**IIMT UNIVERSITY, MEERUT**

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**EVALUATION SCHEME & SYLLABUS**

**FOR**

**BACHELOR OF SCIENCE IN MICROBIOLOGY**

On Choice Based Credit System

(Effective from the Session: 2019-20)

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.Sc. MICROBIOLOGY I YEAR, I SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **S. No.** | **Course Type** | **Course Code** | **Subject** | **Study Scheme** | | | **Credit** | **Evaluation Scheme** | | | | | |
| **L** | **T** | **P** |  | **Internal** | | **External** | | **Total** | |
| 1 | C-1 Theory | BMBC-111 | Introduction To Microbiology and Microbial Diversity | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 2 | C-2 Theory | BMBC-112 | Bacteriology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 3 | DSE-1 Theory | BMBDS-113 | Bioinformatics | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| BMBDS-113a | Microbial Biotechnology |
| 4. | AECC-1 Theory | NHU-112 | Environment & Ecology | 2 | 0 | 0 | 2 | 15 | | 35 | | 50 | |
| 5. | USEC | NECC-111 | Industrial Visit/ Seminar/Presentation the report of visit | 0 | 0 | 0 | 0 | 25 | | 00 | | NC | |
| 6. | USEC | NECC-112 | University Social Responsibility | 0 | 0 | 0 | 0 | 25 | | 00 | | NC | |
| 7. | USEC | NECC-113 | Spoken Tutorial Certification | 1 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| 8. | USEC | NECC-114 | MOOCs/ SWAYAM | 1 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| **PRACTICALS** | | | | | | | | | | | | | |
| 9. | C-1 Lab | BMBC-111P | Introduction To Microbiology and Microbial Diversity Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 10 | C-2 Lab | BMBC-112P | Bacteriology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 11 | DSE-1 Lab | BMBDS-113P | Bioinformatics Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| BMBDS-113aP | Microbial Biotechnology Lab |
|  |  |  | **TOTAL** | **16** | **0** | **6** | **22** | | **215** | | **335** | | **550** |
|  | | | | | | | | | | | | | |
| 12. | USEC | SPT-111 | Sports | 0 | 0 | 0 | 0 | | 50 | | 00 | | NC |

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| **L= Lecture, T= Tutorial, P= Practical** |  |  |  |  |  |  |  |  |  |  |

**B.Sc MICROBIOLOGY I SEMESTER**

**Core Course**

**Paper I (Code: BMBC-111)**

**INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY**

**(Credits: Theory-4, Practicals-2)**

**Lectures: 60**

**Unit I: History of Development of Microbiology 15 Lectures**

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

Role of microorganisms in fermentation, Germ theory of disease, Development of various

microbiological techniques and golden era of microbiology, Development of the field of soil

microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

**Unit II Diversity of Microbial World 40 Lectures**

**A. Systems of classification**

Binomial Nomenclature, Whittaker’s five kingdom and Carl Woese’s three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

**B. General characteristics** of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

• **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of

algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot.

food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life

cycles. Applications of algae in agriculture, industry, environment and food.

• **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent

mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements,

fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis,

asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

**Unit III An overview of Scope of Microbiology 5 Lectures**

**INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY LAB**

**Code: BMBC-111P**

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.

**B.Sc MICROBIOLOGY I SEMESTER**

**Core Course**

**Paper II (Code: BMBC-112)**

**BACTERIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**Lectures: 60**

**Unit I: Cell organization 14 Lectures**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.

Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls,

Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS),

sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell

membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

Endospore: Structure, formation, stages of sporulation.

**Unit II: Bacteriological techniques 5 Lectures**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

**Unit III: Microscopy: 6 Lectures**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence

Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

**Unit IV: Growth and nutrition 8 Lectures**

Nutritional requirements in bacteria and nutritional categories;

Culture media: components of media, natural and synthetic media, chemically defined media,

complex media, selective, differential, indicator, enriched and enrichment media

*Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation,

osmotic pressure, radiation

*Chemical methods of microbial control*: disinfectants, types and mode of action

**Unit V: Reproduction in Bacteria 3 Lectures**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of

growth, calculation of generation time and specific growth rate.

**Unit VI: Bacterial Systematics 8 Lectures**

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain;

conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary

chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.

Differences between eubacteria and archaebacteria.

**Unit VII: Important archaeal and eubacterial groups 16 Lectures**

**Archaebacteria**: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota

(*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens

(*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*,

*Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)]

**Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups:

***Gram Negative:***

Non proteobacteria: General characteristics with suitable examples

Alpha proteobacteria: General characteristics with suitable examples

Beta proteobacteria: General characteristics with suitable examples

Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples

Epsilon proteobacteria: General characteristics with suitable examples

Zeta proteobacteria: General characteristics with suitable examples

***Gram Positive:***

Low G+ C (Firmicutes): General characteristics with suitable examples

High G+C (Actinobacteria): General characteristics with suitable examples

***Cyanobacteria*:** An Introduction

**BACTERIOLOGY LAB: (Code: BMBC-112P)**

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.

2. Simple staining

3. Negative staining

4. Gram’s staining

5. Acid fast staining-permanent slide only.

6. Capsule staining

7. Endospore staining.

8. Isolation of pure cultures of bacteria by streaking method.

9. Preservation of bacterial cultures by various techniques.

10. Estimation of CFU count by spread plate method/pour plate method.

11. Motility by hanging drop method.

**SUGGESTED READINGS**

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

2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall

3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.

5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,

Dordrecht

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

McMillan.

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

Education.

8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott’s Microbiology. 9th edition.

McGraw Hill Higher Education.

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

**B.Sc MICROBIOLOGY I SEMESTER**

**Discipline Specific Elective**

**Paper III (Code: BMBDS-113)**

**BIOINFORMATICS**

**(Credits: Theory-4, Practical-2)**

**Lectures: 60**

**Unit I: Introduction to Computer Fundamentals 8 Lectures**

RDBMS - Definition of relational database

Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

**Unit II: Introduction to Bioinformatics and Biological Databases 14 Lectures**

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 III: Sequence Alignments, Phylogeny and Phylogenetic trees 16 Lectures**

Local and Global Sequence alignment, pairwise and multiple sequence alignment.

Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices

Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA,

Neighbour joining, Maximum Parsomony, Maximum likelihood.

**Unit IV: Genome organization and analysis 10 Lectures**

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy

Major features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis,* Human.

**Unit V: Protein Structure Predictions 12 Lectures**

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling

Structural Classes, Motifs, Folds and Domains

Protein structure prediction in presence and absence of structure template.

Energy minimizations and evaluation by Ramachandran plot

Protein structure and rational drug design.

**BIOINFORMATICS LAB: (Code: BMBDS-113P)**

1. Introduction to different operating systems - UNIX, LINUX and Windows

2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB

3. Sequence retrieval using BLAST

4. Sequence alignment & phylogenetic analysis using clustalW & phylip

5. Picking out a given gene from genomes using Genscan or other softwares (promoter region

identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool

6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)

7. Prediction of different features of a functional gene

**SUGGESTED READING**

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House

2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications

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

4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications,

genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

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

**B.Sc MICROBIOLOGY I SEMESTER**

**Ability Enhancement Compulsory Course**

**Paper IV (Code: NHU-112)**

**ENVIRONMENT & ECOLOGY (Credits: Theory-4)**

**Unit I:** Introduction to environmental studies

• Multidisciplinary nature of environmental studies; components of environment –atmosphere, hydrosphere, lithosphere and biosphere.

• Scope and importance; Concept of sustainability and sustainable development.

**Unit II**: **Ecosystems**

• What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem

b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**Unit III: Natural Resources: Renewable and Non-renewable Resources**

• Land Resources and land use change; Land degradation, soil erosion and desertification.

• Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

• Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

• Heating of earth and circulation of air; air mass formation and precipitation.

• Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

**Unit IV: Biodiversity and Conservation**

• Levels of biological diversity :genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hotspots

• India as a mega-biodiversity nation; Endangered and endemic species of India

• Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

• Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

**Unit V: Environmental Pollution**

• Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution

• Nuclear hazards and human health risks

• Solid waste management: Control measures of urban and industrial waste..

• Pollution case studies.

**Unit VI: Environmental Policies & Practices**

• Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

• Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).

• Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context

**Unit VII: Human Communities and the Environment**

• Human population and growth: Impacts on environment, human health and welfares.

• Carbon foot-print.

• Resettlement and rehabilitation of project affected persons; case studies.

• Disaster management: floods, earthquakes, cyclones and landslides.

• Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.

• Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

• Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

**Unit VIII: Field work**

• Visit to an area to document environmental assets; river/forest/flora/fauna, etc.

• Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.

• Study of common plants, insects, birds and basic principles of identification.

• Study of simple ecosystems-pond, river, Delhi Ridge, etc.

**Suggested Readings:**

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.

2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.

4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.

6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India’s Himalaya dams. Science, 339: 36-37.

7. McCully, P.1996. Rivers no more: the environmental effects of dams(pp. 29-64). Zed Books.

8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

9. Odum, E.P., Odum, h.T. & Andrews, J.1971. Fundamentals of Ecology. Philadelphia: Saunders.

10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

11. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatement. Oxford and IBH Publishing Co. Pvt. Ltd.

12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.

13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.

14. Sengupta, R. 2003.Ecology and economics: An approach to sustainable development. OUP.

15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.

17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.

18. Warren, C.E. 1971. Biology and Water Pollution Control. WB Saunders.

19. Wilson, E.O. 2006. The Creation: An appeal to save life on earth. New York: Norton.

20.World Commission on environment and Development. 1987. Our Common Future. Oxford University Press.

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.Sc. MICROBIOLOGY I YEAR, II SEMESTER**

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| **S. No.** | **Course Type** | **Course Code** | **Subject** | **Study Scheme** | | | **Credit** | **Evaluation Scheme** | | | | | |
| **L** | **T** | **P** |  | **Internal** | | **External** | | **Total** | |
| 1. | C-4 Theory | BMBC-121 | Virology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 2. | C-6 Theory | BMBC-122 | Cell Biology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 3. | C-7 Theory | BMBC-123 | Molecular Biology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 4. | AECC-2 Theory | NHU-121 | English Communication | 2 | 0 | 0 | 2 | 15 | | 35 | | 50 | |
| 5. | USEC | NECC-121 | Industrial Visit/ Seminar/Presentation the report of visit | 0 | 0 | 0 | 0 | 25 | | 00 | | NC | |
| 6. | USEC | NECC-122 | University Social Responsibility | 0 | 0 | 0 | 0 | 25 | | 00 | | NC | |
| 7. | USEC | NECC-123 | Spoken Tutorial Certification | 1 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| 8. | USEC | NECC-124 | MOOCs/ SWAYAM | 1 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| **PRACTICALS** | | | | | | | | | | | | | |
| 9. | C-4 Lab | BMBC-121P | Virology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 10. | C-6 Lab | BMBC-122P | Cell Biology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 11. | C-7 Lab | BMBC-123P | Molecular Biology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
|  |  |  | **TOTAL** | **16** | **0** | **6** | **22** | | **215** | | **335** | | **550** |
|  | | | | | | | | | | | | | |
| 12. | USEC | SPT-121 | Sports | 0 | 0 | 0 | 0 | | 50 | | 00 | | NC |

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| **L= Lecture, T= Tutorial , P= Practical** | | | | | | | | | | |
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**B.Sc MICROBIOLOGY II SEMESTER**

**Core Course**

**Paper I (Code: BMBC-121)**

**VIROLOGY**

**(Credits: Theory-4, Practicals-2)**

**Unit 1 Nature and Properties of Viruses No. of Hours: 12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin.

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses

Viral taxonomy: Classification and nomenclature of different groups of viruses

**Unit 2 Bacteriophages No. of Hours**: **10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

**Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication**

**No. of Hours**: **20**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ɸX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV). Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions.

**Unit 4 Viruses and Cancer No. of Hours: 6**

Introduction to oncogenic viruses

Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

**Unit 5 Prevention & control of viral diseases No. of Hours: 8**

Antiviral compounds and their mode of action

Interferon and their mode of action

General principles of viral vaccination

**Unit 6 Applications of Virology No. of Hours: 4**

Use of viral vectors in cloning and expression, Gene therapy and Phage display

**VIROLOGY LAB : (Code: BMBC-121P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs.

2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.

3. Study of the structure of important bacterial viruses (ɸX 174, T4, λ) using electron micrograph.

4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique

5. Studying isolation and propagation of animal viruses by chick embryo technique

6. Study of cytopathic effects of viruses using photographs

7. Perform local lesion technique for assaying plant viruses.

**SUGGESTED READING**

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology,

Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.

5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.

7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.

8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.

9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication

**B.Sc MICROBIOLOGY II SEMESTER**

**Core Course**

**Paper II (Code: BMBC-122)**

**CELL BIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Structure and organization of Cell No. of Hours: 12**

**Cell Organization** – Eukaryotic (Plant and animal cells) and prokaryotic

Plasma membrane: Structure and transport of small molecules

**Cell Wall:** Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes

**Cytoskeleton:** Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

**Unit 2 Nucleus No. of Hours: 4**

Nuclear envelope, nuclear pore complex and nuclear lamina

Chromatin – Molecular organization, Nucleolus

**Unit 3 Protein Sorting and Transport No. of Hours: 12**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids.

Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

**Unit 4 Cell Signalling No. of Hours: 8**

Signalling molecules and their receptors

Function of cell surface receptors

Pathways of intra-cellular receptors **–** Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

**Unit 5 Cell Cycle, Cell Death and Cell Renewal No. of Hours: 12**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis. Development of cancer, causes and types. Programmed cell death. Stem cells, Embryonic stem cell, induced pleuripotent stem cells

**CELL BIOLOGY LAB : (Code: BMBC-122P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Study a representative plant and animal cell by microscopy.

2. Study of the structure of cell organelles through electron micrographs

3. Cytochemical staining of DNA – Feulgen

4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B

5. Study of polyploidy in Onion root tip by colchicine treatment.

6. Identification and study of cancer cells by photomicrographs.

7. Study of different stages of Mitosis.

8. Study of different stages of Meiosis.

**SUGGESTED READING**

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker’s World of the Cell. 8th edition. Pearson.

2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott.

Williams and Wilkins, Philadelphia.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA

**B.Sc MICROBIOLOGY II SEMESTER**

**Core Course**

**Paper III (Code: BMBC-123)**

**MOLECULAR BIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Structures of DNA and RNA / Genetic Material No. of Hours: 12**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

**Unit 2 Replication of DNA (Prokaryotes and Eukaryotes**) **No. of Hours: 10**

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication.

Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D- loop (mitochondrial), Ө (theta) mode of replication and other accessory protein, Mismatch and excision repair

**Unit 3 Transcription in Prokaryotes and Eukaryotes No. of Hours: 8**

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit.

Transcription in Eukaryotes: RNA polymerases, general Transcription factors

**Unit 4 Post-Transcriptional Processing No. of Hours: 8**

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

**Unit 5 Translation (Prokaryotes and Eukaryotes) No. of Hours: 10**

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation,

Inhibitors of protein synthesis in prokaryotes and eukaryote.

**Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes No. of Hours: 12**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus,*Yeast mating type switching , Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.

**MOLECULAR BIOLOGY LAB: (Code: BMBC-123P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations.

2. Study of semi-conservative replication of DNA through micrographs / schematic representations

3. Isolation of genomic DNA from *E. coli*

4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)

5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)

6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

**SUGGESTED READINGS**

1**.** Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

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

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

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

**B.Sc MICROBIOLOGY II SEMESTER**

**Ability Enhancement Compulsory Courses**

**Paper IV (Code: NHU-121)**

**English Communication**

**(Credits: Theory-4)**

**Unit-1** **Introduction to Communication**

* Nature and Process of Communication
* Levels of Communication
* Language as a tool of Communication

**Unit-2 Language of Communication**

* Verbal and Non-Verbal
* Spoken and Written
* Personal, Social and Business
* Barriers to Communication (Intra-personal, Inter-personal and Organizational communication)

**Unit-3 Speaking Skills**

* Monologue
* Dialogue
* Group Discussion (Methodology & Guidelines)
* Interview (Types & Frequently Asked Questions)
* Public Speaking (Dos & Don'ts)

**Unit-4 Reading and Understanding**

* Reading Comprehension
* Difference between Abstract & Summary
* Paraphrasing
* Precis Writing

**Unit-5** **Writing Skills**

* Notices, Agenda , Minutes of Meeting
* Letter writing (Formal & Informal)
* Email Writing
* Report Writing (Kinds, Structure)

**Recommended Readings:**

1. Fluency in English- Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity,Orient Blackswan, 2013.
4. Language through Literature (forthcoming)ed.Dr.GauriMishra,Dr Ranjana Kaul, Dr Brati Biswas
5. Oxford Guide to writing and speaking , John Seely, O.U.P
6. Effective Technical Communication, M.Asraf Rizvi, Tata McGraw Hill
7. English Grammar & composition,Wren & Martin
8. Technical Communication, Meenakshi Raman & Sangeeta Raman

**Pedagogy for content delivery:**

1. Lectures
2. Presentations
3. Group Discussions
4. Quizzes
5. A/V aids

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.Sc. MICROBIOLOGY II YEAR, III SEMESTER**

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| **S. No.** | **Course Type** | **Course Code** | **Subject** | **Study Scheme** | | | **Credit** | **Evaluation Scheme** | | | | | |
| **L** | **T** | **P** |  | **Internal** | | **External** | | **Total** | |
| 1 | C-8 Theory | BMBC-231 | Microbial Genetics | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 2 | C-9 Theory | BMBC-232 | Environmental Microbiology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 3 | C-11 Theory | BMBC-233 | Industrial Microbiology | 4 | 0 | 0 | 4 | 30 | | 70 | | 100 | |
| 4. | SEC-3 Theory | BMBSE-234 | Biofertilizers and Biopesticides | 2 | 0 | 0 | 2 | 30 | | 70 | | 100 | |
| 5. | USEC | NECC-231 | Industrial Visit/ Seminar/Presentation 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 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| 8. | USEC | NECC-234 | MOOCs/ SWAYAM | 1 | 0 | 0 | 1 | 25 | | 0 | | 25 | |
| **PRACTICALS** | | | | | | | | | | | | | |
| 9. | C-8 Lab | BMBC-231P | Microbial Genetics Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 10 | C-9 Lab | BMBC-232P | Environmental Microbiology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
| 11 | C-11 Lab | BMBC-233P | Industrial Microbiology Lab | 0 | 0 | 2 | 2 | | 20 | | 30 | | 50 |
|  |  |  | **TOTAL** | **16** | **0** | **6** | **22** | | **230** | | **370** | | **600** |
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| 12. | USEC | SPT-231 | Sports | 0 | 0 | 0 | 0 | | 50 | | 00 | | NC |

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| **L= Lecture** |  |  |  |  |  |  |  |  |  |  |
| **T= Tutorial** |  |  |  |  |  |  |  |  |  |  |
| **P= Practical** |  |  |  |  |  |  |  |  |  |  |

**B.Sc. MICROBIOLOGY III SEMESTER**

**Core Course**

**Paper I (Code: BMBC-231)**

**MICROBIAL GENETICS**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Genome Organization and Mutations No. of Hours: 18**

**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 2 Plasmids No. of Hours: 10**

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 3 Mechanisms of Genetic Exchange No. of Hours: 12**

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 4 Phage Genetics No. of Hours: 8**

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

**Unit 5 Transposable elements No. of Hours: 12**

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

**MICROBIAL GENETICS LAB (Code: BMBC-231P)**

**TOTAL HOURS: 60 CREDITS: 2**

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

**B.Sc MICROBIOLOGY III SEMESTER**

**Core Course**

**Paper II (Code: BMBC-232)**

**ENVIRONMENTAL MICROBIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Microorganisms and their Habitats No. of Hours: 14**

Structure and function of ecosystems

Terrestrial Environment: Soil profile and soil microflora

Aquatic Environment: Microflora of fresh water and marine habitats

Atmosphere: Aeromicroflora and dispersal of microbes

Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Microbial succession in decomposition of plant organic matter

**Unit 2 Microbial Interactions No. of Hours: 12**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation.

Microbe-Plant interaction: Symbiotic and non symbiotic interactions.

Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

**Unit 3 Biogeochemical Cycling No. of Hours: 12**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin

Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction

Phosphorus cycle: Phosphate immobilization and solubilisation

Sulphur cycle: Microbes involved in sulphur cycle

Other elemental cycles: Iron and manganese

**Unit 4 Waste Management No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

**Unit 5 Microbial Bioremediation No. of Hours: 5**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

**Unit 6 Water Potability No. of Hours: 5**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples:

(a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

**ENVIRONMENTAL MICROBIOLOGY LAB: (Code: BMBC-232P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.

2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC ).

3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.

4. Assessment of microbiological quality of water.

5. Determination of BOD of waste water sample.

6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase,

amylase, urease) in soil.

7. Isolation of *Rhizobium* from root nodules.

**SUGGESTED READINGS**

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York

5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,Cambridge, England.

11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

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

**B.Sc MICROBIOLOGY III SEMESTER**

**Core Courses**

**Paper III (Code: BMBC-233)**

**INDUSTRIAL MICROBIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1: Introduction to industrial microbiology No. of Hours: 2**

Brief history and developments in industrial microbiology

**Unit 2: Isolation of industrially important microbial strains and fermentation media**

**No. of Hours: 10**

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 3: Types of fermentation processes, bio-reactors and measurement of fermentation parameters No. of Hours: 12**

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 4: Down-stream processing No. of Hours: 6**

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

**Unit 5: Microbial production of industrial products (micro-organisms involved, media,**

**fermentation conditions, downstream processing and uses) No. of Hours: 18**

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

**Unit 6: Enzyme immobilization No. of Hours: 4**

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

**INDUSTRIAL MICROBIOLOGY LAB (Code: BMBC-233P)**

**TOTAL HOURS: 60 CREDITS: 2**

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.

**B.Sc MICROBIOLOGY III SEMESTER**

**Skill Enhancement Elective Courses**

**Paper IV (Code: BMBSE-234)**

**BIOFERTILIZER AND BIOPESTICIDES**

**(Credits: Theory-4)**

**TOTAL HOURS: 30**

**Unit 1 Biofertilizers No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants

*Frankia* - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.

Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

**Unit 2 Non - Symbiotic Nitrogen Fixers No of Hours: 4**

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production

and field application.

**Unit 3 Phosphate Solubilizers No of Hours: 4**

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field

application

**Unit 4 Mycorrhizal Biofertilizers No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum

production of VAM, field applications of Ectomycorrhizae and VAM.

**Unit 5 Bioinsecticides No of Hours: 7**

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides,

*Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

**Suggested Readings**

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.

2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.

3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.

4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.

5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.

6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.Sc. MICROBIOLOGY II YEAR, IV SEMESTER**

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| **S. No.** | **Course Type** | **Course Code** | **Subject** | **Study Scheme** | | | **Credit** | | **Evaluation Scheme** | | | | |
| **L** | **T** | **P** |  | | **Internal** | **External** | | **Total** | |
| 1. | C-12 Theory | BMBC-241 | Immunology | 4 | 0 | 0 | 4 | | 30 | 70 | | 100 | |
| 2. | C-13 Theory | BMBC-242 | Medical Microbiology | 4 | 0 | 0 | 4 | | 30 | 70 | | 100 | |
| 3. | C-14 Theory | BMBC-243 | Recombinant DNA Technology | 4 | 0 | 0 | 4 | | 30 | 70 | | 100 | |
| 4. | SEC-4 Theory | BMBSE-244 | Food Fermentation Techniques | 2 | 0 | 0 | 2 | | 30 | 70 | | 100 | |
| 5. | USEC | NECC-241 | Industrial Visit/ Seminar/Presentation the report of visit | 0 | 0 | 0 | 0 | | 25 | 00 | | NC | |
| 6. | USEC | NECC-242 | University Social Responsibility | 0 | 0 | 0 | 0 | | 25 | 00 | | NC | |
| 7. | USEC | NECC-243 | Spoken Tutorial Certification | 1 | 0 | 0 | 1 | | 25 | 0 | | 25 | |
| 8. | USEC | NECC-244 | MOOCs/ SWAYAM | 1 | 0 | 0 | 1 | | 25 | 0 | | 25 | |
| **PRACTICALS** | | | | | | | | | | | | | |
| 9. | C-12 Lab | BMBC-241P | Immunology Lab | 0 | 0 | 2 | 2 | 20 | | | 30 | | 50 |
| 10. | C-13 Lab | BMBC-242P | Medical Microbiology Lab | 0 | 0 | 2 | 2 | 20 | | | 30 | | 50 |
| 11. | C-14 Lab | BMBC-243P | Recombinant DNA Technology Lab | 0 | 0 | 2 | 2 | 20 | | | 30 | | 50 |
|  |  |  | **TOTAL** | **16** | **0** | **6** | **22** | **230** | | | **370** | | **600** |
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| 12. | USEC | SPT-241 | Sports | 0 | 0 | 0 | 0 | 50 | | | 00 | | NC |

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| **L= Lecture, T= Tutorial, P= Practical** |  |  |  |  |  |  |  |  |  |  |
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**B.Sc MICROBIOLOGY IV SEMESTER**

**Core Courses**

**Paper I (Code: BMBC-241)**

**IMMUNOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Introduction No. of Hours: 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

**Unit 2 Immune Cells and Organs No. of Hours: 7**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

**Unit 3 Antigens No. of Hours: 4**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

**Unit 4 Antibodies No. of Hours: 6**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

**Unit 5 Major Histocompatibility Complex No. of Hours: 5**

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

**Unit 6 Complement System No. of Hours: 4**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

**Unit 7 Generation of Immune Response No. of Hours: 10**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

**Unit 8 Immunological Disorders and Tumor Immunity No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

**Unit 9 Immunological Techniques No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

**IMMUNOLOGY LAB: (Code: BMBC-241P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Identification of human blood groups.

2. Perform Total Leukocyte Count of the given blood sample.

3. Perform Differential Leukocyte Count of the given blood sample.

4. Separate serum from the blood sample (demonstration).

5. Perform immunodiffusion by Ouchterlony method.

6. Perform DOT ELISA.

7. Perform immunoelectrophoresis.

**SUGGESTED READINGS**

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt’s Essential Immunology.11th edition Wiley Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby’s Immunology. 6th edition W.H. Freeman andCompany, New York.

4. Murphy K, Travers P, Walport M. (2008). Janeway’s Immunobiology. 7th edition Garland SciencePublishers, New York.

5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

**B.Sc MICROBIOLOGY IV SEMESTER**

**Core Courses**

**Paper II (Code: BMBC-242)**

**MEDICAL MICROBIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Normal microflora of the human body and host pathogen interaction**

**No. of Hours: 8**

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 2 Sample collection, transport and diagnosis No. of Hours: 5**

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

**Unit 3 Bacterial diseases No. of Hours: 15**

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 4 Viral diseases No. of Hours: 14**

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 5 Protozoan diseases No. of Hours: 5**

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 6 Fungal diseases No. of Hours: 5**

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 7 Antimicrobial agents: General characteristics and mode of action No. of Hours: 8**

**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

**MEDICAL MICROBIOLOGY LAB: (Code: BMBC-242P)**

**TOTAL HOURS: 60 CREDITS: 2**

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 READINGS:**

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.

**B.Sc MICROBIOLOGY IV SEMESTER**

**Core Courses**

**Paper III (Code: BMBC-243)**

**RECOMBINANT DNA TECHNOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Introduction to Genetic Engineering No. of Hours: 2**

Milestones in genetic engineering and biotechnology

**Unit 2 Molecular Cloning- Tools and Strategies No. of Hours: 20**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering.

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases.

**Cloning Vectors:** Definition and Properties

Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids, BACs, YACs

Use of linkers and adaptors

**Expression vectors:** *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

**Unit 3 Methods in Molecular Cloning No. of Hours: 16**

Transformation of DNA: Chemical method, Electroporation,

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery.

DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

**Unit 4 DNA Amplification and DNA sequencing No. of Hours: 10**

PCR: Basics of PCR, RT-PCR, Real-Time PCR

Sanger’s method of DNA Sequencing: traditional and automated sequencing

Primer walking and shotgun sequencing

**Unit 5 Construction and Screening of Genomic and cDNA libraries No. of Hours: 6**

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

**Unit 6 Applications of Recombinant DNA Technology No. of Hours: 6**

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

**RECOMBINANT DNA TECHNOLOGY LAB (Code: BMBC-243P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Preparation of competent cells for transformation

2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.

3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis

4. Ligation of DNA fragments

5. Cloning of DNA insert and Blue white screening of recombinants.

6. Interpretation of sequencing gel electropherograms

7. Designing of primers for DNA amplification

8. Amplification of DNA by PCR

9. Demonstration of Southern blotting

**SUGGESTED READING:**

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein’s Microbiology. McGraw Hill Higher Education

6. Brown TA. (2007). Genomes-3. Garland Science Publishers

7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwel Publishing, Oxford, U.K.

**B.Sc MICROBIOLOGY IV SEMESTER**

**Skill Enhancement Elective Courses**

**Paper IV (Code: BMBSE-244)**

**FOOD FERMENTATION TECHNIQUES**

**(Credits: Theory-2)**

**TOTAL HOURS: 30 CREDITS: 2**

**Unit 1 Fermented Foods No of Hours: 4**

Definition, types, advantages and health benefits

**Unit 2 Milk Based Fermented Foods No of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process.

**Unit 3 Grain Based Fermented Foods No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process.

**Unit 4 Vegetable Based Fermented Foods No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

**Unit 5 Fermented Meat and Fish No of Hours: 4**

Types, microorganisms involved, fermentation process

**Unit 6 Probiotic Foods No of Hours: 4**

Definition, types, microorganisms and health benefits

**SUGGESTED READINGS:**

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press.
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.Sc. MICROBIOLOGY III YEAR, V SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Course Type** | **Course Code** | **Subject** | | | **Study Scheme** | | | | | | | **Credit** | **Evaluation Scheme** | | | | | | |
| **L** | | | **T** | | | **P** |  | **Internal** | | | **External** | **Total** | | |
| 1. | C-3 Theory | BMBC-351 | Biochemistry | | | 4 | | | 0 | | | 0 | 4 | 30 | | | 70 | 100 | | |
| 2. | DSE-4 Theory | BMBDS-352 | Plant Pathology | | | 4 | | | 0 | | | 0 | 4 | 30 | | | 70 | 100 | | |
| BMBDS-352a | Advances in Microbiology | | |
| 3. | DSE-7 Theory | BMBDS-353 | Microbes in Sustainable Agriculture and Development | | | 4 | | | 0 | | | 0 | 4 | 30 | | | 70 | 100 | | |
| BMBDS-353a | Biomathematics & Biostatistics | | |
| 4. | SEC-5 Theory | BMBSE-354 | Management of Human Microbial Diseases | | | 2 | | | 0 | | | 0 | 2 | 30 | | | 70 | 100 | | |
| 5. | USEC | NECC-351 | Industrial Visit/ Seminar/Presentation the report of visit | | | 0 | | | 0 | | | 0 | 0 | 25 | | | 0 | NC | | |
| 6. | USEC | NECC-352 | University Social Responsibility | | | 0 | | | 0 | | | 0 | 0 | 25 | | | 0 | NC | | |
| 7. | USEC | NECC-353 | Spoken Tutorial Certification | | | 1 | | | 0 | | | 0 | 1 | 25 | | | 0 | 25 | | |
| 8. | USEC | NECC-354 | MOOCs/ SWAYAM | | | 1 | | | 0 | | | 0 | 1 | 25 | | | 0 | 25 | | |
| **PRACTICALS** | | | | | | | | | | | | | | | | | | | | |
| 9. | C-3 Lab | BMBC-351P | Biochemistry Lab | | 0 | | | 0 | | | 2 | | 2 | 20 | | 30 | | | | 50 |
| 10. | DSE-4 Lab | BMBDS-352P | Plant Pathology Lab | | 0 | | | 0 | | | 2 | | 2 | 20 | | 30 | | | | 50 |
| BMBDS-352aP | Advances in Microbiology Lab | |
| 11. | DSE-7 Lab | BMBDS-353 | Microbes in Sustainable Agriculture and Development Lab | | 0 | | | 0 | | | 2 | | 2 | 20 | | 30 | | | | 50 |
| BMBDS-353aP | Biomathematics & Biostatistics Lab | |
|  |  |  | **TOTAL** | | **16** | | | **0** | | | **6** | | **22** | **230** | | **370** | | | | **600** |
|  | | | | | | | | | | | | | | | | | | | | |
| 12. | USEC | SPT-351 | Sports | 0 | | | 0 | | | 0 | | | 0 | 50 | 00 | | | | NC | |

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| **L= Lecture, T= Tutorial, P= Practical** |

**B.Sc MICROBIOLOGY V SEMESTER**

**Core Course**

**Paper I (Code: BMBC-351)**

**BIOCHEMISTRY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Bioenergetics No. of Hours: 8**

First and second laws of Thermodynamics. Definitions of Gibb’s Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

**Unit 2 Carbohydrates No. of Hours: 12**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses.

Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose andpyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

**Unit 3 Lipids No. of Hours: 12**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification

Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties.

Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks,

structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides

Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

**Unit 4 Proteins No. of Hours: 12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins.

General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its

Significance, Classification, biochemical structure and notation of standard protein amino acids

Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and

hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid

Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins.

Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of

proteins

**Unit 5. Enzymes No. of Hours: 12**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme

NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site,

transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis.

Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism

Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex:

pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme

activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts

**Unit 6. Vitamins No. of Hours: 4**

Classification and characteristics with suitable examples, sources and importance

**BIOCHEMISTRY LAB: (Code: BMBC-351P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts

2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant

3. Standard Free Energy Change of coupled reactions

4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars

5. Qualitative/Quantitative tests for lipids and proteins

6. Study of protein secondary and tertiary structures with the help of models

7. Study of enzyme kinetics – calculation of *V*max , Km, Kcat values

8. Study effect of temperature, pH and Heavy metals on enzyme activity

9. Estimation of any one vitamin

**SUGGESTED READING**

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning

2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill

Livingstone

3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman

4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company

5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,

6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein’s Microbiology by. 9th Ed., McGrawHill

7. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

**B.Sc MICROBIOLOGY V SEMESTER**

**Discipline Specific Elective Course**

**Paper II (Code: BMBDS-352)**

**PLANT PATHOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Introduction and History of plant pathology No. of Hours: 5**

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch’s postulates. Contributions of eminent Indian plant pathologists.

**Unit 2 Stages in development of a disease No. of Hours: 2**

Infection, invasion, colonization, dissemination of pathogens and perennation.

**Unit 3 Plant disease epidemiology No. of Hours: 5**

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

**Unit 4 Host Pathogen Interaction No. of Hours: 19**

***Defense Mechanisms in Plants***

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, Plant bodies, phenolics, quinones, oxidative bursts].

**Unit 5 Control of Plant Diseases No. of Hours: 10**

Principles & practices involved in the management of plant diseases by different methods, *viz.*

regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material.

cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.

biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants

genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

**Unit 6 Specific Plant diseases No. of Hours: 19**

**Study of some important plant diseases giving emphasis on its etiological agent, symptoms,**

**epidemiology and control**

A. Important diseases caused by fungi

White rust of crucifers - *Albugo candida*

Downy mildew of onion - *Peronospora destructor*

Late blight of potato - *Phytophthora infestans*

Powdery mildew of wheat - *Erysiphe graminis*

Ergot of rye - *Claviceps purpurea*

Black stem rust of wheat - *Puccinia graminis tritici*

Loose smut of wheat - *Ustilago nuda*

Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*

Red rot of sugarcane - *Colletotrichum falcatum*

Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

**PLANT PATHOLOGY LAB (Code: BMBDS-352P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Demonstration of Koch’s postulates in fungal, bacterial and viral plant pathogens.

2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia*, *Ustilago, Fusarium, Colletotrichum.*

**SUGGESTED READINGS**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,

2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.

3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.

4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.

5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

**B.Sc MICROBIOLOGY V SEMESTER**

**Discipline Specific Elective Course**

**Paper II (Code: BMBDS-352a)**

**ADVANCES IN MICROBIOLOGY**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Evolution of Microbial Genomes** **No. of Hours: 15**

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

**Unit 2 Metagenomics** **No. of Hours: 15**

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

**Unit 3 Molecular Basis of Host-Microbe Interactions** **No. of Hours: 15**

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

**Unit 4 Systems and Synthetic Biology** **No. of Hours: 15**

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

**ADVANCES IN MICROBIOLOGY LAB (Code: BMBDS-352aP)**

**TOTAL HOURS: 60**

**CREDITS: 2**

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

**SUGGESTED READING**

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press.
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press.
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press.
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press.
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
6. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook’s Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
7. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
8. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
9. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science.

**B.Sc MICROBIOLOGY V SEMESTER**

**Discipline Specific Elective**

**Paper III (Code: BMBDS-353)**

**MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Soil Microbiology No of Hours: 8**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

**Unit 2 Mineralization of Organic & Inorganic Matter in Soil No of Hours: 8**

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

**Unit 3 Microbial Activity in Soil and Green House Gases No of Hours: 5**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

**Unit 4 Microbial Control of Soil Borne Plant Pathogens No of Hours: 8**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

**Unit 5 Biofertilization, Phytostimulation, Bioinsecticides No of Hours: 15**

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*),

Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae),

Novel combination of microbes as biofertilizers, PGPRs

**Unit 6 Secondary Agriculture Biotechnology No of Hours: 10**

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

**Unit 7 GM crops No of Hours: 6**

Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

**MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT LAB**

**(Code: BMBDS-353P)**

**TOTAL HOURS: 60 CREDITS: 2**

1. Study soil profile

2. Study microflora of different types of soils

3. *Rhizobium* as soil inoculants characteristics and field application

4. *Azotobacter* as soil inoculants characteristics and field application

5. Design and functioning of a biogas plant

6. Isolation of cellulose degrading organisms

**SUGGESTED READINGS**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,

2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.

4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.

10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.

11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.

**B.Sc MICROBIOLOGY V SEMESTER**

**Discipline Specific Elective**

**Paper III (Code: BMBDS-353a)**

**BIOMATHEMATCS & BIOSTATISTICS**

**(Credits: Theory-4, Practicals-2)**

**TOTAL HOURS: 60 CREDITS: 4**

**Unit 1 Biomathematics No of Hours: 30**

Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc.

Simple observations about these functions like increasing, decreasing and, periodicity.

Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence.

Infinite Geometric Series. Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation.

Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations.

Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

**Unit 2 Biostatistics** **No of Hours: 30**

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences;

Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics;

Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom;

Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.

**BIOMATHEMATCS &BIOSTATISTICS LAB (Code: BMBDS-353aP)**

**TOTAL HOURS: 60** **CREDITS: 2**

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

**SUGGESTED READINGS**

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

**B.Sc MICROBIOLOGY V SEMESTER**

**Skill Enhancement Elective Courses**

**Paper IV (Code: BMBSE-354)**

**MANAGEMENT OF HUMAN MICROBIAL DISEASES**

**(Credits: Theory-2)**

**TOTAL HOURS: 30 CREDITS: 4**

**Unit 1 Human Diseases No of Hours: 4**

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

**Unit 2 Microbial diseases No of Hours: 12**

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

**Unit 3 Therapeutics of Microbial diseases No of Hours: 8**

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.**

Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

**Unit 4 Prevention of Microbial Diseases No of Hours: 6**

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

**Vaccines:** Importance, types, vaccines available against microbial diseases, vaccination schedule

(compulsory and preventive) in the Indian context.

**Suggested Readings**

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.

**IIMT UNIVERSITY, MEERUT**

**STUDY & EVALUATION SCHEME**

**B.SC. MICROBIOLOGY, III YEAR (SIXTH SEMESTER) (NON-CBCS)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No.** | **Course Code** | **Subjects** | **Study Scheme** | | | **Evaluation Scheme** | | | |  | |
| **Internal Exam** | | **External Exam** | | **Total** | |
| **L** | **T** | **P** |  | |  | |  | |
| **1.** | BMB-601 | Biosafety, IPR and Bioethics | **3** | **0** | **0** | **30** | | **70** | | **100** | |
| **2.** | BMB-602 | Genomics, Proteomics and Bioinformatics | **3** | **0** | **0** | **30** | | **70** | | **100** | |
| **3.** | BMB-603 | Microbial Biotechnology | **3** | **0** | **0** | **30** | | **70** | | **100** | |
| **PRACTICALS** | | | | | | | | | | | |
| **4.** | BMB-016P | PRACTICAL-XVI (Biosafety, IPR and Bioethics and Microbial Biotechnology Lab) | 0 | 0 | 2 | 15 | | 35 | | 50 | |
| **5.** | BMB-017P | PRACTICAL-XVII (Genomics, Proteomics and Bioinformatics Lab) | 0 | 0 | 2 | 15 | 35 | | 50 | |
| **6.** | BMB-018P | Project Work |  | 0 | 4 | 00 | 100 | | | 100 | |
|  | **Total** |  | **9** | **0** | **8** | **120** | **380** | | | **500** | |

**BMB- 601: BIOSAFETY, IPR AND BIOETHICS**

**Unit 1**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;

Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

**Unit 2**

Biosafety Guidelines: Biosafety guidelines and regulations (National and International);

GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of InternationalAgreements - Cartagena Protocol.

**Unit 3**

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 4**

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 5**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International.

Ethical issues against the molecular technologies.

**PRACTICALS**

Study of components and design of a BSL-III laboratory

2. Filing applications for approval from biosafety committee

3. Filing primary applications for patents

4. Study of steps of a patenting process

5. A case study

**Suggested Reading**

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt.

Ltd., New Delhi.

2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information

Solution Pvt. Ltd. New Delhi.

3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social

Impliocations, Springer India.

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

**BMB-602: GENOMICS, PROTEOMICS AND BIOINFORMATICS**

**UNIT I**

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert

and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone

contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

**UNIT II**

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis:

ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms'

Genomes and Databases.

**UNIT III**

Introduction to protein structure, Chemical properties of proteins. Physical interactions that

determine the property of proteins. Short-range interactions, electrostatic forces, van der waal

interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation

analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures –

Edman degradation.

**UNIT IV**

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation,

solubilization, reduction, resolution.

Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De*

*novo* sequencing using mass spectrometric data.

**UNIT V**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL,

GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the

web. History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

**PRACTICALS**

1. 1.Study of components and design of a BSL-III laboratory.
2. Filing applications for approval from biosafety committee.
3. Filing primary applications for patents.
4. Study of steps of a patenting process.
5. A case study
6. Sequence information resource
7. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
8. Protein information resource (PIR).
9. Understanding and using: PDB, Swissprot, TREMBL.

**SUGGESTED READING**

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.

2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition,

B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,

1989.

6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old.

Blackwell Science, 2001.

7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons

Inc.

8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.

Benjamin Cummings.

9. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

10. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of

recombinant DNA. ASM Press, Washington.

11 . Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

**BMB-603: MICROBIAL BIOTECHNOLOGY**

**Unit 1 Microbial Biotechnology and its Applications**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology.

Use of prokaryotic and eukaryotic microorganisms in biotechnological applications

Genetically engineered microbes for industrial application: Bacteria and yeast

**Unit 2 Therapeutic and Industrial Biotechnology**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase,

recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics. Microbial biosensors.

**Unit 3 Applications of Microbes in Biotransformations**

Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

**Unit 4 Microbial Products and their Recovery**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques

Immobilization methods and their application: Whole cell immobilization

**Unit 5 Microbes for Bio-energy and Environment**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents interactions.

**PRACTICALS**

1. Study yeast cell immobilization in calcium alginate gels.

2. Study enzyme immobilization by sodium alginate method.

3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*).

4. Isolation of xylanase or lipase producing bacteria.

5. Study of algal Single Cell Proteins.

**SUGGESTED READING**

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current

Opinion in Biotechnology, 12, 195–201.

4. Prescott, Harley and Klein’s Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,

6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition.,

Elsevier Science.

9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.