling methods by Murthy M.N., Indian Statistical Institute, Kolkata.
4. Biostatistics by Arora and Malhan, Himalaya Publishing House
5. Fundamentals of Biostatistics (5^{th}) by Bernard Rosner, Ed. Duxbury Thomson
6. Fundamentals of biostatistics by Irfan A Khan, Atiya Khanum. Ukaaz Publications.
7. Statistics for biologist by Campbell R.C (1974). Cambridge University Press, UK.
8. Statistics in biology Vol: 1 by Bliss, C.I.K (1967) Mc Graw Hill, New York.
9. Design and analysis of experiments by Montgomery D.C., John Wiley & Sons
10. How computer work (2000) by Ron White. Tech Media.
11. How the internet work (2000) by Preston Garlla Tech. Media.
12. Practical statistics for experimental biologist by Alastair C. Wardlaw. Wiley.
13. Research methodology methods and statistical techniques by Santosh Gupta. Deep & Deep Publications.
14. Research methodology methods and techniques by C.R. Kothari. New Age International.
15. Research methods in Biological sciences by Palanisamy S. and M. Shanmugavelu. 1997. Palani Paramount publications, Tamilnadu. India
16. From Research to Manuscript- A Guide to Scientific Writing by Michael Jay Katz. Springer
17. How to write and publish a Scientific paper by R.A.Day
18. Scientific English: A Guide for Scientists and Other Professionals, Day, Robert; Sakaduski, Nancy (2011). Third Edition. ABC-CLIO.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – III
Subject: Microbiology
Practical Paper Name: Seminar/NPTL Course
Paper Number: 305

Credits: 01

MB - 305: Seminar

Based on theory paper MB- 301, 302, 303 & 304

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Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Paper Name: FERMENTATION TECHNOLOGY
Paper Number: MB-401

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student able to understand and develop skill of the different microbial fermentation processes, production of fermentation products, therapeutic compound. Bioplastic production, biofertilizer production. Get aware of procedure of IPR, Trademark, copyright.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Microbial Fermentations	1. Metabolic pathways and metabolic control mechanisms, Industrial production of citric acid, lactic acid, enzymes (alpha amylase, lipase, xylase , pectinases, proteases) Acetone- butanol, Lysine and Glutamic acid, Alcoholic beverages, Distilled beverages, Beer, Wine.	Able to understand and explain different types of fermentation and industrial production of citric acid, lactic acid, enzymes, amino acid and alcoholic beverages, beer, wine.	**09**
Unit-II Microbial production of therapeutic compounds	1. Microbial production of therapeutic compounds (β-lactum, aminoglycosides, ansamycines (Rifamycin), Peptide antibiotics (Quinolinones), Biotransformation of steroids, Vit.B-12 and riboflavin fermentation.	Student able to understand the knowledge of antibiotics and its production of rifamycin ,β lactum antibiotics, peptides	**08**
Unit- III Modern trends in microbial production	1. Modern trends in microbial production of bioplastics (PHB,PHA), Bioinsecticides (thuricides) Biopolymer (dextran, alginates, xanthan, pullulan), Biofertilizer	Students have the knowledge of modern trends of microbial productions such as bioplastics, biopolymer,	**17**

	(nitrogen fixer *Azotobacter*, phosphate solubilising microorganisms), Single cell protein and production of biological weapons with reference to anthrax. 2. Useful features of biofuels. The substrate digester and the microorganisms in the process of biogas production (Biomethanation). Production of bioethanol from sugar, molasses, starch and cellulosic materials. Ethanol recovery, Microbial production of hydrogen gas, biodiesel from hydrocarbons.	biofertilizer, bioinsecticides. Able to design and construction of biogas production model practically	
Unit-IV Immobilization techniques, IPR and Patents	1. Some industrial techniques for whole cell and enzyme immobilization. Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries. Intellectual Property Rights (IPR), Patents, Trademarks, copyrights, secrets, Patenting of biological materials, International co-operation, Obligations with patent 2. applications, implication of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeders rights and farmers rights.	Able to develop skill of immobilization techniques, use of it for enzyme immobilization and its application in food pharmaceutical and chemical industries. Students become aware of procedure of IPR patents trademarks, copyrights.	**11**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Practical Paper Name: FERMENTATION TECHNOLOGY
Paper Number: PRACTICAL LAB-VII MB - 401

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students develops skill of production and estimation of acid production glutamic acid, rifamycin production, thuricides, laboratory scale production of biofertilizer. Also acquires skills of microbial production of dextran and hydrogen gas.

1. Production and characterization of citric acid using *A. niger*.
2. Microbial production of glutamic acid.
3. Production of rifamycin using *Nocardia* strain.
4. Comparison of ethanol production using various organic wastes/raw materials. (Free cells / immobilized cells).
5. Production and extraction of thuricides.
6. Laboratory scale production of biofertilizers. (Nitrogen fixer/ Phosphate solubilizers/ Siderophore producers).
7. Microbial production of dextran by *Leuconostoc mesenteroids*.
8. Microbial production of hydrogen gas by algae.

REFERENCES:

1. Annual report in fermentation processes by D. Pearlman, Academic Press
2. Biology of industrial microorganisms by A. L. Demain.
3. Biotechnology. A Text Book of Industrial Microbiology by Creuger and Creuger. Sinaeur associates.
4. Fundamentals of Biochemical Engineering by Bailey and Ollis.
5. Genetics and Biotechnology of Industrial Microorganisms by C. L. Hershnergey, S.W. Queener and Q. Hegeman. Publisher ASM. Ewesis ET. Al 1998 Bioremediation Principles. Mac Graw Hill.
6. Industrial microbiology by G. Reed (ed), CBS publishers (AVI publishing comp.).
7. Manual of Industrial Microbiology and Biotechnology 2nd edition by Davis J.E. and Dmain A. L. ASM Publication.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Paper Name: MEDICAL AND PHARMACEUTICAL MICROBIOLOGY
Paper Number: MB-402

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student able to understand and develop skill for construct antibiotic, microbiological assay drug resistance. Explain the mechanism and action of antibiotic antimicrobial agent. apply safety in microbiology. students will gain the knowledge and can work in hospital, pharmacy and industry

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Antibiotics, synthetic antimicrobial agents and its mechanism	1. Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactums, tetracyclines, ansamycins, macrolid antibiotics). Antifungal antibiotics, antitumour substances. Peptide antibiotics, chloramphenicol, sulphonamides and quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives. 2. Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principal of drug targeting. Drug delivery system in gene therapy. Bacterial resistance to antibiotics, quionolinones. Mode of action of bacterial killing by quinolinones. Mode of action of non-antibiotic antimicrobial agents. Penetrating defenses –How the antimicrobial agents reach the targets (cellular permeability	Student have the knowledge and mechanism of action of antibiotics, synthetic antimicrobial agents, chemical disinfectants, antiseptic and preservatives. Also have knowledge of antibiotic resistance in bacteria	**18**

	barrier, cellular transport system and drug diffusion).		
Unit-II Microbial production and spoilage of pharmaceutical products	1. Microbial production and spoilage of pharmaceutical products (sterile injectable, non injectable, ophthalmic preparation and implants) and their sterilization. Manufacturing procedure and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.	Student able to evaluate microbial production and spoilage of pharmaceutical products. design manufacturing procedure. derive pharmaceuticals products by microbial fermentation process	**09**
Unit- III Regulatory practices, biosensors and applications in pharmaceuticals	1. Financing R & D capital and market outlook, IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drug and biological, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers. 2. Biosensors in pharmaceuticals. Applications of microbial enzymes in pharmaceuticals.	Able to understand government regulatory practices, application of biosensor and microbial enzyme in pharmaceuticals.	**09**
Unit-IV Quality assurance and validation	1. Good manufacturing practices (GMP) and Good laboratory practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. 2. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, radiation, gaseous and filter sterilization). 3. Chemical and biochemical indicators. Design and layout of sterile product manufacturing unit (Designing of microbiology laboratory). Safety in microbiology laboratory.	Able to recognise good manufacturing practices and good laboratory practices. Apply quality assurance and quality management in pharmaceuticals. use safety in microbiology.	**09**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Practical Paper Name: MEDICAL AND PHARMACEUTICAL MICROBIOLOGY
Paper Number: PRACTICAL LAB-VII MB - 402

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students develops skill of production and bioassay of penicillin, estimation of griseofulvin, production of therapeutic enzymes, determination of MIC and LD, sterility testing, and determination of antimicrobial activity of chemical compounds.

1. Spectrophotometric/ Microbiological methods for the determination of Griseofulvin.
2. Microbial production and Bioassay of Penicillin.
3. Bioassay of Chloramphenicol/Streptomycin by plate assay method or turbidometric assay methods.
4. Screening, Production and assay of therapeutic enzymes: Glucose Oxidase/Asperginase/beta lactamase.
5. Treatment of bacterial cells with cetrimide, phenol, and detection of Leaky substances such as amino acids, nucleic acids as cytoplasmic membrane damaging substances.
6. Determination of MIC and LD50 of Ampicillin / Streptomycin.
7. Sterility testing by using *B. sterothermophilus* / B. s*ubtilis*.
8. Testing for microbial contamination. Microbial loads from syrups, suspensions, creams, and other preparations, Determination of D-value and Z-value for heat sterilization in pharmaceuticals.
9. Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.

REFERENCES:

1. Analytical Microbiology by Fredrick Kavanagh volume I &II. Academic Press New York.
2. Biotechnology – Expanding Horizon by B.D. Singh., First Edition, Kalyani Publication, Delhi.
3. Biotechnology by H.J. Rhem & Reed, vol 4 VCH publications, Federal Republic of Germany.
4. Drug carriers in biology & medicine by Gregory Gregoriadis. Acedemic Press New York.
5. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, MurrayM. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York.
6. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
7. Pharmaceutical Biotechnology by S. P. Vyas & V.K. Dixit. CBS publishers & distributors, New Delhi.
8. Pharmaceutical Microbiology by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
9. Pharmacognosy by Gokhle S.D., KoKate C.K. Edition: 18, Nirali Publication.
10. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
11. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.
12. Quality control in the Pharmaceutical industry by Murray S. Cooper Vol. 2, Academic Press New York.
13. Quniolinone antimicrobial agents by David C. Hooper, John S. Wolfson. ASM Washington DC.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Paper Name: ENVIRONMENTAL MICROBIOLOGY
Paper Number: MB-403

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Student able to understand and recognise characteristic of environment and ecosystem, characteristics of waste water, solid waste and its treatment by various methods such as aerobic and anaerobic treatment. Also explains biodeterioration, biotransformation & recovery of Metals & Metalloids and impact of these factors on environment.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Environment and Ecosystems	1. Definitions, biotic & abiotic environment, environmental segments. 2. Composition and structure of environment. 3. Concept of biosphere, communities and ecosystems. 4. Ecosystems characteristics structure and function. 5. Food chains, Food webs and Trophic structures, Ecological pyramid.	Student is enable to differentiate composition and structure of environment. Sketch Food chains, Food webs and Trophic structures, Ecological pyramid.	**08**
Unit-II Waste water and Solid Waste Treatment	1. Need for water management, 2. Sources of measurement of water pollution, waste types solid and liquid. 3. Waste characterization: physical, chemical and biological. 4. Waste treatments: Primary, Secondary & tertiary treatments. 5. Aerobic –Trickling filters, oxidation ponds.	Appraise Need for water management, Sources of measurement of water pollution, waste types solid and liquid. Recognize & realize Waste treatments	**12**

	6. Anaerobic– Anaerobic digestion, anaerobic filters & upflow anaerobic sludge. 7. Effluent treatment Schemes for Dairy, Distillery, Tannery, Sugar and antibiotic industry (Types, Microbes used, types of effluent treatment plants.) 8. Bioconversion of solid waste & utilization as fertilizer. 9. Bioaccumulation of heavy metal ions from industrial Effluents.		
Unit- III Biodeterioration, Biotransformation & Recovery of Metals & Metalloids	1. Concept of Biodeterioration. 2. Biodeterioration of paints, paper & Leather. 3. -Biochemistry and Microorganisms involved in recovery of Metals and Oil. 4. -Microbial transformation of Mercury & Arsenic. 5. Microbiology of degradation of xenobiotics in the environment, Ecological considerations, Decay behaviour. Biomagnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, Oil pollution, Surfactants and Pesticides. 6. GMO'S & its environmental impact assessment and ethical issues.	Able to understand and Interpret Biodeterioration of paints, paper & Leather. Collect information about Microorganisms involved in recovery of Metals and Oil. Able to discuss & demonstrate Microbiology of degradation of xenobiotics in environment, Ecological Considerations, Decay behaviour.	**17**
Unit-IV Global environmental problems, Impacts and Management	1. Biotechnological approaches for tackling following issues 2. Ozone depletion and UV –B. 3. Green House Effect and CFC. 4. Acid rain & CO2, SO2. 5. Acid mine drainage & H2SO4. 6. Eutrophication and P, N. 7. Biocorrosion.	Express ideas about Global environmental problems, Impacts and Management.	**08**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Practical Paper Name: ENVIRONMENTAL MICROBIOLOGY
Paper Number: PRACTICAL LAB-VII MB - 403

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students develops skill and handling of physical analysis of sewage, measurement of BOD/COD, recovery of toxic metal ions from industrial effluent, study of municipal solid waste management, and microbial dye decolouration.

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

REFERENCES:

1. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications.
2. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
3. Basic Principles of Geomicrobiology by A. D. Agate, Pune.
4. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
5. Bioremediation by Baker K.H. And Herson D.S. 1994. MacGraw Hill Inc. N.Y.
6. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. WileyInterscience Publications.
7. Environmental Biotechnology by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
8. Environmental Microbiology by Ralph Mitchell. A John Wiley and Sons. Inc.
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11. Waste Water Microbiology 2nd Edition by Bitton.

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Paper Name: MICROBIAL BIOINFORMATICS, GENOMICS AND PROTEOMICS
Paper Number: MB-404 (Elective)

Credits: 04 **Periods: 45**

Specific Program Outcome:

The student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Molecular Immunology, Microbial Diversity and Extremophiles, Environmental Microbiology, Industrial Microbiology, Fermentation Technology, Food Microbiology, Medical and Pharmaceutical Microbiology and Microbial Pathogenicity. The student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students are able to predict the significance of the biological phenomenon on the basis of available data set. Student develops skill to apply the knowledge of bioinformatic for the analysis of microbial genome and proteins.

Unit Number and Name	Unit Content	Unit – Wise Learning Outcome	Number of Lectures
Unit-I Basics of Bioinformatics	1. Introduction: Definition, history, components, and applications of bioinformatics. Internet and bioinformatics. Data mining- Process, tasks, techniques and applications. 2. Database: Database management system (DBMS), biological databases and information resources, classification of biological databases. 3. Sequence alignment: Pairwise alignment, global and local alignment, end-space free alignment, gap penalty. Similarity matrices (PAM, BLOSUM). Searching sequence databases using BLAST and FASTA. Pairwise sequence alignment using dynamic programming (Needleman-Wunsch and Smith-Waterman algorithms)	Aimed to provide an overview of various bioinformatics tools, databases available and sequence analysis.	**14**
Unit-II Biological databases and	1. Biological databases: PubMed- the central repository for biological database. Metadatabase (Entrez-NCBI). Nucleic acid	Provide knowledge on database concept, management, and	**14**

Multiple sequence alignment	sequence databank (DDBJ, GenBank and EMBL), Ensembl. Protein databases: i. Sequence database (PIR, Swiss-Prot, TrEMBL, Pfam, and PROSITE), ii. Structure database (PDB), iii. Classification database (CATH and SCOPE). Other biological databases (OMIM, ATCC, and KEGG). Molecular visualizing tool (RasMol and MOLMOL) 2. Multiple sequence alignment: Progressive and iterative alignment and tools based on these algorithms- ClustalW and MultAlign. Multiple sequence alignment of related sequence: Position specific scoring matrices, profiles, PSI-BLAST, Markov Model or Markov chain 3. Phylogenetics: Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree-types, constructions and basic tools for phylogenetic analysis.	retrieval along with utilization in gene and protein analysis.	
Unit- III Microbial Genomics	1. Microbial Genome Structure and organization. Principles of microbial genomics such as sequencing, assembly, annotation of microbial genomes and its application to cultured and uncultured microbial community. 2. Methods for gene sequence analysis, types of genomics, gene functions, analysis of gene expression, significance of genome sequencing. Microbial genome projects, Human Microbiome Project. 3. DNA analyses for repeats (Direct and inverted), palindromes, folding programs. Benefits of Pharmacogenomics.	Retrieve information from available databases and use them for microbial identifications and drug designing. Gain ability to modify gene and protein structures in simulated systems.	**08**
Unit-IV Microbial Proteomics	1. Types of proteomics, tools for proteomics-separation and isolation of proteins, methods of studying proteins. 2. Protein Structure Visualization, Comparison, and Classification. Protein structure prediction. Homology or comparative modeling- Remote homology (Threading), 3. Protein function prediction- Introduction to the concepts of molecular modeling. Drug discovery, Structure based drug designing and virtual screening by automated docking, de novo sequence. Introduction to Molecular Docking.	Impart basic knowledge of statistics and tools used for several quantitative analyses in microbiology. Studying proteins. Proteomics databases.	**09**

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Practical Paper Name: MICROBIAL BIOINFORMATICS, GENOMICS AND PROTEOMICS
Paper Number: PRACTICAL LAB-VII MB - 404

Credits: 02

Specific Program Outcome:

Impart Knowledge of the diverse places where microbiology is involved. Understanding of diverse Microbiological processes. Basic skills such as culturing microbes, maintaining microbes, safety issues related to handling of microbes, Good Microbiological practices etc. Moderately advanced skills in working with microbes such as Pathogens. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Specific Course Outcome:

Students develops skill of handling data bases for nucleic acid and protein sequences, structure detection by RASMOL software, gene and protein sequence analysis using BLAST algorithm

1. Studies of public domain databases for nucleic acid and protein sequences.
2. Determination of protein structure (PDB) by using RASMOL software
3. Genome sequence analysis by using BLAST algorithm
4. Protein sequence analysis by using BLAST algorithm
5. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W

REFERENCES:

1. Bioinformatics Methods and Protocols - Misener.
2. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
3. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
4. Bioinformatics 2000 by Higgins and Taylor OUP.
5. Bioinformatics and molecular evolution-P.G. Higgs & T. K. Attwood, 2005 Blackwell Publishing.
6. Bioinformatics by David Mount.
7. Bioinformatics by Prakash S. Lohar., MJP publisher.
8. Data Mining for Genomics and Proteomics-Analysis of Gene and Protein Expression Data by D. M. Dziuda ,Willey publishers
9. Genomics-Fundamentals and Applications by Supratim Choudhart & David B., Carlson
10. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
11. Computer analysis of sequence data by Colte.
12. Essential Bioinformatics by Jin Xiong 2006 Cambridge University press

13. Introduction to Bioinformatics in Microbiology by Henrik Christensen 2018, Springer Nature Switzerland AG
14. Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
15. Introduction to Bioinformatics by Altwood.
16. Protein Engineering: Principles and Practice by Cleland.
17. Microarray- Gene expression Data analysis by Causton, Brazma 2003 Blackwell Publishing
18. Protein Biotechnology by Felix Franks. Humana Press, Totowa, New Jarsey.

Web sites for Proteomics and Genomics

1) www.geneprot.com.

2) www.hybrigenis.com

3) www.mdsproteomics.com

4) www.stromix.com

5) www.syrrx.com

Swami Ramanand Teerth Marathwada University Nanded

Choice Based Credit System (CBCS) Learning Outcome Based Course Structure
(New scheme) for M.Sc. Second Year
Faculty of Science and Technology
Semester – IV
Subject: Microbiology
Practical Paper Name: Seminar/NPTL Course
Paper Number: MB - 405

Credits: 01

MB - 405: Seminar

Based on theory paper
MB- 401, 402, 403 & 404

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED.

Faculty of Science and Technology Semester – IV

Model Question Paper Pattern (Theory) with
effective from 2020 Class: **M. Sc. Second Year**
(Semester III & IV) CBCS Pattern
Subject: MICROBIOLOGY
Papers: **MB-301 to 304** and **MB-401 to 404**

Time: Three Hrs **Max. Marks: 75 (ESE)**

NB: All questions are compulsory

Q. 1: Essay Type Question (On Unit I) 15 Marks

OR

a) Short Question 8 Marks
b) Short Question 7 Marks

Q. 2: Essay Type Question (On Unit II) 15 Marks

OR

ı) Short Question 8 Marks
ɔ) Short Question 7 Marks

Q. 3: Essay Type Question (On Unit III) 15 Marks

OR

ı) Short Question 8 Marks
ɔ) Short Question 7 Marks

Q. 4: Essay Type Question (On Unit IV) 15 Marks

OR

ı) Short Question 8 Marks
ɔ) Short Question 7 Marks

Q. 5: Short Question (Write any three) (On Unit I, II, III,IV) 15 Marks

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED.

Faculty of Science and Technology Semester – IV

Model Question Paper Pattern (Theory) wef: 2020

Class: **M.Sc. Second Year** (Semester III & IV) CBCS Pattern

Subject: MICROBIOLOGY

Practical Paper LAB-V (Based on theory Papers: MB-301 to 302) (Morning) &

LAB-VI (Based on theory papers: MB-303 to 304) (Evening)

For two Consecutive days for each batch

Time: Four Hrs (Morning: 09amTo 1pm &Evening: 2 pm To 6 pm) **Max. Marks: 75 (ESE)**

Q. 1: Long Experiment (MB-301/MB-303)	15
Q. 2: Long Experiment (MB-302/MB-304)	15
Q. 3: Short Experiment (MB-301/MB-303)	10
Q. 4: Short Experiment (MB-302/MB-304)	10
Q. 5: Record Book	10
Q. 6: Viva Voce	15

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SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED.

Model Question Paper Pattern (Theory) wef: 2020

Class: **M. Sc. Second Year** (Semester III & IV)

CBCS Pattern **Subject: MICROBIOLOGY**

Practical Paper LAB-VII (Based on theory Papers: MB-401,402,403 & 404)

LAB –VIII (Dissertation) *(Elective)

For two Consecutive days for each batch

Time: Four Hrs (Morning: 09.00 am to 01.00 pm) **Max. Marks: 75 (ESE)**

Q. 1: Long Experiment (MB-401)	12
Q. 2: Long Experiment (MB-402)	12
Q. 3: Long Experiment (MB-403)	12
Q. 4: Long Experiment (MB-404)	12
Q. 5: Record Book	12
Q. 6: Viva Voce	15