**IIMT UNIVERSITY, MEERUT**

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**EVALUATION SCHEME & SYLLABUS**

**FOR**

**MASTER OF SCIENCE IN MICROBIOLOGY**

On Choice Based Credit System

(Effective from the Session: 2019-20)

**IIMT UNIVERSITY.MEERUT**

**STUDY & EVALUATION SCHEME**

**M.Sc. MICROBIOLOGY, I YEAR (FIRST SEMESTER)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No.** | **Course Type** | **Course Code** | **Subjects**  | **Credit**  | **Study Scheme** | **Evaluation Scheme** |  |
|  | **InternalExam** | **External Exam** | **Total** |
|  | **L** | **T** | **P** |  |  |  |
| 1. | C-1 Theory | MMBC-111 | Fundamentals of Microbiology & Bacteriology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 2 | C-2 Theory | MMBC-112 | Mycology and Phycology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 3 | C-3 Theory | MMBC-113 | Biochemistry and Instrumentation | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 4 | DSE-1 Theory | MMBDS-114 | Immunology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| MMBDS-114a | Biosafety & IPR |
| 5 | USEC | NECC-111 | Industrial Visit/ Seminar/ Presentation on the report of Visit | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 6 | USEC | NECC-112 | University Social Responsibility | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 7 | USEC | NECC-113 | Spoken Tutorial Certification | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
| 8 | USEC | NECC-114 | MOOCs/ SWAYAM | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
| 9 | Lab | MMB-001P | **LAB-I** | **4** | **0** | **0** | **4** | **40** | **60** | **100** |
|  |  | **Total** |  | **22** | **18** | **0** | **4** | **210** | **340** | **550** |
|  |  |
| 10 | USEC | SPT-111 | Sports | 0 | 0 | 0 | 0 | 0 | 50 | 0 |

**NOTE: Project Work, Assignment and Seminar is Compulsory**

**L= Lecture**

**T= Tutorial**

**P= Practical**

**M.Sc. MICROBIOLOGY**

**SEMESTER- I**

**MMBC- 111: FUNDAMENTALS OF MICROBIOLOGY AND BACTERIOLOGY**

**Unit I: Emergence of Microbiology as a Discipline:-** Acharya Shushrut, Jivak, Joseph Lister, Golden age of microbiology, contributions ofRogar Bacon, Salvino D. Armati, GalilioGalilei, Nicholas Appert, Joseph Lister, Louis Pasteur, Robert Koch, E. Jenner, Ivanovski, Beijerinck, Albert J. Kluyver, Antonie Von Leeuwenhoek,MartinusBeijerinck, Mile stones or landmarks in Microbiology. Spontaneous generation controversy; Current thoughts on microbial evolution including the origin of life.

**Unit II: Taxonomy and classification:** Haeckel’s, Whittaker’s, Carl Woese and Cavalier Smith’s concepts of classification; Modern trends in the classification of microbial world including 16S rDNA sequencing, Numerical and molecular taxonomy; Introduction to the Bergey’sManual of Determinative Bacteriology, General characters and classification of Archae;

**UNIT III: Morphology and fine structure of Bacteria:** Morphological types –Size, shape and arrangements; Gram negative, Gram positive, L forms, cell wall, synthesis of peptidoglycan, antigenic properties.

**UNIT IV:** C**ell Appendages and cytoplasmic inclusions**- Capsule, composition and function; flagella, fimbrae, pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes, phycobillisomes, plasmids (types of plasmids); endospores and exospores, heterocyst, polyhydroxybutyrate (PHB), polyphosphate granules.

**UNIT V: Cultivation of Bacteria**: Aerobic, anaerobic, shaker, still cultures, nutritional types, fastidious chemoheterotrophs, laboratory media for cultivation of microorganisms, generation time, asynchronous, synchronous, batch and continuous culture; measurement of growth and factors favouring growth, control of microbial growth (physical, chemical and antibiotic); maintenance and preservation of bacterial cultures.

**PRACTICALS:**

1. Microbiology Good Laboratory Practices and Biosafety.

2. To study the principle and applications of important instruments (biological safety cabinets,

autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the

microbiology laboratory.

3. Preparation of culture media for bacterial cultivation.

4. Sterilization of medium using Autoclave and assessment for sterility

5. Sterilization of glassware using Hot Air Oven and assessment for sterility

6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility

7. Demonstration of the presence of microflora in the environment by exposing nutrient agar

plates to air.

8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts

9. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary Mounts

10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*,

*Entamoeba*, *Paramecium* and *Plasmodium*

**SUGGESTED READING**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition*.* Pearson Education.

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott’s Microbiology. 9th Edition. McGraw Hill International.

5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw, Hill Book Company.

7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

**MMBC-112: MYCOLOGY AND PHYCOLOGY**

**Unit I**

**An Introduction to mycology.** Scope and significance of mycology. Major contributions of P.A.Micheli, Anton de Bary, E.J.Butler, G.C.Ainsworth, K.S.Thind, S.B. Saksena, C.V.Subramanian. Diagnostic features, somatic structure, mode of asexual and sexual reproduction in fungi.

**Classification of fungi.** Criteria used in classification with reference to Ainsworth, Alexopoulos & Mims and Kirk *et al*. system of classification.

**Unit II**

**Reproduction in fungi.** Heterothallism, Heterokaryosis, parasexual cycle, dimorphism in fungi.

**Diagnostic features of major fungal divisions** - Zygomycota, Ascomycota, Basidiomycota,Deuteromycota & Oomycota.

**Unit III**

**Life cycles of industrially and medically important molds and yeasts.** *Rhizopus, Aspergillus, PenicilliumCladosporium, Trichoderma, Microsporum, Epidermophyton, , Saccharomyces, Candida.*

**Life cycles of important plant pathogens.** *Phytophthora, Puccinia, Alternaria, Colletotrichum*.

**Unit IV**

**Fungal biotechnology:** Industrial applications of fungi, Fungal fermentation system, Alcholic beverages (Beer, wine), bread and fermented foods; mushrooms as food; major antibiotics from molds (industrial production of penicillin), fungi as biocontrol agents of plant pathogens.

**Unit V**

**Algae:** Distribution and classification of algae, Somatic structure,Algal nutrition, algal thallus, algal ecology and biotechnology. Asexual and sexual reproduction of microbiologically important taxa of Chlorophyceae,Phaeophyceae, Bacillariophyceaeand Rhodophyceae

**Text and Reference Books:**

1. Aneja, K.R. &Mehrotra, R.S. (2011).Fungal Diversity & Biotechnology. New Age

International Publishers, New Delhi.

1. Alexopoulos, C. J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology.4th

edition John Wiley & Sons, USA.

1. Mehrotra, R.S. and Aneja, K.R. (2010).Introduction to Mycology.Wiley Eastern Ltd.

New Delhi.

1. Moore –Landcker , E.(1996).Fundamentals of the Fungi. Prentice Hall.

**List of Experiments**

1. Preparation and examination of Lactophenol Cotton blue of a mold.

2. Preparation and examination of Cellotape preparation of a mold.

3. Calibration of an ocular micometer.

4. Measurement of conidia/spores of a mold.

5. Isolation of soil mycoflora.

6. Enumeration of fungal aerospora.

7. Identification of yeast- *Saccharomyces cerevisiae*and *Candida albicans.*

8. Identification of the common saprobic molds:

*(a) Aspergillus*

*(b) Penicillium*

*(c) Alternaria*

*(d) Curvularia*

*(e) Cladosporium*

*(f) Rhizopus*

9. Identification of pathogenic fungi

(a) *Puccinia*

(b) *Colletotrichum*

(c) *Phytophthora*

10. Examination of *Agaricus, Ganoderma*and *Morchella*

11. Preparation of wine in the lab.

**MMBC-113: BIOCHEMISTRY AND INSTRUMENTATION**

**Unit-I** Introduction to Biochemistry, Stabilizing forces in biomolecules, Hydrogen bonds, hydrophobic interactions, Van-der Waal’s forces, Principle of thermodynamics, pH and buffers, Transport mechanism: Active and Passive transport.

Amino acid structure, Structure of macromolecules (Carbohydrates, Proteins: primary, secondary, tertiary and quaternary structure, Ramchandran’s plot, Lipids, Nucleic acids)

**Unit II** Enzymes (classification, nature and activity), Factors affecting enzyme activity, Enzyme kinetics, MichaelisMenten Equation, EadieHofstee plot, Hanes-Woolf plot, Enzyme inhibition (Competitive, non-competitive and uncompetitive inhibition) and activation of enzymes, Vitamins and coenzymes, Immobilized enzymes and their uses.

Glycolysis, pentose phosphate and its regulation gluconeogenesis and its regulation. Citric acid cycle & its regulation, conversion of ammonia into urea, electron transport and oxidative phosphorylation, energy field by oxidative-phosphate. Gluconeogenesis, fatty acid oxidation, biosynthesis of fatty acids, triaglycerol and cholesterol, Integration of Metabolism.

**Unit III** Introduction to metabolite purification, Filtration (Microfiltration, Ultrafiltration, Nanofiltration), Dead end and tangential mode of filtration, Darcy’s law, Centrifugation, fixed angle and swing bucket centrifugation, Ultracentrifugation, Differential Centrifugation, Chromatography, types, Paper chromatography, Thin Layer Chromatography, column chromatography, affinity chromatography, gel filtration, ion exchange chromatography, HPLC, gas chromatography, ,Electrophoresis- SDS, immunoelectrophoresis, SDS-PAGE.

**Unit-IV** Microscopy- types and role in biotechnology, compound microscope, and phase contrast microscope, fluorescence microscopy, SEM, TEM, CT- scan, digital microscopy and its role in biotechnology, Spectrophotometry, Lambert Beers law, Autoradiography, NMR, mass spectrometry, radioisotope technique, X-ray crystallography.

**Unit-V** Cytochemistry- principles and application, quantitative chemistry, Molecular diagnostic techniques, PCR, modifications in PCR, real-time PCR, southern, northern, western blotting.

**Practicals:**

1. Separation and identification of amino acids by paper chromatography.
2. Microscopy- fundamental knowledge of Light and Electron microscope.
3. Determination of MIC of given antibiotics using bacteria and Vitamin assay.
4. Quantification of reducing sugars by anthrone method
5. Separation and identification of sugars/lipids by TLC.
6. Quantification of Proteins by Lowry’s method
7. Assay of microbial amylase.
8. Precipitation of Proteins using Ammonium Sulphate,
9. Native gel Electrophoresis and Zymogram
10. SDS-PAGE of Amylase
11. Effect of pH and Temperature on enzyme activity.
12. Enzyme kinetics

**Suggested readings:**

1. Nelson D.L. and Cox M., Lehninger Principles of Biochemistry (2017), Seventh edition, Macmillan Learning, USA
2. Berg J.M., Stryer L., Tymoczko J.L., Gatto G. J., Biochemistry, (2015) Eighth edition, Macmillan Learning, USA
3. Upadhay A., Biophysical Chemistry (2009), Himalaya Publishing House, India
4. Wilson K. and Walker J., Principle and techniques of Biochemistry and Molecular Biology (2010), Cambridge University Press, UK.
5. Voet D., Voet J., Pratt C.W., Fundamentals of Biochemistry: Life at the molecular level, (2016) Fifth Edition, Wiley Publishers, USA

**MMBDS-114: IMMUNOLOGY**

**Unit-I:** Introduction to the immune system: Innate and acquired immunity. Cells involved in immune responses: Lymphoid progenitor, myeloid progenitor cell. Organs involved in the adoptive immune response: primary lymphoid organ and secondary lymphoid organ.

**Unit-II:**  Nature of antigen and antibody: Immunogenicity vs antigenicity, factors influencing immunogenicity, epitopes, haptens, adjuvants and mitogens. Immunoglobulins: structure & types of immunoglobulins, genetic diversity of immunoglobulins, isotypic, allotypic and ideotypic variants.

**Unit-III:** Generation of Diversity in Immune system: B-cell maturation and activation, T-cells maturation and activation. Major histocompatibility complex (MHC) genes and products: Polymorphism of MHC genes, role of MHC antigens in immune responses, antigen processing and presentation.

**Unit-IV:** Complement: Classical alternative and lectin pathway of complement activation, regulation of complement system, biological consequence of complement activation. Cytokines: interferons (α, β & γ), TNF, interleukins (1-16), hematopoietins&chemokines. Vaccines immunizations: types of vaccines and their characteristics.

**Unit-V:** Immune tolerance, hypersensitivity, Autoimmunity, transplantation, immunodeficiency diseases, monoclonal antibody and Hybridoma technology, Antigen-Antibody reactions in vitro: agglutination reactions precipitation reactions (Immunodiffusion, Immunoelectrophorectic method), Immunoblotting, ELISA, RIA, fluorescence immunosorbent assay, immuno-electronmicroscopy.

 **Practicals:**

1. To perform Radial Immunodiffusion (RID) by Mancini’s technique.

2. To perform Double Immunodiffusion (DID) by using Ouchterlony method.

3. To perform the Quantitative precipitation assay-test.

4. To perform hemagglutination assay for ABO blood group typing determination of and Rh factor.

5. To learn the technique of rocket Immuno-electrophoresis.

6. To perform Immuno-electrophoresis of given sample.

7. To determine the concentration of antigen by sandwich ELISA method.

8. To determine Total Leukocytes Count (TLC) of the given sample.

9. To determine Differential Leukocytes Count (DLC) of the given sample.

10. Isolation of lymphocytes from peripheral blood by ficoll method and check the viability of isolated lymphocytes.

11. Amplification of Interleukin-28b gene using Polymerase Chain Reaction assay.

12. Lysis of red blood cells (hypotonic lysis with H2O and ammonium chloride).

**Suggested Readings:**

1. Janeway’sImmunobiology by Kenneth Murphy. Garland Publishing, 9th Edition (March, 2016)
2. How the Immune System Works by Lauren M. Sompayrac Publication: Wiley-Blackwell; 5th Edition (September 2015)
3. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby. Publisher: W. H. Freeman; 6th edition edition (October 2006)
4. Immunology: A Short Course by [Richard Coico](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Richard+Coico%22), [Geoffrey Sunshine](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Geoffrey+Sunshine%22) Publication: John Wiley & Sons, (Jan-2015)
5. Textbook of Immunology by [Arvind Kumar](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Arvind+Kumar%22) Publication: The Energy and Resources Institute (TERI), 01-Jan-2013 Chang, J.H., Jiang, Y., Pillarisetty, V.G., 2016. Role of immune cells in pancreatic cancer from bench to clinical application: An updated review. Medicine 95(49), e5541.
6. Liu, J., Cao, X., 2015. Regulatory dendritic cells in autoimmunity: A comprehensive review. Journal of Autoimmunity 63, 1-12.
7. Ng, S., Galipeau, J., 2015. Concise review: engineering the fusion of cytokines for the modulation of immune cellular responses in cancer and autoimmune disorders. Stem Cells Transl Med 4(1), 66-73.
8. Spagnolo, P., Rossi, G., Cavazza, A., Bonifazi, M., Paladini, I., Bonella, F., Sverzellati, N., Costabel, U., 2015. Hypersensitivity Pneumonitis: A Comprehensive Review. J InvestigAllergolClinImmunol 25(4), 237-250; quiz follow 250.
9. Stenken, J.A., Poschenrieder, A.J., 2015. Bioanalytical chemistry of cytokines--a review. AnalyticaChimicaActa 853, 95-115.
10. Varzaneh, F.N., Keller, B., Unger, S., Aghamohammadi, A., Warnatz, K., Rezaei, N., 2014. Cytokines in common variable immunodeficiency as signs of immune dysregulation and potential therapeutic targets - a review of the current knowledge. J ClinImmunol 34(5), 524-543.
11. Verbik, D., Joshi, S., 1995. Immune cells and cytokines - their role in cancer-immunotherapy (review). Int J Oncol 7(2), 205-223.
12. Weber, R.L., Iacono, V.J., 1997. The cytokines: a review of interleukins. Periodontal ClinInvestig 19(1), 17-22.
13. Yang, C.A., Chiang, B.L., 2015. Inflammasomes and human autoimmunity: A comprehensive review. Journal of Autoimmunity 61, 1-8.

**IIMT UNIVERSITY.MEERUT**

**STUDY & EVALUATION SCHEME**

**M.Sc. MICROBIOLOGY, I YEAR (SECOND SEMESTER)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No.** | **Course Type** | **Course Code** | **Subjects**  | **Credit**  | **Study Scheme** | **Evaluation Scheme** |  |
|  | **InternalExam** | **External Exam** | **Total** |
|  | **L** | **T** | **P** |  |  |  |
| 1. | C-4 Theory | MMBC-121 | Molecular Biology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 2 | C-5 Theory | MMBC-122 | Virology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 3 | C-6 Theory | MMBC-123 | Food Microbiology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 4 | DSE-2 Theory | MMBDS-124 | Environmental Microbiology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| MMBDS-124a | Microbes in Sustainable Agriculture and Development |
| 5 | USEC | NECC-111 | Industrial Visit/ Seminar/ Presentation on the report of Visit | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 6 | USEC | NECC-112 | University Social Responsibility | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 7 | USEC | NECC-113 | Spoken Tutorial Certification | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
| 8 | USEC | NECC-114 | MOOCs/ SWAYAM | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
| 9 | Lab | MMB-002P | **LAB-I** | **4** | **0** | **0** | **4** | **40** | **60** | **100** |
|  |  | **Total** |  | **22** | **18** | **0** | **4** | **210** | **340** | **550** |
|  |  |
| 10 | USEC | SPT-121 | Sports | 0 | 0 | 0 | 0 | 0 | 50 | 0 |

**NOTE: Project Work, Assignment and Seminar is Compulsory**

**L= Lecture**

**T= Tutorial**

**P= Practical**

**M.Sc. MICROBIOLOGY**

**SECOND SEMESTER**

**MMBC-121: MOLECULAR BIOLOGY**

**UNIT I:** Genetic material: Nucleic acids as genetic material, Structure of DNA and RNA; conformational analysis of DNA (sugar puckering, torsion angles); melting of DNA, super-helicity. DNA replication: Arrangement of replicons in a genome, Various modes of replication, Enzymes involved in replication, replication fork and priming, leading and lagging strand, elongation, termination, action of topoisomerases, telomere, single stranded DNA replication, Relationship between DNA replication and cell cycle, DNA copy number maintenance. Recombination and Repair of DNA: DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination repair, SOS repair.

**UNIT II:** Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, Transcription machinery of eukaryotes, various forms of RNA polymerase and cofactors, initiation, elongation and termination, promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription. Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, post-transcriptional gene regulation.

**UNIT III:** Translation: The genetic code and protein structure, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, initiation complex, ribosomes and tRNA, factors, elongation and termination.

**UNIT IV:** Post-translational processes: Protein modification, folding, chaperones, transportation, the signal hypothesis, protein degradation.

**UNIT V:** Gene regulation and expression: regulation of gene transcription in prokaryotes (operon model, negative and positive regulation of lac operon and trp operon), transcriptional switch in bacteriophage, regulation of transcription in eukaryotes, post transcriptional gene silencing and regulation of gene expression.

**Practicals:**

1. Preparation of Stock solutions
2. Isolation of genomic DNA from plant sample by CTAB method.
3. Quantitative and qualitative analysis of DNA by UV-spectrophotometer
4. Agarose Gel electrophoresis of genomic DNA
5. Protein isolation and purification
6. SDS-PAGE gel electrophoresis
7. Amplification of DNA by polymerase chain reaction
8. Plasmid DNA isolation
9. Preparation of competent cell and transformation
10. Selection of recombinant clone

**Suggested readings:**

1. Lewin's Genes XII by Krebs J.E., Goldstein E.S., Kilpatrick S.T., Jones and Bartlett Publishers (2017).

2. Molecular Biology of the Gene by Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Lodish R., Pearson Education (2013).

3. Molecular Cell Biology by Lodish H.F., Berk A. , Kaiser C.A., Krieger M., Bretscher A., Ploegh H. , Amon A., Martin K.C., 8th edition, Macmillan Publishers ( 2016).

4. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp. 8th Edition, [John Wiley & Sons Inc](https://www.bookdepository.com/publishers/John-Wiley-Sons-Inc), (2016).

**MMBC-122: VIROLOGY**

**UNIT I: General Concepts:** Virus history, Diversity, shapes, sizes and components of genomes, Isolation and purification of viruses and components, Consequences of virus infection to animals and human.

**UNIT II: Viral Infection:**Affect on host macromolecules, Viral infection: establishment of the antiviral state, Viruses counter attack mechanisms, Small DNA viruses: parvo- and polyomaviruses, Large DNA viruses: Herpes-adeno- and poxviruses.

**UNIT III: Classification of viruses and nomenclatures:** Positive strand RNA viruses- Picornaviruses, Flaviviruses- West Nile virus and Dengue virus, Coronaviruses- SARS pathogenesis.

**UNIT IV: Negative strand RNA viruses**: Paramyxoviruses, Orthomyxoviruses: Influenza pathogenesis and Bird flu, Rhabdoviruses: Rabies pathogenesis, Double strand RNA (dsRNA) viruses- Reoviruses, Retroviruses: structure, classification, life cycle; reverse transcription, Retroviruses: HIV, viral pathogenesis and AIDS.

**UNIT V: Plant virology:** Significance of plant virology and modern classification of plant viruses and viroids according to ICTV; andcryptograms of various plant viruses and virus groups.

**Practicals:**

1. Introduction to Virology & Lab safety.
2. Labeled Immunoassay: detection of immune complex as a mean of generating a measurable result.
3. ELISA: Detection of antigen-antibody complex.
4. Agglutination: Demonstration the interaction between an antibody and a particulate antigen.
5. Cultivation of viruses with the help of embryonated egg.
6. Immunofluorescence: Rapid identification of microorganism in cell culture.
7. Western Blotting: Identify and characterize specific molecules in a complex mixture.
8. Cell culture technique: Primary Cell culture.
9. Cell culture technique: Recovery of cells from storage.
10. Monolayer cell cultures.

**Suggested readings:**

1. Flint SJ, Enquist LW, Krug RM, Racaniello VR, and Skalka AM (2008), Principles of Virology 3rd edition, ASM Press Publication.
2. Fields B, Knipe D and Howley P (1989), Fields Virology 5th Edition, Lippincott Williams and Wilkins Publisher.
3. White DO and Fenner FJ (1986). Medical Virology 4th edition, Academic Press Inc.
4. Vinod Singh; Text Book of Virology, Ibdc Publishers.
5. Biswas SB &Biswas A (2006). An introduction to viruses, 4th edition, Vikas Publishing house Pvt Ltd, India.

**MMBC-123: FOOD MICROBIOLOGY**

**UNIT I:** Historical development and applications. Major Food borne outbreaks in the 21st Century, Food as substrate for microorganisms, Microorganisms important in food microbiology, Intrinsic and extrinsic factors affecting microbial growth in foods

**UNIT II:** Microbiology of spoilage of specific foods – Cereals, pulses, Bread, Cakes, Fresh fruits and vegetables, Juices, Bottled water, Milk, Tea, Meat and meat products (Fresh and ground meat, sausages), Poultry, Eggs, Sea foods, Fish. Mechanism underlying food spoilages, Food preservation: Chemical, physical and biological methods

**UNIT III:** Food borne intoxication and infections: Botulism, Staphylococcal food poisoning, *Clostridium perfringens*food poisoning, *Bacillus cereus* gastroenteritis, Salmonellosis, *Escherichia coli* diarrhea and colitis, *Vibrio cholera,* Bacterial and mycotoxins, chemical nature of important toxins and mechanism of action, prevention and control of toxin contamination

**UNIT IV:** Sauerkraut, Pickles, Silage, Bread, Baker’s yeast, Yogurt, Microbes as sources of single cell protein (SCP), Nutritive values and production of mushrooms. Edible and poisonous mushrooms, Tropical and temperate mushrooms, use of microbes and microbial enzymes in the improvement of nutritive quality of feed; Rumen microbiology

**UNIT V:** Food additives; microbial and non-microbial contaminants in foods and their analysis, role of biosensors and immuno assays in food quality determination

**Practicals:**

1. **Detection of number of bacteria in milk by SPC.**
2. **Detection of number of bacteria in milk by breed Count method.**
3. **Determination of quality of milk sample by methylene blue reduction test.**
4. **Microbiological examination of food stuff.**
5. **Role of yeasts in bread making.**
6. **Isolation of microbes of different food material.**
7. **Isolation of lipolytic microorganisms from butter.**

**Suggested readings:**

1. Microbiology by Chan ECS, Pelczar Michael J, Krieg NR, by Tata McGraw-Hill Education Pvt. Ltd, 7th Edition, (2009)
2. A textbook of microbiology by R.C. Dubey and D.K. Maheshwari, S Chand Publishing; Fourth edition (2016)
3. Adams M, Moss MO, McClure P, "Food Microbiology" Edition 4" Royal Society of Chemistry Publishers", (2016)
4. Frazier W C, Westoff DC, Vanitha KN, "Food Microbiology" Mc Graham Hill Education (2013)
5. Erkmen O and Bozoglu TF," Food Microbiology: Principles into Practice" John Wiley & Sons Publishers (2016)

**MMBC-124: ENVIRONMENTAL MICROBIOLOGY**

**UNIT I:** History and development of enviormental microbiology, Introduction of air, water and soil microbiology, Occurrence, diversity, adaptations and potential applications of thermophiles, psychrophiles, methanogens, methylotrophs, acidophiles, alkalophiles, halophiles, oligotrophs, barophiles, organic solvent and radiation tolerants, metallophiles.

**UNIT II:** Microbial degradation of lignocellulosic substances, keratin and chitin and Xenobiotics; Microbes in nutrient cycling with special reference to carbon, phosphorous, sulfur and nitrogen cycles.

**UNIT III:** Microbial degradation of pesticides; hydrocarbons; clean-up of sites polluted with oil spills, heavy metals and chlorinated solvents; biological treatment of effluents of sugar, pulp and paper industry, Recovery of minerals and metals from ores, Biodeterioration of properties & cultural heritage; microbial deterioration of paper, textile, wood, paint and metal corrosion. Principal methods for their protection.

**UNIT IV:** Understanding microbial diversity in the environment by culture-dependent approaches and their limitations, and by culture-independent molecular approaches (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, analysis of FAME profiles, measuring metabolic capabilities using BIOLOG microtitre plates, using DNA probes and PCR primers, G+C analysis, slot-blot hybridization of community DNA, and fluorescent *in situ* hybridization of intact cells)

**UNIT V:** Microbes in solid waste and sewage treatment systems. Disinfection of potable water supplies; Chemical and Biological indicators of water safety and quality determination; Microbial assessment of water quality; Standards for tolerable levels of fecal contamination.

**Practicals:**

1. To perform MPN test for determination of water quality
2. To determine BOD for given water sample
3. To determine COD for given water sample
4. IMViC Tests for identification of Enterobacteriaceae members
5. To isolate bacteria from soil by SPC.
6. To isolate fungi from air by settle plate technique
7. To determine efficacy of given disinfectant using Phenol coefficient method.
8. To study fungal spores by cellotape method.
9. To isolate algae from soil sample
10. To isolate microorganisms rhizosphere and phyllosphere.

**Suggested readings:**

1. Microbiology by Chan ECS, Pelczar Michael J, Krieg NR, by Tata McGraw-Hill Education Pvt. Ltd, 7th Edition, (2009).
2. A textbook of microbiology by R.C. Dubey and D.K. Maheshwari, S Chand Publishing; Fourth edition (2016).
3. Modern concept of microbiology by H D Kumar & Swati Kumar.
4. Foundation in Microbiology by Talaro K P, Chess B, McGraw-Hill Education, 9th edition (2014).
5. Prescott’s Microbiology,  McGraw-Hill Education; 10th edition (2016).

**IIMT UNIVERSITY.MEERUT**

**STUDY & EVALUATION SCHEME**

**M.Sc. MICROBIOLOGY, II YEAR (THIRD SEMESTER)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No.** | **Course Type** | **Course Code** | **Subjects**  | **Credit**  | **Study Scheme** | **Evaluation Scheme** |  |
|  | **InternalExam** | **External Exam** | **Total** |
|  | **L** | **T** | **P** |  |  |  |
| 1. | C-7 Theory | MMBC-231 | Industrial Microbiology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 2 | C-8 Theory | MMBC-232 | Medical Microbiology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 3 | C-9 Theory | MMBC-233 | Recombinant DNA Technology | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| 4 | DSE-3 Theory | MMBDS-234 | Microbial Genetics | **4** | **4** | **0** | **0** | **30** | **70** | **100** |
| MMBDS-234A | Advances in Microbiology |
| 5 | USEC | NECC-231 | Industrial Visit/ Seminar/ Presentation on the report of Visit | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 6 | USEC | NECC-232 | University Social Responsibility | **0** | **0** | **0** | **0** | **25** | **0** | **NC** |
| 7 | USEC | NECC-233 | Spoken Tutorial Certification | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
| 8 | USEC | NECC-234 | MOOCs/ SWAYAM | **1** | **1** | **0** | **0** | **25** | **0** | **25** |
|  |  |  |  |  |  |  |  |  |  |  |
| 9 | Lab | MMB-003P | **LAB-III** | **4** | **0** | **0** | **4** | **40** | **60** | **100** |
|  |  | **Total** |  | **22** | **18** | **0** | **4** | **210** | **340** | **550** |
|  |  |
| 10 | USEC | SPT-231 | Sports | 0 | 0 | 0 | 0 | 50 | 0 | 0 |

**NOTE: Project Work, Assignment and Seminar is Compulsory**

**L= Lecture**

**T= Tutorial**

**P= Practical**

**M.Sc. MICROBIOLOGY**

**SEMESTER- III**

**MMBC-231: INDUSTRIAL MICROBIOLOGY**

**Unit I: Introduction to industrial microbiology**

Brief history and developments in industrial microbiology.

**Unit II: Isolation of industrially important microbial strains and fermentation media**

Sources of industrially important microbes and methods for their isolation, preservation and

maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

**Unit III: Types of fermentation processes, bio-reactors and measurement of fermentation parameters**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker’s yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation

parameters - pH, temperature, dissolved oxygen, foaming and aeration

**Unit IV: Down-stream processing**

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

**Unit V: Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)**

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase)

Wine, beer

**Unit VI: Enzyme immobilization**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

**PRACTICALS**

1. Study different parts of fermenter

2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:

(a) Enzymes: Amylase and Protease

(b) Amino acid: Glutamic acid

(c) Organic acid: Citric acid

(d) Alcohol: Ethanol

3. A visit to any educational institute/industry to see an industrial fermenter, and other

downstream processing operations.

**SUGGESTED READINGS**

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited

2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA

3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An

Introduction. 1st edition. Wiley – Blackwell

4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied

Microbiology. 1st edition. W.H. Freeman and Company

5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

**M.Sc. MICROBIOLOGY: III- SEMESTER**

**MMBC- 232: MEDICAL MICROBIOLOGY**

**Unit I: Normal microflora of the human body and host pathogen interaction:** Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

**Unit II: Sample collection, transport and diagnosis :** Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA,

Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

**Unit III: Bacterial diseases:** List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control

Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*, *Treponema pallidum, Clostridium difficie*

**Unit IV: Viral diseases**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

**Unit V: Protozoan diseases**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar

**Unit VI: Fungal diseases**

Brief description of each of the following types of mycoses and one representative disease to be

studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete’s foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

**Unit VII: Antimicrobial agents: General characteristics and mode of action**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

**PRACTICALS**

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.

2. Study of composition and use of important differential media for identification of bacteria: EMB, Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.

3. Study of bacterial flora of skin by swab method.

4. Perform antibacterial sensitivity by Kirby-Bauer method.

5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)

7. Study of various stages of malarial parasite in RBCs using permanent mounts.

**SUGGESTED READING**

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg’s Medical Microbiology. 26th edition. McGraw Hill Publication.

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims’ Medical Microbiology. 4th edition. Elsevier.

4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein’s Microbiology. 9th edition. McGraw Hill Higher Education.

5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

**M.Sc. MICROBIOLOGY**

**SEMESTER- III**

**MMBC-233: RECOMBINANT DNA TECHNOLOGY**

**UNIT I: Tools and Techniques in genetic engineering**- DNA modifying enzymes and restriction enzymes for Genetic engineering , Vectors in gene cloning-Plasmid, Cosmid, Phages, Phasmids, Advanced cloning vectors-BAC, YAC, PAC, Transformation and Transfection, cDNA and genomic DNA library

**UNIT II: Methods of DNA and protein analysis-** Electrophoretic techniques, Southern and Northern Blotting, Preparation of probes, Isolation and purification of DNA, DNA fingerprinting and its application, Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins, Western Blotting.

**Polymerase Chain Reaction-** Concept of PCR, Various kinds of PCR, Real Time PCR, RAPD fingerprinting, Ligation Chain Reaction, Applications of PCR.

**UNIT III: Molecular markers in genome analysis-** RFLP, RAPD, AFLP, SSR and SNP analysis(molecular markers linked to disease resistance genes), Application of molecular markers in forensic, disease prognosis, MALDI-TOF.

**UNIT IV: Molecular mapping of genome-** Genetic and physical maps, physical mapping and map–based cloning, choice of mapping population, Product of DNA technology, transgenic plants.

**UNIT V: Applications-** Genetic diseases-Detection and Diagnosis, DNA marker technology in plants, DNA fingerprinting, genetically engineered biotherapeutics, vaccines and their manufacturing, Transgenic animals and Bio-pharming. Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning, Biosafety and Bioethics.

**PRACTICALS:**

1. Isolation of RNA by CTAB method.
2. Northern Blotting.
3. DNA Extraction by Spooling Method.
4. Isolation of *E. coli* Bacterial Genomic DNA.
5. Study of DNA sequencing methods.
6. Demonstration of genetic recombination in bacteria by conjugation.
7. Protein Isolation and separation by SDS PAGE.
8. DNA Fingerprinting using RAPD Technique.
9. Study about comparison of plasmid and bacteriophage cloning vectors.
10. Demonstration of production of transgenic and knockout mice.

**Suggested Readings:**

1. Biotechnology- Expanding Horizons by B.D. Singh (2014), Kalyani Publication
2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual.3rd edition. Cold Spring Harbor Laboratory Press.

**M.Sc. MICROBIOLOGY: III SEMESTER**

**MMBDS-234: MICROBIAL GENETICS**

**Unit I: Genome Organization and Mutations**

Genome organization: *E. coli, Saccharomyces, Tetrahymena.*

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens;

Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of

Mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

**Unit II: Plasmids**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

**Unit III: Mechanisms of Genetic Exchange**

Transformation - Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, Hfr and F’ strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

**Unit IV: Phage Genetics**

Features of T4 genetics , Genetic basis of lytic *versus* lysogenic switch of phage lambda

**Unit V: Transposable elements**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon

Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize

(Ac/Ds) Uses of transposons and transposition

**PRACTICALS**

1. Preparation of Master and Replica Plates

2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells

3. Study survival curve of bacteria after exposure to ultraviolet (UV) light

4. Isolation of Plasmid DNA from *E.coli*

5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.

6. Demonstration of Bacterial Conjugation

7. Demonstration of bacterial transformation and transduction

8. Demonstration of AMES test

**SUGGESTED READING**

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed.,

Benjamin Cummings

2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin’s Essential Genes, 3rd Ed., Jones and Bartlett Learning

3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education

Learning

4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings

5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers.

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**M.Sc. MICROBIOLOGY, II YEAR (FOURTH SEMESTER)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.****No.** | **Course Type** | **Course Code** | **Subjects** | **Credit** | **Study Scheme** | **Evaluation Scheme** |  |
|  | **Internal Exam**  | **External Exam** | **Total** |
|  | **L** | **T** | **P** |  |  |
| 1 | Core Project | MMBCP-241P | Project Work & Thesis Writing with Oral Presentation | 14 | 0 | 0 | 0 | 140 | 210 | 350 |
|  |  | **Total** |  | **14** | **0** | **0** | **0** | **140** | **210** | **350** |

**L= Lecture**

**T= Tutorial**

**P= Practical**