

# CHOICE BASED CREDIT SYSTEM (CBCS)

## M.SC. MICROBIOLOGY CURRICULUM 2020-21



DEPARTMENT OF MICROBIOLOGY  
TRIPURA UNIVERSITY (A CENTRAL  
UNIVERSITY) SURYAMANINAGAR,  
AGARTALA - 799 022 TRIPURA, INDIA

**M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2020-21)**

<b>SEMESTER I</b>				
<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>CREDITS</b>	<b>Lecture/ Tutorial/ Practical hrs per week</b>
MI-701-C1	Basic Microbiology and Microscopy	CORE	4	3L/1T
MI-702-C1	Microbial ecology and environmental microbiology	CORE	4	3L/1T
MI-703-C1	Microbial Immunology	CORE	4	3L/1T
MI-704-C	Practical's	CORE	4	8P
CSK-II	Compulsory Foundation (Soft Skills)	CF	4	3L/1T
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	<b>24</b>
<b>SEMESTER II</b>				
MI-801-C1	Microbial genetics and bacterial recombination	CORE	4	3L/1T
MI-802-C1	Microbial Physiology and metabolism	CORE	4	3L/1T
MI-803-C1	Virology	CORE	4	3L/1T
MI-804-C	Practical's	CORE	4	8
MI-805-E2	Biophysical and biochemical methods	ELECTIVE	4	3L/1T
MI-806-E1	Microbial Bioreactors for waste water Treatment	ELECTIVE	4	3L/1T
MI-808-E	Innovative concept Development	ELECTIVE	2	2L
<b>Semester wise credits and hours of lectures</b>			<b>26</b>	<b>30</b>
<b>SEMESTER III</b>				
MI-901-C1	Tools and Techniques of Molecular Biology and Bioinformatics	CORE	4	3L/1T
MI-902-C	Practical's	CORE	4	8
MI-903E2	Fermentation Technology and Fermented Foods	ELECTIVE	4	3L/1T
MI-904-E1	Microbial Adaptation	ELECTIVE	2	
MI-905-E	Bacterial secretion system and bacterial quorum sensing	ELECTIVE	2	3L/1T
MI -906-E1	Bacteria and chronic infections	ELECTIVE	4	3L/1T
MI-905-C1	Project Work	CORE	4	3T
	MOOC	ELECTIVE	1	Online
			<b>21</b>	<b>24</b>
<b>SEMESTER IV</b>				
MI-1001-E1	Recent trends in antimicrobial research	ELECTIVE	4	3L/1T
MI-1004-C1	Project Work	CORE	8	8
			<b>12</b>	<b>12</b>
<b>Semester wise credits and hours of lectures</b>				
<b>In addition a 2 credit elective course offered by other departments may be taken by the students</b>				
<b>Grand total of credits and hours of lecture hours</b>			<b>79</b>	
<b>Student have to cover 72 credits for clearing the MScCourse</b>				

## **BASIC MICROBIOLOGY AND MICROSCOPY**

### **PAPER CODE:MI-701-C1**

**Credit: 4**

#### **UNIT-I: BACTERIOLOGY**

**Bacterial cell structure and appendages: Morphological features and arrangement of bacterial cells:** overview of eubacterial cell structure: Gram-positive and Gram-negative bacteria; Extracellular appendages: flagella-arrangement, basic structure and locomotive function; pili- different types, their distribution among bacteria & related functions; fimbriae- occurrence, function and features distinguishing pili and fimbriae; glycocalyx- composition and role in bacteria; and capsule- microcapsule and slime.

**Bacterial cell wall & cell membrane: Detailed structure of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS), protoplasts, sphaeroplasts, L-forms, cell wall synthesis and its inhibitors including different antibiotics; periplasm; molecular and chemical structure of cell membrane; cytoskeleton including tubulin and actin structural filaments and their role in bacteria.**

**Bacterial cell division and reproduction: Binary fission and other forms of reproduction in bacteria; assembly, maintenance and disassembly of Z ring; endospore structure and stages involved in endospore development in Bacillus subtilis and Metabacterium polyspora**

#### **UNIT-II: MYCOLOGY**

**Classification of fungi (Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes) and Slime molds, morphology, structure, cell differentiation, and reproduction of fungi.**

**Heterokaryosis, Sex hormones in fungi, physiological specialization in fungi, Mycorrhiza- ectomycorrhiza, endomycorrhiza and vesicular arbuscular mycorrhiza (VAM).**

**Economic importance, Secondary metabolites from fungi: Terpenes, Nonribosomal peptides, hydrophobins, peptaibols, indole, alkaloids, detailed emphasis on polyketides.**

#### **UNIT- III PHYCOLOGY**

**Phycology: General account of Diversity, distribution, nutrition, mode of reproduction, Life cycle patterns, recent status of algae (evolutionary perspective), ecological significance, phycotoxins, economic importance including role in human affairs (algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment) Distribution and classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta; Algal ecology, Algal toxins, Algal food and algal biotechnology.**

#### **UNIT -IV: MICROSCOPY AND STAINING OF MICROORGANISMS**

**Microscopy: General Principles and components of simple, microscope, compound microscope, bright-field and dark-field microscope, Phase- contrast microscope, fluorescence microscope, Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM), Cytophotometry and flow cytometry**

**Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).**

#### **Reference/Text Book:**

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGrawHill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy McCullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. Microbiology by Michael J Pelczar
5. Fundamental Principles of Bacteriology A J Salle
6. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill.science
7. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dorling Kindersley (india) PvtLtd
8. Microbiology by Stuart Walker, W B Saunders
9. An Introduction to Microbiology by P Tauro, K K Kapoor, K S Yadav

## MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

**PAPER CODE: MI-802C2**

**Credit: 4**

### **UNIT 1 ORIGIN DIVERSITY AND CULTURABILITY CONCEPTS OF MICROBES**

Origin of life: A brief history of the physical origin of the Earth, Chemical and Cellular evolution; Microbial Diversification: Consequences for Earth's Biosphere; Endosymbiotic origin of eukaryotes.

Significance of Biogeochemical cycles: Carbon, Nitrogen, Phosphorous, Sulphur.

Microbial diversity and its types.

Quantitative Ecology: Microbial diversity, OTU, Diversity indices (Shannon, Shimpson), Alpha and beta diversity, Richness and evenness, Samples and samplings,

Concept of cultivability: Determination of total and viable microbial number, Molecular analysis of function and diversity of microbial community, Metagenomics and microbiomics.

### **UNIT 2: CONCEPTS OF MICROBIAL ECOLOGY AND MICROBIAL SUCCESSION**

Microbial Ecology: Basic concept of microbial Ecosystem and Biosphere, Concept of population growth and community dynamics in microbe, Development of microbial communities: r and k strategies.

Physiological ecology of microorganisms: Adaptation to environmental condition, Abiotic growth limiting factors-Leibig's law of minimum, Shelford law of tolerance.

Microbial community succession-biofilm communities.

### **UNIT 3 BIOFERTILIZERS**

History of bio-fertilizers, sources of nitrogen and the importance of bio-fertilizers, description and characteristics of bio-fertilizers-Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Azolla, Phosphate solubilizing microorganisms, VAM.

Bio-fertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control,

Bio-fertilizer application technology, constraints in the commercialization of bio-fertilizer technology

### **UNIT 4: POLLUTION MANAGEMENT AND BIOREMEDIATION**

Water pollution and its sources: Role of organic pollutants in water, concepts of C-BOD, N-BOD and COD, Oxygen-sag curve. Treatment of waste water by aerobic and anaerobic process.

Air pollution and Air borne diseases: Methods for air microflora studies Particulate matters, PAH, Fog and smog, Determination of LD50, Ames test to determine the genotoxicity of toxicants (biological assay to assess the mutagenic potential of chemical compounds)

Soil pollution and management: Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management

Bioremediation of environmental pollutants: bioleaching, biosorption and bioaccumulation of metals from solid and liquid waste.

Biodegradation and biotransformation of Xenobiotics including pesticides chlorinated and nitrated aromatic compounds, phenolic compounds, polycyclic aromatic compounds.

Enzymes and metabolic pathways of degradation of xenobiotic compounds.

### **Reference/Text Books:**

1. Maier, Pepper, Gerba. Environmental Microbiology. Academic Press.
2. Atlas, RM and Bartha, R. Microbial Ecology: Fundamentals and Applications. Pearson.
3. Schmidt and Schaechter. Topics in Ecological and Environmental Microbiology. Academic Press.
4. Environmental Microbiology by A.H. Varnam and M.G. Evans. Manson Publishing Ltd. 2000.
5. Environmental Microbiology by W.D. Grant and P.E. Long. Kluwer Academic Publishers. 1981.
6. Microbiology: An environmental Perspective by P. Edmonds. Macmillan, New York. 1978.
7. Environmental Microbiology by R. Maier, I. Pepper and C. Gerba. 2nd edition. Academic Press. 2009.
8. Environmental Microbiology: Principles and Applications by P.K. Jjemba, Science Publishing Inc. 2004.
9. Advances in Applied Bioremediation by A. Singh, R.C. Kuhad and O.P. Ward. Springer. 2009.

## **MICROBIAL IMMUNOLOGY**

**PAPER CODE:MI-703-C1**

**Credit: 4**

### **UNIT 1:INTRODUCTION**

Concept of Innate and Adaptive immunity, Immune dysfunction and its consequences, Immune cells and Organs: Immune Cells and Organs, Structure, Functions and Properties of Immune Cells -T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Dendritic cell, Structure and Functions of Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT.

### **UNIT 2: ANTIGENS**

Antigens, Antigenicity versus Immunogenicity, Haptens, Characteristics of an antigen - Foreignness, Molecular size and Heterogeneity, T-dependent and T-independent antigens, Adjuvants.

Antibodies and Humoral Immune Response: Basic structure of antibody- CDRs, Framework region, Hinge. Primary and secondary immune response, Antibody mediated effector function, Types and properties of antibodies, Monoclonal antibodies – preparation and applications, Antigen-antibody interaction – Precipitation, Agglutination, Immuno-electrophoresis, Immuno-fluorescence, ELISA.

### **UNIT 3: MAJOR HISTOCOMPATIBILITY COMPLEX AND CELL MEDIATED IMMUNITY**

Organization and inheritance of MHC locus in humans, Structure and functions of MHC I & II molecules; Cellular expression of MHC molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways); Killing mechanisms by CTL, NK cells and ADCC. Complement System: Components of the complement system Activation pathways (Classical, Alternative and Lectin pathways) Biological consequences of complement activation.

### **Unit 4. MEDICAL MICROBIOLOGY**

Classification of medically important microbes, Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases,

#### **Reference/Text Book:**

1. Campbell,N.A. and Reece, J.B. (2008) Biology 8<sup>th</sup> edition, pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al.(2006) Biology 7<sup>th</sup> edition Tata McGraw Hill Publications, NewDelhi.
3. Griffiths, A.J.F et al. (2008) Introduction to Genetic Analysis, 9<sup>th</sup> edition, W.H. Freeman &Co.NY.
4. Albert, B et al. (2008) Molecular Biology of the Cell, 8<sup>th</sup> Edition, Garland Science.NY.

## PRACTICAL

**PAPER CODE:MI-704C**

**Credit: 4**

### **Section – A Basic Microbiology**

1. Laboratory safety rules in Microbiological Laboratory.
2. Preparation of culture media for growth of microorganism (Bacteria and Fungi).
3. Media, Sterilization using the autoclave.
4. Sterilization of equipment's and materials.
5. Pouring a plate and Storage of Media.
6. Inoculation and other aseptic procedure (Using a Wire loop, using a pipette, flaming the neck of bottles and test tubes).
7. Working with bacteria and yeast and obtaining mixed culture from soil (Streak plate, pour plate and Spread plate).
8. Isolation techniques and obtaining pure culture (bacteria and fungi).
9. Microbial Staining (bacteria and fungi).
10. Growth curve, measures of bacterial population by turbidometry.
11. Studying the effect of temperature and pH.
12. Determination of thermal death point and thermal death point of microorganisms.

### **Section-B Microbial Metabolism**

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbache equation.
2. Study of UV absorption spectra of Hemoglobin.
3. Estimation of protein by Lowry's method.

### **Section-C Microbial Immunology**

1. Identification of human blood groups.
2. To separate serum/plasma from the blood sample.
3. To perform total Leukocytes Count (TLC) of the given Blood Sample.
4. To perform Differential Leukocytes Count (TLC) of the given Blood Sample.
5. To perform immunoprecipitation.
6. To perform immunodiffusion by Ouchterlony method.
7. To demonstrate single radial immunodiffusion (SRID) technique.
8. To perform Dot ELISA.

## MICOBIAL GENETICS AND BACTERIAL RECOMBINATION

**PAPER CODE:MI-801C1**

**Credit: 4**

### **UNIT-I: INTRODUCTION TO MOLECULAR BIOLOGY**

DNA structure, forms of DNA and DNA supercoiling; The law of DNA constancy and c-value paradox; properties of DNA-denaturation, renaturation, melting curve and hyper chromicity; DNA replication in prokaryotes: origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading. Restriction endonucleases – types, nomenclature, classification, application; DNA ligases – properties and functions, ligation techniques; DNA modifying enzymes – polymerases, DNase, RNase, polynucleotide kinases, alkaline phosphatases and terminal nucleotidyltransferase. DNA isolation, DNA polymerases

### **UNITII: MUTAGENESIS**

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; Mutagens, Types of mutations, transposon mutagenesis, site directed mutagenesis, Ames test; Environmental mutagenesis and toxicity testing.

### **UNIT-III: GENETIC ASPECTS OF EXTRACHROMOSOMAL ELEMENTS AND VECTORS**

extrachromosomal elements (plasmids and bacteriophages), Plasmids as vectors for gene cloning and plasmid DNA replication; Transposons in prokaryotes and eukaryotes and their uses in genetic analyses; Life cycle of bacteriophages and their uses in microbial genetics. Cloning vehicles: Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid), Bacteriophage ( $\lambda$  phage and M13 vectors), cosmids, phagemids, expression vectors, shuttle vectors, excretion vectors and Animal viral vectors; Promoter inexpression vectors: Lac Z promoter, Lambda PL/ PR Promoter, T7 Promoter, Sp6 Promoter; SV-40 promoter, Cam V35s promoter and Ribosome binding sites.

### **UNIT-IV: BACTERIAL RECOMBINATION**

Bacterial Gene Transfer: gradual development of the concept, Genetic recombination- Bacteriophages; synopsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination gene conversion; Bacterial transformation, Host cell restriction, Transduction, complementation, Conjugation & Transfection.

#### **Reference/ Text Book:**

1. Bushman, F. 2002. Lateral Gene Transfer, Cold Spring Harbor Laboratory Press.
2. Kaper, J. B. and Hacker, J. 1999. Pathogenicity Islands and Other Mobile Virulence Elements, ASM Press, Washington, D.C.
3. Ptashne, M. 2002. Genes and Signals, Cold Spring Harbor Laboratory Press.
4. Miller, J.R. 1992. A Short Course in Bacterial Genetics: Lab Manual, Cold Spring Harbor Laboratory Press.
5. American Society for Microbiology (ASM) home page: <http://www.asmsoc.org>.
6. BioWeb <http://bioweb.uwlax.edu/index.htm>. (A collection of data and tools for genetics and biology).
7. DOE Joint Genomics Institute (JGI): [http://www.jgi.doe.gov/JGI\\_microbial/html/index.html](http://www.jgi.doe.gov/JGI_microbial/html/index.html) (Microbial genome databases and a great resource for genome analysis including BLAST searches.)
8. ExPASy Molecular Biology Server: <http://www.expasy.ch/>. (A very useful site for molecular biology, genomics, and proteomics included predicted peptide mass fingerprints.)

## **MICROBIAL PHYSIOLOGY AND METABOLISM**

**PAPER CODE:MI-702-C1**

**Credit: 4**

### **UNIT-I: GROWTH AND TRANSPORT IN CELL**

Introduction to microbial growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.

Solute Transport: Introduction; Primary and Secondary transport; Kinetics; Membrane transport protein- Porins and aquaporins, mechanosensitive channels; ABC transporter; Group translocation PEP-PTS system; catabolite repression; inducer exclusion and inducer expulsion.

### **UNIT-II METABOLIC PATHWAYS AND REGULATION IN CELL**

Central Metabolic Pathways and Regulation: Glycolysis and its regulation; Gluconeogenesis; Pentose-Phosphate Pathway; Entner-Doudoroff Pathway; Citric Acid Cycle; alternate TCA; Glyoxylate Pathway and its regulation. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Cometabolism of pentoses and hexoses; Succinic and citric acid production.

Nitrogen metabolism: Inorganic Nitrogen assimilation- nitrate and ammonia assimilation; Regulation of glutamate synthetase; General reaction of amino acid and Stickland reaction; Glutathione – Distribution in Bacteria; Biosynthesis and role in redox regulation; Outline of amino acid biosynthesis; protein utilization; detail account on biochemistry of glutamate producing strains.

### **UNIT III: ENZYME AND ENZYME KINATICS**

Enzymes: Introduction, activation energy, enzyme kinetics, significance of Km, catalytic efficiency, turnover number. Methods of plotting enzyme kinetics data: Lineweaver – Burk plot, saturation kinetics. Enzyme inhibition, models and type of inhibition.

Metabolism of lipids: Biosynthesis and degradation of lipids and its regulation in E. coli; Lipid accumulation in yeast.

### **UNIT IV: METABOLISM OF NUCLEOTIDES**

Metabolism of nucleotides: Purine and pyrimidine biosynthesis; deoxyribonucleotide synthesis; regulation of purine and pyrimidine biosynthesis; inhibitors of nucleotide biosynthesis.

Physiological Adaptation and Intracellular signalling: Introduction to two component system; response to physiological stress: aerobic-anaerobic shifts- Arc and Fnr system; osmotic homeostasis; response to nutritional stress: phosphate supply- Pho regulon; and stringent response.

### **Reference/Text Book:**

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA.1999.
2. Microbial Physiology by A.G. Moat, J. W. Foster and M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
3. Lehninger Principles of Biochemistry by D. L. Nelson and M. M. Cox. 6th Edition. W. H. Freeman. 2012
4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.
6. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.
7. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013
8. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.
9. Understanding Enzymes by T. Palmer, E. Horwood. 3rd Edition. Wiley. 1991.



# VIROLOGY

**PAPER CODE:MI-803C1**

**Credit: 4**

## **UNIT 1: INTRODUCTION TO VIROLOGY:**

The Big Picture of all viruses using a common strategy. Virus classification. The infectious cycle, Studying Virus infection. Koch's Postulates for viruses. Virus Genome and Genetics: Virus genome types. Double stranded DNA (dsDNA). Gapped DNA genomes. Single-stranded (ssDNA) genomes. Double stranded RNA (dsRNA). Single stranded RNA (ssRNA): (+) strand RNA. Single stranded (+) sense RNA with DNA intermediate. Single stranded RNA (-) sense. Ambisense RNA genomes.

## **Unit II: Virus Structure:**

Metastability, The tools for the viral structural biology. Helical Symmetry. Icosahedral symmetry. Triangulation number. Quasi-equivalence. Attachment and Entry. Initiation of infection. Affinity. Avidity. Cellular receptor for viruses. Getting into the Nucleus. Disassembly.

RNA directed RNA synthesis, Reverse Transcription & Integration, Translation: Identification of RNA polymerase. How RNA synthesis occurs in viruses? Reverse transcriptase. Retrovirus genome organization. Steps of DNA synthesis in Retroviruses.

Genomic replication of DNA viruses: Basic rules of genome replication in DNA viruses. Viral origins of DNA replication. Generic steps in Transcription. Host Polymerases.

Initiation. Splicing. Alternatesplicing. Promoter Structure. Steps in Regulation of transcription. Enhancers.

Virus coded transcriptional regulators. Transcriptional cascade. Export.

Virus Assembly: Metastable structures. Concentrating components for assembly. Getting things to the right place. How do Virus make Sub-assemblies. Sequential and Concerted assembly. Packaging signals.

Packaging of segmented genome. Acquisition of an envelope. Budding strategies.

## **UNIT III: VIRUS HOST INTERACTIONS AND ANTI VIRAL DRUGS**

Virus Infection basics: Fundamental question of viral pathogenesis, Virion defences to hostile environment. Viral spread. Viremia. Determinants of tissue tropism. Virus shedding. Transmission of infection. Host defense. Innate Immune response.

Virus Virulence. Toxic viral proteins. Virus induced auto-immunity. Acute Persistent Infections: General pattern of infection. Defense against the acute infection. Influenza. Polio. Measles. Rotavirus. Persistent Infection. Chronic vs. Latent Infection.

Vaccines & Anti-Viral drugs: Herd Immunity. Requirement of an effective vaccine. Inactivated vaccine. Subunit vaccines. Live attenuated vaccines. Polio eradication. Anti-Viral drugs. Search for antiviral drugs. Antiviral screening. Resistance to antiviral drugs.

## **UNIT IV: UNUSUAL INFECTIOUS AGENT AND INVESTIGATION OF A VIROUS OUTBREAK:**

Unusual Infectious Agent: Viroids. Origin of Viroids. Satellites. Prions. Transmissible spongiform encephalopathy (TSE) caused by prions. Prion hypothesis. Prion Species barrier.

Investigation of virus Outbreak: Case study of health risk associated with a virus epidemic. The origin of outbreak, the spread, the intervention strategies, public health response.

### **Suggested reading:**

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka. 2nd edition. ASM Press. 2004.
2. Introduction to Modern Virology EPZ by N. Dimmock, A. Easton and K. Leppard. 5th edition. Blackwell Publishing. 2005.
3. Basic Virology by Edward K. Wanger, M. Hewlett, D. Bloom and D. Camerini. 3rd edition. Blackwell Publishing. 2007.
4. Principles of Molecular Virology by A.J. Cann. 3rd edition. Elsevier Academic Press. 2001.

## PRACTICAL

PAPER CODE:MI-804C

Credit: 4

1. Separate serum from the blood sample, Separation of serum protein by vertical gelelectrophoresis.
2. Determination of Molecular weight of Protien by Columnchromatography.
3. Plasmid isolation.
4. BacterialTransformation.
5. Genomic DNA isolation, quantification, purityanalysis.
6. Study of UV absorbance spectra for Protien andDNA.
7. Polymerase chain reaction using the isolated DNA astemplate.
8. Agarose gel electrophoresis of PCRproduct.
9. Gel purification of PCRproduct.
10. Ligation of PCR product into plasmid Vector.
11. Preparation of competent cells by calcium chloridemethod.
12. Transformation of ligated product into host by heat shockmethod.
13. Preparation of competent cells by glycerolmethod.
14. Transformation of ligated product into host by GenePulsar (Electroporation).
15. Demostration of  $\alpha$ -complementation of  $\beta$ -galactosidase through blue whitecolonies.

### **Reference/Text Books:**

1. Sambrook J, Fritsch Ef, Maniatis T. (1989). In: Molecular cloning: A Laboratory Manual(2<sup>nd</sup> ed). CSH Press,USA.
2. R.W.Old& S.B. Primrose (1990) Principles of Gene Manipulation: An Introduction to Genetic Engineering. ClackwellSciencLtd.
3. Protien purification: Principles and Practice by Robert Scopes. Springer Advanced Texts in Chemistry.1993.

## **BIOPHYSICAL AND BIOCHEMICAL METHOD**

**PAPER CODE:MI-805E2**

**Credit: 4**

### **UNIT-I: CHROMATOGRAPHIC TECHNIQUES**

Chromatography: Introduction, Principle of separation/isolation of particular substance, Basic Principle and applications: of gel filtration chromatography, Matrix for of gel filtration chromatography, operation of gel filtration chromatography, ion exchange: principle, types, parameters for choosing right matrix, applications, affinity chromatography: principle, advantages of affinity chromatography, types, choice of matrix, operation and application, gas liquid chromatography: principle, applications, high pressure/performance liquid chromatography(HPLC).

### **UNIT-II: ELECTROPHORETIC TECHNIQUES**

Basics of electrophoresis: electrophoretic mobility and affecting factors, Biological application and interpretation of different types of electrophoresis: PAGE, gradient gel, Agarose Gel Electrophoresis, 2D Electrophoresis, iso-electric focusing, gradient electrophoresis; pulsed field gel electrophoresis, blotting techniques: southern, northern, western.

### **UNIT-III: SPECTROSCOPIC TECHNIQUES**

Spectroscopy, The nature and properties of electromagnetic radiation, Electromagnetic spectrum, Principle of spectroscopy, interaction of electromagnetic radiation with matter, Energy level, molecular orbital theory, Electronic transition, chromophores, UV/Visible spectroscopy, Beer- Lambert Law, application of UV/Visible spectroscopy, infrared spectroscopy, applications, fluorescence spectroscopy, characteristics of fluorescence, resonance energy transfer, applications.

### **UNIT-IV: FLOW CYTOMETRY**

Optics: Forward Angle Light Scatter, Side Scatter Channel, Properties of FSC & SSC, fluorescence Channels, Optical Design, FSC & SSC Dot Plot, Types of Measurements, Fluorescent Dyes and Antibodies, Fluorescence and Fluorochrome. Principles of Fluorescence, Excitation Spectra of Fluorochromes, Emission spectra, applications.

#### **Reference/Text Book:**

1. Instrumental methods of analysis. 6<sup>th</sup> edition by H.H Willard, L.L. Merrit Jr. and others. 1986. CBS Publishers and distributors.
2. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
3. Gel Electrophoresis of proteins – A practical Approach by Hanes.
4. Chromatography: Concepts and Contrasts -1988 by James Miller. John Wiley and Sons. Inc. , New York.
5. Introduction of High performance Liquid chromatography by R.J Hamilton and P.A .Sewell.
6. Spectroscopy by B.P. Straughan and S. Walker.
7. Practical aspects of gas chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons. New York.
8. Gel chromatography by Tibor Kremmery. Wiley Publications.
9. Isotopes and radiations in Biology By C.C. Thornburn, Butterworth and Co. Ltd., London.
10. The Use of Radioactive isotopes in the life sciences by J.M. Chapman and G. Ayrey, George Allen and Unwin Ltd., London.
11. A.L. Lehninger, Principles of Biochemistry, 4<sup>th</sup> edition, W.H Freeman and Company, 20014.
12. Alberts, A. Johnson, J Lewis. Molecular, Biology of cell. Garland Science, 2014.
13. Online Biophysics. V Bloomfield. Pdf. NCBI Website.

## **MICROBIAL BIOREACTOR FOR WASTE WATER TREATMENT**

**PAPER CODE:MI-806E1**

**Credit: 4**

### **Unit I:**

History of Waste water treatment/management: Regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the emergency planning and community right to know act, Pollution Prevention act 1990, an approach to problem solving: a six step method.

### **Unit II:**

Water and Waste water characteristics: Essential Biology Concepts, Ecology, Limnology; Water supply and treatment; Physical, Chemical (inorganic, organic) and biological characteristics of waste water and Collection.

### **Unit III:**

Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water; Non-potable applications of treated waste water, Case study of Waste Water Treatment with high as well as low C/N Ratio.

### **Unit IV:**

Reactor types: suspended growth reactors; batch reactor; continuous- Flow stirred Tank Reactor; membrane reactor; rotating drum reactors; biofilm reactors; aerobic granular sludge reactor.

### **Reference/Text Book:**

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr, WileyBlackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3<sup>rd</sup> Edition by Frank R. Spellman, CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das, Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solutions, 2<sup>nd</sup> Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general Review; Economic and Social Commission for Western Asia. United Nations, New York, 2003, url:
8. Environmental Biotechnology Principles and applications. Bruce E Rittman and Perey L McCarty. TataMcGraw hill Edition (2012) ISBN.10:1-25-900288-8.

## **INNOVATIVE CONCEPT DEVELOPMENT**

**PAPER CODE:MI-808E**

**Credit: 2**

### **UNIT-I**

What is innovation, identify customer/society needs, design thinking skills, environmental sustainability, financial analysis. Identifying a problem, understanding the available solutions, developing an innovative solution(5).

### **UNIT-II**

Basics of intellectual property rights; patents with reference to Life science. Drafting of patent proposals, Collection organization and managing of the literature.(5)

### **UNIT-III**

Current trends in Domestic/commercial water purification methods, energy generation from wastes etc.(2)

Case study on development of diagnostics kits.(4)

Case Study on development of rapid diagnostics.(1)

Case study on IPR(4)

Individual visit for problem identification and proposing innovative solutions.(3)

Internal Assessments: As per the course Instructor

Final Assessments: Presentation of the concept developed by the groups.

### **Reference:**

1. **Purple Cow**, New Edition: Transform your Business by being Remarkable: Seth Godin:Books.
2. The Pumpkin Plan: A simple strategy to grow a remarkable business by Mike Michalowicz.
3. Intellectual property the law of copyrights, patents and trademarks, By Schechter, Rogher E. & Thomas, Jhon R.

## **TOOLS AND TECHNIQUES OF MOLECULAR BIOLOGY AND BIOINFORMATICS**

**PAPER CODE:MI-901C1**

**Credit: 4**

### **UNIT-I BASICS OF DNA TECHNOLOGY**

Introduction to PCR; primer designing, Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products PCR amplification of 16SrDNA, Agarose gel analysis.

### **UNIT-II: MOLECULAR TOOLS AND TECHNIQUES**

Transformation techniques. Genomic libraries- Isolation of genomic DNA fragments, selection of vectors, cDNA libraries and cDNA cloning, shot gun cloning, Bacterial Artificial libraries. Bacterial Transcriptome Analysis, TA cloning, Artificial chromosome vectors (YACs; BACs); Metagenomics, Primer design, AFIGE, PFGE, ARB for bacterial strain identification. Community analysis: Direct and indirect method, RAPD, RFLP, TDDG, DGGE for community Analysis

### **UNIT III: RETRIEVING INFORMATION THROUGH SEQUENCE ALIGNMENT AND PHYLOGENETIC TREE**

Database indexing and specification of search terms, the archives: nucleic acid sequence database, genome database and genomic browsers, protein sequence database, databases of structures, classification of protein structures, accuracy and precision of protein structure determination.

Submission and retrieval of Data in GenBank. Basic principle of genome assembly and annotation. Scoring matrices for nucleic acid and protein sequence analysis: PAM, BLOSSUM. Pairwise and multiple sequence analysis. Database searching using BLAST, Phylogenetic analysis.

### **UNIT IV: STRUCTURAL BIOINFORMATICS AND DRUG DISCOVERY**

Protein stability and folding, Sasisekharan-Ramakrishnan-Ramchandran plot, protein stability and denaturation, superposition of structures and structure alignment DALI & MUSTANG. Evolution of protein structures, protein structure prediction and modelling, prediction of protein function, divergence of function orthologues and prologues; drug discovery and development, lead compound, improving on the lead compound, Quantitative Structure Activity Relationship(QSAR) Molecular modelling in drug discovery.

#### **Reference/ Text Book:**

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. J.D. Watson, N.H. Hopkins, J.W. Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
6. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
7. Molecular Genetics An Introductory Narrative by G S Stent and R Calender, San Francisco, Calif.: W.H. Freeman, 1978.
8. Introduction to Bioinformatics Arthur M. Lesk Oxford University Press (2014) ISBN 978-0-19-872467-4
9. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics Version 3.3.1 (2016-06-21) by W. N. Venables, D. M. Smith and the R Core Team.

## PRACTICALS

**PAPER CODE:MI-902C**

**Credit: 4**

### **Section-A**

1. Understanding the cultivable microbes from dental Flora.
2. Standardization of technique for sampling the dental flora
3. Growing the dental micro-flora in the selected media & determination of  
(a) pre-incubation time &  
(b) requisite dilution to get the CFU count and diversity estimate.
4. Isolation, purification, Characterization of dental micro-flora, & antibiotic sensitivity test.
5. In-vitro set up for testing antibiotic therapy in case of dentine tissue or teeth.
6. Visualization of the teeth surface using Scanning Electron Microscope.
7. To find out the relative proportion of Lactic Acid Bacteria from natural sources.
8. Isolation of acid producing bacterial from various natural sources like grass, intestine of fish and prawn, curd, fermented fish, bee hibe, etc.
9. Characterization of isolates.
10. Testing for biofilm formation by the isolate.
11. Production of Lactic acid from whey in packed bed reactor.

### **Section-B**

1. Gene sequence downloading from gene database.
2. Nucleotide BLAST.
3. Comparison of gene sequence using alignment tool.
4. Amino acid sequence of protein downloading from database.
5. Protein BLAST.
6. Comparison Amino acid sequence of protein using alignment tool.
7. Computation of instability index of proteins.
8. Computation of aliphatic index of proteins.
9. Prediction of phosphorylation sites in the proteins.
10. Computation of hydrophobicity of proteins.

## **FERMENTATION TECHNOLOGY AND FERMENTED FOOD**

**PAPER CODE:MI-903E2**

**Credit: 4**

### **UNIT I: INTRODUCTION TO FERMENTATION TECHNOLOGY**

Origin and History of food fermentation; Basics of fermentation processes; Microbial culture selection for fermentation process. Media formulation, inoculum development and process optimization; Significance of substrates and starter culture; Basic requirements for fermentation and factor affecting fermentation process. Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.

### **UNIT II: TYPES OF FERMENTATION AND PRODUCT RECOVERY**

Types of fermentation- (sub-merged/solid state, Batch /continuous fermentation);

Down stream processing. Recovery of particular matter, product isolation, distillation, centrifugation, whole booth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis. Bioprocess economic and Bioproduct regulation.

### **UNIT III: TRADITIONAL FERMENTED FOOD AND BEVERAGES**

Health benefits and other significance of fermented food and beverages; traditional fermentation of Asia and North East India; Food habits and types of their fermented food; Fermented vegetable (Fermented beans Sauerkraut, Kimchi, Pickle, bamboo shoots); Fermented soyabean products- (Temph, Tofu, Soya sauce); Fermented dairy products (Cheese, Dahi and Yogurt, Butter); Fermented baked product (bread and bakery products) Other fermented food products (Idli, Vada, Dosa, Bhatara, Dhokla); Fermented fish, meat and sausages; Fermented beverages (Sake, Rice beers, Ale, Wines).

### **UNIT IV: INDUSTRIAL APPLICATION OF FERMENTATION TECHNOLOGY**

Fermentation process for Production of SCP; Production of Industrial alcohol (Ethanol and Butanol); Organic acids (Citric acid, Lactic acid, Glutamic acid); Amino acids (Lysine, Phenylalanine, Tryptophan); Biopolymers (Dextran, Xanthan); Antibiotics (cephalosporin's, Tetracycline's, Polyenes); Enzymes (Alpha-amylase, Lipase, Pectinases, Proteases); Vitamins (Vitamin B12 and Riboflavin); Alcoholic beverages (Toddy, Beer, Wine, Champagne, Rum, Brandy, Whisky).

#### **Reference/Text Book:**

1. Food Microbiology by William Frazier, Dannise Westhoff, McGraw-Hill. Inc.
2. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
3. Microbial Physiology by Moat A.G. and Foster J. W. 1999..Wiley.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Principles of Fermentation Technology, 3rd Edition by Stanbury & Whitaker & Hall, Butterworth-Heinemann, Elsevier science.
6. The Art of Fermentation by Sandor Ellix Katz, Chelsea Green Publishing(2012).
7. Mastering Fermentation by Kate Williams, Oxford publishing.



## **MICROBIAL ADAPTATION**

**PAPER CODE:MI-904E1**

**Credit: 2**

### **UNIT-I: ADAPTATION OF EXTREM ENVIRONMENT**

Adaptations to pH, Temperature adaptation, Pressure adaptation, Halophilic adaptations.

### **UNIT-II: PATHOGENIC ADAPTATION TO HOST ENVIRONMENT**

Adaptation to acidic environment, Adaptation to Microaerobic conditions, Adaptation to immune system stress. Adaptation to Metal stress.

### **UNIT-III DORMANCY, DRUG TOLERANCE AND RESISTANCE**

Growth regulation by microbes, Survival and reactivation strategies of pathogens in stress through heterogeneous population generation, Persisters, antimicrobial resistance.

#### **Reference:**

1. Protein adaptation in Extremophiles: January 2008, Publisher: Nova Biomedical, ISBN: 1604560193.
2. Extremophiles and Their Applications in Medical Process: ISBN: 978-3-319-12808-5
3. Tuberculosis and the Tubercle Bacillus, Second Edition, ISBN:9781555819552
4. Reviews and research articles related to topics will be suggested during course.

## **BACTERIAL SECRETION SYSTEM AND BACTERIAL QUORUM SENSING**

**PAPER CODE: MI-905E**

**Credit: 2**

### **UNIT-I: BACTERIAL SECRETION SYSTEM:**

Introduction; Sec secretion pathway; SecB secretion Pathway; SRP pathway; Tat Pathway; Type I, Type II, Type III (T3SS; injectisome, injectosome), Type IV, Type V, Type VI; Sec A2, Sortase and Type VII secretion systems.

### **UNIT-II: QUORUM SENSING:**

Discovery; Role in as illustrated by bioluminescence (*Vibrio fischeri*, *Vibrio harveyi*); Virulence (*Pseudomonas aeruginosa*, *Staphylococcus*); Competence and Sporulation (*Bacillus subtilis*) and antibiotic resistance in bacteria. Quorum quenching: Impact and mechanism.

#### **Reference/Text Book:**

1. Prescott's Microbiology by J. Willey, L. Sherwood and C.J. Woolverton. 10<sup>th</sup> edition. McGraw Hill Education. 2017.
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15<sup>th</sup> Edition. Pearson Education. 2018.
3. Alcamo's Fundamentals of Microbiology by J.C. Pommerville. 10<sup>th</sup> Edition. Jones and Bartlett Learning. 2013.
4. General Microbiology By R. Stanier, J.C. Ingraham, M. Wheelis, R. Painter. 5<sup>th</sup> Edition. Macmillan, Hampshire & London Publishers. 1992.
5. Microbiology By M. Pelczar, E. Chan & R. Reid. 4<sup>th</sup> Edition. McGraw Hill Education. 1998.

# **BACTERIA AND CHRONIC INFECTIONS**

## **PAPER CODE:MI-906-E1**

Credits: 4

### **UNIT 1. INTRODUCTION TO INFECTIONS; PROPERTIES OF BIOFILMS AND CHRONIC INFECTIONS**

Planktonic and biofilm Growing bacteria  
Infection pathogenesis  
Bacteria and Biofilms  
Biofilm properties  
Chronic infections –Host response part1  
Chronic infections –Host response part2  
Chronic infections – Treatment Failure  
Chronic Infections persistency

### **UNIT 2. BACTERIA AND BIOFILMS AS NATURAL INHABITANTS OF OUR BODY; AND BIOFILMS IN CHRONIC INFECTIONS**

Introduction  
Oral biofilms  
Skin Microbiology  
Commensal Biofilm- gut flora  
Bacteria and Biofilms are ubiquitous  
Cystic fibrosis  
Chronic wounds  
Implants  
Tissue filler  
Otitis Media  
Intravascular catheters

### **UNIT 3. DIAGNOSIS AND TREATMENT OF CHRONIC INFECTIONS**

Diagnosis of chronic infections  
Treatment of chronic infections – part 1  
Treatment of chronic infections – part 2 3.4Diagnosis in clinical Practices

### **UNIT4. EVOLUTIONARY PERSPECTIVES OF BIOFILMS**

Adaptation of bacteria to chronic infections  
Evolution of biofilms –part1  
Evolution of biofilms –part2  
Adaptation and evolution in bacteria

#### **Reference/Text Book:**

1. Alcamo's Fundamentals of Microbiology by J.C. Pommerville. 10<sup>th</sup> Edition. Jones and Bartlett Learning.2013.
2. General Microbiology By R. Stanier, J.C. Ingraham, M. Wheelis, R. Painter. 5<sup>th</sup> Edition. Macmillan, Hampshire & London Publishers.1992.
3. Microbiology By M. Pelczer, E. Chan & R. Reid. 4<sup>th</sup> Edition. McGraw Hill Education.1998.
4. Prescott's Microbiology by J. Willey, L. Sherwood and C.J. Woolverton. 10<sup>th</sup> edition. McGraw Hill Education.2017.
5. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15<sup>th</sup> Edition. Pearson Education.2018.

## **PROJECT WORK**

**PAPER CODE:MI-905C1**

**Credit: 4**

### **UNIT-I PREPARATION OF SYNOPSIS**

Introduction and Identification of the problem, Review of literature, Definition of the problem and logical development of a working hypothesis.

### **UNIT-II METHODOLOGY**

Formulation of objectives and experimental design for verifying the hypothesis, standardization of methodology and modifications if any in the protocol.

### **UNIT-III CONDUCTING EXPERIMENTS AND REPORTING THE FINDINGS**

Phase wise working for experimental findings and observation, soft copy report with statistical analysis, result and discussion of the findings, Group discussion and rectification, pre-submission through departmental seminar.

*NB: Evaluation for part one will be done on:*

- 1. Presentation of Synopsis its objectives, expected outcome, and methodology in detail.*
- 2. Assignment for review of literature related to proposed work.*

## RECENT TRENDS IN ANTIMICROBIAL RESEARCH

**PAPER CODE:MI-1001E1**

**Credit: 4**

### **UNIT I: ANTIMICROBIALS**

An outline of the historical development of antimicrobial agents. Reasons for studying the biochemistry and molecular biology of antimicrobial compounds. Uncovering the molecular basis of antimicrobial action. Current trends in the discovery of antimicrobial drugs. Antimicrobial assays in liquid and solid media, susceptibility testing in liquid and solid media.

### **UNIT II: MODE OF ACTION OF ANTIMICROBIALS**

Antibiotics that inhibit peptidoglycan biosynthesis. Drugs that interfere with the biosynthesis of the cell wall of mycobacteria. Fungal cell wall as a target for antimicrobial drugs. Ionophoric antibiotics. Antifungal agents that interfere with the function and biosynthesis of membrane sterols. Inhibitors of nucleic acid biosynthesis. Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents. A unique antifungal antibiotic - griseofulvin.

### **UNIT-III DRUG RESISTANCE**

The Concept of Drug resistance, Multi Drug Resistance; Types of antimicrobial drugs and associated problems of drug Resistance. Mechanisms of bacterial resistance to host cellular and humoral defenses.

### **UNIT IV: MICROBIAL PATHOGENICITY AND EPIDEMIOLOGY**

Virulence factors: Mechanism of adhesion, colonization and invasion of host tissues by bacterial pathogens, measurements of virulence. Microbial toxins: Characteristics, purification, Mode of action and assay (in vivo, in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria.

#### **Reference/Text Book:**

1. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
2. Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal.  
th
3. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4 Ed., Nirali Prakashan.  
th
4. Osol Arther (1975) *Remington's Pharmaceutical Sciences*, 15 Ed., Mack Pub. Co., Pennsylvania.
5. Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.
6. Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12<sup>th</sup> Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
7. Chatwal G. P. (2003) *Biopharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
8. Micheles P. S., Y. L. Khmel'nitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis, A Natural Approach to Drug Discovery*, Trends in Biotechnol. **16**, 197.
9. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.
10. Medical Microbiology: an Introduction to infectious diseases. Sherris, John C., Ed, Elsevier Publication  
nd  
II edition.
11. Multidrug resistance. Annu Rev Biochem. 2009 ; 78: 119–146.  
doi:10.1146/annurev.biochem.78.082907.145923.

## **PROJECT WORK**

**PAPER CODE:MI-1004C1**

**Credit: 8**

### **UNIT-I: CONDUCTING EXPERIMENTS AND REPORTING THE FINDINGS**

Phase wise working for experimental findings and observation, soft copy report with statistical analysis, result and discussion of the findings, Group discussion and rectification, pre-submission through departmental seminar.

### **UNIT-II: PREPARATION OF FINAL DISSERTATION**

Preparation of final dissertation under the following heads and submission in hard and soft copy: Preface, Certificate, Contents, Introduction, Review of literature, Materials and methods, Experimental findings or Results, Discussion and References. Appendices- Statistical tables etc.

### **UNIT-III: PREPARATION OF MANUSCRIPT FOR A RESEARCH PAPER**

Preparation of manuscript with reference to an International/ National journal on Science or microbiology or related to specific subject matter for publication.

*NB: Evaluation for part two will be done on:*

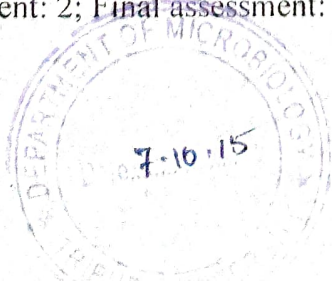
- 1. Preparation of manuscript for a research paper and its communication in a journal*
- 2. Preparation of final dissertation*
- 1. PowerPoint Presentation of overall work of the project*

**M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2015-2016)**

<b>SEMESTER I</b>				
<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>CREDITS</b>	<b>Lecture/ Tutorial/ Practical hrs per week</b>
MICB-701C	Basic Microbiology and Microbial physiology	CORE	4	3L/1T
MICB-702C	Cell biology and Biochemistry	CORE	4	3L/1T
MICB-703C	Biophysics and Instrumentation	CORE	4	3L/1T
MICB-704C	Practicals.	CORE	4	8P
	Compulsory Foundation (Soft Skills)	CF	4	3L/1T
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER II</b>				
MICB-801C	Molecular Biology and Microbial Genetics	CORE	4	3L/1T
MICB-802C	Applied Microbiology	CORE	4	3L/1T
MICB-803E1	Microbial Ecology	ELECTIVE	4	3L/1T
MICB-803E2	Microbial Bioreactors (any one)			
MICB-804C	Practicals	CORE	4	8P
<b>Semester wise credits and hours of lectures</b>			<b>16</b>	
<b>SEMESTER III</b>				
MICB-901C	Molecular tools in Microbiology	CORE	4	3L/1T
MICB-902E1 <sup>s</sup>	Medical Microbiology	ELECTIVE	4+4	6L/2T
MICB-902E2 <sup>s</sup>	Fermented food Technology			
MICB-902E3 <sup>s</sup>	Agriculture and Environmental Microbiology			
MICB-903C	Practicals	CORE	4	8P
<b>Semester wise credits and hours of lectures</b>			<b>16</b>	
<b>SEMESTER IV</b>				
MICB-1001E1	Waste Water Treatment	ELECTIVE	4	3L/1T
MICB-1001E2	Industrial Microbiology	ELECTIVE	4	3L/1T
MICB-1002C	Project Development and Presentation	CORE	8*	16P
MICB-1003C	Bioinformatics & Computational Biostatistics.	CORE PRACTICAL	4	8P
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>Additional Courses- Elective foundation course-</b>			<b>2</b>	
<b>Grand total of credits and hours of lecture hours</b>			<b>74</b>	

<sup>s</sup> Any 2 courses have to be selected from among the 3 courses offered

\* Internal assement: 2; Final assement: 06 credit.



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# MICB-701C: BASIC MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

## **UNIT I: BACTERIOLOGY**

Eubacteria, Archaea, and cyanobacteria. Bacterial structure - Cell envelope, Cell wall, Capsules, Endospore and Bacterial slime. Cytoplasmic membrane, Structure of Flagella, Fimbriae and Pili, Bacterial genetic material: chromosome and plasmids, f-factors and *col* factors; Inclusion granules, Microbial Taxonomy and systematics, Classification and salient features of bacteria according to Bergey's Manual of Determinative Bacteriology.

## **UNIT II: VIROLOGY**

Morphology nomenclature and classification of viruses, ultra-structure, capsid and its arrangements, types of envelopes and its composition, Viral genome. Viroids, virusoids, bacteriophages; human viruses – Epidemiology and life cycle, plant viruses and prions. Mycoplasma: structure and reproduction. Multiplication of viruses. Serological methods and other techniques for the assay of viruses. bacteriophage typing, Antiviral agents and interferons. Application of bacteriophages in health – bacteriophage therapy.

## **UNIT-III: PROTOZOA, FUNGI AND ALGAE**

Characteristics, Structure, Classification, and reproduction of protozoa. Myxomycters: Structure and reproduction. Fungal cell structure, Classification of fungi, Reproduction in fungi, Heterothallism and mating types, Sex hormones in fungi; Fungal toxins. Ultrastructure of Chlorella, desmids and diatoms and methods of reproduction. Single cell protein, Algal toxins, and algal biotechnology.

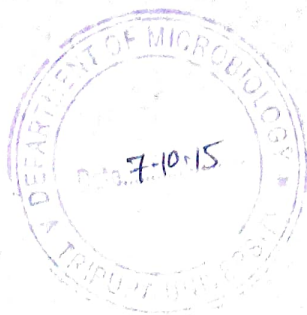
## **UNIT- IV: BASICS OF MICROBIAL PHYSIOLOGY**

Microbial nutrition- Nutrient requirements & nutritional groups; Media Types and maintenance; Media for cultivation of bacteria, fungi and algae; Culture techniques; Synchronous, Continuous, Batch culturing methods. Culture maintenance and preservation. Microbial growth- Definition, growth factors, generation time, growth phases; Methods of growth measurement; Enumeration of bacteria and fungi;

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## MICB -702C: CELL BIOLOGY AND BIOCHEMISTRY

### **UNIT-I: CELL BIOLOGY-I**

Ultra structures and function of Cell wall, Plasma membrane, Membrane Transport and transporter proteins; Mitochondria (pH and electrochemical gradient), Chloroplast

### **UNIT-II: CELL BIOLOGY -II**

Ultra structures and function of ER, Golgi complex, Lysosome, Endosome, Ribosome, Centrosome and Nucleus. Nuclear Transport – Import and Export of protein, Chromatin structure and organization.

Cytoskeleton – Microfilaments, Microtubules

Cell cycle and its regulation, Mitotic and meiotic cell division.

### **UNIT-III: BIOCHEMISTRY-I**

Carbohydrate- Classification and properties of carbohydrates, Aerobic respiration- Glycolysis (EMP-pathway), TCA-cycle with energy production, pentose-phosphate pathway, Oxidation-reduction potential and electromotive force.

Photophosphorylation; Bacterial photosynthesis; Anaerobic respiration - Utilizing NO<sub>2</sub>, Sulfur, CO<sub>2</sub> as electron acceptors, Entner-Doudoroff pathway, Fermentation - lactic acid, ethanol and propionic acid.

### **UNIT-IV: BIOCHEMISTRY-II**

Amino acids- Structural features; classification

Properties and structures of proteins including solubility and denaturation.

Lipid –Classification, properties and characterization of lipids, Bacterial lipids, Major steroids and steroid derivatives of microbial origin.

### **UNIT-V: BIOCHEMISTRY-III**

Enzymes- General properties, Nomenclature and classification, Enzyme Kinetics - Michaelis-Menten equation, Enzyme Inhibition, Ribozyme and Abzyme, Applications of microbial enzymes.

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## MICB -703C: BIOPHYSICS AND BIOINSTRUMENTATION

### **UNIT –I: BASIC LABORATORY INSTRUMENTS**

Buffers: Henderson and Hesselbach equation,  $pK_a$  and  $pK_b$ . Preparation of Buffers.

Viscosity: specific, intrinsic and reduced viscosities, viscometers, determination of molecular size and shape through viscosity.

Osmosis: osmosis in relation to molecular size and molecular weight, osmometer, partial, specific volume and diffusion co-efficient, Dialysis, membrane filtration and its application.

Principle and working of: pH meter, Sterilization techniques

### **UNIT – II: SEPARATION TECHNIQUES**

Centrifugation: Types of centrifuge machines, analytical centrifuges, differential centrifuge, and Ultracentrifuge. Basic principles and applications: of gel filtration chromatography, ion exchange and affinity chromatography, gas liquid chromatography (GLC), high pressure/ performance liquid chromatography (HPLC).

Basic principles of Electrophoresis, Agarose gel and SDS- PAGE, isoelectric focusing, 2D Electrophoresis.

### **UNIT -III: SPECTROSCOPY, RADIOGRAPHY AND TRACER TECHNIQUES**

Spectroscopic techniques: theory and applications of UV, Visible, IR, NMR, Fluorescence, AAS and AES.

Principles and applications of tracer techniques in biology: Radioactive isotopes and half life of isotopes, Effect of radiation on biological system; Autoradiography, Cerenkov radiation, Liquid scintillation counter, Dosimetry. Laboratory procedures and safety aspects.

### **UNIT -IV: MICROSCOPY AND STAINING OF MICROORGANISMS**

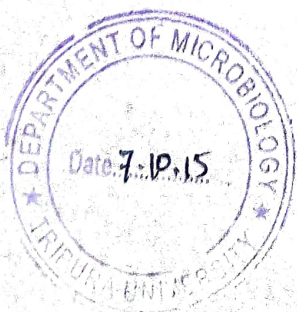
Microscopy: Principles and microscope application of bright-field and dark-field microscopy, Phase- contrast microscopy, fluorescence microscopy, Electron Microscopy : TEM, SEM and AFM , Confocal microscopy

Cytophotometry and flow cytometry.

Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).

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## MICB-704C: PRACTICAL

### Section - A

1. Components of compound microscope. Micrometry.
2. Culture methods, pure culture preparation and sub culturing technique. Microbial growth measurement by direct cell count method, serial dilution method, OD 660nm and standard plate count method.
3. Streak plate and spread plate inoculation for separation of micro-organisms in a mixed microbial population for subsequent pure culture.
4. Staining procedure: Simple staining, negative staining, grams staining, and acid fast staining. Staining of Fungus, spore staining.
5. Biochemical tests- protease activity, catalyse activity, oxidase activity, urese activity.
6. Determination of thermal death point and thermal death time of microorganisms.

### Section -B

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Quantitative analysis and separation of amino acids/ sugars/organic acids by TLC or Paper Chromatography.
3. Study of UV absorption spectra of macromolecules (protein and nucleic acid).
4. Separation of haemoglobin or blue dextran by gel filtration and their spectrophotometric analysis.
5. Estimation of protein by Lowry's method and Bradford method.
6. Estimation of carbohydrate.
7. Estimation of DNA and melting temperature determination by Oswald viscometer.
8. CoT analysis of DNA DNA hybridization by Hydroxylapatite column.

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## MICB-801C: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

### **UNIT-I: INTRODUCTION TO DNA**

Nucleic acids- Structure and properties, Repetitive DNA, DNA renaturation kinetics.  
Forms of DNA and DNA supercoiling.  
DNA replication in prokaryotes: creation of replication fork, various models of DNA replication, enzymes involved in DNA replication.  
Prokaryotic and Eukaryotic gene structure, , Transcription machinery, mRNA processing;  
Reverse transcription; Genetic code and mechanism of translation, Post-tranlational modifications in proteins. Signal sequences and protein transport.

### **UNIT-II: Gene Regulation**

Covalent modification of chromatin, Histone code hypothesis, Chromatin remodeling complexes, heterochromatization, Regulation of gene expression in bacteria (*lac* operon, *trp* operon) and eukaryotes; RNA dependent gene silencing.

### **UNIT-III: DNA MUTATIONS**

Types of mutations, molecular basis of spontaneous and induced mutations, various physical and chemical mutagenic agents, site directed mutagenesis, DNA repair mechanisms. Ames test; Environmental mutagenesis and toxicity testing; Induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants. Transposable elements and mechanisms of transposition. Uses of transposons in genetic analyses.

### **UNIT- IV: BACTERIAL RECOMBINATION**

Bacterial Gene Transfer: gradual development of the concept, Transduction, complementation, Conjugation; Genetic recombination- Bacteriophages; synapsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination, gene conversion; Bacterial transformation, Host cell restriction, & Transfection

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Rusingh  
Department of Microbiology,  
Tribhuvan University



## MICB-802C: APPLIED MICROBIOLOGY

### **UNIT-I: AGRICULTURE MICROBIOLOGY**

Mycorrhizal associations, Role of microbes in organic farming, Biofertilizer and its importance, Biopesticides - classification, Bt toxin and mode of action, Limitation of Bt crops, Neonicotinoids - new generation of biopesticides, Mode of action of neonicotinoids, Concept of integrated pest management, Sustainable agriculture.

### **UNIT-II: MEDICAL MICROBIOLOGY**

Classification of medically important microbes; Bacterial Genetic alterations and drug resistance; Structure and function of immune system including Immune response; Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases, Introduction to medical mycology; Superficial & subcutaneous mycosis; Systemic & opportunistic mycosis; Hospital Acquired infection control programme & biological waste management programme.

### **UNIT-III: FOOD MICROBIOLOGY**

Microorganisms involved in Food Microbiology; Molds and Yeast; Characteristics, Important Genera and Groups of bacteria associated with food industry; Factors effecting growth of microorganisms; Contamination and spoilage; Food Born Illness. Fermented food: nutritional and other benefits.

### **UNIT-IV: INDUSTRIAL MICROBIOLOGY**

Industrial Microbiology- Preview; Industrial Enzymes – Perspectives, Problem and Application; Improvement of Industrial Strains; industrial enzymes; submerged, solid state fermentation, chemostat/Continuous culture Secondary metabolites; biofuel and concept of biorefinery; Microbiology of Pharmaceuticals; Microbial production of industrial solvents;

*A. Singh*

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# MICB-803E1: MICROBIAL ECOLOGY

## **UNIT-I: BASICS OF MICROBIAL ECOLOGY**

Principles and concepts of microbial diversity - Methods of studying diversity - expansion of microbial diversity- estimates of total number of species, measures and indices of diversity- Exploitation and Conservation of microbial diversity, distribution, abundance, ecological niche- physio-chemical characteristics of soil, Role of microbes in biogeochemical cycles.

## **UNIT-II: SOIL MICROBIOLOGY**

Microbial interaction: symbiosis, commensalism, competition, synergism, amensalism, parasitism, Concept of rhizosphere and phyllosphere, Role of Microbes in soil fertility and plant growth. Beneficial Plant-microbe Interactions, Factors influencing soil microflora, Litter decomposition. Roles of microbes in environment; biodegradation of recalcitrant compounds - lignin, pesticides; biotransformation of Xenobiotics, bioaccumulation of metals, bioleaching and microbial bioremediation. Biodegradation of oil and petroleum products.

## **UNIT-III: AERO-MICROBIAL DIVERSITY**

Aeromicrobiology: Microbes diversity in air, Determination of the microbial content of the air- Droplet nuclei, aerosol, aeroallergens; assessment of air quality (solid, liquid impingement methods); air-borne transmission of microbes (viruses, bacteria and fungi), their diseases and preventive measures; Air sampling techniques, Air samples enumeration.

## **UNIT-IV: AQUATIC MICROBIOLOGY**

Aquatic microbiology: Sediments, Surface water, littoral habitats; Soil and associated systems & habitats, factors influencing microflora (Minerals, pH, Organic matter, water and soil texture); altitudinal variations in microflora, Microbes associated at the interface, Microbes associated with plants, animal and insects (Symbiotic and pathogenic); Sewage treatment system (primary, secondary, tertiary and final disinfection of potable water supplies); Biological indicators of water safety and their assessment. Macroscopic marine microbes important in nitrate and sulphate recycling

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Department of Microbiology  
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## MICB-803E2: MICROBIAL BIOREACTORS

### **UNIT-I: MICROBIAL KINETICS**

Basic rate expressions; parameter values; basic mass balances; soluble microbial products; nutrients and electron acceptors; inhibition

### **UNIT-II: REACTORS**

Reactor types: suspended growth reactors; batch reactor ; continuous -Flow Stirred Tank Reactor with Effluent Recycle; membrane reactors; rotating drum reactors; biofilm reactors; reactor arrangements; Mass Balances ; Reactors with Recycling of Settled Cells- CSTR with Settling series and Cell Recycling -Evaluation of assumptions; Engineering Design of Reactors; Reactors in series

### **UNIT-III: BIOFILM KINETICS**

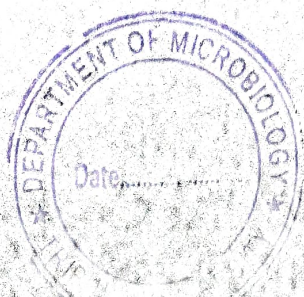
Microbial aggregation; Why biofilms?; The idealized biofilm – substrate phenomenon- the biofilm itself; The steady state biofilm; The steady-State- Biofilm Solution; Estimating parameter values; average biofilm SRT; soluble microbial products and inert biomass;

### **UNIT-IV: ADVANCED MICROBIAL REACTORS FOR WASTE WATER TREATMENT**

Case study of microbial bioreactors for following types of waste water treatment: Municipal, beverage industry effluent, dairy effluent.

*h. w. s.*

*Risingh*  
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## MICB-804C: PRACTICALS

1. Identification of human blood groups.
2. Perform Total and Differential Leukocyte Count of the given blood sample.
3. Separate serum from the blood sample. Separation of serum protein by vertical gel electrophoresis.
4. Determination of Molecular weight of Protein by Column chromatography
5. Perform immunodiffusion by Ouchterlony method.
6. Bacterial Growth curve
7. Plasmid isolation
8. Bacterial Transformation.
9. Genomic DNA isolation, quantification, purity analysis and Restriction digestion.
10. Application of the consortia for plant growth promotion.
11. Testing the plants growth in terms shoot length, leaf number, leaf dimension, number of nodes, chlorophyll content, number of nodules, root branching, etc.
12. The effect of PGPB on leaf epiphytic microbial consortia would be tested.

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Choice -

Attachment 1

# Choice Based Credit System (CBCS)

## M.Sc. MICROBIOLOGY CURRICULUM

2016-17



### DEPARTMENT OF MICROBIOLOGY

TRIPURA UNIVERSITY (A Central University)

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M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2015-2016)

COURSE CODE	COURSE TITLE	COURSE TYPE	CREDITS	Lecture/ Tutorial/ Practical hrs per week
MICB-701C	Basic Microbiology and	CORE	4	3L/1T
MICB-702C	Microbial physiology	CORE	4	3L/1T
MICB-703C	Cell biology and Biochemistry	CORE	4	3L/1T
MICB-704C	Biophysics and Instrumentation	CORE	4	8P
	Practicals,	CORE	4	3L/1T
	Compulsory Foundation (Soft Skills)	CF	4	
Semester wise credits and hours of lectures			20	
<b>SEMESTER II</b>				
MICB-801C	Molecular Biology and Microbial Genetics	CORE	4	3L/1T
MICB-802C	Applied Microbiology	CORE	4	3L/1T
MICB-803C	Bioinformatics and Computational Biostatistics	CORE	4	3L/1T
MICB-804C	Practicals	CORE	4	8
MICB-805E	Microbial Ecology / Bioreactors	ELECTIVE	4	3L/1T
Semester wise credits and hours of lectures			20	
<b>SEMESTER III</b>				
MICB-901C	Tools and Techniques in Microbiology	CORE	4	3L/1T
MICB-902C	Practicals	CORE	4	8
MICB-903E	Waste Water Treatment/ Microbiology of Fermented Food and Products	ELECTIVE	4	4
MICB-904E	Basics of Statistics	<del>SPE</del> ELECTIVE	4	4
MICB905C	Project Work + MOOC	CORE	3+1=4 <del>SPE</del>	8
Semester wise credits and hours of lectures			20	
<b>SEMESTER IV</b>				
MICB-1001E	Intellectual property Rights	ELECTIVE	4	4
MICB-1002E	Advanced Applied Microbiology/ Recent trends in Microbial Research	ELECTIVE	2	2
MICB-1003C	Project Presentation	CORE	4	8
In addition a 2 credit elective course offered by other departments may be taken by the students				
Grand total of credits and hours of lecture hours			72	

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# MICB-701C: BASIC MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

## UNIT-I: BACTERIOLOGY

Introduction to Bacteria and Bacterial structure: Cell envelope, Cytoplasmic membrane, Cell wall, Capsules, flagella, Fimbriae, Intracellular structures, Nuclear material, Ribosome, Inclusion granules, Endospore, Bacterial slime and bio film: Fundamental of Bacterial growth, Requirements for bacterial growth, Carbon and nitrogen sources, Atmospheric conditions, pH, Growth media.

## UNIT-II: VIROLOGY

Brief outlines on discovery of viruses, morphology of viruses, nomenclature and classification, ultra-structure, capsid and its arrangements, types of envelopes and its composition, Viral genomes, Viroids, virusoids, bacteriophages and mycoviruses, prions and spread of prion diseases, Antiviral agents and interferons. Structural organization, multiplication cycle, eclipse phase, phage production, burst size, lytic and lysogenic cycle, bacteriophage typing, application in bacterial genetics, Application of bacteriophages in health - bacteriophage therapy.

Plant virology: Importance, origin, history, Symptoms of diseases; taxonomy ssrna, dsrna and DNA viruses plant virus structures: techniques used to study viral replication and genome organisation Electrophoresis, blotting, nucleic acid hybridization, cloning: Viral genes and gene products; transmission of plant viruses: Vectors, seed, pollen, other. Disease caused by select vural groups Begomoviruses, Tospoviruses, Potyviruses, Comoviruses, other. Persistent (cryptic) plant viruses Endornaviruses, Partitiviruses; Hypovirulence: Plant molecular virology: Plant viruses as gene vectors, viral gene expression Control of viral diseases: Resistance genes, cross protection, seed treatments, cultural, transgenic

## UNIT-III: PHYCOLOGY AND MYCOLOGY

Distribution and classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta; Algal ecology, Algal toxins, Algal food and algal biotechnology. History and development of mycology, General habitat, morphology and reproduction of fungi, Classification of fungi (Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes) and Slime molds, structure and cell differentiation. Homothallism and Heterothallism, Heterokaryosis, Sex hormones in fungi, physiological specialization in fungi, fungal succession on decomposing litter, Mycorrhiza- ectomycorrhiza, endo mycorrhiza and vesicular arbuscular mycorrhiza (VAM), Lichens- ascolichens, basidiolichens and deuterion lichens. Mycoplasma

## UNIT- IV: BASICS OF MICROBIAL PHYSIOLOGY

Microbial nutrition- Nutrient requirements & nutritional groups; Media Types and maintenance; Media for cultivation of bacteria, fungi and algae; Culture techniques; Anaerobic culturing methods; Synchronous, Continuous, Batch culturing methods; Microbial growth- Definition, growth factors, generation time, growth phases; Methods of growth measurement; Enumeration of bacteria; Bacterial endospore- structure, sporulation, germination of spores.

### Reference/Text Book:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, Mc Graw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis
5. Microbiology by Michael J Pelczar
6. Fundamental Principles of Bacteriology A J Salle
7. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science

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External Member,  
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8. Microbiology - An Introduction by Gerard J Tortora, Berdell R Funke, Christine L. Case, David  
 Kindersley (India) Pvt Ltd
9. Microbiology by Stuart Walker, W B Saunders
10. An Introduction to Microbiology by P Lauro, K K Kapoor, KS Yadav

**MICB - 702C: CELL BIOLOGY AND BIOCHEMISTRY**

**UNIT-I: CELL BIOLOGY-I**

Ultra structures and function of Cell wall, Plasma membrane, Membrane Transport and transporter proteins: Mitochondria (pH and electrochemical gradient), Chloroplast

**UNIT-II: CELL BIOLOGY -II**

ER, Golgi complex, Lysosome, Endosome, Ribosome, Centriole, Nucleus, Nuclear Transport -Import and Export of protein, Chromatin structure  
 Cytoskeleton - Microfilaments, Microtubules  
 Cell cycle and its regulation, Mitotic and meiotic cell division.

**UNIT-III: BIOCHEMISTRY-I**

Carbohydrate- Classification and properties of carbohydrates, Aerobic respiration- Glycolysis (EMP-pathway), TCA-cycle with energy production, pentose-phosphate pathway, Oxidation-reduction potential and electromotive force.  
 Photophosphorylation: Bacterial photosynthesis: Anaerobic respiration - Utilizing NO<sub>2</sub>, Sulfur, CO<sub>2</sub> as electron acceptors, Entner-Doudoroff pathway, Fermentation - lactic acid, ethanol and propionic acid.

**UNIT-IV: BIOCHEMISTRY-II**

Amino acids- Structural features, classification  
 Properties and structures of proteins including solubility and denaturation.  
 Lipid -Classification, properties and characterization of lipids, Bacterial lipids, Major steroids and steroid derivatives of microbial origin. Enzymes- General properties, Nomenclature and classification, Enzyme Kinetics - Michaelis-Menten equation, Enzyme Inhibition, Ribozyme and Abzyme, Applications of microbial enzymes.

**Reference/Text Book:**

1. Voet and J.G.Voet. Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger. Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer. Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. Benjamin Lewin. Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. Watson et al.. Molecular Biology of the gene 5th Edition, Pearson Prentice Hall, USA, 2003.
6. Lodish et al.. Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
7. Smith & Wood. Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
8. B. M. Turner. Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
9. B Alberts, A Johnson, J Lewis. Molecular Biology of Cell, Garland Science, 2014.

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**UNIT -I: BASIC LABORATORY INSTRUMENTS**

Buffers: Henderson and Hesselbach equation, pka and pkb. Preparation of Buffers. measurement of pH. types of Electrodes.  
Viscosity: specific, intrinsic and reduced viscosities, viscometers, determination of molecular size and shape through viscosity.  
Osmosis: osmosis in relation to molecular size and molecular weight, osmometer, partial, specific volume and diffusion co-efficient. Dialysis. membrane filtration and its application.  
Principle and working: of pH meter. Laminar-air flow. Autoclave, hot air oven, BOD, Centrifugation: Types of centrifuge machines, analytical centrifuges, differential centrifuge, and Ultracentrifuge.

**UNIT - II: CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES**

Basic principles and applications: of gel filtration chromatography, ion exchange and affinity chromatography, gas liquid chromatography (GLC), high pressure/ performance liquid chromatography (HPLC).  
Basic principles of Electrophoresis and electro-focussing, theory and application of SDS- PAGE. and isoelectric focusing

**UNIT -III: SPECTROSCOPY, RADIOGRAPHY AND TRACER TECHNIQUES**

Spectroscopic techniques: theory and applications of UV, Visible, IR, NMR, Fluorescence, Atomic Absorption. Hydrodynamic methods, Atomic absorption spectroscopy.  
Principles and applications of tracer techniques in biology: Radioactive isotopes and half life of isotopes. Effect of radiation on biological system; Autoradiography, Cerenkov radiation, Liquid scintillation Spectrometry, Dosimetry, laboratory procedures and safety aspects.

**UNIT -IV: MICROSCOPY AND STAINING OF MICROORGANISMS**

Microscopy: General Principles and components of simple, microscope, compound microscope, bright-field and dark-field microscope, Phase- contrast microscope, fluorescence microscope, Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM), Cytophotometry and flowcytometry  
Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).

**Reference/Text Book:**

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
3. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
4. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
5. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
6. Spectroscopy by B.P. Straughan and S. Walker.
7. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
8. Gel Chromatography by TiborKremmery. Wiley Publications.
9. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
10. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.
11. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
12. Alberts, A Johnson, J Lewis. Molecular Biology of Cell. Garland Science, 2014.
13. Online Biophysics. V Bloomfield.pdf. NCBI Website.

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MICB-704C: PRACTICAL

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature.
6. Assay of carbon and nitrogen.
7. Assay of antibiotics production and demonstration of antibiotic resistance.
8. Isolation and screening of industrially important microorganisms.
9. Determination of thermal death point and thermal death time of microorganisms.
10. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
11. Study of UV absorption spectra of Haemoglobin.
12. Estimation of protein by Lowry's method.

Reference/Text Book:

1. Microbiology A Laboratory Manual. 2008. 7<sup>th</sup> Edition by Cappuccino and Sherman; Pearson Education, ISBN 81-317-1437-3.

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# MICB-801C: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

## UNIT-I: INTRODUCTION TO MOLECULAR BIOLOGY

DNA structure, forms of DNA and DNA supercoiling; The law of DNA constancy and c-value paradox; properties of DNA-denaturation, renaturation, melting curve and hyper chromicity; DNA replication in prokaryotes: origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading. Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution, Mutagens, Types of mutations, transposon mutagenesis, site directed mutagenesis, Ames test; Environmental mutagenesis and toxicity testing; Induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants.

## UNIT-II: BACTERIAL RECOMBINATION

Bacterial Gene Transfer: gradual development of the concept, Genetic recombination- Bacteriophages; synopsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination gene conversion; Bacterial transformation, Host cell restriction, Transduction, complementation. Conjugation & Transfection.

## UNIT-III: BASICS OF DNA TECHNOLOGY

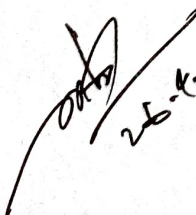
Introduction to genetic engineering; Restriction endonucleases – types, nomenclature, classification, application; DNA ligases – properties and functions, ligation techniques; DNA modifying enzymes – polymerases, DNase, RNase, polynucleotide kinases, alkaline phosphatases and terminal nucleotidyl transferase.

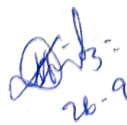
## UNIT-IV: MOLECULAR TOOLS

Plasmids: plasmids as vectors for gene cloning and plasmid DNA replication; Transposons in prokaryotes and eukaryotes and their uses in genetic analyses; Life cycle of bacteriophages and their uses in microbial genetics. Cloning vehicles: Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid), Bacteriophage ( $\lambda$  phage and M13 vectors), cosmids, phagemids, expression vectors, shuttle vectors, excretion vectors and Animal viral vectors; Promoter in expression vectors: Lac Z promoter, Lambda P<sub>L</sub>/ P<sub>R</sub> Promoter, T<sub>7</sub> Promoter, Sp6 Promoter, SV-40 promoter, Cam V35s promoter and Ribosome binding sites. Transformation techniques. Genomic libraries- Isolation of genomic DNA fragments, selection of vectors, cDNA libraries and cDNA cloning, shot gun cloning, Bacterial Artificial libraries.

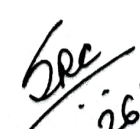
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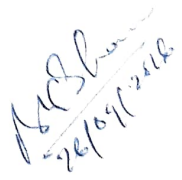
1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
4. Molecular Genetics An Introductive Narrative by G S Stent and R Calender, San Francisco, Calif. : W.H. Freeman, 1978.

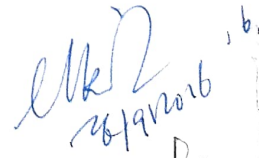
  
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## MICB-802C: APPLIED MICROBIOLOGY

### **UNIT-I: SOIL AND AGRICULTURE MICROBIOLOGY**

History of soil microbiology. Soil microbiology- Stages of Soil Formation. Soil microbes: Agriculture Practices in Stone age. Mycorrhizae. Ectomycorrhizae. Endomycorrhizae. Mycorrhizal inoculation. Horizontal vs Vertical Expansion in Agriculture (Green Revolution). Soil Analysis. Chemical fertilizer. Biofertilizer. Pesticides- classification. Mode of action. Drawbacks of chemical pesticides. Biopesticides - classification. Delta -Endotoxin of *Bacillus thuringiensis*. Three domain structure of delta-endotoxin. Mode of action. Limitation of Bt crops. Neonicotinoids-new generation of biopesticides. Mode of action of neonicotinoids. Sustainable agriculture.

### **UNIT-II: MEDICAL MICROBIOLOGY**

Classification of medically important microbes: Bacterial Genetic alterations and drug resistance: Structure and function of immune system including Immune response: Autoimmunity, Hypersensitivity and Immunodeficiency. Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases. Introduction to medical mycology: Superficial & subcutaneous mycosis; Systemic & opportunistic mycosis; Introduction to parasitic diseases; Protozoan parasites of the intestines; Hospital Acquired infection control programme & biological waste management programme.

### **UNIT-III: FOOD MICROBIOLOGY**

Microorganisms important in Food Microbiology: Molds; Yeast and Yeast like fungi. Industrial Importance; Characteristics. Genera and Groups of bacteria important for food bacteriology; Factors effecting growth of microorganisms; Contamination and spoilage; Food Born Illness

### **UNIT-IV: INDUSTRIAL MICROBIOLOGY**

Industrial Microbiology - Preview; Industrial Enzymes - Perspectives, Problem and Application; Improvement of Industrial Strains; Induced and site directed mutagenesis, Genetic variants; Protein Engineering: Principle and practice with reference to industrial enzymes; Secondary metabolites; submerged, solid state fermentation, chemostat/Continuous culture; Microbiology of food and Pharmaceuticals; Microbial production of industrial solvents; Maintenance of microbial strains; Culture Bank; Bioremediation

### **Reference/Text Books:**

1. Microbial Diversity by Oladele Ogunseitan, Blackwell Publishing, 2005
2. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.
3. Microbial Ecology 4th Ed. by Atlas & Bartha, Benjamin Cummings, 1998.
4. Molecular Microbial Ecology by Osborn & Smith, no assigned readings, but useful background material.
5. Successful Scientific Writing: A Step by Step Guide for the Biological and Medical Sciences by Matthews & Matthews.
6. Atlas RM & Bartha R (1997) Microbial Ecology – Fundamentals and Applications
7. Kirchman DL (2008) Microbial Ecology of the Oceans
8. Barton LL & Northrup DE (2011) Microbial Ecology Wiley-Liss,
9. Begon M, Townsend CR & Harper JL (2006) Ecology – From Individuals to Ecosystems, 4th ed. (Blackwell)
10. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.

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# MICR-803C: BIOINFORMATICS AND COMPUTATIONAL STATISTICS

## Unit I: Computer fundamentals,

Computer system at a glance, processor (CPU, ALU) Memory (ROM, RAM, CACHE data and address bus) Computer system at a glance, processor (CPU, ALU) Memory (ROM, RAM, CACHE data and address bus) Storage, Input & Output devices, Computer peripherals, Binary code and binary system, Algorithms and Flow charts, Software & Hardware, Operating systems, Application software's (Spreadsheet) Mainframe computers, Super computer, Mini and Micro computers, Workstation, Concept of multimedia and its applications, Network concepts (LAN, WAN) and its topology, Network media and hardware, Design and application of modern data communication over telephone lines and Digital telephone lines, Internet protocols HTML, XHTML, XML, WWW (World Wide Web) HTTP, SHTTP, Internet connectivity, search engines.

## Unit II: Basics of Programming AND Retrieving Information:

Learning: P, R, L, Databases: contents, organisation, annotation, quality control, access, links, interoperability & data mining; Programming languages and tools, traditional programming languages, scripting languages, program libraries specialized for molecular biology; Java: computing over the web, Markup languages; Natural language processing and mining the biomedical literature, Application of text mining; Database indexing and specification of search terms, the archives: nucleic acid sequence database, genome database and genomic browsers, protein sequence database, databases of structures, classification of protein structures, accuracy and precision of protein structure determination.

## Unit III: Sequence alignment and phylogenetic tree

Submission and retrieval of Data in GenBank, Basic principle of genome assembly and annotation, Scoring matrices for nucleic acid and protein sequence analysis: PAM, BLOSSUM, Pairwise and multiple sequence analysis; Database searching using BLAST, Phylogenetic analysis, Introduction to R programming, Analysis of Variance, Linear Regression, Multiple linear regression, Multiple linear regression with interaction, Polynomial Regression, Poisson Distribution, Scatter Plot, Correlation and Covariance, Stem and Leaf Plots, Box Plots, t Distribution and T score, One sample Test, Two sample test, Paired Test.

## Unit IV: Structural Bioinformatics and Drug discovery and Computational Statistics (using R)

Protein stability and folding, Sasisekharan-Ramakrishnan-Ramchandran plot, protein stability and denaturation, superposition of structures and structure alignment DALI & MUSTANG, Evolution of function structures, protein structure prediction and modelling, prediction of protein function, divergence of function orthologues and prologues; drug discovery and development, lead compound, improving on the lead compound, Quantitative Structure Activity Relationship(QSAR) Molecular modelling in drug discovery.

## Reference/Text Book:

1. Introduction to Bioinformatics Arthur M. Lesk Oxford University Press (2014) ISBN 978-0-19-872467-4
2. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics Version 3.3.1 (2016-06-21) by W. N. Venables, D. M. Smith and the R Core Team.

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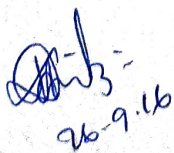
## MICB-804C: PRACTICAL

1. Identification of human blood groups.
2. Perform Total and Differential Leukocyte Count of the given blood sample.
3. Separate serum from the blood sample. Separation of serum protein by vertical gel electrophoresis.
4. Determination of Molecular weight of Protein by Column chromatography
5. Plasmid isolation
6. Bacterial Transformation.
9. Genomic DNA isolation, quantification, purity analysis.
10. Study of UV absorbance spectra for Protein and DNA

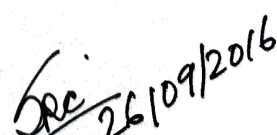
### Reference/ Text Book:

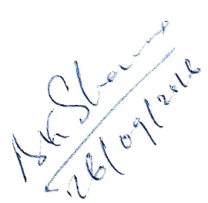
1. Sambrook J, Fritsch EF, Maniatis T. (1989). In: Molecular Cloning: A Laboratory Manual (2nd ed). CSH Press, USA.
2. R.W. Old & S. B. Primrose (1990) *Principles of Gene Manipulation : An Introduction to Genetic Engineering*. Clackwell Science Ltd
3. Protein Purification: Principles and Practice by Robert K Scopes. Springer Advanced Texts in Chemistry. 1993.

  
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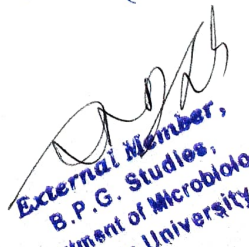
  
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# MICB-805E: MICROBIAL ECOLOGY

## **UNIT-I: BASICS OF MICROBIAL ECOLOGY**

Principles and concepts of microbial diversity - Methods of studying diversity - expansion of microbial diversity- estimates of total number of species, measures and indices of diversity-Exploitation and Conservation of microbial diversity distribution, abundance, ecological niche. Types: Bacterial, Archaeal and Eukaryal. Positive and negative roles of microbes in environment; biodegradation of recalcitrant compounds - lignin, pesticides; bioaccumulation of metals and detoxification - biopesticides; bioleaching (paper, leather, wood, textiles) and bioremediation.

## **UNIT-II: BASICS OF AERO-MICROBIAL DIVERSITY**

Aeromicrobiology: Microbes diversity in air, Determination of the microbial content of the air- Droplet nuclei aerosol, aeroallergens: assessment of air quality (solid, liquid impingement methods); air borne transmission of microbes (viruses, bacteria and fungi), their diseases and preventive measures; Air sampling techniques, Air samples enumeration.

## **UNIT-III: BASICS OF SOIL MICROBIAL DIVERSITY**

Soil classification-physiochemical characteristics, soil microflora distribution - Factors influencing the soil microflora - Role of microorganisms in soil fertility, microbial interactions symbiosis-mutualism, commensalism, competition, synergism, amensalism, parasitism, predation - Interactions between microbes and plants - rhizosphere, phyllosphere, mycorrhizae. Microbial interactions in animals; role of biogeochemical cycles in microbial diversity (carbon, nitrogen, phosphorous and sulphur); Diversity of extremophiles.

## **UNIT-IV: AQUATIC MICROBIAL DIVERSITY**

Aquatic microbiology: Sediments, Surface water, littoral habitats; Soil and associated systems & habitats, factors influencing microflora (Minerals, pH, Organic matter, water and soil texture); altitudinal variations in microflora, Microbes associated at the interface, Microbes associated with plants, animal and insects (Symbiotic and pathogenic); Parasitic microbes, symbiotic microflora, saprophytes; Sewage treatment system (primary, secondary, tertiary and final disinfection of potable water supplies); Biological indicators of water safety and their assessment.

### **Reference/Text Book:**

1. Microbial Diversity by Oladele Ogunseitan, Blackwell Publishing, 2005
2. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.
3. Microbial Ecology 4th Ed. by Atlas & Bartha, Benjamin/Cummings, 1998.
4. Molecular Microbial Ecology by Osborn & Smith, no assigned readings, but useful background material.
5. Successful Scientific Writing: A Step by Step Guide for the Biological and Medical Sciences by Matthews & Matthews.
6. Atlas RM & Bartha R (1997) Microbial Ecology – Fundamentals and Applications
7. Kirchman DL (2008) Microbial Ecology of the Oceans
8. Barton LL & Northrup DE (2011) Microbial Ecology Wiley-Liss,
9. Begon M, Townsend CR & Harper JL (2006) Ecology – From Individuals to Ecosystems, 4th ed.

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# MICB-805E: MICROBIAL BIOREACTORS

## **UNIT-I: MICROBIAL KINETICS**

Basic rate expressions; parameter values; basic mass balances; soluble microbial products; nutrients and electron acceptors; inhibition

## **UNIT-II: REACTORS**

Reactor types: suspended growth reactors; batch reactor; continuous flow Stirred Tank Reactor with Effluent Recycle; membrane reactors; rotating drum reactors; biofilm reactors; reactor arrangements; Mass Balances; Reactors with Recycling of Settled Cells- CSIR with Settling and Cell Recycling -Evaluation of assumptions; Engineering Design of Reactors; Reactors in series

## **UNIT-III: BIOFILM KINETICS**

Microbial aggregation; Why biofilms?: The idealized biofilm -- substrate phenomenon- the biofilm itself. The steady state biofilm: The steady-State- Biofilm Solution; Estimating parameter values; average biofilm S.P.T. soluble microbial products and inert biomass;

## **UNIT-IV: ADVANCED MICROBIAL REACTORS FOR WASTE WATER TREATMENT**

Case study of microbial bioreactors for following types of waste water treatment: Municipal, beverage industry effluent, dairy effluent.

### **Reference/Text Book:**

1. Biochemical Engineering Fundamentals. J. Bailey and DF Ollis McGraw Hill, 2010
2. Bioreaction engineering Principles J. Nielsen and J. Villadsen, Academic Press
3. Environmental Biotechnology Principles and Applications. Bruce E Rittman and Percy L McCarty, TataMcGraw Hill Edition (2012) ISBN. 10:1-25-900288-8.

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# MICB-901C: TOOLS AND TECHNIQUES IN MICROBIOLOGY

Unit I:  
Conventional and insilico techniques. DNA isolation. PCR amplification of 16SrDNA. Agarose gel analysis. PFGE. ARB for bacterial strain identification. Community analysis: Direct and indirect method. Shannon Diversity Index. Equitability Index. RAPD, RFLP, TDDG, DGGE for community Analysis.

Unit II:  
Bacterial Draft Genome Sequence Analysis for strain identification: MAUVE Analysis, BRIG Analysis. Dot plot. Rapid Annotations using Subsystem Technology. Bacterial Transcriptome Analysis: Extracellular Enzymes: intracellular enzymes.

Unit III:  
TA cloning. Artificial chromosome vectors (YACs; BACs); Metagenomics. Primer design: DNA polymerases: Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products:

Unit IV:  
Case study of strain identification using a combination of taxonomic and insilico analysis of bacterial strains of genus *Bacillus*.

### Reference/ Text Book:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition. S.B. University Press. 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3. CSHL. 2001.
3. Brown TA. Genomes. 3rd ed. Garland Science 2006
4. Aziz RK, Bartels D, Best AA, DeJongh M, Disz T, Edwards RA, Formosa K, Gerdes S, Glass EM, Kubal M, Meyer F, Olsen GJ, Olson R, Osterman AL, Overbeek RA, McNeil LK, Paarmann D, Paczian T, Parrello B, Pusch GD, Reich C, Stevens R, Vassieva O, Vonstein V, Wilke A, Zagnitko O. 2008. The RAST server: rapid annotations using subsystems technology. BMC Genomics 9:75.
5. [www.arb-home.de](http://www.arb-home.de)
6. Rang J et al Comparative analysis of genomics and proteomics in *Bacillus thuringiensis*. PLoS ONE. 2015. 10(3):e0119065

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## MICB-902C: PRACTICALS

### A) Understanding the cultivable microbes from dental Flora.

Experiment 1:- Standardization of technique for sampling the dental flora.

Experiment 2:- Growing the dental micro-flora in the selected media & determination of (a) pre-incubation time &

(b) requisite dilution to get the CFU count and diversity estimate.

Experiment 3:- Isolation, purification, Characterization of dental micro-flora, & antibiotic sensitivity test.

Experiment 4:- In-vitro set up for testing antibiotic therapy in case of dentine tissue or teeth.

Experiment 5:- Visualization of the teeth surface using Scanning Electron Microscope.

### B) To find out the relative proportion of Lactic Acid Bacteria from natural sources.

Experiment 6:- Isolation of acid producing bacterial from various natural sources like grass, intestine of fish and prawn, curd, fermented fish, bee hibe, etc

Experiment 7:- Characterization of isolates.

Experiment 8:- Testing for biofilm formation by the isolate.

Experiment 9:- Production of Lactic acid from whey in packed bed reactor.

### References:

- 1) Mishra, M., S. Ghosh, L.E. Alex, I. Mukherjee, T.P. Sinha, A.R. Thakur and S Ray Chaudhuri. 2012. Developing a system for antibacterial treatment of dental caries using culture based approach. OnLine J. Biol. Sci., 12: 44-53.
- 2) V Helen Shiphrah, Sayanti Sahu, Ashoke Ranjan Thakur and S Ray Chaudhuri. 2013 Screening of bacteria for lactic acid production from whey water. American Journal of Biochemistry and Biotechnology, 9 (2): 118-123.
- 3) Ghosh, S., G. Roy and B. Mukherjee, 2009. Dental mold: A novel formulation to treat common dental disorders. AAPS Pharm. Sci. Tech., 10: 692-702. PMID: 19466555
- 4) Martín R, Soberón N, Vanechoutte M, Camino FV, Suárez JE. Characterization of indigenous vaginal lactobacilli from healthy women as probiotic candidates. International microbiology: Official journal of the Spanish Society for Microbiology. 2008;11(4):261-6.

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# MICB-903E: MICROBIOLOGY OF FERMENTED FOOD AND PRODUCTS

**Unit I: Introduction**-Origin and History of food fermentation; Fermented foods "from art to science"; Basis of fermentation processes; Health benefits and other significances of fermented food and beverage; Fermented foods in the twenty-first century.

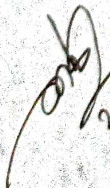
**Unit II: Basics of Fermentation Technology**-Types of fermentation- (submerged solid state, Batch/continuous fermentation); Basic Structure of fermentors and types; Basic process and requirements for fermentation and factor affecting fermentation process; Upstream and Downstream processing of microbial products and quality control of products; Basic strain improvement process; Recent developments in fermentation technology.

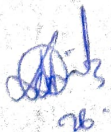
**Unit III: Traditional Fermented Food and Beverages**- Tradition of fermented food and beverages of Asia and North East India; Food habits and types of their fermented food: Fermented baked product; Fermented vegetable foods- Sauerkraut, Kimchi, Pickle, bamboo shoots; Fermented soyabean products- (Temph, Tofu, Soya sauce); fermented beans; Fermented dairy products-Cheese, Dahi and Yogurt, Butter, Other fermented food products- Idli, Vada, Dosa, Bhatara, Dhokla; Fermented fish, meat and sausages; Fermented beverages- Sake, Rice beers, Ale, Wines.

**Unit IV: Industrial Application of Fermentation Products**- Production of Industrial alcohol- Ethanol and Butanol; Organic acids- Citric acid, Lactic acid, Glutamic acid; Amino acids- (Lysine, Phenylalanine, Tryptophan); Biopolymers- (Dextran, Xanthan); Antibiotics- (cephalosporin's, Tetracycline's, Polymyxins); Enzymes- (Alpha-amylase, Lipase, Pectinases, Proteases); Vitamins- (Vitamin B12 and Riboflavin); Single cell protein; Alcoholic beverages- (Toddy, Beer, Wine, Champagne, Rum, Brandy, Whisky).

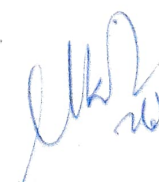
## **Reference/Text Book:**


1. Food Microbiology by William Frazier, Dannise Westhoff, McGraw-Hill, Inc.
2. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
3. Microbial Physiology by Moat A.G. and Foster J. W. 1999., Wiley.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York
5. Principles of Fermentation Technology, 3rd Edition by Stanbury & Whitaker & Hall. Butterworth-Heinemann, Elsevier science.
6. The Art of Fermentation by Sandor Ellix Katz, Chelsea Green Publishing (2012).
7. Mastering Fermentation by Kate Williams, Oxford publishing.

  
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## MICB-903E: WASTE WATER TREATMENT

**Unit I:** History of Waste water treatment/management: Early civilization, Middle Age, Age of Enlightenment, industrial revolution, the progressive era, the great depression and World War II, post war era. Present regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the emergency planning and community right to know act, Pollution Prevention act 1990, an approach to problem solving: a six step method.

**Unit II:** Water and Waste water characteristics: Essential Biology Concepts, Ecology, Limnology: Water supply and treatment: Physical, Chemical (inorganic, organic) and biological characteristics of waste water and Collection.

**Unit III:** Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water: Non-potable applications of treated waste water, design of water treatment systems: Design of waste water treatment systems, Environmental sustainability, Environmental Public Health

### Reference/Text Book:

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr. Wiley Blackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3<sup>rd</sup> Edition by Frank R. Spellman. CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das. Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solutions, 2<sup>nd</sup> Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general review; ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA. United Nations, New York, 2003, url:

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## MICB-904E: BASICS OF STATISTICS

Types of statistical data: primary and secondary data. Classification, Tabulation and Diagrammatic presentation of data. Frequency Distribution, Cumulative Distribution and their graphical representation. Histogram, Frequency Polygon, Frequency Curve and Ogive. Measures of central tendency: Arithmetic, geometric and harmonic mean, median and mode. Measures of dispersion: Mean Deviation, Variance, Moments, skewness and kurtosis and their measures based on quantiles and moments. Correlation Coefficient and its Properties, Spearman's Rank Correlation Coefficient. Correlation and Regression Analysis. Fitting of Linear equation by the principle of Least Squares. Partial and multiple correlation. Random Experiments and Random Events. Classical and Axiomatic definitions of Probability (discrete sample space only). Conditional Probability. Independence of Events and Bayes Theorem. Random Variable and its Probability Distribution, Cumulative Distribution Function, Probability Mass Function and Probability Density Function. Mathematical Expectation, Variance and Moments. Simple Theorems including theorems on expectation and variance of a sum of random variables and expectation of product of Random Variables. Moment generating functions; characteristic functions; probability inequalities (Chebyshev, Markov, Jensen). Introduction of some distributions: Bernoulli, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions. Population, sample, Statistic, standard error, estimation, confidence interval and confidence level. confidence interval estimate of proportion and mean. Hypothesis and its types, errors, critical region, level of significance, power and p-values. Test statistics: Student's t-test, Chi-square, F and Z-Statistics and their applications in testing of hypothesis. Exact and Large sample tests. Analysis of Variance. Non-parametric test - sign, median, run, Mann-Whitney test. Chi square test of goodness of fit, Chi square analysis of contingency table.

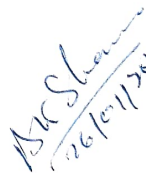
### Reference/Text Books:

- [1] Mukhopadhyay, P: Mathematical Statistics. Books and Allied (P) Ltd.
- [2] Mukhopadhyay, P: Applied Statistics. Books and Allied (P) Ltd.
- [3] Goon, A. M. ... Gupta, M. K and Dasgupta, B.: Fundamentals of Statistics; Vol. I, II
- [4] Rohatgi, V.K. and Ehsanes Saleh, A. K. Md. : An introduction to Probability and Statistics
- [5] Gupta, S.C. and Kapoor, V.K. : Fundamentals of Mathematical Statistics
- [6] Gupta, S.C. and Kapoor, V.K. : Fundamentals of Applied Statistics

  
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## MICB-905C: PROJECT WORK

### Unit -1 Unit -1 Preparation of synopsis

Introduction and Identification of the problem. Review of literature. Definition of the problem and logical development of a working hypothesis.

### Unit -2 Methodology

Formulation of objectives and experimental design for verifying the hypothesis. standardization of methodology and modifications if any in the protocol

### Unit -3 Conducting experiments and reporting the findings

Phase wise working for experimental findings and observation, soft copy report with statistical analysis. result and discussion of the findings. Group discussion and rectification. pre-submission through departmental seminar.

**NB:** Evaluation for part one will be done on:

1. Presentation of Synopsis its objectives, expected outcome, and methodology in detail.
2. Assignment for review of literature related to proposed work.

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## MICB-1002E: ADVANCED APPLIED MICROBIOLOGY

### UNIT-I Agriculture Microbiology

**Role of microorganisms in soil fertility-** Interactions among microorganisms, mutualisms, commensalism, competition, amensalism, parasitism, predation – Interactions between microbes and plants - rhizosphere, phyllosphere, mycorrhizae. Biogeochemical - carbon cycle - role of microbes in carbon cycle- trophic relationships-mobilization and immobilisation of carbon with rhizosphere. Nitrogen cycle - mechanism of biological nitrogen fixation-ammonification-nitrification- denitrification and microorganisms involved in such processes. Phosphorous cycle - Sulphur cycle. Biofertilizer for sustainable agriculture *Rhizobium*

*Azospirillum Azotobacter, Azolla*, applications methods of biofertilizers - significance of biofertilizers.

**Microbial interactions in animals (Fish and Shrimps)-GI Tract microbial biodiversity, Fish probiotics.**

Biogeochemical cycles in terms of aquaculture,

**Pond water treatment for sustainable aquaculture-** Water pollution - sources and nature of pollutants in water - Sewage - industrial effluent - agrochemicals - Eutrophication - waterborne diseases. Potable water. Assessment of microbiological quality of water. Brief account on bioterrorism. Bioremediation. Biofloc technology

### UNIT-II FOOD MICROBIOLOGY

**Importance of studying food and dairy microbiology:** Primary sources of microorganisms in foods.

Factors influencing microbial growth in foods – extrinsic and intrinsic.

**Principles of food preservation:** Preservation methods - irradiations - drying, heat processing, chilling and freezing, high pressure, modification of atmosphere and chemical preservatives. Contamination. preservation and spoilage of fruits vegetables, meat, dairy, agricultural and poultry products.

**Food sanitation in food manufacture and in the retail trade:** Nutritional value of fermented foods. Food control agencies and its regulations. Bacterial pathogens such as *Brucella*, *Clostridium*, *Bacillus*, *E. coli*, *Listeria*, *Salmonella*, *Staphylococcus*, *Vibrio* and *Yersinia*.

### Reference/Text Books:

1. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
2. Ec Eldowney S, Hardman DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.
3. Dink J, Elias V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
4. Ramanathan, and Muthukaruppan SM (2005) Environmental Microbiology. OmSakti Pathipagam. Annamalai Nagar.
5. Andrews AT, Varley J. (1994) Biochemistry of milk products. Royal Society of Chemistry.
6. Banwart GJ. (1989), Basic food microbiology, Chapman & Hall, New York.
7. Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.

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Chairman,  
B.P.G. Studies,  
Department of Microbiology,  
Tirupura University

Member,  
B.P.G. Studies,  
Department of Microbiology,  
Tirupura University

# MICB-1002E: RECENT TRENDS IN MICROBIAL RESEARCH

## Unit I: Antimicrobials

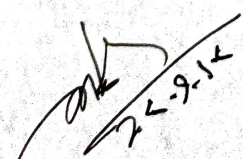
an outline of the historical development of antimicrobial agents. Reasons for studying the biochemistry and molecular biology of antimicrobial compounds. Uncovering the molecular basis of antimicrobial action. Current trends in the discovery of antimicrobial drugs. Antimicrobial assays in liquid and solid media. Susceptibility testing in liquid and solid media. Antibiotics that inhibit peptidoglycan biosynthesis. Drugs that interfere with the biosynthesis of the cell wall of mycobacteria. Fungal cell wall as a target for antimicrobial drugs. Ionophoric antibiotics. Antifungal agents that interfere with the function and biosynthesis of membrane proteins. Inhibitors of nucleic acid biosynthesis. Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents. A unique antifungal antibiotic- griseofulvin, antiviral agents, antiprotozoal agents. Drug transport across cell walls and membranes. Multi drug resistance.

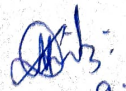
## Unit II: Microbial Pathogenicity and Epidemiology

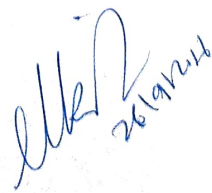
Virulence factors: Mechanism of adhesion, colonization and invasion of host tissues by bacterial pathogens. Measurements of virulence. Mechanisms of bacterial resistance to host cellular and humoral defenses. Microbial toxins: Characteristics, purification, Mode of action and assay (in vivo, in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria.

### Reference/Text Book:

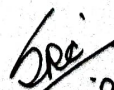
1. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
2. Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal.
3. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4<sup>th</sup> Ed., Nirali Prakashan.
4. Osol Arther (1975) *Remington's Pharmaceutical Sciences*, 15<sup>th</sup> Ed., Mack Pub. Co., Pennsylvania.
5. Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.
6. Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12<sup>th</sup> Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
7. Chatwal G. P. (2003) *Biopharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
8. Micheles P. S., Y. L. Khmelnsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis: A Natural Approach to Drug Discovery*, Trends in Biotechnol. 16, 197.
9. Altreuter D., and D S. Clark, (1999), *Combinatorial Biocatalysis: Taking the Lead From Nature*, Curr. Opin. Biotechnol. 10, 130.
10. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael
11. Medical Microbiology edited by Samuel Baron. Fourth edition. ( University of Texas Medical Branch of Galvesion)
12. Medical Microbiology: an Introduction to infectious diseases. Sherris, John C, Ed. Elsevier Publication
13. Multidrug resistance. Annu Rev Biochem. 2009 ; 78: 119-146.  
doi:10.1146/annurev.biochem.78.082907.145923.

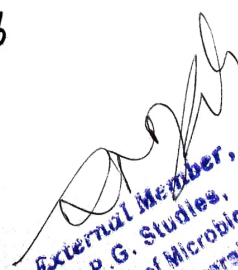
  
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Chairman, 26/09/2016  
B.P.G. Studies,  
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External Member,  
B.P.G. Studies,  
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Tirupura University.

## PAPER -1003C: PROJECT WORK

### Unit-1 **Conducting experiments and reporting the findings**

Phase wise working for experimental findings and observation, soft copy report with statistical analysis, result and discussion of the findings. Group discussion and rectification, pre-submission through departmental seminar.

### Unit-2 **Preparation of final dissertation**

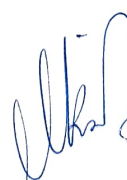
Preparation of final dissertation under the following heads and submission in hard and soft copy: Preface, Certificate, Contents, Introduction, Review of literature, Materials and methods, Experimental findings or Results, Discussion and References. Appendices- Statistical tables etc.

### Unit-3 **Preparation of manuscript for a research paper**

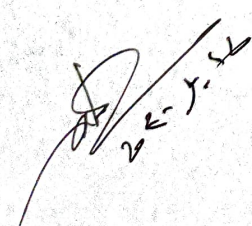
Preparation of manuscript with reference to an International/ National journal on Science or microbiology or related to specific subject matter for publication.

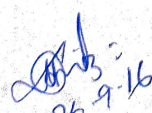
**NB: Evaluation for part two will be done on:**

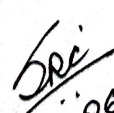
1. Preparation of manuscript for a research paper and its communication in a journal
2. Preparation of final dissertation
3. PowerPoint Presentation of overall work of the project

  
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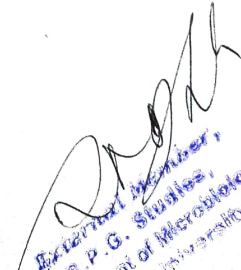
  
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Chairman,  
B.P.G. Studies,  
Department of Microbiology,  
Tripura University.

  
Examiner Member,  
B.P.G. Studies,  
Department of Microbiology,  
Tripura University

# MOOC Courses for the Department of Microbiology

1. Water and Wastewater Treatment Engineering by MITOpenCourseWare  
<https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-85-water-and-wastewater-treatment-engineering-spring-2006/>
2. Microbiology <http://www.scienceprofonline.com/virtual-micro-main.html>
3. Microbiology <http://www.microbiologyonline.org.uk/about-microbiology>

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 Member,  
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 Tripura University.

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 Chairman,  
 B.P.G. Studies,  
 Department of Microbiology,  
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# Choice Based Credit System (CBCS)

## M.Sc. MICROBIOLOGY CURRICULUM 2017-18



### DEPARTMENT OF MICROBIOLOGY

TRIPURA UNIVERSITY (A Central University)

SURYAMANINAGAR, AGARTALA – 799 022

TRIPURA, INDIA

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**M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2015-2016)**

<b>SEMESTER I</b>				
<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>CREDITS</b>	<b>Lecture/ Practical hrs per week</b>
MICB-701C	Basic Microbiology and Microbial physiology	CORE	4	4L
MICB-702C	Cell biology and Biochemistry	CORE	4	4L
MICB-703C	Biophysics and Instrumentation	CORE	4	4L
MICB-704C	Practicals.	CORE	4	8P
	Compulsory Foundation (Soft Skills)	CF	4	4L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER II</b>				
MICB-801C	Molecular Biology and Microbial Genetics	CORE	4	4L
MICB-802C	Applied Microbiology	CORE	4	4L
MICB-803C	Bioinformatics and Computational Biostatistics	CORE	4	4L
MICB-804C	Practicals	CORE	4	8P
MICB-805E1/MICB-806E1	Microbial Adoption / Microbial Technology for Water and Waste Water	ELECTIVE	4	4L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER III</b>				
MICB-901C	Tools and Techniques in Microbiology	CORE	4	4L
MICB-902C	Practicals	CORE	4	8P
MICB-903E	Microbiology of Fermented Food and Products	ELECTIVE	4	4L
MICB-904E	Basics of Statistics	ELECTIVE	4	4L
MICB905C	Project Work+MOOC	CORE	3+1=4	7P+1L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER IV</b>				
MICB-1001E	Intellectual property Rights	ELECTIVE	4	4L
MICB-1002E1	NPTTEL Courses	ELECTIVE	2	2L
MICB-1003E1	Recent trends in Antimicrobial Research	ELECTIVE	2	2L
MICB-1004C	Project Presentation	CORE	4	8P
MICB-1004E	Recent trends in Antimicrobial Research	ELECTIVE	2	2L

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In addition a 2 credit elective course offered by other departments/University approved online courses may be taken by the students

Grand total of credits and hours of lecture hours	72	
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## MICB-701C: BASIC MICROBIOLOGY AND MICROBIAL PHYSIOLOGY

### **UNIT-I: BACTERIOLOGY**

Introduction to Bacteria and Bacterial structure: Cell envelope, Cytoplasmic membrane, Cell wall, Capsules, Flagella, Fimbriae, Intracellular structures, Nuclear material, Ribosome, Inclusion granules, Endospore, Bacterial slime and bio film; Fundamental of Bacterial growth, Requirements for bacterial growth, Carbon and nitrogen sources, Atmospheric conditions, pH, Growth media.

### **UNIT-II: VIROLOGY**

Brief outlines on discovery of viruses, morphology of viruses, nomenclature and classification, ultrastructure, capsid and its arrangements, types of envelops and its composition, Viral genomes, Viroids, virusoids, cynthophages and mycoviruses, prions and spread of prion diseases, Antiviral agents and interferons. Structural organization, multiplication cycle, eclipse phase, phage production, burst size, lytic and lysogenic cycle, bacteriophage typing, application in bacterial genetics, Application of bacteriophages in health – bacteriophage therapy.

Plant virology: Importance, origin, history, Symptoms of diseases; taxonomy ssrna, dsrna and DNA viruses plant virus structures; techniques used to study viral replication and genome organisation Electrophoresis, blotting, nucleic acid hybridization, cloning ; Viral genes and gene products; transmission of plant viruses: Vectors, seed, pollen, other. Disease caused by select vural groups Begomoviruses, Tospoviruses, Potyviruses, Comoviruses, other. Persistent (cryptic )plant viruses Endornaviruses, Partitiviruses; Hypovirulence; Plant molecular virology: Plant viruses as gene vectors, viral gene expression Control of viral diseases: Resistance genes, cross protection, seed treatments, cultural, transgenic

### **UNIT-III: PHYCOLOGY AND MYCOLOGY**

Distribution and classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta; Algal ecology, Algal toxins, Algal food and algal biotechnology. History and development of mycology, General habitat, morphology and reproduction of fungi, Classification of fungi (Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes) and Slime molds, structure and cell differentiation. Homothallism and Heterothallism, Hetrokaryosis, Sex hormones in fungi, physiological specialization in fungi, fungal succession on decomposing litter, Mycorrhiza- ectomycorrhiza, endomycorrhiza and vesicular arbuscularmycorrhiza (VAM), Lichens- ascolichens, basidiolichens and deuteron lichens. Mycoplasma

### **UNIT-IV: BASICS OF MICROBIAL PHYSIOLOGY**

Microbial nutrition- Nutrient requirements & nutritional groups; Media Types and maintenance; Media for cultivation of bacteria, fungi and algae; Culture techniques; Anaerobic culturing methods; Synchronous, Continuous, Batch culturing methods;

Microbial growth- Definition, growth factors, generation time, growth phases; Methods of growth measurement; Enumeration of bacteria; Bacterial endospore- structure, sporulation, germination of spores.

### **Reference/Text Book:**

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis

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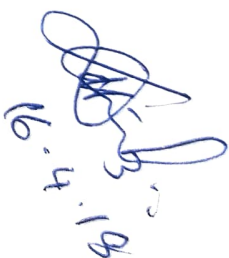
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5. Microbiology by Michael J Pelczar
6. Fundamental Principles of Bacteriology A J Salle
7. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
8. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dr<sup>g</sup> Kindersley (india) Pvt Ltd
9. Microbiology by Stuart Walker, W B Saunders
10. An Introduction to Microbiology by P Tauro, K K Kapoor, KS Yadav

  
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**UNIT-I: CELL BIOLOGY-I**

Ultra structures and function of Cell wall, Plasma membrane, Membrane Transport and transporter protein  
Mitochondria (pH and electrochemical gradient), Chloroplast

**UNIT-II: CELL BIOLOGY -II**

ER, Golgi complex, Lysosome, Endosome, Ribosome, Centriole, Nucleus, Nuclear Transport –Import a  
Export of protein, Chromatin structure  
Cytoskeleton – Microfilaments, Microtubules  
Cell cycle and its regulation, Mitotic and meiotic cell division,

**UNIT-III: BIOCHEMISTRY-I**

Carbohydrate- Classification and properties of carbohydrates, Aerobic respiration- Glycolysis (EMPathway  
TCA-cycle with energy production, pentose-phosphate pathway, Oxidation-reduction potential  
electromotive force.  
Photophosphorylation; Bacterial photosynthesis; Anaerobic respiration - Utilizing NO<sub>2</sub>, Sulfur, CO<sub>2</sub>  
electron acceptors, Entner-Doudoroff pathway, Fermentation - lactic acid, ethanol and propionic acid.

**UNIT-IV: BIOCHEMISTRY-II**

Amino acids- Structural features, classification  
Properties and structures of proteins including solubility and denaturation.  
Lipid –Classification, properties and characterization of lipids, Bacterial lipids, Major steroids and sterol  
derivatives of microbial origin. Enzymes- General properties, Nomenclature and classification, Enzyme  
Kinetics - Michaelis-Menten equation, Enzyme Inhibition, Ribozyme and Abzyme, Applications of micro  
enzymes.

**Reference/Text Book:**

1. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H.Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. Watson et al., Molecular Biology of the gene 5th Edition, Pearson Prentice Hall. USA, 2003.
6. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
7. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
8. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
9. B Alberts, A Johnson, J Lewis, Molecular Biology of Cell. Garland Science, 2014.

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**UNIT -I: BASIC LABORATORY INSTRUMENTS**

Buffers: Henderson and Hesselbach equation, pKa and pKb. Preparation of Buffers, measurement of pH, types of Electrodes.

Viscosity: specific, intrinsic and reduced viscosities, viscometers, determination of molecular size and shape through viscosity.

Osmosis: osmosis in relation to molecular size and molecular weight, osmometer, partial, specific volume and diffusion co-efficient, Dialysis, membrane filtration and its application.

Principle and working: of pH meter, Laminar-air flow, Autoclave, hot air oven, BOD, Centrifugation: Types of centrifuge machines, analytical centrifuges, differential centrifuge, and Ultracentrifuge.

**UNIT - II: CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES**

Basic principles and applications: of gel filtration chromatography, ion exchange and affinity chromatography, gas liquid chromatography (GLC), high pressure/ performance liquid chromatography (HPLC).

Basic principles of Electrophoresis and electro-focussing, theory and application of SDS- PAGE, and isoelectric focusing

**UNIT -III: SPECTROSCOPY, RADIOGRAPHY AND TRACER TECHNIQUES**

Spectroscopic techniques: theory and applications of UV, Visible, IR, NMR, Fluorescence, Atomic Absorption. Hydrodynamic methods, Atomic absorption spectroscopy.

Principles and applications of tracer techniques in biology: Radioactive isotopes and half life of isotopes. Effect of radiation on biological system; Autoradiography, Cerenkov radiation, Liquid scintillation Spectrometry; Dosimetry, laboratory procedures and safety aspects.

**UNIT -IV: MICROSCOPY AND STAINING OF MICROORGANISMS**

Microscopy: General Principles and components of simple, microscope, compound microscope, bright-field and dark-field microscope, Phase- contrast microscope, fluorescence microscope, Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM).  
Cryophotometry and flowcytometry

Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).

**Reference/Text Book:**

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Spectroscopy, Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
3. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
4. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
5. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
6. Spectroscopy by B.P. Straughan and S. Walker.
7. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message. John Wiley and Sons, New York.
8. Gel Chromatography by Tiborkremmery. Wiley Publications.
9. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
10. The use of radioactive isotopes in the life sciences by J.M. Chapman and G. Ayrey, George Allen and Unwin Ltd, London.

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11. A.L. Lehninger, Principles of Biochemistry, 4th edition, W. H Freeman and Company, 2004.
12. Alberts, A Johnson, J Lewis. Molecular Biology of Cell. Garland Science, 2014.
13. Online Biophysics. V Bloomfield.pdf. NCBI Website.

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MICB-704C: PRACTICAL

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.
8. Determination of thermal death point and thermal death time of microorganisms.
9. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
10. Study of UV absorption spectra of Haemoglobin.
11. Estimation of protein by Lowry's method.

Reference/Text Book:

1. Microbiology A Laboratory Manual. 2008. 7<sup>th</sup> Edition by Cappuccino and Sherman; Pearson Edn  
ISBN 81-317-1437-3.

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## MICB-801C: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

### **UNIT-I: INTRODUCTION TO MOLECULAR BIOLOGY**

DNA structure, forms of DNA and DNA supercoiling; The law of DNA constancy and c-value paradox; properties of DNA-denaturation, renaturation, melting curve and hyper chromicity; DNA replication in prokaryotes: origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading.

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; Mutagens, Types of mutations, transposon mutagenesis, site directed mutagenesis, Ames test; Environmental mutagenesis and toxicity testing; Induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants.

### **UNIT-II: BACTERIAL RECOMBINATION**

Bacterial Gene Transfer: gradual development of the concept, Genetic recombination- Bacteriophages: synopsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination gene conversion; Bacterial transformation, Host cell restriction, Transduction, complementation, Conjugation & Transfection.

### **UNIT-III: BASICS OF DNA TECHNOLOGY**

Introduction to genetic engineering; Restriction endonucleases – types, nomenclature, classification, application; DNA ligases – properties and functions, ligation techniques; DNA modifying enzymes – polymerases, DNase, RNase, polynucleotide kinases, alkaline phosphatases and terminal nucleotidyltransferase.

### **UNIT-IV: MOLECULAR TOOLS**

Plasmids; plasmids as vectors for gene cloning and plasmid DNA replication; Transposons in prokaryotes and eukaryotes and their uses in genetic analyses; Life cycle of bacteriophages and their uses in microbial genetics. Cloning vehicles: Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid), Bacteriophage ( $\lambda$  phage and M13 vectors), cosmids, phagemids, expression vectors, shuttle vectors, excretion vectors and Animal viral vectors; Promoter in expression vectors: Lac Z promoter, Lambda P<sub>L</sub>/ P<sub>R</sub> Promoter, T<sub>7</sub> Promoter, Sp6 Promoter; SV-40 promoter, Cam V35s promoter and Ribosome binding sites. Transformation techniques. Genomic libraries- Isolation of genomic DNA fragments, selection of vectors, cDNA libraries and cDNA cloning, shot gun cloning, Bacterial Artificial libraries.

### **Reference/Text Books:**

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
4. Molecular Genetics An Introductive Narrative by G S Stent and R Calender, San Francisco, Calif. : W.H. Freeman, 1978.

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**UNIT-I: SOIL AND AGRICULTURE MICROBIOLOGY**

History of soil microbiology, Stages of Soil Formation, Role of soil microbes in soil formation; Mycorrhizae, Ectomycorrhizae, Endomycorrhizae, Horizontal vs Vertical Expansion in Agriculture (Green Revolution), Soil Analysis, Chemical fertilizer, Biofertilizer, Pesticides- classification, Mode of action, Drawbacks of chemical pesticides, Biopesticides classification, Delta –Endotoxin of Bacillus thuringiensis, Mode of action, Limitation of Bt crops, Neonicotinoids-new generation of biopesticides, Mode of action of neonicotinoids, Sustainable agriculture.

**UNIT-II: MEDICAL MICROBIOLOGY**

Classification of medically important microbes; Bacterial Genetic alterations and drug resistance; Structure and function of immune system including Immune response; Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases. Introduction to medical mycology; Superficial & subcutaneous mycosis; Systemic & opportunistic mycosis; Introduction to parasitic diseases; Protozoan parasites of the intestines; Hospital Acquired infection control programme & biological waste management programme.

**UNIT-III: FOOD MICROBIOLOGY**

Microorganisms important in Food Microbiology; Molds; Yeast and Yeast like fungi, Industrial Importance; Characteristics, Genera and Groups of bacteria important for food bacteriology; Factors effecting growth of microorganisms; Contamination and spoilage; Food Born Illness.

**UNIT-IV: INDUSTRIAL MICROBIOLOGY**

Industrial Microbiology- Preview; Industrial Enzymes – Perspectives, Problem and Application; Improvement of Industrial Strains; Induced and site directed mutagenesis, Genetic variants; Protein Engineering: Principle and practice with reference to industrial enzymes; Secondary metabolites: submerged, solid state fermentation, chemostat/Continuous culture; Microbiology of food and Pharmaceuticals; Microbial production of industrial solvents; Maintenance of microbial strains: Culture Bank; Bioremediation

**Reference/Text Books:**

1. Microbial Diversity by OladeleOgunseitan, Blackwell Publishing, 2005
2. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.
3. Microbial Ecology 4th Ed. by Atlas & Bartha, Benjamin/Cummings, 1998.
4. Molecular Microbial Ecology by Osborn & Smith, no assigned readings, but useful background material.
5. Successful Scientific Writing: A Step by Step Guide for the Biological and Medical Sciences by Matthews & Matthews.
6. Atlas RM & Bartha R (1997) Microbial Ecology – Fundamentals and Applications
7. Kirchman DL (2008) Microbial Ecology of the Oceans
8. Barton LL & Northrup DE (2011) Microbial Ecology Wiley-Liss,
9. Begon M, Townsend CR & Harper JL (2006) Ecology – From Individuals to Ecosystems, 4th ed. (Blackwell)
10. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.

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# MICB-803C: BIOINFORMATICS AND COMPUTATIONAL STATISTICS

## **Unit I: Computer fundamentals.**

Computer system at a glance processor (CPU, ALU) Memory (ROM, RAM, CACHE data and address bus) Storage, Input & Output devices, Computer peripherals, Binary code and binary system, Algorithms and Flow charts, Software & Hardware, Operating systems. Application software's (Spreadsheet) Mainframe computers, Super computer, Mini and Micro computers, Workstation, Concept of multimedia and its applications. Network concepts (LAN, WAN) and its topology, Network media and hardware. Design and application of modern data communication over telephone lines and Digital telephone lines. Internet protocols HTML, SHTML, XML, WWW (World Wide Web) HTTP, SHTTP, Internet connectivity, search engines.

## **Unit II: Basics of Programming AND Retrieving Information:**

Learning PERL, Databases: contents, organisation, annotation, quality control, access, links, interoperability & data mining; Programming languages and tools, traditional programming languages, scripting languages, program libraries specialized for molecular biology; Java: computing over the web, Markup languages; Natural language processing and mining the biomedical literature, Application of text mining. Database indexing and specification of search terms, the archives: nucleic acid sequence database, genome database and genomic browsers, protein sequence database, databases of structures, classification of protein structures, accuracy and precision of protein structure determination.

## **Unit III: Sequence alignment and phylogenetic tree**

Submission and retrieval of Data in GenBank. Basic principle of genome assembly and annotation. Scoring matrices for nucleic acid and protein sequence analysis: PAM, BLOSSUM. Pairwise and multiple sequence analysis. Database searching using BLAST, Phylogenetic analysis. Introduction to R programming, Analysis of Variance, Linear Regression, Multiple linear regression, Multiple linear regression with interaction, Polynomial Regression, Poisson Distribution, Scatter Plot, Correlation and Covariance, Stem and Leaf Plots, Box Plots, t Distribution and T score, One sample Test, Two sample test, Paired Test.

**Unit IV: Structural Bioinformatics and Drug discovery and Computational Statistics (using R)** Protein stability and folding, Sasisekharan-Ramakrishnan-Ramchandran plot, protein stability and denaturation, superposition of structures and structure alignment DALI & MUSTANG. Evolution of protein structures, protein structure prediction and modelling, prediction of protein function, divergence of function orthologues and prologues; drug discovery and development, lead compound, improving on the lead compound, Quantitative Structure Activity Relationship(QSAR) Molecular modelling in drug discovery.

### Reference/Text Book:

1. Introduction to Bioinformatics Arthur M. Lesk Oxford University Press (2014) ISBN 978-0-19872467-4
2. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics Version 3.3.1 (2016-06-21) by W. N. Venables, D. M. Smith and the R Core Team.

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## MICB-804C: PRACTICAL

1. Identification of human blood groups.
2. Perform Total and Differential Leukocyte Count of the given blood sample.
3. Separate serum from the blood sample. Separation of serum protein by vertical gel electrophoresis.
4. Determination of Molecular weight of Protein by Column chromatography
5. Plasmid isolation
6. Bacterial Transformation.
9. Genomic DNA isolation, quantification, purity analysis.
10. Study of UV absorbance spectra for Protein and DNA

### Reference/ Text Book:

1. Sambrook J, Fritsch EF, Maniatis T. (1989). In: *Molecular Cloning: A Laboratory Manual* (2nd ed). CSH Press, USA.
2. R.W. Old & S. B. Primrose (1990) *Principles of Gene Manipulation : An Introduction to Genetic Engineering*, Clackwell Science Ltd
3. *Protein Purification: Principles and Practice* by Robert K Scopes. Springer Advanced Texts in Chemistry. 1993.

  
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## MICB-805E: MICROBIAL ADAPTATION BIOLOGY

### **UNIT-I: Adaptation to Extreme Environment**

Adaptations to pH, Temperature adaptations, Pressure adaptation, Halophilic adaptations, Radiation adaptation,

### **UNIT-II: Pathogenic adaptation to host environment**

Adaptation to acidic environment, Adaptation to Microaerobic conditions, Adaption to immune system stress, Adaptation to Metal stress

### **UNIT-III: Modulation of host pathways by pathogens for adaptation/survival**

Modulation in glycolytic flux, Endoplasmic reticulum stress, Modulation in host Mitochondria, Apoptosis, Necrosis, Phagosome maturation, Autophagy regulation

### **UNIT-IV: Dormancy, Drug Tolerance and Resistance**

Growth regulation by microbes, Survival and reactivation strategies of pathogens in stress through heterogeneous population generation, Persisters, antimicrobial resistance

#### **Reference/Text Books:**

1. Protein adaptation in Extremophiles: January 2008, Publisher: Nova Biomedical, ISBN: 1604560193
2. Extremophiles and Their Applications in Medical Processes: ISBN 978-3-319-12808-5
3. Tuberculosis and the Tubercle Bacillus, Second Edition, ISBN: 9781555819552
4. Reviews and research articles related to topics will be suggested during course

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# MICB- 806E WATER AND WASTE WATER TREATMENT

**Unit I:** Basic Water Chemistry; Water Microbiology; Water Ecology and Limnology; Water Quality monitoring; History of Waste water treatment/management;

**Unit II:** Potable water sources; Water Treatment Operations; Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water;

**Unit III:** Non-potable applications of treated waste water, Environmental sustainability, Environmental Public Health.

**Unit IV:** Regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the emergency planning and community right to know act, Pollution Prevention act 1990, an approach to problem solving: a six step method; Case study.

## **Reference/Text Book:**

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr, Wiley Blackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3rd Edition by Frank R. Spellman, CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das, Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solitions, 2nd Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general review; ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA. United Nations, New York, 2003, url:

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Rajesh Kumar 16/04/18  
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# MICB-901C: TOOLS AND TECHNIQUES IN MICROBIOLOGY

## **Unit I:**

Selective isolation of microbes: selection of medium and growth condition. Characterization of isolates: conventional and insilico techniques, DNA isolation, PCR amplification of 16SrDNA, Agarose gel analysis, AFIGE, PFGE, ARB for bacterial strain identification. Community analysis: Direct and indirect method, Shannon Diversity Index, Equitibility Index. RAPD, RFLP, TDDG, DGGE for community Analysis.

## **Unit II:**

Bacterial Draft Genome Sequence Analysis for strain identification; MAUVE Analysis, BRIG Analysis, Dot plot, Rapid Annotations using Subsystem Technology, Bacterial Transcriptome Analysis; Extracellular Enzymes: intracellular enzymes.

## **Unit III:**

TA cloning, Artificial chromosome vectors (YACs; BACs); Metagenomics, Primer design; DNA polymerases; Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; **Unit IV:**

Case study of strain identification using a combination of taxonomic and insilico analysis of bacterial strains of genus *Bacillus*.

## Reference/ Text Book:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Aziz RK, Bartels D, Best AA, DeJongh M, Disz T, Edwards RA, Formsma K, Gerdes S, Glass EM, Kubal M, Meyer F, Olsen GJ, Olson R, Osterman AL, Overbeek RA, McNeil LK, Paarmann D, Paczian T, Parrello B, Pusch GD, Reich C, Stevens R, Vassieva O, Vonstein V, Wilke A, Zagnitko O. 2008. The RAST server: rapid annotations using subsystems technology. BMC Genomics 9:75.
5. [www.arb-home.de](http://www.arb-home.de)
6. Rang J et al Comparative analysis of genomics and proteomics in *Bacillus thuringiensis*. PLoS ONE. 2015. 10(3):e0119065

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**A) Understanding the cultivable microbes from dental Flora.**

Experiment 1:- Standardization of technique for sampling the dental flora.

Experiment 2:- Growing the dental micro-flora in the selected media & determination of (a) pre-incubation time & (b) requisite dilution to get the CFU count and diversity estimate.

Experiment 3:- Isolation, purification, Characterization of dental micro-flora, & antibiotic sensitivity test.

Experiment 4:- In-vitro set up for testing antibiotic therapy in case of dentine tissue or teeth.

Experiment 5:- Visualization of the teeth surface using Scanning Electron Microscope.

**B) To find out the relative proportion of Lactic Acid Bacteria from natural sources.**

Experiment 6:- Isolation of acid producing bacterial from various natural sources like grass, intestine of fish and prawn, curd, fermented fish, bee hive, etc

Experiment 7:- Characterization of isolates.

Experiment 8:- Testing for biofilm formation by the isolate.

Experiment 9:- Production of Lactic acid from whey in packed bed reactor.

**References:**

- 1) Mishra, M., S. Ghosh, L.E. Alex, I. Mukherjee, T.P. Sinha, A.R. Thakur and S Ray Chaudhuri, 2012. Developing a system for antibacterial treatment of dental caries using culture based approach. OnLine J. Biol. Sci., 12: 44-53.
- 2) V Helen Shiphrah, Sayanti Sahu, Ashoke Ranjan Thakur and S Ray Chaudhuri. 2013 Screening of bacteria for lactic acid production from whey water. American Journal of Biochemistry and Biotechnology, 9 (2): 118-123.
- 3) Ghosh, S., G. Roy and B. Mukherjee, 2009. Dental mold: A novel formulation to treat common dental disorders. AAPS Pharm. Sci. Tech., 10: 692-702. PMID: 19466555
- 4) Martín R, Soberón N, Vaneechoutte M, Camino FV, Suárez JE. Characterization of indigenous vaginal lactobacilli from healthy women as probiotic candidates. International microbiology: Official journal of the Spanish Society for Microbiology. 2008;11(4):261-6.

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Ashok Kumar 16.04/18  
S. Ghosh 16.4.18  
S. Ray 8/11/19  
S. Ghosh 16/04/2018

## MICB-903E: MICROBIOLOGY OF FERMENTED FOOD AND PRODUCTS

**Unit I: Introduction**-Origin and History of food fermentation; Fermented foods “from art to science”; Basics of fermentation processes; Health benefits and other significances of fermented food and beverages; Fermented foods in the twenty-first century.

**Unit II: Basics of Fermentation Technology**-Types of fermentation- (sub-merged/solid state, Batch /continuous fermentation); Basic Structure of fermentors and types; Basic process and requirements for fermentation and factor affecting fermentation process; Upstream and Downstream processing of microbial products and quality control of products; Basic strain improvement process; Recent developments in fermentation technology.

**Unit III: Traditional Fermented Food and Beverages**- Tradition of fermented food and beverages of Asia and North East India; Food habits and types of their fermented food; Fermented baked product; Fermented vegetable foods- Sauerkraut, Kimchi, Pickle, bamboo shoots; Fermented soyabean products- (Temph, Tofu, Soya sauce); fermented beans; Fermented dairy products-Cheese, Dahi and Yogurt, Butter; Other fermented food products- Idli, Vada, Dosa, Bhatara, Dhokla; Fermented fish, meat and sausages; Fermented beverages- Sake, Rice beers, Ale, Wines.

**Unit IV: Industrial Application of Fermentation Products**- Production of Industrial alcohol- Ethanol and Butanol; Organic acids- Citric acid, Lactic acid, Glutamic acid; Amino acids- (Lysine, Phenylalanine, Tryptophan); Biopolymers- (Dextran, Xanthan); Antibiotics- (cephalosporin's, Tetracycline's, Polyenes); Enzymes- (Alpha-amylase, Lipase, Pectinases, Proteases); Vitamins- (Vitamin B12 and Riboflavin); Single cell protein; Alcoholic beverages- (Toddy, Beer, Wine, Champagne, Rum, Brandy, Whisky).

### **Reference/Text Book:**

1. Food Microbiology by William Frazier, Dannise Westhoff, McGraw-Hill. Inc.
2. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
3. Microbial Physiology by Moat A.G. and Foster J. W. 1999.. Wiley.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Principles of Fermentation Technology, 3rd Edition by Stanbury & Whitaker & Hall, Butterworth-Heinemann, Elsevier science.
6. The Art of Fermentation by SandorEllix Katz, Chelsea Green Publishing (2012).
7. Mastering Fermentation by Kate Williams, Oxford publishing.

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## MICB-903E: WASTE WATER TREATMENT

**Unit I:** History of Waste water treatment/management: Early civilization, Middle Age, Age of Enlightenment, the industrial revolution, the progressive era, the great depression and World War II, post war era, Present day regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response Compensation and Liability Act (CERCLA), the emergency planning and community right to know act Pollution Prevention act 1990, an approach to problem solving: a six step method.

**Unit II:** Water and Waste water characteristics: Essential Biology Concepts, Ecology, Limnology; Water supply and treatment; Physical, Chemical (inorganic, organic) and biological characteristics of waste water and Collection.

**Unit III:** Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water; Non-potable applications of treated waste water, design of water treatment systems; Design of waste water treatment systems, Environmental sustainability, Environmental Public Health

### **Reference/Text Book:**

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr, Wiley Blackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3<sup>rd</sup> Edition by Frank R. Spellman, CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das, Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solitions, 2<sup>nd</sup> Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general review; ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA. United Nations, New York, 2003, url:

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## MICB-904E: BASICS OF STATISTICS

types of statistical data: primary and secondary data, Classification, Tabulation and Diagrammatic representation of data, Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive. Measures of central tendency: Arithmetic, geometric and harmonic mean, median and mode. Measures of dispersion: Mean Deviation, Variance, moments, skewness and kurtosis and their measures based on quantiles and moments.

Correlation Coefficient and its Properties, Spearman's Rank Correlation Coefficient. Correlation and Regression Analysis, Fitting of Linear equation by the principle of Least Squares. Partial and multiple correlation. Random Experiments and Random Events, Classical and Axiomatic definitions of Probability (discrete sample space only). Conditional Probability, Independence of Events and Bayes Theorem.

Random Variable and its Probability Distribution, Cumulative Distribution Function, Probability Mass Function and Probability Density Function, Mathematical Expectation, Variance and Moments, Simple Theorems including theorems on expectation and variance of a sum of random variables and expectation of product of Random Variables. Moment generating functions; characteristic functions; probability inequalities (Tchebyshef, Markov, Jensen).

Introduction of some distributions: Bernoulli, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions. Population, sample, Statistic, standard error, estimation, confidence interval and confidence level, confidence interval estimate of proportion and mean. Hypothesis and its types, errors, critical region, level of significance, power and p-values. Test statistics: Student's t-test, Chi-square, F and Z-Statistics and their applications in testing of hypothesis. Exact and Large sample tests. Analysis of Variance. Nonparametric test - sign, median, run, Mann-Whitney test. Chi square test of goodness of fit, Chi square analysis of contingency table.

### Reference/Text Books:

- [1] Mukhopadhyay, P: Mathematical Statistics. Books and Allied (P) Ltd.
- [2] Mukhopadhyay, P: Applied Statistics. Books and Allied (P) Ltd.
- [3] Goon, A. M. ., Gupta, M. K and Dasgupta, B.: Fundamentals of Statistics; Vol. I, II
- [4] Rohatgi, V.K. and Ehsanes Saleh, A. K. Md. : An introduction to Probability and Statistics
- [5] Gupta, S.C, and Kapoor, V.K. : Fundamentals of Mathematical Statistics [6] Gupta, S.C, and Kapoor, V.K. : Fundamentals of Applied Statistics

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**Unit -1 Preparation of Project Action Plan**

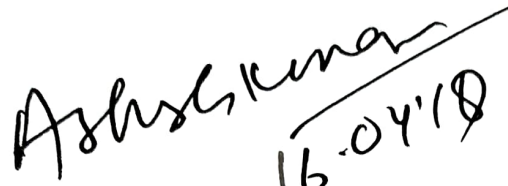
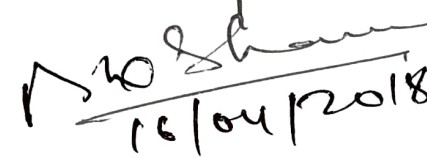
Review of literature, Identification of the problem, Logical development of a working hypothesis, work done in the ongoing semester with statistical analysis (if any). 5 spiral bound copies have to be submitted atleast 15 days before the date of examination.


**Unit – 2 MOOC**

Courses selected by the Department and approved by the authority will be opted. The final assessment will be based on the online assessment conducted by the Online Course Coordinator.

  
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# MICB-1001E: INTELLECTUAL PROPERTY RIGHTS

**Unit I:** Intellectual Property Creation, Protection, and Management; Introduction, Definition & Function of Different IPR's, Case Studies on Why IPR's are Important, and How to Protect/Enforce Them. Trademarks: Introduction, Types of Trade Mark, Mode of Protection, Registration Procedure, Case Studies; Passing Off/Opposition/Litigation Actions, Brand and Trade Mark Valuation. Copyright; Meaning & Importance, Subject Matter & Term, Registration Procedure; Ownership, Economic/Moral Rights, Assignment, Transmission and Licensing; Performer Rights, Broadcast Reproduction Rights, Infringement of Copyright, Remedies of Infringement, Civil, Administrative;

**Unit II:** Patents: Introduction; Definition, Importance & Type of Patents; Patentable Inventions; Prior Art Search – Need and procedure; Patent Drafting/Filing – Procedure and Best Practices: Overview of Patent Filing Procedure, Who can be an Applicant?, Form of Application, Formalities to keep in mind while filing Patent Application; Publication and Examination of Applications; Representation & Pre grant Opposition; Anticipation; Secrecy of Invention; Grant of Patent; Rights of Patentee; Amendment of Application and Specifications; Restoration of Lapsed Patents; Post grant Opposition; Freedom to Operate Searches – Need and Procedure; Compulsory Licensing, Use of Inventions for Govt. Purposes & Revocation; Infringement of Patent & Remedies

**Unit III:** Designs: Introduction; Definition & Importance; Registration Procedure; Overview; Prerequisites of Registration; Application for Registration; Publication; Grant of Certificate; Copyright in Registered Designs & Duration; Cancellation of Registration; Piracy of Registered Designs and Remedies. Geographical Indication: Introduction; Definition & Importance; Registration of GI – Procedure. Plant Varieties and Farmers' Rights: Introduction, Objective and Definition; Registration of Plant Varieties: Application; Requirements for Registration; Requirements for Denomination given to Variety; Non Registerable Varieties (S. 29); Tests to be conducted; Acceptance of Application; Publication of Application; Opposition; Registration; Duration, Effect of Registration and Benefit Sharing; Farmers' Rights; Compulsory License; Plant Varieties Protection Appellate Tribunal; Infringement, Offences and Penalties. Semiconductor Integrated Circuits Layout Designs: Introduction, Importance and Definition; Importance & Definition; Registration – Procedure; Absolute Grounds for Prohibition of Registration; Objections to Acceptance; Publication of Application; Opposition; Registration.

**Unit IV:** IP Litigation: Introduction; Civil vs. Criminal Remedies – Advantages & Strategy; Filing Procedure in Various Civil Courts / High Courts; Defenses in case of Infringement Suit; Pointers Specific to Certain type Civil IP Litigation (e.g. Trademarks, Copyright, Patents etc.); Criminal Litigation; Pointers Specific to Certain type criminal IP Litigation (e.g. Trademarks, Copyright etc.) Confidential Information / Trade Secret: Introduction & Advantages; Type of CI / TS; Requirements for Consideration of Information as CI / TS; Remedies against Breach of Confidence. IP Licensing: Introduction; Meaning & Importance; Licensing vs. Assignment; Compulsory Licensing & Procedure; Strategies for successful transfer of technology. IP Valuation: Introduction; Various Methods of IP Valuation; When to use which Method? IP Due Diligence And Audit: Introduction; Procedure. IP Strategy: IP Portfolio Development Strategy; IP Litigation Strategy; IP Licensing, Tech Transfer, and Commercialization Strategy

## Reference/Text Books:

1. Intellectual property counseling and litigation, Ed by Horwith & Worwitz
2. Intellectual property the law of copyrights, patents and trademarks, By Schechter, Roger E. & Thomas, John R.

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## MICB-1002E: RECENT TRENDS IN ANTIMICROBIAL RESEARCH

### **Unit I: Antimicrobials**

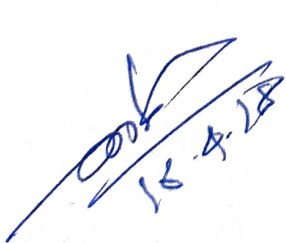
An outline of the historical development of antimicrobial agents. Reasons for studying the biochemistry and molecular biology of antimicrobial compounds. Uncovering the molecular basis of antimicrobial action. Current trends in the discovery of antimicrobial drugs. Antimicrobial assays in liquid and solid media, susceptibility testing in liquid and solid media. Antibiotics that inhibit peptidoglycan biosynthesis. Drugs that interfere with the biosynthesis of the cell wall of mycobacteria. Fungal cell wall as a target for antimicrobial drugs. Ionophoric antibiotics. Antifungal agents that interfere with the function and biosynthesis of membrane sterols. Inhibitors of nucleic acid biosynthesis. Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents. A unique antifungal antibiotic- griseofulvin, antiviral agents, antiprotozoal agents. Drug transport across cell walls and membranes. Multi drug resistance.

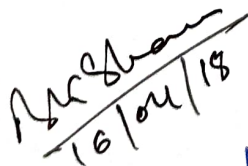
### **Unit II: Microbial Pathogenicity and Epidemiology**

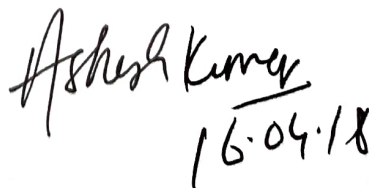
Virulence factors: Mechanism of adhesion, colonization and invasion of host tissues by bacterial pathogens, measurements of virulence. Mechanisms of bacterial resistance to host cellular and humoral defenses. Microbial toxins: Characteristics, purification, Mode of action and assay (in vivo, in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria.

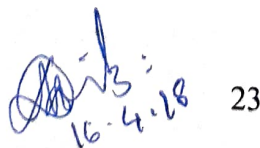
#### Reference/Text Book:

1. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
2. Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal.
3. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4<sup>th</sup> Ed., NiraliPrakashan.
4. OsolArther (1975) *Remington's Pharmaceutical Sciences*, 15<sup>th</sup> Ed., Mack Pub. Co., Pennsylvania.
5. Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.
6. Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12<sup>th</sup> Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
7. Chatwal G. P. (2003) *Biopharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
8. Micheles P. S., Y. L. Khmel'nitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis, A Natural Approach to Drug Discovery*, Trends in Biotechnol. **16**, 197.
9. Altreuter D., and D S. Clark, (1999), *Combinatorial Biocatalysis: Taking the Lead From Nature*, Curr. Opin. Biotechnol. **10**, 130.
10. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael
11. Medical Microbiology edited by Samuel Baron. Fourth edition. ( University of Texas Medical Branch of Galvesion)
12. Medical Microbiology: an Introduction to infectious diseases. Sherris, John C, Ed, Elsevier Publication and II edition.
13. Multidrug resistance. Annu Rev Biochem. 2009 ; 78: 119-146.  
doi:10.1146/annurev.biochem.78.082907.145923.

  
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PAPER -1003C: PROJECT WORK


**Unit -1**


Preparation of final dissertation under the following heads: Certificate, Acknowledgement, Contents/Index, Introduction, Objectives, Materials and methods, Results, Discussion, Conclusion/Summary and References. Appendices- Statistical tables etc.


The report (5) has to be submitted as hard bound copy (at least one).

  
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**Choice Based Credit System (CBCS)**

**M.Sc. MICROBIOLOGY CURRICULUM**

**2018-19**



**DEPARTMENT OF MICROBIOLOGY**

**TRIPURA UNIVERSITY (A Central University)**

**SURYAMANINAGAR, AGARTALA – 799 022**

**TRIPURA, INDIA**



**M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2018-2019)**

<b>SEMESTER I</b>				
<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>CREDITS</b>	<b>Lecture/ Practical hrs per week</b>
MICB-701C	Basic Microbiology and Microbial physiology	CORE	4	4L
MICB-702C	Cell biology and Biochemistry	CORE	4	4L
MICB-703C	Biophysics and Instrumentation	CORE	4	4L
MICB-704C	Practical	CORE	4	8P
	Compulsory Foundation (Soft Skills)	CF	4	4L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER II</b>				
MICB-801C	Molecular Biology and Microbial Genetics	CORE	4	4L
MICB-802C	Applied Microbiology	CORE	4	4L
MICB-803C	Genetic Engineering	CORE	4	4L
MICB-804C	Practicals	CORE	4	8P
MICB-805E/ MICB-806E	Microbial Adaptation/ Microbial Technology for Water and Waste Water	ELECTIVE	4	4L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER III</b>				
MICB-901C	Tools and Techniques in Microbiology	CORE	4	4L
MICB-902C	Practicals	CORE	4	8P
MICB-903E	Microbiology of Fermented Food and Products	ELECTIVE	4	4L
MICB-904E	Basics of Statistics	ELECTIVE	4	4L
MICB-905C	Project Work+MOOC	CORE	3+1=4	7P+1L
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	
<b>SEMESTER IV</b>				
MICB-1001E	Intellectual property Rights	ELECTIVE	4	4L
MICB-1002E	NPTEL Courses	ELECTIVE	2	2L
MICB-1003C	Project Presentation	CORE	4	8P
MICB-1004E	Recent trends in Antimicrobial Research	ELECTIVE	2	2L
<b>In addition a 2 credit elective course offered by other departments/University approved online courses may be taken by the students</b>				

**MICB-701C: BASIC MICROBIOLOGY AND MICROBIAL PHYSIOLOGY****UNIT-I: BACTERIOLOGY**

Introduction to Bacteria and Bacterial structure; Cell envelope, Cytoplasmic membrane, Cell wall, Capsules, Flagella, Fimbriae, Intracellular structures, Nuclear material, Ribosome, Inclusion granules, Endospore, Bacterial slime and bio film; Fundamental of Bacterial growth, Requirements for bacterial growth, Carbon and nitrogen sources, Atmospheric conditions, pH, Growth media.

**UNIT-II: VIROLOGY**

Brief outlines on discovery of viruses, morphology of viruses, nomenclature and classification, ultrastructure, capsid and its arrangements, types of envelops and its composition, Viral genomes, Viroids, virusoids, cynophages and mycoviruses, prions and spread of prion diseases, Antiviral agents and interferons.

Structural organization, multiplication cycle, eclipse phase, phage production, burst size, lytic and lysogenic cycle, bacteriophage typing, application in bacterial genetics, Application of bacteriophages in health – bacteriophage therapy.

Plant virology: Importance, origin, history, Symptoms of diseases; taxonomy ssrna, dsrna and DNA viruses plant virus structures; techniques used to study viral replication and genome organisation Electrophoresis, blotting, nucleic acid hybridization, cloning ;Viral genes and gene products; transmission of plant viruses: Vectors, seed, pollen, other. Disease caused by select vural groups Begomoviruses, Tospoviruses, Potyviruses, Comoviruses, other. Persistent (cryptic) plant viruses Endornaviruses, Partitiviruses; Hypovirulence; Plant molecular virology: Plant viruses as gene vectors, viral gene expression Control of viral diseases: Resistance genes, cross protection, seed treatments, cultural, transgenic

**UNIT-III: PHYCOLOGY AND MYCOLOGY**

Distribution and classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta; Algal ecology, Algal toxins, Algal food and algal biotechnology. History and development of mycology, General habitat, morphology and reproduction of fungi, Classification of fungi (Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes) and Slime molds, structure and cell differentiation.

Homothallism and Heterothallism, Hetrokaryosis, Sex hormones in fungi, physiological specialization in fungi, fungal succession on decomposing litter, Mycorrhiza- ectomycorrhiza, endomycorrhiza and vesicular arbuscularmycorrhiza (VAM), Lichens- ascolichens, basidiolichens and deutron lichens. Mycoplasma

**UNIT-IV: BASICS OF MICROBIAL PHYSIOLOGY**

Microbial nutrition- Nutrient requirements & nutritional groups; Media Types and maintenance; Media for cultivation of bacteria, fungi and algae; Culture techniques; Anaerobic culturing methods; Synchronous, Continuous, Batch culturing methods; Microbial growth- Definition, growth factors, generation time, growth phases; Methods of growth measurement; Enumeration of bacteria; Bacterial endospore- structure, sporulation, germination of spores.

**Reference/Text Book:**

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black

4. General Microbiology by Roger Y Stanier, John L Ingraham, Mark L Wheelis
5. Microbiology by Michael J Pelczar
6. Fundamental Principles of Bacteriology A J Salle
7. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
8. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dorling Kindersley (india) Pvt Ltd
9. Microbiology by Stuart Walker, W B Saunders
10. An Introduction to Microbiology by P Tauro, K K Kapoor, KS Yadav

## MICB -702C: CELL BIOLOGY AND BIOCHEMISTRY

### **UNIT-I: CELL BIOLOGY-I**

Ultra structures and function of Cell wall, Plasma membrane, Membrane Transport and transporter proteins; Mitochondria (pH and electrochemical gradient), Chloroplast

### **UNIT-II: CELL BIOLOGY -II**

ER, Golgi complex, Lysosome, Endosome, Ribosome, Centriole, Nucleus, Nuclear Transport –Import and Export of protein, Chromatin structure  
Cytoskeleton – Microfilaments, Microtubules  
Cell cycle and its regulation, Mitotic and meiotic cell division,

### **UNIT-III: BIOCHEMISTRY-I**

Carbohydrate- Classification and properties of carbohydrates, Aerobic respiration- Glycolysis (EMP pathway), TCA-cycle with energy production, pentose-phosphate pathway, Oxidation-reduction potential and electromotive force.

Photophosphorylation; Bacterial photosynthesis; Anaerobic respiration - Utilizing NO<sub>2</sub>, Sulfur, CO<sub>2</sub> as electron acceptors, Entner-Doudoroff pathway, Fermentation - lactic acid, ethanol and propionic acid.

### **UNIT-IV: BIOCHEMISTRY-II**

Amino acids- Structural features, classification

Properties and structures of proteins including solubility and denaturation.

Lipid –Classification, properties and characterization of lipids, Bacterial lipids, Major steroids and steroid derivatives of microbial origin. Enzymes- General properties, Nomenclature and classification, Enzyme Kinetics - Michaelis-Menten equation, Enzyme Inhibition, Ribozyme and Abzyme, Applications of microbial enzymes.

### **Reference/Text Book:**

1. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. Watson et al., Molecular Biology of the gene 5th Edition, Pearson Prentice Hall. USA, 2003.
6. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
7. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
8. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
9. B Alberts, A Johnson, J Lewis. Molecular Biology of Cell. Garland Science, 2014.

## MICB -703C: BIOPHYSICS AND INSTRUMENTATION

### **UNIT –I: BASIC LABORATORY INSTRUMENTS**

Buffers: Henderson and Hesselbach equation, pka and pkb. Preparation of Buffers, measurement of pH, types of Electrodes. Viscosity: specific, intrinsic and reduced viscosities, viscometers, determination of molecular size and shape through viscosity. Osmosis: osmosis in relation to molecular size and molecular weight, osmometer, partial, specific volume and diffusion co-efficient, Dialysis, membrane filtration and its application. Principle and working: of pH meter, Laminar-air flow. Autoclave, hot air oven, BOD. Centrifugation: Types of centrifuge machines, analytical centrifuges, differential centrifuge, and Ultracentrifuge.

### **UNIT – II: CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES**

Basic principles and applications: of gel filtration chromatography, ion exchange and affinity chromatography, gas liquid chromatography (GLC), high pressure/ performance liquid chromatography (HPLC). Basic principles of Electrophoresis and electro-focussing, theory and application of SDS-PAGE, and isoelectric focusing

### **UNIT -III: SPECTROSCOPY, RADIOGRAPHY AND TRACER TECHNIQUES**

Spectroscopic techniques: theory and applications of UV, Visible, IR, NMR, Fluorescence, Atomic Absorption, Hydrodynamic methods, Atomic absorption spectroscopy.

Principles and applications of tracer techniques in biology: Radioactive isotopes and half life of isotopes, Effect of radiation on biological system; Autoradiography, Cerenkov radiation, Liquid scintillation Spectrometry, Dosimetry, laboratory procedures and safety aspects.

### **UNIT -IV: MICROSCOPY AND STAINING OF MICROORGANISMS**

Microscopy: General Principles and components of simple, microscope, compound microscope, bright-field and dark-field microscope, Phase- contrast microscope, fluorescence microscope, Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM), Cytophotometry and flowcytometry. Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).

#### **Reference/Text Book:**

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
3. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
4. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
5. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
6. Spectroscopy by B.P. Straughan and S. Walker.
7. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
8. Gel Chromatography by TiborKremmery. Wiley Publications.
9. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
10. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.
11. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
12. Alberts, A Johnson, J Lewis. Molecular Biology of Cell. Garland Science, 2014.
13. Online Biophysics. V Bloomfield.pdf. NCBI Website.

## MICB-704C: PRACTICAL

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.
8. Determination of thermal death point and thermal death time of microorganisms.
9. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
10. Study of UV absorption spectra of Haemoglobin.
11. Estimation of protein by Lowry's method.

### Reference/Text Book:

1. Microbiology A Laboratory Manual. 2008. 7<sup>th</sup> Edition by Cappuccino and Sherman; Pearson Education, ISBN 81-317-1437-3.

**UNIT-I: INTRODUCTION TO MOLECULAR BIOLOGY**

DNA structure, forms of DNA and DNA supercoiling; The law of DNA constancy and c-value paradox; properties of DNA-denaturation, renaturation, melting curve and hyper chromicity; DNA replication in prokaryotes: origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading.

**UNIT-II: PROKARYOTIC TRANSCRIPTION AND TRANSLATION**

Transcription: Prokaryotic RNA polymerase and sigma factors, Promoters, Mechanism of transcription in Prokaryotes: Initiation, Elongation, Termination, Translation: Genetic Code, Ribosome Structure, tRNAs, Aminoacyl tRNA synthetase, Initiation, Elongation, Termination; Translational Control. Regulation of Gene Expression: Prokaryotes: Operon Concept, Positive and Negative Regulation, Attenuation, Catabolite Repression, Riboswitches.

**UNIT-III: MUTAGENESIS**

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; Mutagens, Types of mutations, transposon mutagenesis, site directed mutagenesis, Ames test; Environmental mutagenesis and toxicity testing; Induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants.

**UNIT-IV: BACTERIAL RECOMBINATION**

Bacterial Gene Transfer: gradual development of the concept, Genetic recombination- Bacteriophages; synapsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination gene conversion; Bacterial transformation, Host cell restriction, Transduction, complementation, Conjugation & Transfection.

**Reference/Text Books:**

1. Benjamin Lewin, *Gene IX*, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; *Molecular Biology of the Gene*, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; *Molecular Biology of the Cell*, 4th edition, Garland, 2002.
4. *Molecular Genetics An Introductive Narrative* by G S Stent and R Calender, San Francisco, Calif. : W.H. Freeman, 1978.

**UNIT-I: SOIL AND AGRICULTURE MICROBIOLOGY**

History of soil microbiology, Stages of Soil Formation, Role of Soil microbes in soil formation; Mycorrhizae, Ectomycorrhizae, Endomycorrhizae, Horizontal vs Vertical Expansion in Agriculture (Green Revolution), Soil Analysis, Chemical fertilizer, Biofertilizer, Pesticides- classification, Mode of action, Drawbacks of chemical pesticides, Biopesticides classification, Delta –Endotoxin of *Bacillus thuringiensis*, Mode of action, Limitation of Bt crops, Neonicotinoids-new generation of biopesticides, Mode of action of neonicotinoids, Sustainable agriculture.

**UNIT-II: MEDICAL MICROBIOLOGY**

Classification of medically important microbes; Structure and function of immune system including Immune response: Immune Cells and Organs, Structure, Functions and Properties of Immune Cells -T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Dendritic cell, Structure and Functions of Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT. Autoimmunity, Hypersensitivity and Immunodeficiency, Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases, Introduction to medical mycology; Superficial & subcutaneous mycosis; Systemic & opportunistic mycosis;

**UNIT-III: FOOD MICROBIOLOGY**

Microorganisms important in Food Microbiology; Molds; Yeast and Yeast like fungi, Industrial Importance; Characteristics, Genera and Groups of bacteria important for food bacteriology; Factors effecting growth of microorganisms; Contamination and spoilage; Food Born Illness.

**UNIT-IV: INDUSTRIAL MICROBIOLOGY**

Industrial Microbiology- Preview; Industrial Enzymes – Perspectives, Problem and Application; Improvement of Industrial Strains; Induced and site directed mutagenesis, Genetic variants; Protein Engineering: Principle and practice with reference to industrial enzymes; Secondary metabolites: submerged, solid state fermentation, chemostat/Continuous culture; Microbiology of food and Pharmaceuticals; Microbial production of industrial solvents; Maintenance of microbial strains: Culture Bank; Bioremediation

**Reference/Text Books:**

1. Microbial Diversity by Oladele Ogunseitan, Blackwell Publishing, 2005
2. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.
3. Microbial Ecology 4th Ed. by Atlas & Bartha, Benjamin/Cummings, 1998.
4. Molecular Microbial Ecology by Osborn & Smith, no assigned readings, but useful background material.
5. Successful Scientific Writing: A Step by Step Guide for the Biological and Medical Sciences by Matthews & Matthews.
6. Atlas RM & Bartha R (1997) Microbial Ecology – Fundamentals and Applications
7. Kirchman DL (2008) Microbial Ecology of the Oceans
8. Barton LL & Northrup DE (2011) Microbial Ecology Wiley-Liss,
9. Begon M, Townsend CR & Harper JL (2006) Ecology – From Individuals to Ecosystems, 4th ed. (Blackwell)
10. Brock Biology of Microorganisms 11th Ed. by Madigan & Martinko, Prentice Hall, 2006.



## **MICB-803C: Genetic Engineering**

### **UNIT-I**

Introduction to recombinant DNA technology; Basic techniques; Prokaryotes and microbial eukaryotes as hosts for molecular cloning; Restriction and other enzymes; Characteristics of vectors (plasmid, bacteriophage, cosmid and shuttle vectors)

### **UNIT-II**

Genomic and cDNA libraries; Recombinant selection and screening; Expression of cloned DNA molecules; CRISPR system.

### **UNIT-III**

Methods of nucleic acid and protein separation and DNA & protein sequencing; RFLP; PCR and gene amplification; Site-directed mutagenesis; Antisense RNA approach; mRNA differential display.

### **UNIT-IV**

Metabolic strategies for hyperproduction of metabolites; Protein engineering; Industrial application of gene manipulation (production of novel proteins, vaccines, small molecules and destruction of xenobiotic compounds); the new genomics-global view of biology; Ethical issues and biosafety regulations.

### **Text Books**

1. RW Old and SB Primrose, Principles of Gene Manipulation-An Introduction to Genetic Engineering, Blackwell Scientific Publications, USA, Fifth Edition, 1980, ISBN: 0520041518.
2. Benjamin Lewin, Genes V, Oxford University Press, USA Fifth Edition, 1992, ISBN: 0198542879.
3. J Sambrook, E F Fritsch and T Maniatis, Molecular Cloning-A Laboratory Manual (I-III Volumes), ColdSpring Harbor Lab. Press, USA, ISBN: 0879693096

## MICB-804C: PRACTICAL

### **UNIT-I Immunology and Biochemistry**

1. To separate serum/ plasma and leucocytes from the blood sample
2. Separation of serum protein by vertical gel electrophoresis.
3. To perform immunodiffusion by Ouchterlony method
4. To demonstrate single radial immunodiffusion (SRID) technique
5. To perform Dot ELISA
6. Determination of Molecular weight of Protein by Column chromatography
7. Study of UV absorbance spectra for Protein and DNA

### **UNIT-II Molecular Biology**

8. Genomic DNA isolation, quantification, purity analysis.
9. Polymerase chain reaction using the isolated DNA as template.
10. Agarose gel electrophoresis and gel purification of PCR product.
11. Ligation of PCR product into plasmid vector.
12. Transformation and demonstration of  $\alpha$ -complementation of  $\beta$ -galactosidase through blue white colonies
13. Plasmid isolation and gel retardation assay.

### **Reference/ Text Book:**

1. Sambrook J, Fritsch EF, Maniatis T. (1989). In: *Molecular Cloning: A Laboratory Manual* (2nd ed). CSH Press, USA.
2. R.W. Old & S. B. Primrose (1990) *Principles of Gene Manipulation: An Introduction to Genetic Engineering*. Clackwell Science Ltd
3. *Protein Purification: Principles and Practice* by Robert K Scopes. Springer Advanced Texts in Chemistry. 1993.

## MICB-805E: MICROBIAL ADAPTATION BIOLOGY

### **UNIT-I: Adaptation to Extreme Environment**

Adaptations to pH, Temperature adaptations, Pressure adaptation, Halophilic adaptations, Radiation adaptation.

### **UNIT-II: Pathogenic adaptation to host environment**

Adaptation to acidic environment, Adaptation to Microaerobic conditions, Adaption to immune system stress, Adaptation to Metal stress

### **UNIT-III: Modulation of host pathways by pathogens for adaptation/survival**

Modulation in glycolytic flux, Endoplasmic reticulum stress, Modulation in host Mitochondria, Apoptosis, Necrosis, Phagosome maturation, Autophagy regulation

### **UNIT-IV: Dormancy, Drug Tolerance and Resistance**

Growth regulation by microbes, Survival and reactivation strategies of pathogens in stress through heterogeneous population generation, Persisters, antimicrobial resistance

### **Reference/Text Books:**

1. Protein adapatation in Extremophiles: January 2008, Publisher: Nova Biomedical, ISBN: 1604560193
2. Extremophiles and Their Applications in Medical Processes: ISBN 978-3-319-12808-5
3. Tuberculosis and the Tubercle Bacillus, Second Edition, ISBN: 9781555819552
4. Reviews and research articles related to topics will be suggested during course

## **MICB- 806E WATER AND WASTE WATER TREATMENT**

**Unit I:** Basic Water Chemistry; Water Microbiology; Water Ecology and Limnology; Water Quality monitoring; History of Waste water treatment/management;

**Unit II:** Potable water sources; Water Treatment Operations; Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water;

**Unit III:** Non-potable applications of treated waste water, Environmental sustainability, Environmental Public Health.

**Unit IV:** Regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the emergency planning and community right to know act, Pollution Prevention act 1990, an approach to problem solving: a six step method; Case study.

### **Reference/Text Book:**

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr, Wiley Blackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3rd Edition by Frank R. Spellman, CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das, Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solutions, 2nd Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general review; ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA. United Nations, New York, 2003, url:

## MICB-901C: TOOLS AND TECHNIQUES IN MICROBIOLOGY

### **Unit I:**

Selective isolation of microbes: selection of medium and growth condition. Characterization of isolates: conventional and insilico techniques, DNA isolation, PCR amplification of 16SrDNA, Agarose gel analysis, AFIGE, PFGE, ARB for bacterial strain identification. Community analysis: Direct and indirect method, Shannon Diversity Index, Equitibility Index. RAPD, RFLP, TDDG, DGGE for community Analysis.

### **Unit II:**

Bacterial Draft Genome Sequence Analysis for strain identification; MAUVE Analysis, BRIG Analysis, Dot plot, Rapid Annotations using Subsystem Technology, Bacterial Transcriptome Analysis; Extracellular Enzymes; intracellular enzymes.

### **Unit III:**

TA cloning, Artificial chromosome vectors (YACs; BACs); Metagenomics, Primer design; DNA polymerases; Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products;

### **Unit IV:**

Case study of strain identification using a combination of taxonomic and insilico analysis of bacterial strains of genus *Bacillus*.

### **Reference/ Text Book:**

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Aziz RK, Bartels D, Best AA, DeJongh M, Disz T, Edwards RA, Formsma K, Gerdes S, Glass EM, Kubal M, Meyer F, Olsen GJ, Olson R, Osterman AL, Overbeek RA, McNeil LK, Paarmann D, Paczian T, Parrello B, Pusch GD, Reich C, Stevens R, Vassieva O, Vonstein V, Wilke A, Zagnitko O. 2008. The RAST server: rapid annotations using subsystems technology. BMC Genomics 9:75.
5. [www.arb-home.de](http://www.arb-home.de)
6. Rang J et al Comparative analysis of genomics and proteomics in *Bacillus thuringiensis*. PLoS ONE. 2015. 10(3):e0119065

**UNIT-I Understanding the cultivable microbes from dental Flora.**

Experiment 1:- Standardization of technique for sampling the dental flora.

Experiment 2:- Growing the dental micro-flora in the selected media & determination of (a) pre-incubation time & (b) requisite dilution to get the CFU count and diversity estimate.

Experiment 3:- Isolation, purification, Characterization of dental micro-flora, & antibiotic sensitivity test.

Experiment 4:- In-vitro set up for testing antibiotic therapy in case of dentine tissue or teeth.

Experiment 5:- Visualization of the teeth surface using Scanning Electron Microscope.

**UNIT-II To find out the relative proportion of Lactic Acid Bacteria from natural sources.**

Experiment 6:- Isolation of acid producing bacterial from various natural sources like grass, intestine of fish and prawn, curd, fermented fish, bee hibe, etc

Experiment 7:-Characterization of isolates.

Experiment 8:- Testing for biofilm formation by the isolate.

Experiment 9:- Production of Lactic acid from whey in packed bed reactor.

**UNIT-III Bioinformatics**

1. Gene sequence downloading from gene database
2. Nucleotide BLAST
3. Comparison of gene sequences using alignment tool
4. Amino acid sequence of protein downloading from database
5. Protein BLAST
6. Comparison of Amino acid sequence of proteins using alignment tool
7. Computation of instability index of proteins
8. Prediction of globularity in the proteins
9. Computation of aliphatic index of proteins
10. Prediction of phosphorylation sites in the proteins
11. Computation of hydrophobicity of proteins

**References:**

- 1) Mishra, M., S. Ghosh, L.E. Alex, I. Mukherjee, T.P. Sinha, A.R. Thakur and S Ray Chaudhuri, 2012. Developing a system for antibacterial treatment of dental caries using culture based approach. OnLine J. Biol. Sci., 12: 44-53.

- 2) V Helen Shiphrah, SayantiSahu, AshokeRanjan Thakur and S RayChaudhuri. 2013 Screening of bacteria for lactic acid production from whey water. American Journal of Biochemistry and Biotechnology, 9 (2): 118-123.
- 3) Ghosh, S., G. Roy and B. Mukherjee, 2009. Dentalmold: A novel formulation to treat common dentaldisorders. AAPS Pharm. Sci. Tech., 10: 692-702.PMID: 19466555
- 4) Martín R, Soberón N, Vaneechoutte M, Camino FV, Suárez JE. Characterization of indigenous vaginal lactobacilli from healthy women as probiotic candidates. International microbiology: Official journal of the Spanish Society for Microbiology. 2008;11(4):261-6.

## MICB-903E: MICROBIOLOGY OF FERMENTED FOOD AND PRODUCTS

**Unit I: Introduction**-Origin and History of food fermentation; Fermented foods “from art to science”; Basics of fermentation processes; Health benefits and other significances of fermented food and beverages; Fermented foods in the twenty-first century.

**Unit II: Basics of Fermentation Technology**-Types of fermentation- (sub-merged/solid state, Batch /continuous fermentation); Basic Structure of fermentors and types; Basic process and requirements for fermentation and factor affecting fermentation process; Upstream and Downstream processing of microbial products and quality control of products; Basic strain improvement process; Recent developments in fermentation technology.

**Unit III: Traditional Fermented Food and Beverages**- Tradition of fermented food and beverages of Asia and North East India; Food habits and types of their fermented food; Fermented baked product; Fermented vegetable foods- Sauerkraut, Kimchi, Pickle, bamboo shoots; Fermented soyabean products- (Temph, Tofu, Soya sauce); fermented beans; Fermented dairy products-Cheese, Dahi and Yogurt, Butter; Other fermented food products- Idli, Vada, Dosa, Bhatara, Dhokla; Fermented fish, meat and sausages; Fermented beverages- Sake, Rice beers, Ale, Wines.

**Unit IV: Industrial Application of Fermentation Products**- Production of Industrial alcohol- Ethanol and Butanol; Organic acids- Citric acid, Lactic acid, Glutamic acid; Amino acids- (Lysine, Phenylalanine, Tryptophan); Biopolymers- (Dextran, Xanthan); Antibiotics- (cephalosporin's, Tetracycline's, Polyenes); Enzymes- (Alpha-amylase, Lipase, Pectinases, Proteases); Vitamins- (Vitamin B12 and Riboflavin); Single cell protein; Alcoholic beverages- (Toddy, Beer, Wine, Champagne, Rum, Brandy, Whisky).

### **Reference/Text Book:**

1. Food Microbiology by William Frazier, Dannise Westhoff, McGraw-Hill. Inc.
2. Microbial Physiology and Metabolism by Caldwell D.R. 1995 Brown Publishers.
3. Microbial Physiology by Moat A.G. and Foster J. W. 1999. Wiley.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Principles of Fermentation Technology, 3rd Edition by Stanbury & Whitaker & Hall, Butterworth-Heinemann, Elsevier science.
6. The Art of Fermentation by Sandor Ellix Katz, Chelsea Green Publishing (2012).
7. Mastering Fermentation by Kate Williams, Oxford publishing.



## MICB-904E: BASICS OF STATISTICS

Types of statistical data: primary and secondary data, Classification, Tabulation and Diagrammatic representation of data. Frequency Distribution, Cumulative Distribution and their graphical representation, Histogram, Frequency Polygon, Frequency Curve and Ogive. Measures of central tendency: Arithmetic geometric and harmonic mean, median and mode. Measures of dispersion: Mean Deviation, Variance, moments, skewness and kurtosis and their measures based on quantiles and moments.

Correlation Coefficient and its Properties, Spearman's Rank Correlation Coefficient. Correlation and Regression Analysis, Fitting of Linear equation by the principle of Least Squares. Partial and multiple correlation. Random Experiments and Random Events, Classical and Axiomatic definitions of Probability (discrete sample space only), Conditional Probability, Independence of Events and Bayes Theorem.

Random Variable and its Probability Distribution, Cumulative Distribution Function, Probability Mass Function and Probability Density Function, Mathematical Expectation, Variance and Moments, Simple Theorems including theorems on expectation and variance of a sum of random variables and expectation of product of Random Variables. Moment generating functions; characteristic functions; probability inequalities (Tchebyshef, Markov, Jensen).

Introduction of some distributions: Bernoulli, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions. Population, sample, Statistic, standard error, estimation, confidence interval and confidence level, confidence interval estimate of proportion and mean. Hypothesis and its types, errors, critical region, level of significance, power and p-values. Test statistics: Student's t-test, Chi-square, F and Z-Statistics and their applications in testing of hypothesis. Exact and Large sample tests. Analysis of Variance. Nonparametric test - sign, median, run, Mann-Whitney test. Chi square test of goodness of fit, Chi square analysis of contingency table.

### Reference/Text Books:

- [1] Mukhopadhyay, P: Mathematical Statistics. Books and Allied (P) Ltd.
- [2] Mukhopadhyay, P: Applied Statistics. Books and Allied (P) Ltd.
- [3] Goon, A. M. ., Gupta, M. K and Dasgupta, B.: Fundamentals of Statistics; Vol. I, II
- [4] Rohatgi, V.K. and Ehsanes Saleh, A. K. Md. : An introduction to Probability and Statistics
- [5] Gupta, S.C, and Kapoor, V.K. : Fundamentals of Mathematical Statistics [6] Gupta, S.C, and Kapoor, V.K. : Fundamentals of Applied Statistics

## **MICB-905C: PROJECT WORK + MOOC**

### **Unit -1 Preparation of Project Action Plan**

Review of literature, Identification of the problem, Logical development of a working hypothesis, work done in the ongoing semester with statistical analysis (if any). 5 spiral bound copies have to be submitted atleast 15 days before the date of examination.

### **Unit – 2 MOOC**

Courses selected by the Department and approved by the authority will be opted. The final assessment will be based on the online assessment conducted by the Online Course Coordinator.

## MICB-1001E: INTELLECTUAL PROPERTY RIGHTS

**Unit I:** Intellectual Property Creation, Protection, and Management; Introduction, Definition & Function of Different IPR's, Case Studies on Why IPR's are Important, and How to Protect/Enforce Them. Trademarks: Introduction, Types of Trade Mark, Mode of Protection, Registration Procedure, Case Studies: Passing Off/Opposition/Litigation Actions, Brand and Trade Mark Valuation. Copyright; Meaning & Importance, Subject Matter & Term, Registration Procedure; Ownership, Economic/Moral Rights, Assignment, Transmission and Licensing; Performer Rights, Broadcast Reproduction Rights, Infringement of Copyright, Remedies of Infringement, Civil, Administrative;

**Unit II:** Patents: Introduction; Definition, Importance & Type of Patents; Patentable Inventions; Prior Art Search – Need and procedure; Patent Drafting/Filing – Procedure and Best Practices: Overview of Patent Filing Procedure. Who can be an Applicant? Form of Application, Formalities to keep in mind while filing Patent Application; Publication and Examination of Applications; Representation & Pre grant Opposition: Anticipation; Secrecy of Invention; Grant of Patent; Rights of Patentee; Amendment of Application and Specifications; Restoration of Lapsed Patents; Post grant Opposition; Freedom to Operate Searches – Need and Procedure; Compulsory Licensing, Use of Inventions for Govt. Purposes & Revocation; Infringement of Patent & Remedies

**Unit III:** Designs: Introduction; Definition & Importance; Registration Procedure; Overview; Prerequisites of Registration; Application for Registration; Publication; Grant of Certificate; Copyright in Registered Designs & Duration; Cancellation of Registration; Piracy of Registered Designs and Remedies. Geographical Indication: Introduction; Definition & Importance; Registration of GI – Procedure. Plant Varieties and Farmers' Rights: Introduction, Objective and Definition; Registration of Plant Varieties: Application; Requirements for Registration; Requirements for Denomination given to Variety; Non Registerable Varieties (S. 29); Tests to be conducted; Acceptance of Application; Publication of Application; Opposition; Registration; Duration, Effect of Registration and Benefit Sharing; Farmers' Rights; Compulsory License; Plant Varieties Protection Appellate Tribunal; Infringement, Offences and Penalties. Semiconductor Integrated Circuits Layout Designs: Introduction, Importance and Definition; Importance & Definition; Registration – Procedure; Absolute Grounds for Prohibition of Registration; Objections to Acceptance; Publication of Application; Opposition; Registration.

**Unit IV:** IP Litigation: Introduction; Civil vs. Criminal Remedies – Advantages & Strategy; Filing Procedure in Various Civil Courts / High Courts; Defenses in case of Infringement Suit; Pointers Specific to Certain type Civil IP Litigation (e.g. Trademarks, Copyright, Patents etc.); Criminal Litigation; Pointers Specific to Certain type criminal IP Litigation (e.g. Trademarks, Copyright etc.) Confidential Information / Trade Secret: Introduction & Advantages; Type of CI / TS; Requirements for Consideration of Information as CI / TS; Remedies against Breach of Confidence. IP Licensing: Introduction; Meaning & Importance; Licensing vs. Assignment; Compulsory Licensing & Procedure; Strategies for successful transfer of technology. IP Valuation: Introduction; Various Methods of IP Valuation; When to use which Method? IP Due Diligence And Audit: Introduction; Procedure. IP Strategy: IP Portfolio Development Strategy; IP Litigation Strategy; IP Licensing, Tech Transfer, and Commercialization Strategy.

Reference/Text Books:

1. Intellectual property counseling and litigation, Ed by Horwith&Worwitz
2. Intellectual property the law of copyrights, patents and trademarks, By Schechter, Roger E. & Thomas, John R.

# MICB-1002E: RECENT TRENDS IN ANTIMICROBIAL RESEARCH

## **Unit I: Antimicrobials**

An outline of the historical development of antimicrobial agents. Reasons for studying the biochemistry and molecular biology of antimicrobial compounds. Uncovering the molecular basis of antimicrobial action. Current trends in the discovery of antimicrobial drugs. Antimicrobial assays in liquid and solid media, susceptibility testing in liquid and solid media. Antibiotics that inhibit peptidoglycan biosynthesis. Drugs that interfere with the biosynthesis of the cell wall of mycobacteria. Fungal cell wall as a target for antimicrobial drugs. Ionophoric antibiotics. Antifungal agents that interfere with the function and biosynthesis of membrane sterols. Inhibitors of nucleic acid biosynthesis. Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents. A unique antifungal antibiotic-griseofulvin, antiviral agents, antiprotozoal agents. Drug transport across cell walls and membranes. Multi drug resistance.

## **Unit II: Microbial Pathogenicity and Epidemiology**

Virulence factors: Mechanism of adhesion, colonization and invasion of host tissues by bacterial pathogens, measurements of virulence. Mechanisms of bacterial resistance to host cellular and humoral defenses. Microbial toxins: Characteristics, purification, Mode of action and assay (in vivo, in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria.

### Reference/Text Book:

1. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
2. Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal.
3. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4<sup>th</sup> Ed., NiraliPrakashan.
4. OsolArther (1975) *Remington's Pharmaceutical Sciences*, 15 Ed., Mack Pub. Co., Pennsylvania.
5. Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.
6. Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12<sup>th</sup> Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
7. Chatwal G. P. (2003) *Biopharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
8. Micheles P. S., Y. L. Khmel'nitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis, A Natural Approach to Drug Discovery*, Trends in Biotechnol. **16**, 197.
9. Altreuter D., and D S. Clark, (1999), *Combinatorial Biocatalysis: Taking the Lead From Nature*, Curr. Opin. Biotechnol. **10**, 130.
10. **Virulence mechanisms of bacterial pathogens (Second edition)** by Roth, Bolin, Brogden Minion and Michael
11. **Medical Microbiology** edited by Samuel Baron. Fourth edition. ( University of Texas Medical Branch of Galvesion)
12. **Medical Microbiology: an Introduction to infectious diseases.** Sherris, John C, Ed, Elsevier Publication, II edition.
13. **Multidrug resistance.** Annu Rev Biochem. 2009 ; 78: 119-146. doi:10.1146/annurev.biochem.78.082907.145923.

## PAPER -1003C: PROJECT WORK

### **Unit -1**

Preparation of final dissertation under the following heads: Certificate, Acknowledgement, Contents/Index, Introduction, Objectives, Materials and methods, Results, Discussion, Conclusion/Summary and References. Appendices- Statistical tables etc.

The report (5) has to be submitted as hard bound copy (at least one).

# Choice Based Credit System (CBCS)

## M.Sc. MICROBIOLOGY CURRICULUM 2019-20



### DEPARTMENT OF MICROBIOLOGY

TRIPURA UNIVERSITY (A Central University)  
SURYAMANINAGAR, AGARTALA – 799 022  
TRIPURA, INDIA

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## M.Sc MICROBIOLOGY COURSE (CBCS) CURRICULUM (2019-20)

<b>SEMESTER I</b>				
<b>COURSE CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>CREDITS</b>	<b>Lecture/ Tutorial/ Practical hrs per week</b>
MI-7 -C	Basic Microbiology and Microscopy	CORE	4	3L/1T
MI-7 -C	Microbial Physiology and metabolism	CORE	4	3L/1T
MI-7 -C	Microbial Immunology	CORE	4	3L/1T
MI-7 -C	Practicals.	CORE	4	8P
MI-7 -C	Compulsory Foundation (Soft Skills)	CF	4	3L/1T
<b>Semester wise credits and hours of lectures</b>			<b>20</b>	<b>24</b>

<b>SEMESTER II</b>				
MI-8 -C	Micobial genetics and bacterial recombination	CORE	4	3L/1T
MI-8 -C	Environmental microbiology	CORE	4	3L/1T
MI-8 -C	Virology	CORE	4	3L/1T
MI-8 -C	Practicals	CORE	4	8
MI-8 -E	Biophysical and biochemical methods	ELECTIVE	4	3L/1T
MI-806-E	Microbial Bioreactors for Waste Water Treatment	ELECTIVE	4	3L/1T
MI-808-E	Innovative Concept Development	ELECTIVE	2	2L
<b>Semester wise credits and hours of lectures</b>			<b>26</b>	<b>30</b>

<b>SEMESTER III</b>				
MI-9 -C	Tools and techniques of molecular biology and bioinformatics	CORE	4	3L/1T
MI-9 -C	Practicals	CORE	4	8
MI-9 -E	Fermentation Technology and Fermented Foods	ELECTIVE	4	3L/1T
MI-9 -E	Microbial adaptation	ELECTIVE	2	
MI-9 -E	Bacterial secretion system and bacterial quorum sensing	ELECTIVE	2	3L/1T
MI-9 -C	Project work	CORE	4	3T
MI-9 -C	MOOC	ELACTIVE	1	Online
<b>Semester wise credits and hours of lectures</b>			<b>21</b>	<b>24</b>

<b>SEMESTER IV</b>				
MI-10 -E	Recent trends in antimicrobial research	ELECTIVE	4	3L/1T
MI-10 -C	Project work	CORE	8	8
<b>Semester wise credits and hours of lectures</b>			<b>12</b>	<b>12</b>
<b>In addition a 2 credit elective course offered by other departments may be taken by the students</b>				
<b>Grand total of credits and hours of lecture hours</b>			<b>79</b>	
<b>Student have to cover 72 cradits for clearing the MSc Course</b>				

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## BASIC MICROBIOLOGY AND MICROSCOPY

PAPER CODE:

Credit: 4

### UNIT-I: BACTERIOLOGY

Bacterial cell structure and appendages: Morphological features and arrangement of bacterial cells; overview of eubacterial cell structure: Gram-positive and Gram-negative bacteria; Extracellular appendages: flagella-arrangement, basic structure and locomotive function; pili- different types, their distribution among bacteria & related functions; fimbriae- occurrence, function and features distinguishing pili and fimbriae; glycocalyx- composition and role in bacteria; and capsule- microcapsule and slime.

Bacterial cell wall & cell membrane: Detailed structure of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS), protoplasts, sphaeroplasts, L-forms, cell wall synthesis and its inhibitors including different antibiotics; periplasm; molecular and chemical structure of cell membrane: cytoskeleton including tubulin and actin structural filaments and their role in bacteria.

Bacterial cell division and reproduction: Binary fission and other forms of reproduction in bacteria: assembly, maintenance and disassembly of Z ring; endospore structure and stages involved in endospore development in *Bacillus subtilis* and *Metabacterium polyspora*

### UNIT-II: MYCOLOGY

Classification of fungi (Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes) and Slime molds, morphology, structure, cell differentiation, and reproduction of fungi.

Heterokaryosis, Sex hormones in fungi, physiological specialization in fungi, Mycorrhiza- ectomycorrhiza, endomycorrhiza and vesicular arbuscular mycorrhiza (VAM).

economic importance, Secondary metabolites from fungi: Terpenes, Nonribosomal peptides, hydrophobins, peptaibols, indole, alkaloids, detailed emphasis on polyketides.

### UNIT- III PHYCOLOGY

Phycology: General account of Diversity, distribution, nutrition, mode of reproduction, Life cycle patterns, recent status of algae (evolutionary perspective), ecological significance, phycotoxins, economic importance including role in human affairs (algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment) Distribution and classification of algae, thallus organization in algae, reproduction in algae; Brief account of Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta; Algal ecology, Algal toxins, Algal food and algal biotechnology.

### UNIT-IV: MICROSCOPY AND STAINING OF MICROORGANISMS

Microscopy: General Principles and components of simple, microscope, compound microscope, bright-field and dark-field microscope, Phase- contrast microscope, fluorescence microscope, Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM).  
Cytophotometry and flowcytometry

Fixation and staining: Simple staining, negative staining, gram staining, acid fast staining, structural stains (Endospore, capsule and flagella).

#### Reference/Text Book:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Principles of Microbiology by Ronald M. Atlas (1995), Amy Mc Cullen
3. Microbiology: Principles and Explorations by Jacquelyn Black
4. Microbiology by Michael J Pelczar
5. Fundamental Principles of Bacteriology A J Salle
6. Foundations in Microbiology by Kathleen park Talaro, McGraw Hill. science
7. Microbiology: An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case, Dorling Kindersley (india) Pvt Ltd
8. Microbiology by Stuart Walker, W B Saunders
9. An Introduction to Microbiology by P Tauro, K K Kapoor, KS Yadav

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## MICROBIAL PHYSIOLOGY AND METABOLISM

### PAPER CODE:

Credit: 4

### UNIT-I: GROWTH AND TRANSPORT IN CELL

Introduction to microbial growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.

Solute Transport: Introduction: Primary and Secondary transport: Kinetics: Membrane transport protein- Porins and aquaporins, mechanosensitive channels; ABC transporter; Group translocation PEP-PTS system: catabolite repression: inducer exclusion and inducer expulsion.

### UNIT-II METABOLIC PATHWAYS AND REGULATION IN CELL

Central Metabolic Pathways and Regulation: Glycolysis and its regulation; Gluconeogenesis; Pentose-Phosphate Pathway; Entner-Doudoroff Pathway; Citric Acid Cycle; alternate TCA; Glyoxylate Pathway and its regulation. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Cometabolism of pentoses and hexoses; Succinic and citric acid production.

Nitrogen metabolism: Inorganic Nitrogen assimilation- nitrate and ammonia assimilation; Regulation of glutamate synthetase; General reaction of amino acid and Stickland reaction; Glutathione – Distribution in Bacteria; Biosynthesis and role in redox regulation; Outline of amino acid biosynthesis; protein utilization: detail account on biochemistry of glutamate producing strains.

### UNIT III: ENZYME AND ENZYME KINATICS

Enzymes: Introduction, activation energy, enzyme kinetics, significance of  $K_m$ , catalytic efficiency, turnover number. Methods of plotting enzyme kinetics data: Lineweaver – Burk plot, saturation kinetics. Enzyme inhibition, models and type of inhibition.

Metabolism of lipids: Biosynthesis and degradation of lipids and its regulation in *E. coli*; Lipid accumulation in yeast.

### UNIT IV: METABOLISM OF NUCLEOTIDES

Metabolism of nucleotides: Purine and pyrimidine biosynthesis; deoxyribonucleotide synthesis; regulation of purine and pyrimidine biosynthesis; inhibitors of nucleotide biosynthesis.

Physiological Adaptation and Intracellular signalling: Introduction to two component system; response to physiological stress: aerobic-anaerobic shifts- Arc and Fnr system; osmotic homeostasis; response to nutritional stress: phosphate supply- Pho regulon; and stringent response.

### **Reference/Text Book:**

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA. 1999.
2. Microbial Physiology by A.G. Moat, J. W. Foster and M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
3. Lehninger Principles of Biochemistry by D. L. Nelson and M. M. Cox. 6th Edition. W. H. Freeman. 2012
4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.
5. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.
6. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013
7. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.
8. Understanding Enzymes by T. Palmer, E. Horwood. 3rd Edition. Wiley. 1991.

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## MICROBIAL IMMUNOLOGY

**PAPER CODE:**

**Credit: 4**

### **UNIT 1:INTRODUCTION**

Concept of Innate and Adaptive immunity, Immune dysfunction and its consequences. **Immune cells and Organs:** Immune Cells and Organs, Structure, Functions and Properties of Immune Cells -T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Dendritic cell, Structure and Functions of Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT.

### **UNIT 2: ANTIGENS**

Antigens, Antigenicity versus Immunogenicity, Haptens, Characteristics of an antigen - Foreignness, Molecular size and Heterogeneity, T-dependent and T-independent antigens, Adjuvants. Antibodies and Humoral Immune Response: Basic structure of antibody- CDRs, Framework region, Hinge. Primary and secondary immune response, Antibody mediated effector function, Types and properties of antibodies, Monoclonal antibodies – preparation and applications, Antigen-antibody interaction – Precipitation, Agglutination, Immunoelectrophoresis, Immunofluorescence, ELISA.

### **UNIT 3: MAJOR HISTOCOMPATIBILITY COMPLEX AND CELL MEDIATED IMMUNITY**

Organization and inheritance of MHC locus in humans. Structure and functions of MHC I & II molecules: Cellular expression of MHC molecules: Antigen processing and presentation (Cytosolic and Endocytic pathways): Killing mechanisms by CTL, NK cells and ADCC. **Complement System:** Components of the complement system Activation pathways (Classical, Alternative and Lectin pathways) Biological consequences of complement activation.

### **Unit 4. MEDICAL MICROBIOLOGY**

Classification of medically important microbes. Autoimmunity, Hypersensitivity and Immunodeficiency. Different types of antigen-antibody reactions and their utilization in diagnosis in different diseases.

### **Reference Books:**

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al. (2006) Biology 7th edition Tata McGraw Hill Publications, New Delhi
3. Griffiths, A.J.F et al. (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY.
4. Albert, B et al. (2008) Molecular Biology of the Cell, 8<sup>th</sup> edition, Garland Science. NY.

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PRACTICAL

PAPER CODE: MI-704C

Credit: 4

Section –A BASIC MICROBIOLOGY

1. Laboratory safety rules in microbiological laboratory.
2. Preparation of culture media for growth of microorganisms (Bacteria and Fungi).
3. Media, Sterilisation using the autoclave
4. Sterilisation of equipment and materials
5. Pouring a plate and Storage of media
6. Inoculation and other aseptic procedures (Using a wire loop, Using a pipette, Flaming the neck of bottles and test tubes)
7. Working with bacteria and yeast and obtaining mixed culture from soil (Streak plate, Pour plate and Spread plate)
8. Isolation techniques and obtaining pure culture (bacteria and Fungi).
9. Microbial staining (bacteria and fungi).
10. Growth curve, measure of bacterial population by turbidometry
11. studying the effect of temperature and pH,
12. Determination of thermal death point and thermal death point of microorganisms.

Section-B Microbial METABOLISM

1. Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Study of UV absorption spectra of Haemoglobin.
3. Estimation of protein by Lowry's method.

Section-C Microbial Immunology

1. Identification of human blood groups
2. To separate serum/ plasm from the blood sample
3. To perform Total Leukocyte Count (TLC) of the given blood sample
4. To perform Differential Leukocyte Count (DLC) of the given blood sample
5. To perform Immunoprecipitation
6. To perform immunodiffusion by Ouchterlony method
7. To demonstrate single radial immunodiffusion (SRID) technique
8. To perform Dot ELISA

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# MICROBIAL GENETICS AND BACTERIAL RECOMBINATION

PAPER CODE:

Credit: 4

## UNIT-I: INTRODUCTION TO MOLECULAR BIOLOGY

DNA structure, forms of DNA and DNA supercoiling; The law of DNA constancy and c-value paradox; properties of DNA-denaturation, renaturation, melting curve and hyper chromicity; DNA replication in prokaryotes: origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading. Restriction endonucleases – types, nomenclature, classification, application; DNA ligases – properties and functions, ligation techniques; DNA modifying enzymes – polymerases, DNase, RNase, polynucleotide kinases, alkaline phosphatases and terminal nucleotidyltransferase. DNA isolation, DNA polymerases

## UNIT II: MUTAGENESIS

Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; Mutagens, Types of mutations, transposon mutagenesis, site directed mutagenesis, Ames test; Environmental mutagenesis and toxicity testing; Induction of mutation in *Neurospora crassa* and yeast. cytoplasmic inheritance and biochemical mutants.

## UNIT-III: GENETIC ASPECTS OF EXTRACHROMOSOMAL ELEMENTS AND VECTORS

extrachromosomal elements (plasmids and bacteriophages), Plasmids as vectors for gene cloning and plasmid DNA replication; Transposons in prokaryotes and eukaryotes and their uses in genetic analyses; Life cycle of bacteriophages and their uses in microbial genetics. Cloning vehicles: Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid), Bacteriophage ( $\lambda$  phage and M13 vectors), cosmids, phagemids, expression vectors, shuttle vectors, excretion vectors and Animal viral vectors; Promoter in expression vectors: Lac Z promoter, Lambda P<sub>L</sub>/ P<sub>R</sub> Promoter, T<sub>7</sub> Promoter, Sp6 Promoter; SV-40 promoter. Cam V35s promoter and Ribosome binding sites.

## UNIT-IV: BACTERIAL RECOMBINATION

Bacterial Gene Transfer: gradual development of the concept, Genetic recombination- Bacteriophages; synopsis of homologous duplexes, breakages and re-union; role of Rec A in recombination; Legitimate and illegitimate recombination gene conversion; Bacterial transformation, Host cell restriction, Transduction, complementation, Conjugation & Transfection.

### Reference/ Text Book:

1. Bushman, F. 2002. Lateral Gene Transfer, Cold Spring Harbor Laboratory Press.
2. Kaper, J. B. and Hacker, J. 1999. Pathogenicity Islands and Other Mobile Virulence Elements, ASM Press, Washington, D.C.
3. Ptashne, M. 2002. Genes and Signals, Cold Spring Harbor Laboratory Press.
4. Miller, J.R. 1992. A Short Course in Bacterial Genetics: Lab Manual, Cold Spring Harbor Laboratory Press.
5. American Society for Microbiology (ASM) home page: <http://www.asmtusa.org>.
6. BioWeb <http://bioweb.uwlax.edu/index.htm>. (A collection of data and tools for genetics and biology).
7. DOE Joint Genomics Institute (JGI): [http://www.jgi.doe.gov/JGI\\_microbial/html/index.html](http://www.jgi.doe.gov/JGI_microbial/html/index.html) (Microbial genome databases and a great resource for genome analysis including BLAST searches.)
8. ExPASy Molecular Biology Server: <http://www.expasy.ch/>. (A very useful site for molecular biology, genomics, and proteomics included predicted peptide mass fingerprints.)

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UNIT.1 DEVELOPMENT IN FIELD OF ENVIRONMENTAL MICROBIOLOGY:

Development of microbial ecology and emergence of field of environmental microbiology, significant applications of microbes in solving environmental pollution problems  
Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment: Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells, Metagenomic analysis of solid and aquatic sediments

UNIT II :MICROBIAL DIVERSITY IN EXTREME ENVIRONMENTS:

Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, organic solvent and radiation tolerant, metallophilic, acidophiles, alkaliphiles and halophiles, Biotechnological applications.  
Soil and water microbiology: Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

UNIT-III: BIOMASS WASTE MANAGEMENT OF PLANT'S RESIDUES:

Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) bioleaching, (iii) textiles (iv) biofuels, (v) animal feed production. Liquid waste management: Treatment of sewage (Primary, Secondary and Tertiary treatments), Treatment of Industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters)

UNIT IV: SOLID WASTE MANAGEMENT:

Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management  
Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides, use of biosensors for their detection. 8 Microbes in oil and mineral recovery: Microbial enhanced oil recovery, Bioleaching of copper, gold and uranium, electronic waste management.

Reference/Text Books:

1. Microbial Ecology by R.M. Atlas and R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993.
2. Environmental Microbiology by A.H. Varnam and M.G. Evans. Manson Publishing Ltd. 2000.
3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland, D.A. Lipson, A. L. Mills and L.D. Stetzenbach. 3rd edition. Blackwell Publishing. 2007.
4. Environmental Microbiology by W.D. Grant and P.E. Long. Kluwer Academic Publishers. 1981. 5. Environmental Microbiology edited by R. Mitchell and J-D Gu. 2nd edition. WileyBlackwell. 2009.
6. Microbiology: An environmental Perspective by P. Edmonds. Macmillan, New York. 1978.
7. Environmental Microbiology by R. Maier, I. Pepper and C. Gerba. 2nd edition. Academic Press. 2009.
8. Environmental Microbiology: Principles And Applications by P.K. Jjemba, Science Publishing Inc. 2004.
9. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad and A. Singh. I.K. International. 2007.
10. Applied Bioremediation and Phytoremediation by A. Singh and O.P. Ward. Springer. 2004.
11. Microbial and Enzymatic Degradation of Wood and Wood components by K-E.L. Eriksson, R.A. Blanchette and P. Ander. Springer. 1990.
12. Advances in Applied Bioremediation by A. Singh, R.C. Kuhad and O.P. Ward. Springer. 2009. 13. Environmental Microbiology of Aquatic & Waste systems by N. Okafor. 1st edition, Springer, New York. 2011.

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PAPER CODE:

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UNIT 1: INTRODUCTION TO VIROLOGY:

The Big Picture of all viruses using a common strategy. Virus classification. The infectious cycle, Studying Virus infection. Koch's Postulates for viruses. Virus Genome and Genetics: Virus genome types. Double stranded DNA (dsDNA). Gapped DNA genomes. Single-stranded (ssDNA) genomes. Double stranded RNA (dsRNA). Single stranded RNA (ssRNA): (+) strand RNA. Single stranded (+) sense RNA with DNA intermediate. Single stranded RNA (-) sense. Ambisense RNA genomes.

Unit II: Virus Structure:

Metastability. The tools for viral structural biology. Helical Symmetry. Icosahedral symmetry. Triangulation number. Quasi-equivalence. Attachment and Entry. Initiation of infection. Affinity. Avidity. Cellular receptor for viruses. Getting into the Nucleus. Disassembly. RNA directed RNA synthesis, Reverse Transcription & Integration, Translation: Identification of RNA polymerase. How RNA synthesis occurs in viruses? Reverse transcriptase. Retrovirus genome organization. Steps of DNA synthesis in Retroviruses. Genomic replication of DNA viruses: Basic rules of genome replication in DNA viruses. Viral origins of DNA replication. Generic steps in Transcription. Host Polymerases. Initiation. Splicing. Alternate splicing. Promoter Structure. Steps in Regulation of transcription. Enhancers. Virus coded transcriptional regulators. Transcriptional cascade. Export. Virus Assembly: Metastable structures. Concentrating components for assembly. Getting things to the right place. How do Virus make Sub-assemblies. Sequential and Concerted assembly. Packaging signals. Packaging of segmented genome. Acquisition of an envelope. Budding strategies.

UNIT III: VIRUS HOST INTERACTIONS AND ANTI-VIRAL DRUGS:

Virus Infections basics: Fundamental questions of viral pathogenesis. Virion defenses to hostile environment. Viral spread. Viremia. Determinants of tissue tropism. Virus shedding. Transmission of infection. Host defense. Innate immune response. Virus Virulence. Toxic viral proteins. Virus induced auto-immunity. Acute & Persistent Infections: General pattern of infection. Defense against the acute infection. Influenza. Polio. Measles. Rotavirus. Persistent Infections. Chronic vs. Latent Infection. Vaccines & Anti-Viral drugs: Herd Immunity. Requirement of an effective vaccine. Inactivated vaccine. Subunit vaccines. Live attenuated vaccines. Polio eradication. Anti-Viral drugs. Search for antiviral drugs.. Antiviral screening. Resistance to antiviral drugs.

UNIT IV: UNUSUAL INFECTIOUS AGENT AND INVESTIGATION OF A VIRUS OUTBREAK

Unusual Infectious Agent: Viroids. Origin of viroids. Satellites. Prions. Transmissible spongiform encephalopathy (TSE) caused by prions. Prion hypothesis. Prion species barrier. Investigation of a virus outbreak: Case study of health risk associated with a virus epidemic. The origin of outbreak, the spread, the intervention strategies, public health response.

**Suggested reading:**

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka. 2nd edition. ASM Press. 2004.
2. Introduction to Modern Virology EPZ by N. Dimmock, A. Easton and K. Leppard. 5 th edition. Blackwell Publishing. 2005.
3. Basic Virology by Edward K. Wanger, M. Hewiett, D. Bloom and D. Camerini. 3 rd edition. Blackwell Publishing. 2007.
4. Principles of Molecular Virology by A.J. Cann. 3rd edition. Elsevier Academic Press. 2001.

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PRACTICAL

PAPER CODE:

Credit: 4

1. Separate serum from the blood sample. Separation of serum protein by vertical gel electrophoresis.
2. Determination of Molecular weight of Protein by Column chromatography
3. Plasmid isolation
4. Bacterial Transformation.
5. Genomic DNA isolation, quantification, purity analysis.
6. Study of UV absorbance spectra for Protein and DNA
7. Polymerase chain reaction using the isolated DNA as template
8. Agrose gel electrophoresis of PCR product
9. Gel purification of PCR product
10. Ligation of PCR product into plasmid vector
11. Preparation of competent cells by calcium chloride method
12. Transformation of ligated product into host by heat shock method
13. Preparation of competent cells by glycerol method
14. Transformation of ligated product into host by Gene Pulsar (Electroporation)
15. Demonstration of  $\alpha$ -complementation of  $\beta$ -galactosidase through blue white colonies

Reference/ Text Book:

1. Sambrook J, Fritsch EF, Maniatis T. (1989). In: Molecular Cloning: A Laboratory Manual (2nd ed). CSH Press, USA.
2. R.W. Old & S. B. Primrose (1990) *Principles of Gene Manipulation : An Introduction to Genetic Engineering*. Clackwell Science Ltd
3. *Protein Purification: Principles and Practice* by Robert K Scopes. Springer Advanced Texts in Chemistry. 1993.

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# BIOPHYSICAL AND BIOCHEMICAL METHODS

PAPER CODE:  
Credit: 4

## **UNIT – I: CHROMATOGRAPHIC TECHNIQUES**

Chromatography: Introduction, Principle of separation/isolation of particular substance, Basic principles and applications: of gel filtration chromatography, Matrix for of gel filtration chromatography, operation of gel filtration chromatography, ion exchange: principle, types, parameters for choosing right matrix, applications, affinity chromatography: principle, advantages of affinity chromatography, types, choice of matrix, operation and applications, gas liquid chromatography: principle, applications, high pressure/ performance liquid chromatography (HPLC).

## **UNIT – II: ELECTROPHORETIC TECHNIQUES**

Basics of electrophoresis: electrophoretic mobility and affecting factors, Biological applications and interpretation of different types of electrophoresis: PAGE, gradient gel, Agarose Gel Electrophoresis, 2D Electrophoresis, iso-electric focusing, gradient electrophoresis; pulsed field gel electrophoresis, blotting techniques: southern, northern, western

## **UNIT -III: SPECTROSCOPIC TECHNIQUES**

Spectroscopy, The nature and properties of electromagnetic radiation, Electromagnetic spectrum, Principle of Spectroscopy, interaction of electromagnetic radiation with matter, Energy level, molecular orbital theory, Electronic transitions, chromophores, UV/Visible spectroscopy, Beer-Lambert Law, applications of UV/Visible spectroscopy, Infrared spectroscopy, applications, fluorescence spectroscopy, characteristics of fluorescence, resonance energy transfer, applications

## **UNIT -IV: FLOWCYTOMETRY**

Optics: Forward Angle Light Scatter, Side Scatter Channel, Properties of FSC & SSC, Fluorescence Channels, Optical Design, FSC vs SSC Dot Plot, Types of Measurements, Fluorescent Dyes and Antibodies, Fluorescence and Fluorochrome. Principles of Fluorescence, Excitation Spectra of Fluorochromes, Emission Spectra, Applications,

### **Reference/Text Book:**

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.
3. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.
4. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.
5. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.
6. Spectroscopy by B.P. Straughan and S. Walker.
7. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.
8. Gel Chromatography by Tibor Kremmery. Wiley Publications.
9. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.
10. The use of radioactive isotopes in the life sciences by J.M. Chapman and G. Ayrey, George Allen and Unwin Ltd., London.
11. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
12. Alberts, A Johnson, J Lewis. Molecular Biology of Cell. Garland Science, 2014.
13. Online Biophysics. V Bloomfield.pdf. NCBI Website.

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# Microbial Bioreactors for Waste Water Treatment

**Paper code:**

**Credit: 4**

**Unit I:**

History of Waste water treatment/management; Regulation of discharges to water: Clean Water Act (CWA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the emergency planning and community right to know act, Pollution Prevention act 1990, an approach to problem solving: a six step method.

**Unit II:**

Water and Waste water characteristics: Essential Biology Concepts, Ecology, Limnology; Water supply and treatment; Physical, Chemical (inorganic, organic) and biological characteristics of waste water and Collection.

**Unit III:**

Waste Water Treatment-Conventional Physico Chemical Methods, Biological Methods of Treatment of Waste water; Non-potable applications of treated waste water, Case study of waste water treatment with high as well as low C/N ratio.

**Unit IV:**

Reactor types: suspended growth reactors; batch reactor; continuous -Flow Stirred Tank Reactor; membrane reactors; rotating drum reactors; biofilm reactors; aerobic granular sludge reactor.

## Reference/Text Book:

1. Environmental Engineering Principles and Practice by Richard O Mines, Jr, Wiley Blackwell
2. Environmental Pollution Control Microbiology by Ross E McKinney, Marcel Dekker, Inc
3. Handbook of Water and waste water treatment plant operations, 3rd Edition by Frank R. Spellman, CRC Press, Taylor and Francis Group.
4. Sustainable Water Engineering Theory and Practice by Chandrappa and Das, Wiley.
5. Water Resources An integrated approach by Joseph Holden, Routledge, Taylor and Francis Group.
6. Drinking Water Quality Problems and Solutions, 2nd Ed, N F Gray, Cambridge.
7. Waste Water Treatment Technologies: A general review; ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA. United Nations, New York, 2003, url:
8. Environmental Biotechnology Principles and Applications. Bruce E Rittman and Perey L McCarty. TataMcGraw Hill Edition (2012) ISBN. 10:1-25-900288-8.

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**Unit I**  
What is innovation, identify customer/society needs, design thinking skills, environmental sustainability, financial analysis. Identifying a problem, understanding the available solutions, developing an innovative solution. (5)

**Unit II**  
Basics of Intellectual property rights; Patents with reference to Life Sciences. Drafting of patent proposals, Collection organization and managing of the literature. (5)

**Unit III**  
Case studies  
Current trends in Domestic/commercial water purification methods, energy generation from wastes etc. (2)  
Case study on development of diagnostic kits. (4)  
Case study on development of rapid diagnostics. (1)  
Case study on IPR (4)  
Industrial visit for problem identification and proposing innovative solutions. (3)

Internal Assessments: as per the course instructor

Final Assessment: Presentation of the concept developed by the groups.

**Reference :**

1. **Purple Cow**, New Edition: Transform Your Business by Being Remarkable: Seth Godin: Books.
2. **The Pumpkin plan**: a simple strategy to grow a remarkable business by Mike Michalowicz
3. **Intellectual property the law of copyrights, patents and trademarks**, By Schechter, Roger E. & Thomas, John R.

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# TOOLS AND TECHNIQUES OF MOLECULAR BIOLOGY AND BIOINFORMATICS

PAPER CODE:  
Credit: 4

## UNIT-III: BASICS OF DNA TECHNOLOGY

Introduction to PCR; primer designing, Types of PCR - multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products PCR amplification of 16SrDNA. Agarose gel analysis.

## UNIT-IV: MOLECULAR TOOLS AND TECHNIQUES

Transformation techniques. Genomic libraries- Isolation of genomic DNA fragments, selection of vectors, cDNA libraries and cDNA cloning, shot gun cloning, Bacterial Artificial libraries, Bacterial Transcriptome Analysis, TA cloning, Artificial chromosome vectors (YACs; BACs); Metagenomics, Primer design, AFGE, PFGE, ARB for bacterial strain identification. Community analysis: Direct and indirect method. RAPD, RFLP, TDDG, DGGE for community Analysis

## UNIT III: RETRIEVING INFORMATION THROUGH SEQUENCE ALIGNMENT AND PHYLOGENETIC TREE

Database indexing and specification of search terms, the archives: nucleic acid sequence database, genome database and genomic browsers, protein sequence database, databases of structures, classification of protein structures, accuracy and precision of protein structure determination. Submission and retrieval of Data in GenBank. Basic principle of genome assembly and annotation. Scoring matrices for nucleic acid and protein sequence analysis: PAM, BLOSSUM. Pairwise and multiple sequence analysis. Database searching using BLAST, Phylogenetic analysis.

## UNIT IV: STRUCTURAL BIOINFORMATICS AND DRUG DISCOVERY

Protein stability and folding, Sasisekharan-Ramakrishnan-Ramchandran plot, protein stability and denaturation, superposition of structures and structure alignment DALI & MUSTANG. Evolution of protein structures, protein structure prediction and modelling, prediction of protein function, divergence of function orthologues and prologues; drug discovery and development, lead compound, improving on the lead compound, Quantitative Structure Activity Relationship(QSAR) Molecular modelling in drug discovery.

### Reference/ Text Book:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition. S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3. CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
6. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
7. Molecular Genetics An Introductive Narrative by G S Stent and R Calender, San Francisco, Calif. : W.H. Freeman, 1978.
8. Introduction to Bioinformatics Arthur M. Lesk Oxford University Press (2014) ISBN978-0-19-872467-4
9. An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics Version 3.3.1 (2016-06-21) by W. N. Venables, D. M. Smith and the R Core Team.

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Section -A

1. Understanding the cultivable microbes from dental Flora.
2. Standardization of technique for sampling the dental flora.
3. Growing the dental micro-flora in the selected media & determination of  
(a) pre-incubation time &  
(b) requisite dilution to get the CFU count and diversity estimate.
4. Isolation, purification, Characterization of dental micro-flora, & antibiotic sensitivity test.
5. In-vitro set up for testing antibiotic therapy in case of dentine tissue or teeth.
6. Visualization of the teeth surface using Scanning Electron Microscope.
7. To find out the relative proportion of Lactic Acid Bacteria from natural sources.
8. Isolation of acid producing bacterial from various natural sources like grass, intestine of fish and prawn, curd, fermented fish, bee hibe, etc
9. Characterization of isolates.
10. Testing for biofilm formation by the isolate.
11. Production of Lactic acid from whey in packed bed reactor.

Section-B

1. Gene sequence downloading from gene database
2. Nucleotide BLAST
3. Comparison of gene sequences using alignment tool
4. Amino acid sequence of protein downloading from database
5. Protein BLAST
6. Comparison of Amino acid sequence of proteins using alignment tool
7. Computation of instability index of proteins
8. Computation of aliphatic index of proteins
9. Prediction of phosphorylation sites in the proteins
10. Computation of hydrophobicity of proteins

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# FERMENTATION TECHNOLOGY AND FERMENTED FOOD

PAPER CODE:

Credit: 4

## UNIT-I: INTRODUCTION TO FERMENTATION TECHNOLOGY

Origin and History of food fermentation; Basics of fermentation processes; Microbial culture selection for fermentation processes. Media formulation, inoculum development and process optimization; Significance of substrates and starter culture; Basic requirements for fermentation and factor affecting fermentation process. Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a reactor. Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.

## UNIT-II TYPES OF FERMENTATION AND PRODUCT RECOVERY

Types of fermentation- (submerged/solid state, Batch /continuous fermentation); Down Stream processing. Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis. Bioprocess economics and Bioproduct regulation.

## UNIT III: TRADITIONAL FERMENTED FOOD AND BEVERAGES-

Health benefits and other significances of fermented food and beverages; Traditional fermentation of Asia and North East India; Food habits and types of their fermented food; Fermented vegetables (Fermented beans Sauerkraut, Kimchi, Pickle, bamboo shoots); Fermented soyabean products (Temph, Tofu, Soya sauce); Fermented dairy products (Cheese, Dahi and Yogurt, Butter); Fermented baked product (bread and bakery products); Other fermented food products (Idli, Vada, Dosa, Bhatura, Dhokla); Fermented fish. Fermented meat and sausages; Fermented beverages (Sake, Rice beers, Ale, Wines).

## UNIT IV: INDUSTRIAL APPLICATION OF FERMENTATION TECHNOLOGY-

Fermentation processes for production of SCP; Production of Industrial alcohol (Ethanol and Butanol); Organic acids (Citric acid, Lactic acid, Glutamic acid); Amino acids (Lysine, Phenylalanine, Tryptophan); Biopolymers- (Dextran, Xanthan); Antibiotics- (cephalosporin's, Tetracycline's, Polyenes); Enzymes- (Alpha-amylase, Lipase, Pectinases, Proteases); Vitamins- (Vitamin B12 and Riboflavin); Alcoholic beverages- (Toddy, Beer, Wine, Champagne, Rum, Brandy, Whisky).

### **Reference/Text Book:**

1. Food Microbiology by William Frazier, Dannise Westhoff, McGraw-Hill. Inc.
2. Microbial Physiology and Metabolism by Caldwell D.R. 1995Brown Publishers.
3. Microbial Physiology by Moat A.G. and Foster J. W. 1999.. Wiley.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press. New York.
5. Principles of Fermentation Technology, 3rd Edition by Stanbury & Whitaker & Hall, Butterworth-Heinemann, Elsevier science.
6. The Art of Fermentation by SandorEllix Katz, Chelsea Green Publishing (2012).
7. Mastering Fermentation by Kate Williams, Oxford publishing.

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# MICROBIAL ADAPTATION

PAPER CODE:  
Credit: 2

## UNIT-I: ADAPTATION TO EXTREME ENVIRONMENT

Adaptations to pH, Temperature adaptations, Pressure adaptation, Halophilic adaptations

## UNIT-II: PATHOGENIC ADAPTATION TO HOST ENVIRONMENT

Adaptation to acidic environment, Adaptation to Microaerobic conditions, Adaption to immune system stress, Adaptation to Metal stress

## UNIT-III: DORMANCY, DRUG TOLERANCE AND RESISTANCE

Growth regulation by microbes, Survival and reactivation strategies of pathogens in stress through heterogeneous population generation, Persisters, antimicrobial resistance

### Reference:

1. Protein adaptation in Extremophiles: January 2008, Publisher: Nova Biomedical, ISBN: 1604560193
2. Extremophiles and Their Applications in Medical Processes: ISBN 978-3-319-12808-5
3. Tuberculosis and the Tubercle Bacillus, Second Edition, ISBN: 9781555819552
4. Reviews and research articles related to topics will be suggested during course

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# BACTERIAL SECRETION SYSTEM AND BACTERIAL QUORUM SENSING

PAPER CODE:  
Credit: 2

## UNIT I: BACTERIAL SECRETION SYSTEM:

Introduction: Sec secretion pathway; SecB secretion pathway; SRP pathway; Tat pathway; Type I, Type II, Type III (T3SS; injectisome, injectosome), Type IV, Type V, Type VI; Sec A2, Sortases and Type VII secretion systems.

## UNIT II: QUORUM SENSING:

Discovery: Role in as illustrated by bioluminescence (*Vibrio fischeri*, *Vibrio harveyi*); virulence (*Pseudomonas aeruginosa*, *Staphylococcus*); competence and sporulation (*Bacillus subtilis*) and antibiotic resistance in bacteria. Quorum quenching: impact and mechanism.

### **Reference Books :**

1. Prescott's Microbiology by J. Willey, L. Sherwood and C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
4. General Microbiology by R. Stanier, J. Ingraham, M. Wheelis, R. Painter. 5th edition. Macmillan, Hampshire & London Publishers. 1992.
5. Microbiology by M. Pelczar, E. Chan & R. Reid. 4th Edition. McGraw Hill Education. 1998

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## PROJECT WORK

PAPER CODE: MI- 905C  
Credit: 4

### UNIT -1 UNIT -1 PREPARATION OF SYNOPSIS

Introduction and Identification of the problem, Review of literature, Definition of the problem and logical development of a working hypothesis.

### UNIT -2 METHODOLOGY

Formulation of objectives and experimental design for verifying the hypothesis, standardization of methodology and modifications if any in the protocol

### UNIT -3 CONDUCTING EXPERIMENTS AND REPORTING THE FINDINGS

Phase wise working for experimental findings and observation, soft copy report with statistical analysis, result and discussion of the findings, Group discussion and rectification, pre-submission through departmental seminar.

**NB: Evaluation for part one will be done on:**

1. Presentation of Synopsis its objectives, expected outcome, and methodology in detail.
2. Assignment for review of literature related to proposed work.

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UNIT I: ANTIMICROBIALS

An outline of the historical development of antimicrobial agents. Reasons for studying the biochemistry and molecular biology of antimicrobial compounds. Uncovering the molecular basis of antimicrobial action. Current trends in the discovery of antimicrobial drugs. Antimicrobial assays in liquid and solid media. Susceptibility testing in liquid and solid media.

UNIT II: MODE OF ACTION OF ANTIMICROBIALS

Antibiotics that inhibit peptidoglycan biosynthesis. Drugs that interfere with the biosynthesis of the cell wall of mycobacteria. Fungal cell wall as a target for antimicrobial drugs. Ionophoric antibiotics. Antifungal agents that interfere with the function and biosynthesis of membrane sterols. Inhibitors of nucleic acid biosynthesis. Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents. A unique antifungal antibiotic- griseofulvin.

UNIT -III DRUG RESISTANCE

The concept of drug resistance, Multi drug resistance; Types of antimicrobials drugs and associated problems of drug Resistance. Mechanisms of bacterial resistance to host cellular and humoral defenses

UNIT III: MICROBIAL PATHOGENECITY AND EPIDEMIOLOGY

Virulence factors: Mechanism of adhesion, colonization and invasion of host tissues by bacterial pathogens. measurements of virulence. Microbial toxins: Characteristics, purification, Mode of action and assay (in vivo, in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria.

Reference/Text Book:

1. Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
2. Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal.
3. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4<sup>th</sup> Ed., NiraliPrakashan.
4. OsolArther (1975) *Remington's Pharmaceutical Sciences*, 15<sup>th</sup> Ed., Mack Pub. Co., Pennsylvania.
5. Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action. The Basis of Pharmacology*, Harper international edition New York.
6. Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12<sup>th</sup> Ed., Vol. 1 & 2. Popular Prakashan, Mumbai.
7. Chatwal G. P. (2003) *Biopharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
8. Micheles P. S., Y. L. Khmel'nitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis. A Natural Approach to Drug Discovery*, Trends in Biotechnol. 16, 197.
9. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael
10. Medical Microbiology: an Introduction to infectious diseases. Sherris, John C, Ed, Elsevier Publication II<sup>nd</sup> edition.
11. Multidrug resistance. Annu Rev Biochem. 2009 ; 78: 119-146. doi:10.1146/annurev.biochem.78.082907.145923.

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# PROJECT WORK

COURSE CODE: MI-1003C  
UNIT: 4

## UNIT - 1 CONDUCTING EXPERIMENTS AND REPORTING THE FINDINGS

Phase wise working for experimental findings and observation, soft copy report with statistical analysis, result and discussion of the findings, Group discussion and rectification, pre-submission through departmental seminar.

## UNIT - 2 PREPARATION OF FINAL DISSERTATION

Preparation of final dissertation under the following heads and submission in hard and soft copy: Preface, Certificate, Contents, Introduction, Review of literature, Materials and methods, Experimental findings or Results, Discussion and References. Appendices- Statistical tables etc.

## UNIT - 3 PREPARATION OF MANUSCRIPT FOR A RESEARCH PAPER

Preparation of manuscript with reference to an International/ National journal on Science or microbiology or related to specific subject matter for publication.

**NB: Evaluation for part two will be done on:**

1. Preparation of manuscript for a research paper and its communication in a journal
2. Preparation of final dissertation
1. PowerPoint Presentation of overall work of the project

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## Department of Microbiology

Tripura University (A Central University)

Suryamainagar - 799022

Tripura, India



Date: 7th October 2015

Minutes of Board of Post Graduate Studies (BPGS) meeting of Microbiology Department held on 7<sup>th</sup> October, 2015 at 11.00 am in Department of Microbiology.

List of members present:

- |   |                          |
|---|--------------------------|
| 1. Prof. Krisanu Chakravarti, Calcutta University, Kolkata          | - External expert member |
| 2. Prof. Rajiv K. Singh, Rajiv Gandhi University, Arunachal Pradesh | - External expert member |
| 3. Prof. A.K Saha, Department of Botany, TU                         | - Member                 |
| 4. Dr. Shaon Ray Chaudhuri, Department of Microbiology, TU          | - Member                 |
| 5. Dr. Debashis Maiti, Department of Human Physiology, TU           | - Member                 |
| 6. Dr. Shiv Shankar Singh, Department of Zoology, TU                | - Member                 |
| 7. Dr. Surjit Bhattacharjee, Department of Mol Bio & bioinfo, TU    | - Member                 |
| 8. Dr. Bipin Kumar Sharma, Department of Microbiology, TU           | - Convenor               |

At the outset, the convenor welcomed all the members present and discussed the agenda of the meeting as follows:

1. Discussion and modification of MSc (CBCS) syllabus and necessary approval after modification
2. Approvals of RAC committee for PhD Students.
3. Approval for the exam proposal for conducting MSc programme of the department.

**The BPGS meeting took the following decisions and resolutions.**

1. Six RAC committees for six PhD Students, Department of microbiology are been formed respectively and are been approved by the experts and the board members of the meeting as proposed by the chairman BPGS, for regular assessment of the progress of the proposed PhD works of the students as follows:

a) For Mrs Lovely Rahaman.

External Expert: Prof. Sarbani Giri. Dept. of Life Science and Bioinformatics, Assam University.

Internal Expert: Prof. A.K. Saha. Dept. of Botany.

Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.

Dr. Debashish Maiti. Dept. of Human Physiology.

Dr. B.K. Sharma. Dept. of Microbiology.

b) For Mr Sushanta Ghosh.

External Expert: Dr. Manabendra Mandal. Dept. of Molecular Biology and Biotechnology, Tezpur University

Internal Expert: Prof. A.K. Saha. Dept. of Botany.

Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.

Dr. Debashish Maiti. Dept. of Human Physiology.

Dr. B.K. Sharma. Dept. of Microbiology.

c) For Mr David Lalvohbika Kaipeng.

External Expert: Prof. D. K. Jha Dept. of Botany, Guwahati University

Internal Expert: Prof. B.K. Datta. Dept. of Botany.

Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.

Dr. Debashish Maiti. Dept. of Human Physiology.

Dr. B.K. Sharma. Dept. of Microbiology.

d) For Ms Salina Debbarma.

External Expert: Prof. D. K. Jha Dept. of Botany, Guwahati University

Internal Expert: Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.

Dr. Shiv Sankar Singh. Dept. of Zoology.

Dr. Sourabh Deb. Dept. of Forestry and Biodiversity.

Dr. B.K. Sharma. Dept. of Microbiology.

- c) For Ms Monika Das.  
 External Expert: Prof. Sarbani Giri. Dept. of Life Science and Bioinformatics, Assam  
 Univeristy.  
 Internal Expert: Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.  
 Dr. Debashish Maiti. Dept. of Human Physiology.  
 Dr. Sourabh Deb. Dept. of Forestry and Biodiversity.  
 Dr. B.K. Sharma. Dept. of Microbiology.

- f) For Ms Nandita Nath.  
 External Expert: Dr. Manabendra Mandal. Dept. of Molecular Biology and  
 Biotechnology, Tezpur University  
 Internal Expert: Prof. B.K. Datta. Dept. of Botany.  
 Dr. Shaon Ray Chaudhuri. Dept. of Microbiology.  
 Dr. Shiv Sankar Singh. Dept. of Zoology.  
 Dr. B.K. Sharma. Dept. of Microbiology.

- The exam proposal for MSc Microbiology odd semester, to be conducted in December 2015 is been placed for approval and discussion and is been approved accordingly after necessary modifications as suggested by the board members.
- The M.Sc Microbiology CBCS (Choice Based Credit System) syllabus is discussed in detail for modification as suggested by the board members and is accepted for approval in the modified form. However, the syllabus content finalization is yet to be done on 8<sup>th</sup> Oct 2015.



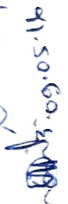



The meeting was conducted in two consecutive sessions and finally came to end with vote of thanks by the convener at 6.30pm.

- Prof. Krisanu Chakravarti, Calcutta University, Kolkata.
- Prof. Rajiv K. Singh, Rajiv Gandhi University, Arunachal Pradesh
- Prof. Sangram Sinha, Department of Botany, TU
- Prof. A.K Saha, Department of Botany, TU
- Dr. Shaon Ray Chaudhuri, Department of Microbiology, TU
- Dr. Debashis Maiti, Department of Human Physiology, TU
- Dr. Shiv Shankar Singh, Department of Zoology, TU
- Dr. Surajit Bhattacharjee, Department of Mol Bio & bioinfo., TU
- Dr. Bipin Kumar Sharma, Department of Microbiology, TU

K. G. S. S. 7/10/15  
Rusingh  
Ajay Krishna Saha  
Shaon Ray Chaudhuri 07/10/15  
07/10/15  
07/10/15  
Surajit Bhattacharjee  
07/10/15  
07/10/15  
 CONVENER

**Proceedings of the 2<sup>nd</sup> meeting of BPGS (Urgent) of the Department of Microbiology held on 9<sup>th</sup> May 2016 at 10.30AM in the office of the Head, Department of Microbiology**

Members Present:

1. Prof S Sinha, Department of Botany, TU:  9.5.16
2. Prof M K Singh, Dean Faculty of Science, TU:  9/5/2016
3. Dr D Maiti, Department of Physiology, TU:  09.05.16
4. Dr S Basak, Department of Molecular Biology and Bioinformatics, TU:  Basak 9/5/16.
5. Dr B K Sharma, Department of Microbiology, TU:  B K Sharma 9/5/2016
6. Dr S Ray Chaudhuri, Department of Microbiology, TU:  Sharm Ray Chaudhuri 9/5/16

At the outset at Chairman of BPGS, Department of Microbiology welcomed the members. The members were appraised about the necessity of holding the urgent BPGS meeting in order to place the syllabus framework of MSc Microbiology before the Academic Council meeting scheduled to be held on 12<sup>th</sup> May 2016. Thereafter the agenda wise discussion started:

**Agendum 1 1/2/2016:** Confirmation of previous BPGS meeting held on 8<sup>th</sup> August 2014

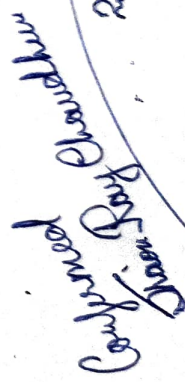
Confirmed.

**Agendum 2 2/2/2016:** Approval of the MSc CBCS system frame work for the Department of Microbiology  
The syllabus frame work was sent to the external and internal for their views. The comments from the experts were placed before the members in the meeting and it was discussed. The frame work was modified in the light of the comments received from the expert members. It was resolved that the revised syllabus be sent to academic council for approval.

**Agendum 3 3/2/2016:** To consider the constitution of RAC for the four research scholars working with Dr B K Sharma.

The Research Advisory Committee for each individual research scholar proposed by the Supervisor (Dr B K Sharma) was considered and approved.

The meeting ended with the formal vote of thanks by the Chairman of BPGS, Dept. of Microbiology

 26/5/16

Course Code	Course Type	Name of the Course	Credits	Lecturer/Tutorial/Practical hrs per Week
<b>Semester 1`</b>				
MICB-701C	CORE	Basic Microbiology and Microbial physiology	4	4
MICB-702C	CORE	Cell biology and Biochemistry	4	4
MICB-703C	CORE	Biophysics and Instrumentation	4	4
MICB-704C	CORE	Practical	4	8
MICB-705E	ELECTIVE	Computer foundation(Soft skills)	4	4
<b>Semester 2</b>				
MICB-801C	CORE	Molecular Biology and Microbial Genetics	4	4
MICB-802C	CORE	Applied Microbiology	4	4
MICB-803C	CORE	Bioinformatics & Computational Biostatistics.	4	4
MICB-804C	CORE	Practical	4	8
MICB-805E	ELECTIVE	Microbial ecology/Bioreactors	4	4
<b>Semester 3</b>				
MICB-901C	CORE	Tools and Techniques in Microbiology	4	4
MICB-902C	CORE	Practical	4	8
MICB-903E	ELECTIVE	Waste Water Treatment/ Fermented food technology	4	4
MICB-904E	ELECTIVE	Basics of Statistics	4	4
MICB-905C	CORE	Project Work	4	8
<b>Semester 4</b>				
MICB-1001E	ELECTIVE	Intellectual Property Rights, Bioethics, Bioentrepreneurship	4	4
MICB-1002E	ELECTIVE	Advance Applied Microbiology / Recent Trends on Microbiology Research	2	2
MICB-1003C	CORE	Project Presentation	4	8
In addition a 2 credit Elective course offered by other departments may be taken by the student				
Grand total of credits and hours of lectures			72	

Dr. S. B. 09.05.16

Basak 4/15/16

Dr. S. B. 09.05.16

Dr. S. B. 09.05.16

Dr. S. B. 09.05.16

Assistant Professor,  
B.P.O. Statistics,  
Department of Microbiology,  
University.

RAC committees for PhD Students, Department of microbiology are been formed for regular assessment of the progress of the proposed PhD works of the students as follows:

**a) For Mrs Lovely Rahaman.**

External Expert:

Prof. Sarbani Giri. Professor, Dept. of Life Science and Bioinformatics, Assam University. (External Member)

Internal Expert:

Prof. A.K. Saha. Professor, Dept. of Botany, Tripura University (Member)

Dr. Shaon Ray Chaudhuri. Associate Professor, Dept. of Microbiology, Tripura University (Member)

Dr. Aparna Sen, Associate professor, department of, Microbiology, Lady Brabourne College, Kolkata (Member)

Dr. B.K. Sharma. Assistant Professor, Dept. of Microbiology, Tripura University (Convener)

**b) For Mr Sushanta Ghosh.**

External Expert:

Dr. Manabendra Mandal. Associate Professor, Dept. of Molecular Biology and Biotechnology, Tezpur University (External Member)

Internal Expert:

Dr. Shaon Ray Chaudhuri. Associate Professor, Dept. of Microbiology, Tripura University (Member)

Dr. Amitava Bhattacharjee, Assistant Professor, Department of Microbiology, Assam University, Silchar. (Member)

Dr. Debashish Maiti. Associate Professor, Dept. of Human Physiology, Tripura University (Member)

Dr. B.K. Sharma. Assistant Professor, Dept. of Microbiology, Tripura University (Convener)

**c) For Mr David Lalvohbika Kaipeng.**

External Expert: Prof.

D. K. Jha, Professor, Dept. of Botany, Guwahati University (External Member)

Internal Expert:

Dr. Shaon Ray Chaudhuri. Associate Professor, Dept. of Microbiology, Tripura University (Member)

Dr. Debashish Maiti. Associate Professor, Dept. of Human Physiology, Tripura University (Member)

Dr. Sukhendu Mandal, Assistant Professor, Department of Microbiology, University of Calcutta. (Member)

Dr. B.K. Sharma. Assistant Professor, Dept. of Microbiology, Tripura University (Convener)

**d) For Ms Nandita Nath.**

External Expert:

Dr. Manabendra Mandal. Associate Professor, Dept. of Molecular Biology and Biotechnology, Tezpur University (External Member)

Internal Expert:

Prof. B.K. Datta. Professor, Dept. of Botany, Tripura University (Member)

Dr. Shaon Ray Chaudhuri. Associate Professor, Dept. of Microbiology, Tripura University (Member)

Dr. Debashish Maiti. Associate Professor, Dept. of Human Physiology, Tripura University (Member)

Dr. B.K. Sharma. Assistant Professor, Dept. of Microbiology Tripura University (Convener)

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*Handwritten signature*  
Member,  
B.P.G. Studies,  
Department of Microbiology,  
Tripura University.

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B.P.G. Studies,  
Department of Microbiology,  
Tripura University.

*Handwritten signature*  
Member,  
B.P.G. Studies,  
Department of Microbiology,  
Tripura University.

## Notice

The 3<sup>rd</sup> BPGS meeting will be held on 26<sup>th</sup> September 2016 (Monday) from 10.00 AM in the Room of HOD Microbiology to discuss the following agenda:

- Agenda 1/3/16: To confirm the proceeding of the 2<sup>nd</sup> BPGS meeting held on 9<sup>th</sup> May 2016.
  - Agenda 2/3/16: Discussion and modification of the full syllabus for the MSc. in Microbiology as per CBCS system.
- The full syllabus that was circulated was further modified to incorporate the suggestions of the external experts and internal members. The frame work would also be modified further to incorporate the MOOC/online courses of 1 credit in the 3<sup>rd</sup> semester as per the directive of the higher authority. There is also a suggestion to change the title of the some offered papers.
- Agenda 3/3/16: Approval of the RAC recommendation for PhD registration of Ms Nandita Nath under Dr B K Sharma.

The recommendation of the RAC for Ms Nandita Nath based on her presentation is being placed for necessary approval.

- Agenda 4/3/16: PhD Coursework syllabus would be placed for notification  
The syllabus for the PhD course work is placed for approval.
- ❖ Agenda 5/3/16: List of paper setter and examiner for the upcoming Examination of the 1<sup>st</sup> and 3<sup>rd</sup> Semester would be placed for notification.
- ❖ Agenda 6/3/16: RAC recommendation for Mrs Lovely Rahaman, Mr. David Lalvohbika Kaipeng and Mr Susanta Ghosh would be notified.
- ❖ Agenda 7/3/16: Any other issue with the permission of the chair.

All members are cordially invited to attend the meeting.

*Sham Ray Chaudhuri*

Dr. Shaon Ray Chaudhuri 10/9/2016  
Convener, BPGS

CC:

1. PA to Hon'ble Vice Chancellor
2. Registrar, Tripura University
3. Controller of Examination, Tripura University
4. Finance Officer, Tripura University
5. Dean, Faculty of Science, Tripura University
6. Internal Members of the BPGS (Prof Sangram Sinha; Dr Surajit Basak; Dr Debasish Maiti)
7. External Members of BPGS (Prof Bharat B Chaitoo; Dr Sunik Kumar Mukherjee; Dr Santanu Datta)



26/9/2016

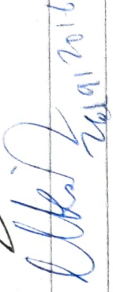
### 3<sup>rd</sup> BPGS meeting of the Dept. of Microbiology

#### Members Present.

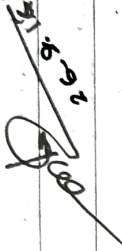
1. Dr. Santanu Datta



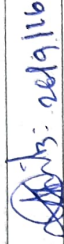
2. Prof. M K Singh (Dean)



3. Prof. Sangrami Sinha



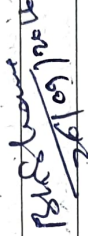
4. Dr. D Maiti



5. Dr. S Basak



6. Dr. B K Sharma



7. Dr. S Ray Chaudhuri



The 3<sup>rd</sup> BPGS meeting started at 10.15 AM with the above mentioned members.

1/3/16: The proceedings of the 2<sup>nd</sup> BPGS meeting was confirmed by merging the units.

- The course name "Fermented food technology" is converted to "Microbiology of Fermented Food and Products".
- The paper "Intellectual Property Rights, Bioethics and Biopreneurship" would be converted to "Intellectual Property Rights". The fifth unit under bioethics and biopreneurship would be deleted.
- The MSc Microbiology students would be encouraged to take courses offered by other departments of Tripura University on "Entrepreneurship".
- The MOOC courses proposed by the Department were approved.

3/3/16: The synopsis of Ms Nandita Nath was approved for registration.  
4/3/2016: The Ph.D course work syllabus for the advanced courses were modified and approved.

5/3/2016: The List of paper setters and examiners for the upcoming examination was approved. Prof A K Saha of Botany department was selected as the Moderator along with the internal faculty member. HOD is authorized to prepare the list of moderators in progress report of  
6/3/2016: The RAC recommendation of Mrs Lovely Rahaman, Mr. David Lalvohbika Kaipeng and Mr. Susanta Ghosh was notified. The modification in documentation was incorporated in case of Mrs Lovely Rahaman.

<sup>Misc</sup> 7/3/2016: Keeping in mind the syllabus of the MSc course, the external expert <sup>(Visiting Fellow)</sup> proposed to the department to prepare a list of External Experts who might be willing to teach modules of the syllabus with their consent and biobdata. The final list would be placed at the BPGS for approval before passing it on to the Honorable Vice Chancellor. HOD has been authorized to prepare the list accordingly.

The meeting ended with a vote of thanks by the HOD, Microbiology.

Sharon Ray Chaudhuri

26/9/2016

B. P. G. Studies,  
Department of Microbiology,  
Tatyasaheb Kore University.

## NOTICE

The 3<sup>rd</sup> BPGS meeting was held at 10.15AM on 26<sup>th</sup> September 2016 at the Department of Microbiology in presence of the members listed below:

1. Dr. Santanu Datta (External expert)
  2. Prof. M K Singh
  3. Prof. S Sinha
  4. Dr. D Maiti
  5. Dr. S Basak
  6. Dr. B K Sharma
  7. Dr. S R Chaudhuri
- Agendum 01/03/16: The confirm the Proceedings of the 2<sup>nd</sup> Meeting held on 9<sup>th</sup> May 2015. The proceedings of the 2<sup>nd</sup> BPGS meeting was placed before the members and confirmed.
  - Agendum 02/03/16: Discussion and modification of the full syllabus for the MSc. In Microbiology as per CBCS system. The modified syllabus with inputs from external BPGS members were placed before the committee.
    - i. The M.Sc Syllabus was approved with certain changes (Attachment I). The courses with more than 4 units were converted to 4 units by margining the units as found suitable.
    - ii. The course name “Fermented Food technology” was converted to “Microbiology of Fermented Food and Products”.
    - iii. The paper “Intellectual Property Rights”, Bioethics and Bioentrepreneurship” was converted to “Intellectual Property Rights”.
    - iv. MSc Microbiology students would be encourages to take courses offered by other Department on “Entrepreneurship”.
    - v. The MOOC courses proposed by the Department were approved. (Attachment II)
  - Agendum 03/03/16: Approval of the RAC recommendation of PhD Registration of Ms Nandita Nath under Dr B K Sharma  
The recommendation of the RAC based on the presentation of Ms Nandita Nath as well as her synopsis were placed before the members. The synopsis of Ms Nandita Nath was approved for Registration.
  - Agendum 04/03/16: The PhD course work syllabus for placed for notification and approval. The advanced courses was approved (Annexure III).
  - Agendum 05/03/16: The list of paper setter and examiners for the upcoming examination was placed for notification. It was approved. Prof. AK Saha, Department of Botany was selected as the Moderated along with the internal faculty members. HOD is authorized to prepare the list as and when required (Annexure IV).

*Sharon Roy Chaudhuri*  
26/9/2016

- Agendum 06/03/16: The RAC recommendation of progress report of Mrs Lovely Rahman, Mr. David Lalvochbika Kaipeng and Mr Sushanta Ghosh for notification.

The RAC recommendation were placed before the committee. The modification in documentation were incorporated in case of Mrs Lovely Rahman. It was notified.

- Agendum 07/03/16: Miscellaneous  
Keeping in mind the Syllabus of the MSc Course, the external expert proposed the department to prepare a list of External experts (Visiting Fellow) who might be willing to teach modules of the syllabus with their consent and biodata. The final list would be placed at the BPGS for approval before passing it on to the Hon'ble vice Chancellor. HOD has been authorized to prepare the list accordingly.

The meeting ended with a vote of Thanks by the HOD, Microbiology.

*Sham Roy Choudhury*  
26/9/2016

अध्यक्ष / Head

सूक्ष्म-जीविकी विभाग,

Department of Microbiology

त्रिपुरा विश्वविद्यालय

Tripura University

## Notice

The 4<sup>th</sup> BPGS meeting of the Department of Microbiology will be held on 16<sup>th</sup> April 2018 at 11.30AM in the office of the Head of the Department to discuss the following Agenda:

1. Agenda 1/4/18: To confirm the proceedings of the 3<sup>rd</sup> BPGS meeting held on 26<sup>th</sup> September 2016.
2. Agenda 2/4/18: Approval of the RAC committee of Ms Tethi Biswas.
3. Agenda 3/4/18: Approval of the RAC committee of Ms Sinchini Barman.
4. Agenda 4/4/18: Approval of the RAC committee of Mr Gourav Bhattacharjee
5. Agenda 5/4/18: Approval of the RAC committee of Ms Mandakini Gogoi.
6. Agenda 6/4/18: Discuss the revised syllabus of the current PhD course work
7. Agenda 7/4/18: Discuss the revised syllabus offered in the current semester of the MSc course.
8. Agenda 8/4/18: Discuss and modify (if required) the revised syllabus for the coming batch of the MSc course (July 2018 onwards).
9. Agenda 9/4/18: Any other issue with permission of the chair.

All members are cordially invited to attend the meeting.

*Shraon Ray Chaudhuri*

Dr Shaon Ray Chaudhuri 28/3/2018  
Convener, BPGS

अध्यक्ष / Head

सूक्ष्म-जीविकी विभाग,

Department of Microbiology

त्रिपुरा विश्वविद्यालय

Tripura University

## Minutes of the 4<sup>th</sup> BPGS Meeting

The 4<sup>th</sup> BPGS meeting of the Department of Microbiology will be held on 16<sup>th</sup> April 2018 at 11.AM in the office of the Head of The Department. The members present are listed below:

1. Prof. S. Sinha
2. Dr. D Maiti
3. Dr. B K Sharma
4. Dr. A Kumar
5. Dr. S R Chaudhuri

The meeting started with the head Department of Microbiology introducing to the new incumbent.

- Agendum 01/04/18: To confirm the proceeding of the 3<sup>rd</sup> BPGS meeting held on 26<sup>th</sup> September 2016.

The minutes of the 3<sup>rd</sup> BPGS meeting was placed:

### Action taken report:

The MSc syllabus was already approved by the BFs. Post facto recommendation of the syllabus was obtained.

The PhD coursework syllabus was approved and adopted for the previous coursework.

The approved paper setters, examiners and moderators were approved by the higher authority for the previous semester examination.

In the current semester NPTEL courses were adopted and no Visiting Faculty were invited.

- Agendum 02/04/18: Approval of the RAC Committee of Ms Tethi Biswas. The resolution of the Departmental research Committee held on 9<sup>th</sup> April 2018 for the RAC committee of Ms Tethi Biswas was placed before the members and approved.
- Agendum 03/04/18: Approval of the RAC Committee of Ms Sinchini Barman. The resolution of the Departmental research Committee held on 9<sup>th</sup> April 2018 for the RAC committee of Ms Sinchini Barman was placed before the members and approved.
- Agendum 04/04/18L: Approval of the RAC Committee of Mr Gourav Bhattacharjee. The resolution of the Departmental research Committee held on 9<sup>th</sup> April 2018 for the RAC committee of Mr Gourav Bhattacharjee was placed before the members and approved.
- Agendum 05/04/18L: Approval of the RAC Committee of Ms Mandakini Gogoi. The resolution of the Departmental research Committee held on 9<sup>th</sup> April 2018 for the RAC committee of Ms Mandakini Gogoi was placed before the members and approved.
- Agendum 06/04/18: Discuss the revised syllabus of the current PhD course work. PhD course work syllabus was discussed. It was approved that the scholars will take NPTEL courses to earn additional credits in Semester I to V as per the requirements of the current PhD regulations (page 13).
- Agendum 07/04/18: Discuss the revised syllabus offered in the current semester of the MSc course. The changes in MSc syllabus for the current semester were placed before the committee and it was approved.

- Agendum 08/04/18: Discuss and modify (if required) the revised syllabus for the coming batch of the MSc course (July 2018 onwards).

Agendum was withdrawn till the next BPGS meeting in presence of External Expert.

- Agendum 09/04/18: Any other issue with permission of the chair.
- The DRC was approved by BPGS.**  
The Chairman thanked the members present in the meeting.

*Shovan Roy Chaudhuri*

16/4/18

16/4/2018  
4<sup>th</sup> BPGS Meeting of the Dept of Microbiology  
Venue: HOD office; Time: 11:45 AM  
Members Present:

1. Prof Sangram Sinha

cos  
16.4.18

2. Dr. D. Maiti

Devesh Mishra: 16.04.18

3. Dr. B. K. Shama

NK Sharma  
16/04/2018

4. Dr. Ashutosh Kumar

Ashutosh Kumar  
16/04/2018

5. Dr. Shaon Roy Chaudhuri

SR: 16/4/2018

Minutes attached on the previous page.




## NOTICE

The 5<sup>th</sup> BPGS meeting of the Department of Microbiology will be held on 19<sup>th</sup> July 2019 at 11.AM in the office of the Head of the Department. To discuss following Agenda:

1. Agenda 1/7/19: To confirm the proceedings of the 4<sup>th</sup> BPGS meeting held on the 16<sup>th</sup> April 2018.
2. Agenda 2/7/19: Revision of Msc Syllabus.
3. Agenda 3/7/19: Approval of Tethi Biswas PhD Registration.
4. Agenda 4/7/19: Approval of the RAC Committee of Ms Ankurita Bhowmik.
5. Agenda 5/7/19: Appointment of RAC External Expert for Scholar (Lovely Rahman, David Lalvohbika Kaipeng, Sushanta Ghosh).
6. Miscellaneous if any.

All Members are cordially invited to attend the Meeting.

  
अध्यक्ष प्राध्यापी/Head (I/C,  
सूक्ष्म-जीविकी विभाग  
Department of Microbiology  
त्रिपुरा विश्वविद्यालय  
Tripura University

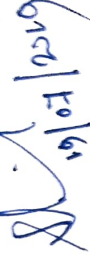

Dr. Bipin Kumar Sharma

Convener, BPGS



### Minutes of the 5<sup>th</sup> BPGS Meeting

The 5<sup>th</sup> BPGS meeting of the Department of Microbiology was held on 19<sup>th</sup> July 2019 at 11:00 A.M in the office of the Head of the Department. The members present are listed below:

- 1) Prof. Sukanta Banik :  19/07/2019
- 2) Prof. Samir Kumar Shil :  19/7/19
- 3) Dr. Ashutosh Kumar : Ashutosh Kumar 19/7/19
- 4) Dr. Ashwini Chauhan : Ashwini 19/7/19
- 5) Dr. Shaon Ray Chaudhuri : Shaon Ray Chaudhuri 19/7/19
- 6) Dr. Surajit Bhattacharjee : Surajit Bhattacharjee 19/07/2019
- 7) Dr. Bipin Kumar Sharma : BK Sharma 19/07/2019

1. Agenda 1/7/19: To confirm the proceedings of the 4<sup>th</sup> BPGS meeting held on the 16<sup>th</sup> April 2018.
- Regarding agenda 1 to confirm the proceedings of 4<sup>th</sup> BPGS meeting held on 16<sup>th</sup> April 2018 was discussed and confirmed.
2. Agenda 2/7/19: Revision of MSc Syllabus.
- The revised and modified syllabus was placed in the meeting for discussion, some corrections and modifications were suggested and discussed especially regarding the project and MOOC courses, which was incorporated and the syllabus with modification was approved.
3. Agenda 3/7/19: Approval of Ms. Tethi Biswas PhD Registration.
- Matter was discussed and registration was approved for Ms. Tethi Biswas with effect from 18th December 2018.
4. Agenda 4/7/19: Approval of the RAC Committee of Ms. Ankurita Bhowmik.
- RAC committee for Ms. Ankurita Bhowmik was been proposed by the supervisor Dr. Ashwini Chauhan. It was noted that the proposed Co-supervisor is a medical practitioner with MD degree. As per PhD regulations Tripura University, 2016 the Co-supervisor/RAC member has to be a PhD holder.
- The PhD course work examination of the student is due in August 2019 and requires functioning RAC Committee for evaluation. Hence, it is proposed that RAC Committee may be approved without the Co-supervisor at the moment. The request may be made by the supervisor to the University Authority for acceptance of candidature of proposed Co-supervisor.
- The names of RAC member approved by BPGS are as follows:

- i. Dr. Ashwini Chauhan
  - ii. Dr. Ashutosh Kumar
  - iii. Dr. Pratap Chandra Acharya
  - iv. Dr. Bipin Kr. Sharma
  - v. Dr. Samir K. Mukherji (External Expert)
5. Agenda 5/7/19: Appointment of External Expert for Pre PhD seminar for the Scholars (Mrs. Lovely Rahaman, Mr. David Lalvohbika Kaipeng, Mr. Sushanta Ghosh)
- External expert for Pre PhD submission of Scholars Mrs. Lovely Rahaman, Mr. David Lalvohbika Kaipeng and Mr. Sushanta Ghosh has been proposed by the Supervisor as follows:

Sl no	Name of the scholar	Name of experts for pre PhD seminar
1	Mrs. Lovely Rehaman	Prof. A.K. Shukla, Department of Botany and Faculty of Earth science, IGNTU, Amarkantak
2	Mr. Susanta Ghosh	Prof. R. K. Singh, Dept of Botany Rajiv Gandhi University, Arunachal Pradesh
3	Mr. David L. Keipeng	Prof. Manabendra Mandal, dept. of Molecular Biology and Biotechnology, Tezpur University

The names proposed have been approved by the BPGS.

6. Change of RAC member for Ms. Mandakini Gogoi
- As per the Tripura University PhD regulation 2016, the RAC should include a member from other department; the member approved for Ms. Mandakini Gogoi is Dr. Alok Prashad Das, Dept. of Chemical & Polymer Engineering, Tripura University. Since he was relocated to other University, the name of Dr. Surajit Bhattacharya (as proposed by the PI) was been approved by DRC and the same is approved by the BPGS.
7. The withdrawal of Co-Supervisor for the PhD thesis of Mr. David L. Keipeng
- On recommendation of RAC held on 17/07/2019, the BPGS member unanimously approved the matter of withdrawal of the name of Co- Supervisor Dr. Sukhendu Mandal of Calcutta University and recommended the matter to be processed for further action.

The convener thanked the members present in the meeting.  
The meeting ends at 2.30 PM.

*P.K. Shaw*  
12/07/2019

CONVENER BPGS

अध्यक्ष प्रभारी/Head (I/C)  
सूक्ष्म-जैविकी विभाग  
Department of Microbiology  
त्रिपुरा विश्वविद्यालय  
Tripura University

5<sup>th</sup> BPGS Meeting of Dept of Microbiology  
Venue: HOD Office : Time 11. Am

19.07.2019

Members present:

1. Prof Sukanta Banik

2 Prof Samir Sil. - JS 19/7/19

3. Dr Shaon Ray Choudhuri Shaon Ray Choudhuri 19/7/19

④ Dr Bipin Kumar Sharma BK Sharma 19/07/2019

⑤ Dr Surajit Bhattacharyya Surajit Bhattacharyya 19/07/2019

⑥ Dr Ashwini Chauhan A Chauhan 19/7/19

⑦ Dr Ashutosh Kumar. Ashutosh Kumar 19/7/19



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Suryamaninagar, Agartala,

Tripura – 799 022

Webpage: [www.tripurauniversity.in](http://www.tripurauniversity.in)

Department of Microbiology

Ref. No: BPGS/MicroTU/16062020/01

Date: 16<sup>th</sup> June 2020

## NOTICE

Sir/Madam,

As per the requirement of Dr Shaon Ray Chaudhuri, Supervisor of Ms Tethi Biswas, an internal BPGS meeting is called on of 24<sup>th</sup> June 2020 at 10.30AM on a single agenda of reporting the Pre-Ph.D Public Summary presentation of Ms Tethi Biswas, <sup>as well as Mr Nandita, Ph.D.</sup> and get her list of Adjudicators approval (Copy attached below) by the members.

This is for your kind information and request for your kind presence for the said BPGS meeting on 24<sup>th</sup> June 2020 at 10.30 AM.

Thanking you  
With Regards

*BK Sharma*  
*16/06/2020*

Dr Bipin Kumar Sharma  
Coordinator  
Department of Microbiology  
Tripura University



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Department of Microbiology

Date: 24<sup>th</sup> June 2020

Minutes of Board of Post Graduate Studies (BPGS) meeting of Microbiology Department held on 24<sup>th</sup> June 2020 at 10.30AM in the Department of Microbiology.

List of Members present:

1. Prof S. K. Sil, Department of Human Physiology, TU

2. Dr Shaon Ray Chaudhuri, Department of Microbiology, TU

3. Dr Surajit Bhattacharjee, Department of Molecular Biology and Bioinformatics, TU

4. Dr Ashutosh Kumar, Department of Microbiology, TU

5. Dr Ashwini Chauhan, Department of Microbiology, TU

6. Dr Bipin Kumar Sharma, Department of Microbiology, TU

Samin L A 24/06/2020

Shaon Ray Chaudhuri 24/6/2020

Swrajit Bhattacharjee 24/06/2020

Ashutosh Kumar 24/06/2020

Dr. Shaon 24/06/2020

Ashwini Chauhan 24/6/2020

At the outset the Convener welcomed all the members present and informed them that the first two public seminars (Pre PhD Summary Presentation) of the Department took place on 16<sup>th</sup> June 2020 and 23<sup>rd</sup> June 2020 at 12 Noon. He placed the documents produced by the supervisors showing satisfactory performance of the candidates (Ms Tethi Biswas and Ms Nandita Nath) as stated by the RAC members. The list of adjudicators recommended by the RAC for both the candidates was also placed for approval.

### The BPGS members took the following resolutions.

1. The successful completion of the step of Pre PhD Summary submission and Presentation by Ms Tethi Biswas and Ms Nandita Nath were noted.
2. The lists of 6 adjudicators proposed by the concerned Supervisors and recommended by the respective RAC were approved by the BPGC.

Finally the Convener thanked the members for their presence in the meeting and the meeting ended at 11.30AM.

Dr. Shaon  
24/06/2020

Convener



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Department of Microbiology

Email: [hod\\_microbiology@tripurauniv.in](mailto:hod_microbiology@tripurauniv.in)

Ref. No: BPGS/MicroTU/02092020/01

Date: 02/09/2020

## NOTICE

Sir/Madam,

As per the requirement of DRC chairman, Microbiology Department, an internal BPGS meeting is called on September 18, 2020 at 1PM to approve the RAC committee members of PhD students; Ms. Sharmistha Tapadar (Supervisor: Dr. Ashutosh Kumar) and Ms. Purnita Bhattacharyya (Supervisor: Dr. Ashutosh Kumar).

This is for your kind information and request for your kind presence for the said BPGS meeting on September 18, 2020 at 1PM.

Thanking you.

*P. S. Sharma*  
02/09/2020

Convener BPGS

अध्यक्ष प्रभारी/Head (i/c)  
सूक्ष्म-जैविकी विभाग  
Department of Microbiology  
त्रिपुरा विश्वविद्यालय  
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Email: [hod\\_microbiology@tripurauniv.in](mailto:hod_microbiology@tripurauniv.in)

Date: 18/09/2020

Minutes of Board of Post Graduate Studies (BPGS) meeting of Microbiology Department held on September 18, 2020 at IPM in the Department of Microbiology.

List of Members present:

1. Prof. S.K. Sil, Department of Human Physiology, TU *Samin kumar Sol* 18/09/2020
2. Dr. Shaon Ray Chaudhuri, Department of Microbiology, TU *Shaon Ray Chaudhuri* 18/9/2020
3. Dr. Surajit Bhattacharjee, Department of Molecular Biology and Bioinformatics, TU *Surajit Bhattacharjee* 18/09/2020
4. Dr. Ashutosh Kumar, Department of Microbiology, TU *Ashutosh Kumar* 18/9/2020
5. Dr. Ashwini Chauhan, Department of Microbiology, TU *Ashwini Chauhan* 18/9/2020
6. Dr. Bipin Kumar Sharma, Department of Microbiology, TU *Bipin Kumar Sharma* 18/09/2020

1. RAC committee for Ms. Sharmistha Tapadar was proposed by the supervisor Dr. Ashutosh Kumar before the members and approved.

The names of RAC member approved by the BPGS are as follows:

- i. Dr. Ashutosh Kumar [supervisor]
- ii. Dr. Yusuf Akhter [co-supervisor]
- iii. Dr. Bipin Kumar Sharma
- iv. Dr. Shiv Shankar Singh
- v. Dr. Md. Imtaiyaz Hassan (External Expert)

2. RAC committee for Ms. Purnita Bhattacharyya was proposed by the supervisor Dr. Ashutosh Kumar before the members and approved.

- i. Dr. Ashutosh Kumar [supervisor]
- ii. Dr. Shaon Ray Chaudhuri
- iii. Dr. Ashwini Chauhan
- iv. Dr. Pratap Chandra Acharya
- v. Dr. Deeksha Tripathi (External Expert)

Finally, the convener thanked the members for their presence in the meeting, and the meeting ended at 3PM.

*Dr. Ashwini Chauhan*  
18/09/2020

Convener BPGS  
अध्यक्ष प्रवर्तनी/Head (I/L)  
सूक्ष्म-जैविकी विभाग  
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