**DEPARTMENT OF MICROBIOLOGY, K.U., KURUKSHETRA**

**Revised M.Sc. SYLLABUS (CBCS) (w.e.f. Session 2016-2017)**

**Semester I**

|  |  |  |  |  |  |  |  |
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| **Paper Code** | **Title of Paper** | **Type of Paper**  | **Hours/****Week** | **Credits** | **Internal****Assessment** | **External****Marks** | **Total Marks** |
| MB-101 | Microbial World - I | Core | 4 | 4 | 20 | 80 | 100 |
| MB-102 | Microbial World - II | Core | 4 | 4 | 20 | 80 | 100 |
| MB-103 | Microbial Genetics-I | Core | 4 | 4 | 20 | 80 | 100 |
| MB-104 | Microbial Biochemistry | Core | 4 | 4 | 20 | 80 | 100 |
| MB-105 | Practical-1 (Based on MB-101 & MB-102) | Core | 8 | 4 | 20 | 80 | 100 |
| MB-106 | Practical-2(Based on MB-103 & MB-104) | Core | 8 | 4 | 20 | 80 | 100 |
| **Total** | **24** |  **600** |

**Semester II**

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| **Paper Code** | **Title of Paper** | **Type of Paper**  | **Hours/****Week** | **Credits** | **Internal****Assessment** | **External****Marks** | **Total Marks** |
| MB-201 | Bacterial Physiology & Metabolism | Core | 4 | 4 | 20 | 80 | 100 |
| MB-202 | Lab Techniques in Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-203 | Microbial Genetics-II | Core | 4 | 4 | 20 | 80 | 100 |
| MB-204 | Agricultural Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-205 | Seminar | Core  | 1 | 1 | - | - | 25 |
| MB-206 | General Microbiology | Open# Elective | 2 | 2 | 10 | 40 | 50 |
| MB-207 | Practical-3 (Based on MB-201 & MB-202) | Core | 8 | 4 | 20 | 80 | 100 |
| MB-208 | Practical-4 (Based on MB-203 & MB-204) | Core | 8 | 4 | 20 | 80 | 100 |
| **Total** | **27** |  **675** |

**Project training for 2 months in various research institutes/industries etc. during Summer Vacations**

**#This paper is meant for M.Sc. students of faculty of life sciences other than Microbiology. Microbiology students will opt for ‘open elective’ from some other department of Life Sciences**

**Semester III**

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| **Paper Code** | **Title of Paper** | **Type of Paper**  | **Hours/****Week** | **Credits** | **Internal****Assessment** | **External****Marks** | **Total Marks** |
| MB-301 | Food & Dairy Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-302 | Microbial Biotechnology & Industrial Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-303 | Medical Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-304A | Cellular Microbiology & Immunology  | Elective\*(Any one of the two) | 4 | 4 | 20 | 80 | 100 |
| MB-304B | Fundamentals of Bioinformatics | 4 | 4 | 20 | 80 | 100 |
| MB-305 | Project Seminar | Core  | 1 | 1 | - | - | 25 |
| MB-306 | Applied Microbiology | Open# Elective | 2 | 2 | 10 | 40 | 50 |
| MB-307 | Practical-5(Based on MB-301 & MB-302) | Core | 8 | 4 | 20 | 80 | 100 |
| MB-308 | Practical-6 (Based on MB-303 & MB-304) | Core | 8 | 4 | 20 | 80 | 100 |
| **Total** | **27** |  **675** |

**\*Students will opt for one paper out of MB304A and MB 304B**

**#This paper is meant for M.Sc. students of faculty of life sciences other than Microbiology.**

**Microbiology students will opt for ‘open elective’ from some other department of Life Sciences**

 **Semester IV**

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| **Paper Code** | **Title of Paper** | **Type of Paper**  | **Hours/****Week** | **Credits** | **Internal****Assessment** | **External****Marks** | **Total Marks** |
| MB-401 | Biostatistics & Computers | Core | 4 | 4 | 20 | 80 | 100 |
| MB-402 | Recombinant DNA Technology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-403 | Environmental Microbiology | Core | 4 | 4 | 20 | 80 | 100 |
| MB-404A | Bio fertilizers | Elective\*(Any one of the two) | 4 | 4 | 20 | 80 | 100 |
| MB-404B | Intellectual Property Rights& Entrepreneurship | 4 | 4 | 20 | 80 | 100 |
| MB-405 | Practical-7(Based on MB-402, MB-403 & MB-404) | Core | 8 | 4 | 20 | 80 | 100 |
| MB-406 | Project Training Report & Viva | Core |  8 | 4 | -- | 100 | 100 |
| **Total** | **24** | **600** |
|  **Grand Total (Semester I-IV)** |  | **2550** |

**\*Students will opt for one paper out of MB404A and MB 404B**

**SEMESTER I**

**MB 101. MICROBIAL WORLD – I**

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| **Objectives:** To introduce the subject of microbiology to the students in the light of their existing knowledge of biological systems. To inculcate interest in microbiology among students. **Outcomes:** After studying this course, the students will have the brief knowledge of different bacteria classification methods and basics of microbiology. They will know how to grow and preserve bacteria. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks.**

**Unit I:**

History, development and scope of microbiology. Prokaryotic and eukaryotic cellular organisation. Simple staining and Gram staining technique of bacteria. Brief account of general methods of classifying the bacteria. Whittaker’s five kingdom concept.

**Unit II:**

Cell arrangement and shapes of bacteria. Major characteristics (morphological, physiological, metabolical, ecological, cultural, serological, pathogenic, phylogenetic of microorganisms used in microbial taxonomy. Bergey’s manual and its importance in classification. Brief account of different bacterial groups- sporulating bacteria, gram positive cocci, archaebacteria, actinomycetes, rickettsia & chlamydia, mycoplasma, spirochetes.

**Unit III:**

Nutritional types of bacteria. Concept of pure culture, methods of isolation of pure culture. Types of culture media. Maintenance and preservation of microbial cultures. Cultural characteristics of bacteria.

**Unit IV:**

Control of microorganisms by physical methods – Dry heat, moist heat, radiations, osmotic pressure, filtration methods; chemical methods-characteristics of an ideal antimicrobial chemical agent, phenols, alcohols, quaternary ammonium compounds, halogens, heavy metals and their compounds, aldehydes, ethylene oxide and their application. Antibiotic susceptibility testing. Mode of action of antibiotics-cephalosporin, chloramphenicol, ciprofloxacin, polymyxin B, sulphonamides. Antimicrobial drug resistance- Mechanism and spread.

**Text and Reference Books:**

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR(2003). General Microbiology, MacMillan.

2. Tortora GJ, Funke BR & Case CL(2010). Microbiology: An introduction with Mastering Microbiology,10th ed. Benjamin Cummings.

3. Madigan MT, Martinko JM, Stahl DA & Clark DP(2012). Brock Biology of Microorganisms, 13th ed., Benjamin Cummings

4. Mackie & McCartney Practical Medical Microbiology (1996). Collee JG, Fraser AG, Marmion BP & Simmons A (eds.), Churchill Livingstone, Edinburgh.

6. Atlas RM, Parks LC & Brown AL(1995). Laboratory Manual of Experimental Microbiology. Mosby-Year Book, Inc., Missouri.

7. Willey JM, Sherwood LM & Woolverton CJ DA(2008). Prescott, Harley and Klein’s Microbiology, 7th ed., McGraw Hill International Edition, USA.

8. Cappuccino JG & Sherman N (2005).Microbiology –A Laboratory Manual Pearson Education Inc

**Practicals**

1. Preparation of culture media: Nutrient agar, Potato dextrose agar, Czapek-Dox agar.

2. Study of different isolation techniques

(a) Pour plate. (b) Spread plate. (c) Streak plate.

3. Staining techniques: -

 (a) Simple staining (b) Gram staining (c) Negative staining (d) Endospore staining. (e) Capsule staining

4. Standard plate count.

5. Antibiotic sensitivity test.

6. Biochemical tests for identification of bacteria- Indole production, Methyl red, Voges Prausker, Citrate utilization test, Carbohydrate fermentation test, Nitrate reduction test, Urease test.

**MB 102. MICROBIAL WORLD – II**

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| **Objectives:** To provide the basic knowledge such as structure, classification, nutrition and reproduction of microorganisms other than bacteria. The applications of each of the group of microbe will also be discussed in brief.**Outcomes:** Thestudent will be aware with importance of fungi, algae, viruses and protozoa.  |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Fungi- Classification of fungi. Kirk et al. system of classification. Modes of Reproduction in fungi. Fungi as saprotrophs & their role in decomposition in cellulose, hemicellulose, pectin and lignin. Types of mycosis, brief account of Dermatophytes, Chromomycosis, Cryptococcosis and Aspergillosis.

**Unit II**

Algae- Structure, nutrition and Reproduction in algae.Distribution and classification of algae. Economic importance of Algae as food, Source of agar-agar, alginate, diatomite and iodine etc, antibiotics from algae, use in fisheries and malaria control.

**Unit III**

Virus- Nomenclature, Classification and Properties of viruses, Morphology and Structure of viruses- Capsid and its symmetry with special reference to bacteriophage, Lytic and lysogenic cycle. Viriods and Prions. Primary cell, Diploid cell strains, Continuous cell lines. One step growth curve, Detection of virus growth in cell culture.

**Unit IV**

Protozoa-Morphology, reproduction, modes of nutrition, modes of transmission, locomotory organelles, encystment, excystment. Life cycle, pathogenic, mechanisms and control of parasitic infections viz. amoebiasis, toxoplasmosis, malaria, sleeping sickness. Giardiasis*.*

**Text and Reference Books:**

1. Barsanti L & Gualtieri P(2006). Algae: Anatomy, Biochemistry and Biotechnology, Taylor and Francis.

2. Arora DR & Arora B (2004). Medical Parasitology, 2nd ed., CBS Publishers,

New Delhi.

3. Madigan MT, Martinko JM, Stahl DA & Clark DP(2012). Brock Biology of Microorganisms, 13th ed., Benjamin Cummings.

4. Landracker EM (1996).Fundamentals of the Fungi, 4th ed., Benjamin Cummings.

5. Carter JB & Saunders VA (2007) Virology-Principles and Applications, John Wiley and Sons

6. Alexopoulos CJ Mims CW & Blackwell M (1996). Introductory Mycology.4th ed., John Wiley & Sons, USA.

7. Chatterjee KD (2007) Parasitology, 12th edition , Chatterjee Medical publishers India.

8. Atlas RM, Parks LC & Brown AL(1995). Laboratory Manual of Experimental Microbiology. Mosby-Year Book,Inc., Missouri.

9. Brown AE(2005). Benson’s microbiological applications. TataMacGrawHill

**Practicals**

1. Lactophenol Cotton blue staining of mold- Preparation and examination of slides.

2. Cellotape preparation and examination of a mold.

3. Isolation of soil mycoflora.

4. Measurement of conidia/spores of a mold.

5. Demonstaration of the common saprobic molds:

*(a) Aspergillus(b) Penicillium(c) Alternaria(d) Curvularia(e) Cladosporium (f) Rhizopus*

6. Isolation of algae from soil/water.

7. Enumeration of bacteriophage in a sample by plaque forming unit (PFU)

8. Isolation of free living protozoa from pond water.

9. Study of special features of parasitic protozoa: *Entamoeba histolytica, Giardia, Plasmodium,*

*Toxoplasma.*

**MB 103. MICROBIAL GENETICS-I**

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| **Objectives:** To provide students understanding of structure and functions of bacterial nucleic acid. **Outcome:** The students will be well versed with bacterial genetics and the related processes.  |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit - I**

Essential of genetics: A brief Overview of Microbial genetics. Beginning of experimental proof of DNA: Transforming principle contribution of Griffith, Macleod, Avery, McCarty, Hershey and Chase. RNA as a genetic material, DNA and RNA structure, different types of DNA. Denaturation and Renaturation Kinetics , Cot value, DNA polymerases , Proof reading activity , C- value paradox , Superhelicity in DNA, Linking No. , Topological Properties, Mechanism of action of Topoisomerases.

**Unit-II**

Maintenance of Structure of DNA. DNA damage and repair: Base excision, mismatch. SOS and Recombination repair. Mutation: Molecular basis of mutation, Base analogues, chemical mutagens, intercalating agent, radiation as mutagens, mutation rate, reversion and suppression, Ames test, significance and harmful effects of mutations. Transposable genetic elements, IS sequences, composite transposon, mechanism and significance of transposition.

**Unit-III**

Maintenance of Genetic Information. DNA replication: General principle, Initiation, Elongation and Termination. Semi-conservative replication, different modes of replication, Replication in retroviruses, Inhibitors of DNA replication, Relationship between cell cycle and Replication.

**Unit-IV**

Genetic recombination in Bacteria. Bacterial Conjugation: Sex Factor, Hfr factor, F +× F—cross, interrupted mating, mapping genes in bacteria.

Bacterial Transformation-The Discovery of transformation, competence, molecular mechanism of transformation, mapping by transformation. Bacterial Transduction- DNA transfer by Transduction, Specialized and generalized transduction. co- transduction and linkage , mapping by co-transduction.

**Text and Reference Books:**

1. Maloy SR, Cronan JE Jr. & Freifelder D(Reprint 2009). Microbial Genetics, 2nd ed., Narosa Publishing House

2. Snyder L & Champness W(2007). Molecular Genetics of Bacteria, 3rd ed., ASM Press

3. Gardner JE, Simmons MJ & Snustad DP(1991). Principles of Genetics. John Wiley & Sons

4. Nelson DL & Cox MM(2008).Lehninger’s Principles of Biochemistry 5th ed., W.H. Freeman and Company

5. Mahajan R, Sharma J & Mahajan RK(2010). Practical Manual of Biotechnology. Vayu Education of India,New Delhi.

**Practicals**

1. To perform antibiotics susceptibility test.

2. Isolation of antibiotic resistant bacterial population by gradient plate method.

3. Determination of Minimum Inhibitory concentration (MIC) of antibiotics.

4. Isolation of thermotolerant mutants of a bacterial/yeast culture by spread plating technique.

5. UV mutagenesis of a given bacterial culture.

6. To perform genetic recombination (conjugation) in bacteria (through teaching kit).

7. To perform genetic recombination (Transformation) in bacteria (through teaching kit)

**MB 104. MICROBIAL BIOCHEMISTRY**

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| **Objectives**: To impart brief knowledge about enzymology and macromolecules. Catalytic role of enzymes, their structure, physicochemical, kinetics.**Outcomes:** The students will have the understanding of enzymes and their kinetics, bioenergetics, macromolecules and their metabolism in brief.  |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit –I**

Enzyme Classification:-Specificity, active site, activity unit, isozymes. Enzyme kinetics. Mechaelis Menton equation for simple enzymes. Ribozyme and abzyme.

Determination of kinetic parameters. Multistep reactions and rate limiting steps, enzyme inhibition, allosterism. Principles of allosteric regulation.

**Unit-II**

Basic aspects of bioenergetics:- Entropy, enthalpy, e-carriers, e-donors, inhibitors, uncouplers, energy bond. Flow of energy through biosphere, strategy of energy production in the cells, oxidation –reduction reactions, coupled reactions, group transfer, ATP production , Free energy and spontaneity of reaction G, G0, G’ & equilibrium , basic concepts of acid , base, pH and buffers.

**Unit-III**

Structure and classification of macromolecules: - Proteins, carbohydrates, lipids and nucleic acids. Vitamins and their role as co-enzymes. Denovo and salvage pathways of synthesis of purine and pyrimidine.

**Unit-IV**

Cell metabolisms: - catabolic principles & breakdown of carbohydrates and anaplerotic reaction. β – oxidation of fatty acids. Deamination of amino acids and urea cycle.

Biosynthesis of lipids – fatty acids. Triacyl glycerol, phospholipids and regulation of fatty acid metabolism.

**Text and Reference Books:**

1. Nelson DL & Cox MM(2008). Lehninger’s Principles of Biochemistry 5th ed., WH Freeman & Company

2. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., WH Freeman & Company

3. Conn E.E. & Stumpf PK (1988) Outline of Biochemistry John Wiley & Sons.

4. Sawhney SK & Singh R(1996). Introductory Practical Biochemistry, Narosa Publishing House Pvt Ltd, New Delhi.

5. Mahajan R, Sharma J & Mahajan RK(2010). Practical Manual of Biotechnology. Vayu Education of India, New Delhi.

**Practicals**

1. Preparation of various buffers: phosphate buffer, sodium carbonate-bicarbonate buffer,

2. Estimation of protein in a given sample using Bradford method.

3. General test for carbohydrates-Molisch’s/Anthrone.

4. Test to distinguish between monosaccharides and reducing disaccharides- Barfoed’s.

5. Test for ketoses- seliwanoff’s.

6. Test for pentoses- Bial’s

7. Test for galactose- mucic acid

8. Test for glycerol-Acrolein

8. Chemical estimation of proteins by Lowry’s method.

9. Chemical estimation of sugars by DNS method.

10. Detection of reducing and non reducing sugars

**MB-105: PRACTICAL- 1 (Based on MB-101 & MB-102)**

**MB-106: PRACTICAL-2 (Based on MB-103 & MB-104)**

**SEMESTER II**

**MB: 201. BACTERIAL PHYSIOLOGY AND METABOLISM**

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| **Objectives:** To make the students aware with various structures of bacterial cell and their functions, growth and reproduction, cultivation, energy generation and metabolic pathways**Outcome:** After the completion of the course, the students will learn about bacterial cell and its structural components, carbohydrate metabolism, bacterial fermentations, ATP generation, cultivation of bacteria, measurement of bacterial growth, synthesis of cell components and various physiological features. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, and IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit-I**

Morphological types of prokaryotes. Structure & functions of cell wall of archaebacteria, gram positive & gram negative bacteria, cell membrane, capsule, flagella, pili, gas vesicles, carboxysomes, magnetosomes, nucleoid, bacterial endospore. Reserve food material- poly β-hydroxy butyrate, poly-phosphate granules, sulphur inclusions, cyanophycin granules. Peptidoglycan synthesis. Cell differentiation – sporulation and germination in Bacillus.

**Unit-II**

Bacterial growth and its measurement, growth curve, generation time. Batch, continuous, synchronous and diauxic growth. Modes of reproduction. Cultivation of microorganisms. Factors affecting growth-solutes, pH, temperature and oxygen. Transport of nutrients across the cell membrane- passive, facilitated, active transport and group translocation. Bioluminescence in bacteria.

**Unit-III**

Metabolites-primary, secondary and precursor. ATP generation, oxidative and substrate level phosphorylation, electron transport chain. Carbohydrate metabolism- Glycolysis, Entener Doudoroff pathway, Kreb cycle, glyoxalate pathway and gluconeogenesis.CO2 fixation and reverse TCA.

**Unit-IV**

Anoxygenic and oxygenic photosynthesis. Brief account of chemolithotrophy - Sulphur, iron and hydrogen oxidation, nitrification and methanogenesis. Fermentations- definition and types, homo & heterolactic fermentation, ethanol, acetate, mixed acid, butanediol, butanol, acetone, ethanoacetate fermentation. Pasteur effect.

**Text and Reference Books:**

1. Gottschalk G(1986). Bacterial Metabolism, Springer,

2. Caldwell DR(2002).Microbial Physiology and Metabolism, 2nd ed., Star

3. Moat AG, Foster JW & Spector MP(2002). Microbial Physiology,4th ed., John Wiley and Sons

4. Nelson DL & Cox MM(2008). Lehninger’s Principles of Biochemistry, 5th ed., WH Freeman & Company

5. Berg JR, Tymoczko CZ & Stryer L(2006). Biochemistry, 6th ed., W.H. Freeman and Company

6. Madigan MT, Martinko JM, Stahl DA & Clark DP (2012). Brock Biology of Microorganisms,

13th ed., Benjamin Cummings.

7. Prescott LM, harley JP & Klein DA(2005).Microbiology, McGraw Hill International Edition, USA.

8. Atlas RM, Parks LC & Brown AL (1995). Laboratory Manual of Experimental Microbiology. Mosby-Year Book,Inc., Missouri.

9. Cappuccino JG & Sherman N (2005). Microbiology-A Laboratory Manual, Pearson Education Inc

7. Willey JM, Sherwood LM & Woolverton CJ DA(2008). Prescott, Harley & Klein’s Microbiology, 7th ed., McGraw Hill International Edition, USA.

9. Brown AE (2005). Benson’s microbiological applications. TataMacGrawHill

**LIST OF PRACTICALS**

1. Determination of size of bacteria

2. Detection of motility of bacteria by hanging drop technique

3. Study of growth of bacteria

4. Detection of gelatin liquefaction

5. Detection of protease production

6. Detection of amylase production

7. Effect of pH on the growth of bacteria

8. Effect of temperature on the growth of bacteria

9. Effect of osmotic pressure on the growth of bacteria

10. Determination of thermal death time and thermal death point.

**MB 202: LAB TECHNIQUES IN MICROBIOLOGY**

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| **Objectives:** To impart practical knowledge about various techniques used in microbiology, biochemistry and molecular biology.**Outcome:** After the completing the course the students will be having the comprehensive knowledge of various types of microscopy used in microbiology, various type of blotting and ELISA. Also they will be well versed with different types of electrophoretic, chromatographic techniques and spectroscopic techniques. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

 **Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Principles and working of bright field microscope, fluorescent microscope, phase contrast microscope, electron microscope (SEM & TEM), dark field microscopy. confocal microscopy.

Flow cytometry- flurochromes, fluorescent probe and working principle.

**Unit II**

Principles of types of blotting, immunoblotting-Southern, Northern, Western and Dot blots.

Electroimmunodiffusion, Immunofluorescence, Radioimmunoassay, and Enzyme linked immunosorbent assay. DNA microarray techniques and its applications.

**Unit III**

 Polyacrylamide gel electrophoresis (PAGE), agarose gel electrophoresis, native PAGE, SDS-PAGE, 2D electrophoresis. Gel filtration, ion exchange & affinity chromatography, paper chromatography, Thin Layer Chromatography, HPLC, GC-basic concept.

**Unit IV**

Centrifugation, ultracentrifugation, and its application. Density gradient , sedimentation.

Spectroscopy – UV, IR, NMR. X-ray diffraction, circular dichromism for microbiologists.Methods of bacterial and enzyme immobilization, their advantages and applications.

**Text and Reference Books:**

1. Freifelder. Physical biochemistry, freeman company.

2. Wilson K & Walker J(2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th ed.,Cambridge University Press.

3. David Sheehan(2009). Physical Biochemistry: Principles and Applicatons, John Wiley & Sons Ltd, Chichester, England,

4. Upadhyay, upadhyay & Nath. Biophysical chemistry.

5. Sawhney SK & Singh R(1996). Introductory Practical Biochemistry, Narosa Publishing House Pvt Ltd, New Delhi.

6. Cappuccino JG & Sherman N(2005).Microbiology –A Laboratory Manual Pearson Education Inc

7. Skoog, Holler & Nieman. Principles of Instrumental Analysis.

8. Mahajan R, Sharma J & Mahajan RK(2010). Practical Manual of Biotechnology. Vayu Education of India

**LIST OF PRACTICALS**

1. Working of microscope.

2. Various types of Electroimmunodiffusion.

3. Isolation of proteins from bacterial culture by ammonium sulphate ppt. and NaCl extraction.

4. Demonstration of PAGE and SDS-PAGE.

5. To study principle and working of spectrophotometer.

6. Demonstration of thin layer chromatography.

7. Demonstration of paper chromatography.

**MB 203. MICROBIAL GENETICS-II**

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| **Objectives:** To make students learn regulation of gene expression which is the base of recombinant DNA technology.**Outcome:** After learning this course, students will be well aware of:1. How flow of genetic information takes place from gene to protein, i.e., central dogma.2. How this basic information can be exploited for genetic engineering, molecular biology, recombinant DNA technology for the benefit of mankind. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit-I**

Transcription : General principle . Basic apparatus , Initiation , Elongation and termination , Types of RNA polymerases , Monocistronic and polycistronic RNA, Regulation at initiation , Alternate sigma factor , rho dependent and independent termination , hairpin and attenuation.

**Unit -II**

Maturation and processing of RNA: Methylation, Poly A tail, Capping, Cutting and degradation of tRNA, Splicing mechanism.

Basic feature of genetic code: Triplet code, Deciphering of genetic code, Degeneracy, Characteristics of genetic code, Variation in different organism, Wobble hypothesis.

**Unit-III**

Translation : Central dogma, Basic apparatus, initiation, elongation, termination, coupled transcription and translation , aminoacyl site , peptidyl site, initiation elongation termination factors, aminoacyl tRNA synthetases, leader sequences, in vitro translation system. RNAi. Post translational modifications.

**Unit-IV**

Regulation of gene expression: Constitutive and inducible genes, Operon concept, catabolite repression, Positive and negative regulation, lac , trp . ara operon, stringent response , ppGpp, cAMP as regulatory molecules.

**Text and Reference Books:**

1. Maloy SR, Cronan JE &Freifelder D(2009). Microbial Genetics, Jones& Bartlett publishers.

2. Dale JW(2001). Microbial Genetics of bacteria, Jones& Bartlett publishers.

3. Lewin B(2008). gene XI , Oxford University press.

4. Freifelder D (2008). Molecular Biology Jones and Bartlett Publishers USA

5. Lodish et al (2007). Molecular Cell Biology W.H freeman.

**LIST OF PRACTICALS**

1. Demonstration of picking and patching colonies.

2. To perform Replica plating technique for transfer of bacterial cultures.

3. Isolation of Plasmid DNA by using alkaline lysis (miniprep through teaching kit).

4. Transformation of bacteria with plasmid DNA using CaCl2.

5. Preparation of genomic DNA from bacteria (CTAB method).

6. Demonstration of agarose gel electrophoresis.

7. To estimate the concentration and purity of DNA and RNA by spectrophotometric method

8. Colorimetric estimation of DNA.

9. Colorimetric estimation of RNA.

**MB 204: AGRICULTURAL MICROBIOLOGY**

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| **Objective:** Objective of this course is to teach students regarding basics of microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities**Outcome:** The students will be taught the role of various bio-geochemical cycles in the environment. Basic biochemistry involved in the process of nitrogen fixation along with other interactions. Also the students will be aware of various microbial diseases of plants and the role of bio control agents along with their classification and mechanisms. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Role of microbes in biogeochemical cycles- Carbon cycle, Nitrogen cycle, Sulphur cycle, phosphorous cycle. Factors affecting the movement of microorganisms in soil- Adsorption to soil particles, soil physical properties, plant roots, soil animals and human beings.

**Unit II**

Ecophysiological interactions in microbes & higher plants- Interaction with plant parts with specific examples of mycorhhiza, lichens, rhizobacteria.

Microbial diseases of pants: Fungus: *Phytophthora, Puccinia, Venturia, Colletotrichum*.

Transmission of plant viruses: mechanical, vegetative, graft, etc. Effects of viruses on plants: external and internal symptoms.

**Unit III**

Nitrogen fixation- Biochemistry of N2fixation, properties of terrestrial nitrogen fixing organisms, free living diazotrophs. Symbiotic nitrogen fixation: Rhizobium-Legume association, Actinorhizal associations, contribution of symbiotic nitrogen fixation. Denitrification.

**Unit IV**

Biocontrol – Concept, types, mode of action & applications of biopesticides and bioherbicides, Biopesticides- classification, advantages. Major biopesticides based on bacteria, viruses & fungi (*Bacillus thuringiensis* (Bt) toxin, Boverin, DeVine, Collego). Microbial degradation of polymers: lignin, cellulose, hemicelluloses. Factors affecting the degradation of organic matter.

**Text and Reference Books:**

1. Paul EA. (2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.

2. Varnam AH & Evans MG (2000). Environmental Microbiology, Manson Publishing Ltd.

3. Christon J.Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills (2007).Manual of Environmental Microbiology, ASM Press

4. Spencer JFT, Alicia L & Ragout de Spencer (2004).Environmental Microbiology: Methods and Protocols. Springer,

5. Paul EA. (2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.

6. Burlage R.S., Atlas R., Stahl D., Geesey G. & Sayler G. (1998) Techniques in Microbial Ecology. Oxford University press, Inc.

**LIST OF PRACTICALS**

1. To demonstrate the liberation of ammonia from nitrogenous organic compound (ammonification).

2. To demonstrate the reduction of nitrates to nitrogen gas (denitrification).

3. Isolation of rhizosphere and nonrhizosphere microflora.

4. Isolation of cellulose degrading microorganisms from soil.

5. Identification of pathogenic fungi:

*(a) Puccinia (b) Colletotrichum (c)Phytophthora*

6. Isolation of *Rhizobium* from root nodules.

7. Isolation of antibiotic producing bacteria from soil.

**MB-205: SEMINAR Marks 25**

**MB-206: GENERAL MICROBIOLOGY (Open Elective)**

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| **Objective:** The course is about the development and basic techniques used in the microbiology. The students will be covering the various physiological characteristics and classification of bacteria.**Outcome:** The students will be having the knowledge about various types of microscopy. Various methods of staining and groups of bacteria. Also they students will study about the various methods of cultivation and preservation of bacteria. |

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

 **Max.Marks:50(Ext. 40+ Int. 10)**

 **Time: 3 hrs**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, four questions from each unit (I& II) should be set.**

**● Candidates will be required to attempt five questions in all, selecting at least two questions from each unit (I & II) and the compulsory question 1.**

**● Each question will carry 8 marks.**

**Unit I**

History, development, scope and applications of Microbiology. General methods of sterilization. Introduction to Microscopy: bright field microscopy, dark field microscopy, phase contrast microscopy, electron microscopy. Various methods of staining of bacteria (simple, negative and Gram) and fungus (mold and yeast). Whittaker system of classification.Brief introduction to Bergey’s manual and groups of bacteria (gram positive and negative, spirochetes, endosporulating bacteria, actinomycetes, archaea, mycoplasma)

**Unit II**

Morphology & fine structure of bacterial cell wall, cell membrane, flagella and capsules. Formation of spores. Bacterial growth curve and measurement. Nutritional requirements and nutritional types of bacteria. Pure culture techniques –pour plate, spread plate, streak plate and serial dilution agar plate method. Advantages and disadvantages of various techniques. Preservation of microbial culture-serial subculture, at very low temperature, overlaying culture with mineral oil, lyophilization or freeze drying, in liquid nitrogen.

**Text and Reference Books:**

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR(2003). General Microbiology, MacMillan.

2.Pelczar MJ, Chan ECS & Krieg NR(1986). Microbiology, 5th ed. Tata McGraw Hill.

3. Tortora GJ, Funke BR & Case CL(2010). Microbiology: An introduction with Mastering Microbiology,10th ed. Benjamin Cummings.

4. Madigan MT, Martinko JM, Stahl DA & Clark DP(2012). Brock Biology of Microorganisms, 13th ed., Benjamin Cummings

5.Willey JM, Sherwood LM & Woolverton CJ DA(2008). Prescott, Harley and Klein’s Microbiology, 7th ed., McGraw Hill International Edition, USA.

**MB-207: PRACTICAL-3 (Based on MB 201 and MB 202)**

**MB-208: PRACTICAL-4 (Based on MB 203 and MB 204)**

**SEMESTER III**

**MB 301. FOOD & DAIRY MICROBIOLOGY**

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| **Objective:** To impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration. **Outcomes:** To familiarize the students with food microbiology including fermented food, dairy, food preservation, spoilage and detection of food borne diseases, their control measures. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors (Nutrient contents, pH, moisture contents/water activity, antimicrobial barriers, Antimicrobial substances), Extrinsic factors (relative humidity, temperature, gaseous atmosphere).

Composition of milk, sources of microorganisms in milk and their control. Number and type of microorganisms present in milk. Microbiological examination of milk and milk products. Legal standards for milk and milk products, grading of milk and certified milk, microbiology of lactic cultures, dairy products manufactured.

**Unit II**

Microbial spoilage of foods: Microbiology of spoilage of specific foods – Bread, Cakes,

Fresh fruits and vegetables, Juices, Meat and meat products, Poultry, Eggs, Sea foods, Fish.

Food preservation (protection):Heat, Low temperature storage, Freezing, Dehydration and water availability, Lyophilization, Osmotic pressure, Filtration, Irradiation, Chemical preservatives.

**Unit III**

Food borne intoxication and infections-Major differences and examples of infective and toxic types, Botulism, Staphylococcal food poisoning, *Clostridium perfringens* food poisoning, *Bacillus cereus* gastroenteritis, Salmonellosis, *Escherichia coli* diarrhea and colitis, *Vibrio cholerae*. Fungal poisonings: *Aspergillus , Penicillium ,Claviceps ,Fusarium.*

**Unit IV**

Sauerkraut, pickles, bread, yogurt, silage, baker’s yeast production from microorganisms. Microbes as sources of single cell protein (SCP), advantages of SCP. Edible and poisonous mushrooms, production of Mushroom- Agaricus, volverella and Pluerotus.

**Text and Reference Books:**

1. Adams MR & Moss MO(1995). Food Microbiology, Royal Society of Chemistry Publication, Cambridge.

2. Frazier, WC & Westhoff, DC(1998). Food Microbiology. Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi.

3. Ray, Bibek(1996). Fundamental Food Microbiology, CRC Press.

4. Jay JM et al. (2005).Modern Food Microbiology. 7th ed., Springer Science.

5. Montville TJ, Matthews KR, Food Microbiology: An Introduction, 2nd ed., ASM Press (2008)

6. Robinson R K(2002). Dairy Microbiology Handbook, 3rd ed., John Wiley & Sons

**MB 302: MICROBIAL BIOTECHNOLOGY & INDUSTRIAL MICROBIOLOGY**

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| **Objective:** To familiarize students about microbial processes/systems/activities for the development of industrially important products/processes. **Outcomes:** Students will be aware about industrially important microorganisms and different aspects of microbial fermentation and production. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Isolation, Screening, Improvement and maintenance of industrial organisms, Fermenter design and instrumentation, immobilized cell reactor, solid state fermentation (SSF) , substrates for industrial fermentation.

**Unit II**

Fermentation System: Primary and secondary metabolites, batch, fed batch and continuous fermentation system, fermentation kinetics, chemostat, turbidostat, gas exchange and mass transfer.

**Unit III**

Downstream processing (DSP) and product recovery. Production of Biofertilizers, Biopesticides, Edible Mushroom, Single Cell Protein (SCP), steroid conversion and biotransformation.

**Unit IV**

Biotechnological applications of microbes in the commercial production of the following:

Alcoholic beverages: Beer, Whisky

Organic acids: Citric, lactic and acetic acid.

Microbial enzymes: amylases, proteases and lipases.

Antibiotics: penicillin, tetracycline

Amino acids: Glutamic acid, lysine.

**Text and Reference Books:**

1. Stanburry et al. (2011). Principle of fermentation technology Pergamon Press.

2. Reed G (2001). Industrial Microbiology CBS Publisher.

3. Cruger & Cruger, (2005), Microbial Biotechnology, Panima Press

4. Moo-Young M, Cooney CL & Humphery AE (1985). Comprehensive Biotechnology-The Principles, Applications & Regulations of Biotechnology in Industry, Agriculture & Medicine, Pergamon Press

5. Atlas RM, Park LC & Brown AL (1995).Laboratory Manual of Experimental Microbiology. Mosby-YearBook,Inc.,Missouri

**MB 303. MEDICAL MICROBIOLOGY**

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| **Objective:** To provide the knowledge about microbial diseases, their causative agents, virulence and control measures. Mechanism of disease. **Outcome:** The students will be having knowledge about disease transmissions, pathogenesis and diagnostics of bacterial and viral diseases. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Normal microflora of human body-skin, oral cavity, respiratory tract, gastrointestinal tract and urogenital tract. Significance of normal microflora. Gnotobiotic animals and their use. Sources of infection for man: exogenous infections – patient, carriers (healthy, convalescent, paradoxical, chronic), infected animals, soil and endogenous infections.

**Unit II**

Host-pathogen interaction- colonization, invasion, virulence, nosocomial infections, septicemia, septic shock, transmission and spread of infection. Pathogenic properties of bacteria. Virulence Factors, Non-specific antibacterial defence of host.

**Unit III**

Bacterial diseases (with reference to morphology, pathogenesis, epidemiology and lab diagnosis) caused by *Staphylococcus aureus, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponema pallidum*. Exotoxins and endotoxins. Mode of action of tetanus, botulinum, diphtheria and cholera toxins. Methods for measurement of virulence.

**Unit IV**

Viral diseases (with reference to morphology, pathogenesis, epidemiology and lab diagnosis) caused bysmall pox, influenza, Hepatitis, Rabies, AIDS. Cultivation of animal Viruses- Animal inoculation, Embryonated eggs and Cell culture. Cytopathic effect. Modes of transmission of viruses. Antiviral drugs: acyclovir, amantadine, AZT, idoxuridine, interferon.

**Text and Reference Books:**

1.Mims CA(2004). Medical Microbiology, 3rd ed, Mosby 2.Carter JB & Saunders VA (2007) Virology-Principles and Applications, John Wiley and Sons

3. Paniker CKJ(2007). Ananthanarayan and Paniker’s Textbook of Microbiology, Orient Longman Pvt. Limited, India.

4. Greenwood D, Slack RCB & Peutherer JF(2006). Medical Microbiology, A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis & Control, Churchill Livingstone, Elsevier, India.

5. Baron EJ, Peterson LR & Finegold SM Mosby (1990). Bailey and Scott’s Diagnostic Microbiology

6. Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E & Adelberg EA (2004). Jawetz M & Adelberg's Medical Microbiology, 23rd ed, Lange Publication.

7. Mackie & McCartney Practical Medical Microbiology (1996). Collee JG, Fraser AG, Marmion BP & Simmons A (eds.), Churchill Livingstone,Edinburgh.

8. Zuckerman AJ, Banatwala JE &Pattison JR(2009). Principles & Practice of Clinical Virology, John Wiley & sons Ltd.

9. Brown AE(2005). Benson’s microbiological applications, TataMacGrawHill

**MB 304A. CELLULAR MICROBIOLOGY & IMMUNOLOGY**

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| **Objective:** To familiarize the students with the cell biology at molecular level. To discuss the role of immune system in health and diseases. **Outcome:** The studentswill beaware withprokaryotic and eukaryotic interactions and signaling. Also various components of immune system and vaccines. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Introduction: - emergence of cellular microbiology, cellular biology underlying prokaryotic and eukaryotic interactions: ultra-structure, genome expression, pathogenicity island.

**Unit II**

Prokaryotic and eukaryotic signalling mechanisms: - eukaryotic cell to cell signalling, endocrine signalling, and cytokines prokaryotic signalling: quorum sensing and bacterial pheromones intracellular signalling, signalling pathways.

**Unit III**

Innate immunity, factors affecting innate immunity. Acquired immunity- natural and artificial immunity, active and passive immunity. Antigen, hapten and adjuvants.

Immunoglobulins-types, structure and functions.

**Unit IV**

Lymphoid organs and cells of immune system, cellular and humoral immune response. Brief account of Complement system and Major histocompatibility complex.

Immunology in health and disease- autoimmunity, immunodeficiencies hypersensitivity; concept of immunotherapy.

**Vaccines**- Prerequisites of a good vaccine, Types of vaccine- viral, bacterial, recombinant, DNA, subunit vaccines.

**Text and Reference Books:**

1. Henderson et al.(1999). Cellular Microbiology. Wiley.

2. De Bruijn et al.(1998). Bacterial Genomes. Chapman & Hall.

3. Goldsby, kindt & Osborne(2006). Kuby’s Immunology WH Freeman & co.

4. Tizard(1995). An Introduction to Immunology.Harcourt Brace College Publication

5. Delves PJ & Roitt IM(2006). Roitt's Essential Immunology, 11th ed., Wiley-Blackwell

6. Mackie & McCartney Practical Medical Microbiology (1996). Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A (eds.), Churchill Livingstone,Edinburgh.

7. Atlas RM, Park LC & Brown AL(1995).Laboratory Manual of Experimental Microbiology. Mosby-YearBook,Inc.,Missouri

8. Dorman CJ(1994).Genetics of Bacterial Virulence, Blackwell.

**MB 304B: FUNDAMENTALS OF BIOINFORMATICS**

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| **Objective:** To impart an introductory knowledge about the subject of Bioinformatics to the students. To explore the usage of various Open source software for Bioinformatics applications.**Outcome:** The students will be made aware about various tools of bioinformatics and phylogenetic analysis. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks.**

**Unit I**

Introduction, overview and needs of bioinformatics technology. Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

**Unit II**

Introduction to sequence alignment and its applications.

Pair wise sequence alignment: Concept of global and local alignment, Dot Plot, algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods), Introduction to BLAST, types of BLAST, algorithm of BLAST and interpretation of its result.

Substitution matrices: Introduction to substitution matrices: PAM and BLOSUM matrices, concept of log odd ratio.

**Unit III**

Multiple sequence alignment: Methods of multiple sequence alignment, Tools of MSA– ClustalW, TCoffee; Position specific scoring matrices, introduction to consensus sequences, motifs and profiles. Significance of alignments: E value, Scores

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes

Basic concepts of Genome, transcriptome, proteome.

**Unit IV**

Phylogenetic Analysis: Introduction to phylogenetic analysis and its application. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA,

Neighbour joining, Maximum Parsomony, Maximum likelihood.

Genome Annotation: Concept of genome annotation, methods of gene identification.

Tools of gene identification: GenScan, Grail, GeneID and Glimmer.

**Text and Reference Books:**

1. A. D. Baxevanis, B. F. F. Ouellette (2001). Bioinformatics: A practical guide to the analysis of genes and proteins (John Wiley and Sons).

2. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition

4. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

5. Attwood TK & Parry-Smith DJ. 2003. Introduction to Bioinformatics. Pearson Edu.

**MB-305: SEMINAR Marks 25**

**MB-306: APPLIED MICROBIOLOGY**

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| **Objective:** To impart the basic information about the applications of various microbes in various fields like soil, water, food and their control.**Outcome:** The students will be made aware with applied fields of microbiology. |

**Max.Marks:50(Ext. 40+ Int. 10)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, four questions from each unit (I, II) should be set.**

**● Candidates will be required to attempt five questions in all, selecting at least two question from each unit (I, II,) and the compulsory question 1.**

**● Each question will carry 8 marks.**

**Unit I**

Rhizosphere & Rhizoplane micro-organisms and its significance.

Biofertilizers and its examples. Nitrogen fixing bacteria: Symbiotic & non-symbiotic; Phosphorous solubilizing bacteria; plant growth promoting rhizobacteria; mycorrhiza.

Methods of determination Antimicrobial activity – well diffusion method and MIC

Modes of transmission of disease: air, water, soil, contact, animals.

Coliforms as the biological indicators of water safety and their assessment

**Unit II**

Ethanol fermentation by yeast: beer and wine

Food borne disease: Staphylococcal food poisoning, Salmonellosis

Food spoilage: spoilage of various food products meat, milk, canned food, fruit and vegetables

Control of microbes in food by physical methods: temperature, irradiation, filtration, osmotic pressure.

Microbes as food: SCP, mushroom,

Use of Genetically Engineered Micro-organisms (GEMs)

(a) Production of antibiotics: Penicillin

(b) Biopesticides: Bt toxin, Boverin, DeVine

(c) Control of pollution: degradation of xenobiotic compound

**Text and Reference Books:**

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR(2003). General Microbiology, MacMillan.

2. Tortora GJ, Funke BR & Case CL(2010). Microbiology: An introduction with Mastering Microbiology,10th ed. Benjamin Cummings.

3. Madigan MT, Martinko JM, Stahl DA & Clark DP(2012). Brock Biology of Microorganisms, 13th ed., Benjamin Cummings

4. Willey JM, Sherwood LM & Woolverton CJ DA(2008). Prescott, Harley and Klein’s Microbiology, 7th ed., McGraw Hill International Edition, USA.

**MB-307: PRACTICAL-5 (Based on MB-301 & MB-302)**

1. Isolation and Identification of microorganisms from spoiled foods.

(a) Bread (b) Fruits

(c) Meat (d) Cake

2. Enumeration of bacteria in milk and presumptive test for coliforms.

3. To study Litmus milk reactions.

4. To perform methylene blue reduction test of raw and pasteurized milk.

5. Isolation of Lactobacilli and Streptococci from curd.

6. Sauerkraut production in the lab.

7. Isolation of important bacteria involved in food spoilage *(Bacillus, Escherchia,*

*Staphylococcus).*

8. Identification of common molds involved in food spoilage *(Aspergillus, Penicillium,*

*Cladosporium, Fusarium, Rhizopus, Mucor).*

9. Isolation of amylase producing bacteria from soil

10 Preparation of standard curve of reducing sugars by DNS method

11. Quantitative estimation of amylolytic potential of isolated bacterial culture

12. Isolation of yeasts from natural environment

13. To perform an experiment to show the Ethanol fermentation by yeast.

14. Quantitative estimation of ethanol by distillation method

15. Demonstration of surface fermentation

16. Demonstration of submerged fermentation

17. Demonstration of solid state fermentation

18. Whole cell immobilization of bacterial cell using calcium alginate

**MB-308: PRACTICAL-6 (Based on MB-303 & MB-304)**

1. Detection of susceptibility to dental caries

2. Bacteriological examination of skin and throat.

3. Viable count of bacteria in urine sample.

4. Dnase agar tests and coagulation test for identification of Staphylococcus.

5. Study of identification tests for medically important Streptococcus.

6. Isolation of enteric pathogens from stool by direct plating method.

7. Determination of minimal inhibitory concentration (MIC) and MBC.

8. Cultivation and enumeration of coliphages from sewage.

9. General tests for identification of bacteria from clinical samples including

IMViC test, Carbohydrate fermentation test, Nitrate reduction test, Triple sugar agar test, Urease test, Catalase test, Oxidase test

10 To study chemotactic behavior of given culture of bacteria.

11. To perform mechanism of infection by bacterial invasion of the host cell.

12. Determination of total leucocytes count

13. Determination of differential leucocytes count

14. Determination of total erythrocytes count

15. Ouchterlony Double Immunodiffusion technique

16. Radial Immunodiffusion technique

17. Agglutination reactions

18. Haemagglutination reactions

**SEMESTER IV**

**MB 401. BIOSTATISTICS & COMPUTERS**

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| Objective: The objective of this course is to introduce the basic concepts of computing withintroduction to operating system. To understand the basic principles of statistics and mathematics and their applications in relation to Biological system. **Outcome:** The students will be made aware about software and hardware, they will also be exposed to various statistical methods to analyze their experimental data. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Introduction to computer: Classification of computers –computer generation-low , medium and high level languages .Software and hardware –operating systems , compilers and interpreters , mini , main frame and super computer , their characteristics and applications .BIT ,BYTE and WORD ,Computer memory and its types. Data representation and storage –binary codes, binary systems and its relationship to Boolean Operations.

**Unit II**

Microsoft excel: Data entry, graphs, aggregate functions- formulations and functions (students are expected to be familiar with all operations).Different numbers systems and conversions. Input output devices, secondary storage media. Internet: How internet works? Significance.

**Unit III**

Biostatistics: Statistics, its meaning and objectives .Population samples, frequency tables and their graphs, measures of central tendency (mean, mode, median) and their dispersion. Concepts of moments, Skewness and kurtosis. Intuitive definition of random variables, probability mass function and probability density function, expectation and variance .Standard distribution ; binomial , Poisson and normal distribution with their important properties and significance.

**Unit IV**

Fitting of main distributions and testing of goodness –of – the –fit with special reference to χ2- test, t –test, Z-test. Fitting of trends; linear and quadratic with least square method. Lines of regression, coefficient of correlation, coefficient of variation and their significance. Analysis of variance; one way and two way classification.

**Text and Reference Books:**

1. Rosne B(2005). Fundamentals of Biostatistics, Cengage Learning

2. Zar JH(2009). Biostatistical Analysis, Pearson Education 5th ed.

3. Campbell RC (1989).Statistics for Biologists, Cambridge university press.

4. Daniel WW (1995). Biostatistics: A Foundation for Analysis in Health Science, 6th ed., John Wiley

5. Snedecar GW & Cochram WG (1967). Statistical Methods, Oxford Press.

6. White Ron (2001) .How Computers Work? Techmedia.

**MB 402. RECOMBINANT DNA TECHNOLOGY**

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| **Objective:** To impart latest information on the molecular biochemistry of isolation, transfer and expression of genes in microbes and biochemical approaches employed in genetic technology.**Outcome:** the students will be made aware with various cloning techniques and DNA sequencing methods. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Core techniques and essential enzymes used in rDNA technology: -Restriction

digestion, ligation and transformation.

**Unit II**

Cloning vectors:-Plasmids, phages and cosmids, cloning strategies, cloning and

selection of individual genes ,gene libraries : c DNA and genomic libraries.

**Unit III**

Specialised cloning strategies:- Expression vectors, promoter probe vectors, vectors for

library construction- artificial chromosomes.

**Unit IV**

DNA sequencing methods:- Dideoxy and chemical method. Sequence assembly,

Automated sequencing, Genome sequencing, and physical mapping of genomes.

PCR- Methods and applications

**Text and Reference Books:**

1. Old & Primrose (1994). Principles of gene manipulation. Blackwell Scientific Publications.

2. Sambrook & Russel (2001). Molecular Cloning, 3rd volume. CSH Press.

3. Genome Analysis. 4th volume. (2000). CSH Press.

4. Lewin B(2004). Genes VIII, International Edition, Pearson Education

5. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, & Walter P(2008). Molecular Biology of the Cell, 5th ed., Garland Science Publishing

6. Fritsch J & Maniatis EF(1999). Molecular Cloning A laboratory Manual, Cold Spring Harbor Laboratory

**MB 403. ENVIRONMENTAL MICROBIOLOGY**

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| **Objective:** To teach and create awareness regarding role of microorganisms in environment. To apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.**Outcome:** The students will be made aware with water, soil, air microbiology and bioremediation. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Water microbiology**-** Significance, Major waterborne diseases and their preventive measures. Sewage treatment system (primary, secondary, tertiary and final). Disinfection of potable water supplies. Bacterial indicators of water safety and their assessment.

**Unit II**

Interactions between diverse microbial populations-Neutralism, Commensalisms, Mutualism, Synergism, Competition, Amensalism, Parasitism & Predation. Diversity of microorganisms in air and their significance, Microbial aeroallergens**.** Biosurfactants- definition, microbial origin, classification and properties. Biogas production-anarobic digestion- hydrolysis, acetogenesis and methanogenesis; microorganisms involved and feed stocks.

**Unit III**

Microbial biodegradation of petroleum products in terrestrial, aquatic environment. Problems related to SO4, reducing bacteria in petroleum industries and their metabolism, ecology and physiology. Treatment and disposal of petroleum refinery waste. Recovery of petroleum from oil bearing rocks

**Unit IV**

Microbial bioremediation- Bioremediation, biodegradation of major groups of environmental pollutants, mechanisms of metabolizing different classes of organic pollutants, prospects of microbial application to toxic waste treatment. Biodeterioration and Bioremediation. Biodegradation of xenobiotic compounds.

**Text and Reference Books:**

1. Mitchell RG & Ji-Dong(2010). Environmental Microbiology, 2nd ed, Wiley-Blackwell

2. Barton LL & Northup DE(2008). Microbial Ecology, John Wiley & Sons

3. Martin Alexander (1977). Soil Microbiology. John Wiley.

4. Paul EA(2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.

5. Campbell R (1983). Microbial Ecology. Blackwell.

6. Atlas RM & Bartha R (1993) Microbial Ecology, Benjamin Cummings Publishing Co, Redwood City, CA.

7. Mahajan R, Sharma J & Mahajan RK(2010). Practical Manual of Biotechnology. Vayu Education of India,New Delhi

8. Pepper I.L. & Gerba C. P. Environmental Microbiology: Laboratory manual. Elsevier Academic press.

9. Burlage R.S., Atlas R., Stahl D., Geesey G. & Sayler G. (1998) Techniques in Microbial Ecology. Oxford University press, Inc.

**MB 404A: BIO FERTILIZERS**

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| Objective: To familiarize the students and even farmers with mass scale production of different agriculturally important microorganisms which are being used as biofertilizers formaintaining the soil and plant health for sustaining crop productivity and their importancein organic farming.Outcome: The students will be made aware with different types of biofertilizers and production. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Soil as microenvironment, Distribution of soil microorganisms in soil and different zones of soil. Factors influencing the soil microflora-role of microorganisms in soil fertility. Interactions among microorganisms; Interactions between microbes and plants- rhizosphere organisms and phyllosphere. Introduction to biofertilizers- definition, types of biofertilizers; Characterstic features of the following biofertilizer organisms: *Azospirillium*, *Azotobacter*, *Bacillus, Pseudomonas, Rhizobium*, *Frankia, Anabaena* and *Nostoc*

**Unit II**

Plant nutrients- Essential plant nutrients, Criteria of essentiality, Forms of nutrients in soil, Functions, deficiency symptoms. Soil fertility, Role of microorganisms in soil fertility, Microbial successions, Biological control, Biopesticides an overview, Composting, vermicomposting

**Unit III**

Biofertilization process- soil organic matter, decomposition of soil organic matter, C:N ratio. humus formation, Microbial transformation of Nitrogen, Phosphorus and Sulfur in soil, Phosphate solubilization and mobilization. Biological Nitrogen fixation-symbiotic and asymbiotic

**Unit IV**

Mycorrhizae- Ecto and endomycorrhizae and their importance in agriculture. Organic manures: Preparation, properties, and use in crop production, nutrient enriched compost, green manure; Plant growth promoting rhizobacteria, BGA- Application methods of biofertilizers-significance of biofertilizers.

**Text and Reference Books:**

1. Paul EA. (2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.
2. Gaur A.C. (2006) Handbook of organic farming and biofertilizer, Ambika book agency, Jaipur
3. Alexander M. (1977). Soil Microbiology. John Wiley
4. Kosuge T and Nester EW. (1989). Plant-Microbe Interactions: Molecular and Genetic perspectives.vols I-IV, McGraw Hill
5. Pradhan S. (2007). Soil health improvement by biofertilizer,biotech book,Ansari road New Delhi
6. Pand H. and Hota D. (2007). Biofertilizer and organic farming, Gene tech book Ansari road New Delhi
7. Sharma A.K. (2009) Biofertilizer for sustainable agriculture, Agrobios, Jaipur

**MB 404B: INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP**

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| Objective: To learn the IPR issues in Biological sciences with special emphasis on microorganisms.**Outcome:** The students will have the knowledge about biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products. |

**Max.Marks:100 (Ext. 80+ Int. 20)**

**Time: 3 hrs**

**INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES**

**● Nine questions of equal marks should be set.**

**● Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.**

**● Eight questions, two questions from each unit (I, II, III, IV) should be set.**

**● Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.**

**● All questions will carry equal marks**

**Unit I**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

**Unit II**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

**Unit III**

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

**Unit IV**

Entrepreneurship: Selection of a product, line design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc**.**

**Text and Reference Books:**

1. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Implications, Springer India.

2. Singh I. and Kaur B, Patent law and Entrepreneurship, Kalyani Publishers (2006).

3. Desai V, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).

4. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

**MB- 405: PRACTICAL-7 (Based on MB-402; MB-403 and MB-404)**

1. To isolate plasmid DNA from a given culture

2. To prepare agrose gel and to run the plasmid DNA samples

3. Isolation of chromosomal DNA

4. Plant DNA extraction by Phenol: Chlorophorm method

5. Estimation of proteins in given samples by Lowry method.

6. To carry out the extraction of proteins from given culture.

7. To develop competent cells of *E.coli*

8. To carry out the transformation by competent *E. coli* cells.

9. Extraction of DNA from Onion.

10. To test the given sample for purity of DNA content1. Detection of coliforms in water by multiple tubes fermentation test (Presumptive, confirmed, completed test).

11. Enumeration of water microflora by SPC.

12. To determine the quality of water sample using membrane filter method.

13. To study the phosphate solublization by bacteria.

14. Study of various PGPR traits of bacteria.

15. Isolation of soil microflora (bacteria and fungi) by serial dilution agar plate method

16 Study of indoor and outdoor microflora by petriplate exposure technique.

17. To study the antagonism among microorganism.

18. Isolation of *Pseudomonas* and *Trichoderma* from soil*.*

**MB- 406: PROJECT TRAINING REPORT & VIVA Marks 100**