**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 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 with introduction 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**

Soil Microbiology –positive & negative interactions, Interactions between diverse microbial populations-Neutralism, Commensalisms, Mutualism, Synergism, Competition, Amensalism, Parasitism & Predation. Diversity of microorganisms in air and their significance, Determination of the microbial content of the air. Microbial aeroallergens**.**

Bio synthesis of surface active agent and methane production.

**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 for maintaining the soil and plant health for sustaining crop productivity and their importance in 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**