



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 1st Semester Courses in **Microbiology** (June 2014 onwards)

Contents:

Theory Syllabus for Courses:

MS.MIC.1.01 – **VIROLOGY AND CELL BIOLOGY**

MS.MIC.1.02 - **GENETICS**

MS.MIC.1.03 - **MICROBIAL BIOCHEMISTRY I**

MS.MIC.1.04 - **IMMUNOLOGY**

Practical Syllabus for Courses:

MS.MIC.1.01.PR: **VIROLOGY, CELL BIOLOGY AND SCIENTIFIC COMMUNICATION**

MS.MIC.1.02.PR: **GENETICS**

MS.MIC.1.03.PR: **MICROBIAL BIOCHEMISTRY I**

MS.MIC.1.04.PR: **IMMUNOLOGY**

Title: VIROLOGY AND CELL BIOLOGY

Course: MS.MIC.1.01

LEARNING OBJECTIVES

1. Understand the structure and replication of bacteriophages, plant and animal viruses
2. Understand the structure and function of the cell membrane and various cell organelles

Number of lectures: 60

UNIT 1: INTRODUCTION TO VIROLOGY, STUDY OF BACTERIOPHAGES, PLANT VIRUSES, VIROIDS, INSECT VIRUSES AND PRIONS

15 LECTURES

LEARNING OBJECTIVES

1. Understand the architecture and replication of bacteriophages
2. Understand the structure and replication of Plant viruses and viroids
3. Understand the structure and significance of Insect viruses
4. Understand prions and prion mediated pathogenesis in humans

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|---|-----------|
| 1. Introduction to Virology | 1L |
| • An Overview | |
| i. Virus impact | |
| ii. Virus architecture and nomenclature | |
| 2. Bacteriophages | 1L |
| • General properties of phages | |
| • Properties of phage infected bacterial cultures | |
| • Specificity of Phage Infection | |
| 3. <i>E.coli</i> Single/double stranded DNA and RNA phages | 3L |
| • Structure, Gene organization and Replication of | |
| i. T4 phage | |
| ii. T7 phage | |
| iii. Δ phage | |
| iv. Phage Φ X174 | |
| v. Filamentous DNA phages | |
| vi. Single stranded RNA phages | |
| 4. Plant Viruses | 2L |
| • General aspects of viruses and classification | |
| • Structure of Viruses and Viroids | |
| • Replication of Viruses and Viroids | |
| • Plant satellite Viruses and Virusoids | |

- Diagnosis and control of diseases caused by plant viruses

5. Comparative study of **2L**

- TMV and Citrus Tristeza Virus (CTV)
- Cucumber Mosaic virus and Cauliflower Mosaic virus

6. Baculoviruses (Insect viruses) **2L**

- Significance
- Viral structure
- Genome
- Host range
- Transmission

7. Prions **1L**

- History
- Proteins involved and “Protein only” Hypothesis
- Diseases
 - i. CJD
 - ii. BSE

8. Anti - Viral Drugs **2L**

- Screening for Antiviral Compounds
- Designer Antivirals and computer-based searching
- Examples of approved drugs and resistance
- Searching for new targets
- Antiviral Gene Therapy

9. Viral Bioinformatics **1L**

- Introduction
- Biological databases
- Biological applications

UNIT 2: LIFE CYCLES OF PATHOGENIC VIRUSES

15 LECTURES

LEARNING OBJECTIVES

1. Understand the structure and replication of animal viruses causing significant diseases.
2. Study virus evolution and the emergence of new and re-emerging animal viruses affecting human health.

1. Double stranded RNA viruses- Reoviruses- e.g. Rotavirus **2L**

2. Single stranded RNA viruses with negative sense –Orthomyxoviruses- e.g. Influenza viruses **2L**

- 3. Single stranded RNA viruses with positive sense-**Picornaviruses- e.g. Hepatitis A Virus **2L**
- 4. Single stranded RNA RT viruses-** Retroviruses- Human Immunodeficiency Virus **2L**
- 5. Double stranded DNA viruses-** Herpes viruses- e.g. HSV, EBV **2L**
- 6. Double stranded DNA-RT viruses-**Hepadna viruses- e.g. Hepatitis B virus **2L**
- 7. Single stranded DNA virus-** Parvoviruses **2L**
- 8. New and reemerging viruses** **1L**
- Evolution , Emergence and adaptation
 - Sources and causes of emergent viruses
 - i. Ecological factors
 - ii. Climate variability
 - iii. Human factors- social behaviour
 - iv. Exposure to zoonotic diseases
 - v. Human movement
 - Example : SARS

UNIT 3: MEMBRANE STRUCTURE AND TRANSPORT

15 LECTURES

LEARNING OBJECTIVES

1. Understand the origin of the cell
2. Understand the structure and function of the Cell membrane

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- 1. Origin of cellular life** **2L**
- Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers
 - The first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes
- 2. Cell membrane structure** **6L**
- Lipid bilayer
 - Membrane proteins
 - Spectrins, Glycophorin
 - Multipass membrane proteins
 - Bacteriorhodopsin
- 3. Membrane Transport** **7L**
- Principles of membrane transport

- Transporters and Active Membrane Transport
- Ion channels
- Electrical properties of membranes with examples.

UNIT 4: SINGLE MEMBRANE ORGANELLES

15 LECTURES

LEARNING OBJECTIVES

1. Understand the structure and function of the single membrane organelles
2. Understand and apply microscopic techniques to the study of cell structure

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| 1. Intracellular Compartments and protein sorting | 6L |
| <ul style="list-style-type: none">● Compartmentalization of cells● Transport of molecules between the nucleus and cytosol● Transport of proteins into mitochondria and chloroplasts● Peroxisomes● Endoplasmic reticulum | |
| 2. Intracellular vesicular traffic | 4L |
| <ul style="list-style-type: none">● Endocytosis● Exocytosis● Transport from the ER through the Golgi apparatus | |
| 3. Cell study – microscopy | 5L |
| <ul style="list-style-type: none">● Phase contrast microscopy● Fluorescence microscopy● Confocal microscopy● Electron microscopy.● Atomic force microscopy● TIRF microscopy | |

CIA: Test, Assignment

References:-

Unit 1

1. A Textbook of Microbiology – Dubey,R.C., Maheshwari,D.K. 3rd revised ed.; 2012, S. Chandand Company.
2. Molecular Biology, Freifelder, David; 2nded, 1987, Narosa Publishing H.
3. Microbial Genetics, Maloy, S.R.; Cronan, J.E.; Freifelder, David ; 2nd ed, 1994, Jones and Bartlett Publishers.
4. Microbiology – Davis, B.D; Dulbecco,R; Eisen, H.N.andGinsberg,H.S.; 4th ed., 1990,Lippincott, Philadelphia
5. Principles of Virology –Flint,S.J.; Enquist,L.M.; RacanielloV.R; and Skalka, A.M. 3rd ed. 2009, Vol I & II, ASM.
6. Understanding Viruses –Shors,T., 2009, Jones and Bartlett publishers.

7. Basic Virology, Wagner E,K; Hewlett, M.J, Bloom, D.C., Camerini, D, 3rded, 2008, Blackwell Publishing
8. Plant Virology – Matthews, R.E.F. ; 3rded, 1991, Academic Press, San Diego

Unit 2

1. Textbook of Microbiology, Ananthnarayan,R& Paniker,C.K.J.,-9th edition ,2013 University press
2. Principles of Virology, Flint,S.J.; Enquist,L.M.; Racaniello, V.R;and Skalka,A.M. 3rd ed. 2009, Vol I & II, ASM.
3. Understanding Viruses, Shors,T., 2009, Jones and Bartlett publishers.
4. Basic Virology, Wagner E,K; Hewlett, M.J, Bloom, D.C., Camerini, D, 3rd edition, 2008, Blackwell Publishing.

Unit 3

1. Molecular Biology of the Cell – Albert,B.; Johnson,A.; Lewis,J.; Raff,M.; Roberts K. &Walter P.; 5thed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology - Lodish,H; Berk,A.;Kaiser,C.A. Krieger,M.;Bretscher,A; Ploegh,H.; Amon, A. and Scott,M.,7th edition, 2013,W.H Freeman and Company , New York
3. The Cell: A Molecular Approach, Cooper,G.;Hausman, R., 5th edition, 2009, ASM Press

Unit 4

1. Molecular Biology of the Cell – Albert,B; Johnson,A; Lewis,J; Raff,M.; Roberts K. &Walter P; 5thed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology - Lodish,H; Berk,A.;Kaiser,C.A. Krieger,M.;Bretscher,A; Ploegh,H.; Amon, A. and Scott,M.,7th edition, 2013,W.H Freeman and Company , New York
3. The Cell: A Molecular Approach, Cooper,G.;Hausman, R., 5th edition, 2009, ASM Press

Title: GENETICS

Course: MS.MIC.1.02

LEARNING OBJECTIVES

1. Understand concepts involved in recombination, mutations, repair & regulation of gene expression in bacteria and eukaryotes
2. Understand concepts of cytoplasmic inheritance and transposable elements in eukaryotes
3. Understand viral genetics and study applications based on gene transfer
4. Study the genetic basis of cancer

Number of lectures: 60

UNIT 1: GENE EXPRESSION AND ITS REGULATION

15 LECTURES

LEARNING OBJECTIVES

Understand gene expression and its regulation in prokaryotes and eukaryotes

A. GENE EXPRESSION IN EUKARYOTES

5L

1. Transcription

- Transcription process
- Post transcriptional processing- structure of mRNA, pre-mRNA processing, addition of 5' cap, addition of Poly (A) tail, RNA splicing, RNA editing.
- Small RNA molecules- RNA interference, types, processing & function of microRNAs

2. Translation

- Mechanism of translation, mRNA surveillance.
- Post translational modification of proteins

B. REGULATION OF GENE EXPRESSION

10L

1. Control of gene expression in prokaryotes

- Genes & regulatory element
- Levels of gene regulation
- DNA binding proteins
- Operons
- Antisense RNA molecules
- Riboswitches

2. Control of gene expression in eukaryotes

- Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling, DNA methylation.
- Regulation through transcriptional activators, Co-activators & repressors, enhancers and insulators
- Regulation through RNA processing & degradation
- Regulation through RNA interference

UNIT 2: REPLICATION, RECOMBINATION, MUTATION AND REPAIR IN EUKARYOTES **15 LECTURES**

LEARNING OBJECTIVES

1. Understand link between replication and cell cycle in bacteria
2. Understand the significance of homologous recombination in bacteria and eukaryotes
3. Understand the molecular basis of mutations and DNA repair mechanisms in prokaryotes and eukaryotes

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| 1. Regulation of replication | 3L |
| ● Bacterial replication and cell cycle | |
| 2. Recombination | 6L |
| ● Homologous recombination in eukaryotes | |
| ● Mating type switching | |
| 3. Mutations | 3L |
| ● Mutations in humans and their effects | |
| ● Molecular basis of mutation - Types, mutations induced by chemicals, radiation and transposable genetic elements; expanding trinucleotide repeats and inherited human diseases | |
| 4. DNA repair mechanisms | 3L |
| ● Excision repair in mammalian cells | |
| ● Mismatch repair in mammalian cells | |
| ● Recombination repair in mammalian cells | |
| ● Conserved repair systems in eukaryotic cells | |
| ● Non-homologous end joining (NHEJ) pathway for repairing double stranded breaks | |
| ● Inherited human diseases with defects in DNA repair | |

UNIT 3: CYTOPLASMIC INHERITANCE & TRANSPOSABLE GENETIC ELEMENTS **15 LECTURES**

LEARNING OBJECTIVES

1. Understand cytoplasmic inheritance
2. Understand the mechanisms of chromosomal rearrangements and its effects on gene expression

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| 1. Cytoplasmic inheritance | 9L |
| ● Mitochondrial DNA- Genome structure, replication, transcription & translation, analysis for study of evolutionary relationships | |
| ● Chloroplast DNA - Gene structure and organization, replication, transcription and translation | |

- Comparison of nuclear, eukaryotic, eubacterial mitochondrial and chloroplast DNA
- Examples of extra nuclear inheritance
 - i. Poky mutant of *Neurospora*
 - ii. Yeast petite mutant

2. Transposable genetic elements

6L

- Transposable Elements in Eukaryotes
 - i. Ac and Ds Elements in Maize
 - ii. P Elements and Hybrid Dysgenesis in *Drosophila*
 - iii. Mariner, an Ancient and Widespread Transposon
- Retrotransposons
 - i. Retrovirus like elements
 - ii. Retroposons
- The Genetic and Evolutionary Significance of Transposable Elements
 - i. Transposons and Genome Organization
 - ii. Transposons and Mutation
 - iii. Rearrangement of Immunoglobulin Genes
 - iv. Evolutionary Issues Concerning Transposable Elements

UNIT 4: VIRAL GENETICS AND GENETICS OF CANCER

15 LECTURES

LEARNING OBJECTIVES

1. Understand the significance of recombination and mapping of bacteriophage genome
2. Study of the application & analysis based on concepts of gene transfer
3. Understand the genetic basis of cancer

1. Viral genetics

5L

- Mapping the Bacteriophage genome
 - i. Genetic fine structure mapping
 - ii. Deletion mapping
- Overlapping genes : Bacteriophage Φ X174
- Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons

2. Genetic basis of cancer

10L

- Cancer: A Genetic Disease
 - i. Forms of Cancer
 - ii. Cancer and the Cell Cycle
- Oncogenes
 - i. Tumor-Inducing Retroviruses and Viral Oncogenes
 - ii. Proto-Oncogenes
 - iii. Chromosome Rearrangement and Cancer
- Tumor Suppressor Genes

- i. Inherited Cancers and Knudson's Two-Hit Hypothesis
 - ii. Cellular Roles of Tumor Suppressor Proteins
- Genetic Pathways to Cancer

CIA: Quiz, Assignment

References: -

Unit 1

1. Genetics: A Conceptual Approach, Benjamin Pierce 3rd edition, 2008, W. H. Freeman & Co.

Unit 2

1. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers
2. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th edition, 2007, Pearson Education
3. Principles of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
4. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers

Unit 3

1. Genetics: A Conceptual Approach, Benjamin Pierce 3rd edition, 2008, W. H. Freeman & Co
2. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
3. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers
4. Fundamental Bacterial Genetics, Trun, Trempy, 1st edition, 2004, Blackwell Publishing
5. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th edition, 2007, Pearson Education

Unit 4

1. Molecular Biology, R. F. Weaver, 4th edition, 1999 McGraw-Hill
2. Recombinant DNA, J.D. Watson, 2nd edition, 1992, Scientific American Books
3. Principles of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
6. Genetics: A Conceptual Approach, Benjamin Pierce 3rd edition, 2008, W. H. Freeman & Co
4. I Genetics, A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International Edition
5. Concepts of Genetics, Klug & Cummings, 7th edition, 2007, Pearson Education

Title: MICROBIAL BIOCHEMISTRY I

Course: MS.MIC.1.03

LEARNING OBJECTIVES

1. Understand the molecular details of bioorganic molecules
2. Understand protein structure, folding and structural bioinformatics
3. Understand bacterial photosynthesis, nitrogen fixation and extracellular transport

4. Understand signalling systems and stress responses in bacteria

Number of lectures: 60

UNIT 1: BIOMOLECULES

15 LECTURES

LEARNING OBJECTIVES

1. Understand the structure and function of carbohydrates and lipids.
2. Understand structural details of nucleic acids and factors involved.

1. Carbohydrates

5L

- Carbohydrates and stability of glycosidic bond
- Glycoconjugates, proteoglycans, glycoproteins and glycolipids
- Homopolysaccharide folding
- Functions of oligosaccharides & polysaccharides

2. Lipids

5L

- Lipid classification
- Structure of lipids in membranes- glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaebacteria
- Sphingolipids, terpenes, isoprenoids
- Functions of lipids-signals, cofactors, pigments

3. Nucleic Acids

5L

- The factors that determine the structure of DNA- denaturation & melting curve, Hydrogen bonds & hydrophobic interactions, Base stacking, Ionic strength.
- Renaturation Kinetics- C_0t curve analysis.
- Forms of DNA & circular superhelical DNA.
- Special base sequences & Structural consequences- direct & inverted repeats
- Cruciform, hairpin & stem-loop structures.

UNIT 2: AMINO ACIDS AND PROTEINS

15 LECTURES

LEARNING OBJECTIVES

1. Understand the structures and functions of amino acids and proteins.
2. Understand protein folding and misfolding.
3. Understand structural bioinformatics.

1. Amino acids & primary structure of Proteins

4L

- Classification and stereochemistry
- Derivative and ionization
- Structure of peptide bond & its stability
- Protein sequencing

2. Secondary, Tertiary & Quaternary Structure of Proteins

6L

- Ramachandran plot
- Secondary structures- α helix & other helices, β structures, non-repetitive structures
- Tertiary structure- super secondary motifs- $\beta\alpha\beta$ motif, β hairpin motif, $\alpha\alpha$ motif & Greek Key motif, α/β barrels & open β sheets.
- Thermodynamics of folding & protein stability- Electrostatic forces, Van der Waals forces, Hydrogen bonding forces, Disulfide bonds, Protein Denaturation & stability of thermostable protein.
- Chaperonins and prion motifs and domains
- Quaternary Structure- subunit interactions & symmetry in protein

3. Structural Bioinformatics **5L**

- Protein databases- NCBI, Swiss-Prot (ExPasy) PDB, PIR
- Protein Structure visualization- SPDBV, Jmol, Rasmol
- Structural Classification- CATH, SCOP, Pfam, CE & VAST.

UNIT 3: CELLULAR EXPORT SYSTEMS, BACTERIAL PHOTOSYNTHESIS AND BIOLOGICAL NITROGEN FIXATION **15 LECTURES**

LEARNING OBJECTIVES

1. Understand cellular export systems
2. Understand bacterial photosynthesis.
3. Understand biological nitrogen fixation.

1. Cellular export systems **5L**

- Extracellular protein secretion
- Drug export system

2. Bacterial Photosynthesis **5L**

- Phototropic bacterial families
- Photosynthetic Apparatus and its Reactions
- Carbon metabolism

3. Biological Nitrogen Fixation **5L**

- Nitrogen Fixing organisms
- Biochemistry of nitrogen fixation
- Regulation of nitrogenase

UNIT 4: SIGNALLING AND STRESS **15 LECTURES**

LEARNING OBJECTIVES

1. Understand the signalling systems in bacteria
2. Understand the synthesis of virulence factors in response to physical and chemical factors

3. Understand bacterial development and quorum sensing

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- 1. Introduction to two-component signalling systems** **5L**
- a. Response by facultative anaerobes to
 - i. Anaerobiosis
 - ii. Nitrate and nitrite
 - iii. Nitrogen supply
 - iv. Inorganic phosphate supply
 - b. Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria
 - c. Response to osmotic pressure and temperature
 - d. Response to potassium ion and external osmolarity
 - e. Response to carbon sources
 - f. Bacterial response to environmental stress
 - i. Heat-shock response
 - ii. Repairing damaged DNA
 - iii. The SOS response
 - iv. Oxidative stress
- 2. Synthesis of virulence factors in response to** **5L**
- a. Temperature
 - b. pH
 - c. Nutrients
 - d. Osmolarity
 - e. Quorum sensors
 - f. Chemotaxis, photoresponses and aerotaxis
- 3. Bacterial development and quorum sensing** **5L**
- a. Myxobacteria
 - b. *Caulobacter*
 - c. Bioluminescence systems similar to LuxR/LuxI in non-luminescent bacteria
 - d. Biofilms and Quorum Sensing

CIA: Tests

References: -

Unit 1

1. Principles of Biochemistry, Zubay, G., 4th edition, 1998, Wm.C. Brown Publishers
2. Principles Biochemistry, Mathew, Van Holde and Ahern , 3rd edition, 1999, Pearson Education
3. Lehninger principles of Biochemistry, Cox and Nelson, 4th edition, 1994, CBS publishers and Distributors Pvt. Ltd.

Unit 2

1. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Willey and Sons Inc.

Unit 3

1. The physiology and biochemistry of prokaryotes , White D., Drummond, T. J. and Fuqua C., 3rd edition, 2007, Oxford University Press

Unit 4

1. Biochemistry, Voet D. and Voet J.G., 4th edition, 1995, John Willey and Sons Inc.
2. Bacterial Metabolism, Gottschalk, G., 2nd edition, 1985, Springer-Verlag

Title: IMMUNOLOGY

Course: MS.MIC.1.04

LEARNING OBJECTIVES

1. Understand maturation and activation of T/B cells
2. Understand immune response to infectious agents and in turn the immune evasion mediated by these agents
3. Know advances in innate immunity, immune tolerance, immunological techniques, autoimmunity, vaccine, transplantation immunology, immunodeficiency diseases and cancer immunology

Number of lectures: 60

UNIT 1: T/B MATURATION & ACTIVATION AND IMMUNE RESPONSE TO INFECTIOUS DISEASES **15 LECTURES**

LEARNING OBJECTIVES

1. Know the immune response to prion, viral, bacterial and parasite infections
2. Understand the microbial mechanisms of evading the immune system
3. Understand the maturation, activation and memory generation for T and B cells.

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| 1. Immune response to Infectious agents | 5L |
| • Prions | |
| • Viruses | |
| • Bacteria | |
| • Parasites | |
| 2. Microbial mechanisms of evading the immune system | 3L |
| 3. T/B cell, maturation, activation and memory generation | 7L |
| • Organization and expression of lymphocyte receptor gene | |
| • T/B cell activation and differentiation | |
| • T/B cell memory generation | |

UNIT 2: RECENT ADVANCES IN IMMUNOLOGY **15 LECTURES**

LEARNING OBJECTIVES

1. Know advances of innate immunity, immune tolerance and techniques in immunology

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| 1. Recent advances in Non-specific immunity | 6L |
| • Physiological & immunological barriers. | |
| • Induced Cellular Innate Responses | |
| i. TLRs | |
| ii. NLRs | |
| iii. CLR | |

- iv. Antimicrobial Peptides
- v. Interferon
- vi. Cytokines
- Phagocytosis
- Inflammation
- Interaction between Innate and Adaptive Immune system
- Autophagy

2. Recent advances in immune tolerance **4L**

- Central Tolerance
- Peripheral Tolerance
- Tolerance Induction
- T-cell Tolerance
- B-cell Tolerance
- T reg

3. Experimental techniques in Immunology **5L**

- Assays of Cell Death
- Immunofluorescence-Based Imaging Techniques
- FACS
- Antibody genes and antibody engineering

UNIT 3: IMMUNE SYSTEM AND HEALTH

15 LECTURES

LEARNING OBJECTIVES

1. Know the advances in autoimmunity
2. Know the advances in the fields of vaccines

1. Recent advances in autoimmunity **5L**

- Interplaying Factors
- Triggering Factors
- Mechanisms of Damage
- Organ Specific Autoimmune Diseases
- Systemic Autoimmune Diseases
- Animal Models for Autoimmune Diseases
- Proposed Mechanisms for Induction of Autoimmunity
- Treatment of Autoimmune Diseases

2. Recent advances in vaccines **10L**

- Malaria
- HIV
- Pertussis
- HPV
- Tuberculosis

UNIT 4: CHALLENGES IN IMMUNE SYSTEM

15 LECTURES

LEARNING OBJECTIVES

1. Know the advances in the fields of transplantation immunology, immunodeficiency diseases and cancer immunology

1. Transplantation & Transfusion Immunology

5L

- Antigens Involved in Graft Rejection
- Allorecognition
- Graft Rejection-Role of APCs & Effector Cells
- Graft v/s Host Diseases
- Immuno Suppressive Therapies
- Blood Transfusion
 - i. ABO & Rh Blood Groups (revision)
 - ii. Potential Transfusion Hazards
 - iii. Transfusion Alternatives

2. Immunodeficiency diseases

5L

- Primary Immunodeficiency
- Defects in the Complement System
- Treatment Approaches for Immunodeficiency
- Animal Models of Primary Immunodeficiency
- Secondary Immunodeficiency & AIDS

3. Cancer immunology

5L

- Cancer: Origin & Terminology
- Malignant Transformation of Cells
- Oncogenes & Cancer Induction
- Tumors of the Immune System
- Tumor Antigens
- Tumor Evasion of the Immune System
- Cancer Immunotherapy

CIA: Test, Presentation

References:-

Unit 1

1. Immunology – Essential and Fundamental, Pathak, S. and Palan, U., 3rd edition, 2011, Capital publishing company.
2. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6th edition, 2006, W.H. Freeman and company.
3. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7th edition, 2013, International edition, Macmillan higher education.

4. Janeway's Immunobiology - The immune system in health and disease, Murphy, M. K., Travers, P., Walport, M. and Janeway, C., 6th edition, 2011, Garland Science, 2011
5. Mims' Pathogenesis of Infectious Disease, Mims, A. C., Nash, A. and Stephen, J., 5th edition, 2000, Academic press.
6. Kauffman, S. H. E., Rouse B.T. and Sacks D.L., The immune response to infection, 2011, ASM press, Washington, USA
7. Aguzzi, A., Nuvolone, M. And Zhu, C., The immunobiology of prion diseases, 2013, *Nature*, **13**:888-902
8. Current Published papers on recent advances to be referred.

Unit 2

1. Immunology – Essential and Fundamental, Pathak, S. and Palan, U., 3rd edition, 2011, Capital publishing company.
2. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6th edition, 2006, W. H. Freeman and company.
3. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7th edition, 2013, International edition, Macmillan higher education.
4. Immunology an introduction, Tizard, R. I., 4th edition, 1995, Saunders College Pub.
5. Takeuchi, O. and Akira, S., Pattern recognition receptors and inflammation, 2010, *Cell*, **140**: 805-820
6. Current Published papers on recent advances to be referred.

Unit 3

1. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6th edition, 2006, W. H. Freeman and company.
2. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7th edition, 2013, International edition, Macmillan higher education.
3. Immunology – Essential and Fundamental, Pathak, S. and Palan, U., 3rd edition, 2011, Capital publishing company.
4. Immunology an introduction, Tizard, R. I., 4th edition, 1995, Saunders College Pub.
5. Janeway's Immunobiology –the immune system in health and disease, Murphy, M. K., Travers, P., Walport, M. and Janeway, C., 6th edition, 2011, Garland Science.
6. Chen, Y.Z. and Dolin R., Novel HIV vaccine strategies: overview and perspective, 2013, *Therapeutic Advances in Vaccines*, **(0)0**-1-14
7. Kim, K.S., Park, S.A., Ko, K., Yi, S., Cho, Y.J., Current status of human papillomavirus vaccines, 2014, *Clin Exp Vaccine Res*; **3**:168-175
8. Arama, C. and Troye-Blomberg, M., The path of malaria vaccine development: challenges and perspectives, *The journal of internal medicine*, 2014, doi: 10.1111/joim.12223
9. Rosalind Rowland¹ and Helen McShane, Tuberculosis vaccines in clinical trials, *Expert Rev Vaccines*, 2011 May ; **10(5)**: 645–658
10. Current Published papers on recent advances in relevant vaccines to be referred.

Unit 4

1. Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6th edition, 2006, W. H. Freeman and company.
2. Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7th edition, 2013, International edition, Macmillan higher education.
3. Roitt's Essential Immunology, Delves, J. P., Martin, J. S., Burton, R. D. and Roitt, M. I., 12th edition, 2011, John Wiley & Sons.
4. Current Published papers on recent advances to be referred.

MICROBIOLOGY

MS.MIC.1.PR

Practicals semester I

VIROLOGY, CELL BIOLOGY AND SCIENTIFIC COMMUNICATION

MS.MIC.1.01.PR

1. Egg inoculation and cultivating animal virus in embryonated egg. Demonstration
2. Cultivation of macrophage cell lines and study of cell viability
3. Study of Cell membrane integrity using uptake of neutral red.
4. Isolation and purification of coliphages from sewage
5. Phage Typing of *E. coli* / *Salmonella* strains.
6. Study of One Step Growth Curve of Lambda phage / T4 Phage.
7. Study of Lysogeny in *E. coli*.
8. Isolation of Lysozyme from egg white.
9. Preparation of protoplast using Lysozyme.
10. Study of cell cytology using Phase contrast Microscopy. Demonstration
11. Study of Cell structure using Confocal Microscopy. Demonstration
12. Study of Cell structure using Fluorescence Microscopy. Demonstration
13. Scientific communication skills: Referencing, Oral and poster presentation, Concept of plagiarism, summary writing.
14. Working in a Microbiology laboratory- practices and co-ordination
15. Industrial visit

CIA: Literature survey

GENETICS

MS.MIC.1.02PR

1. β galactosidase assay
2. UV mutagenesis
3. Acridine orange mutagenesis
4. Isolation of mutants by Replica plate technique
5. Penicillin enrichment technique
6. Ames test
7. Isolation of host range mutants
8. Identification of phage nucleic acid
9. Polymerase chain reaction

10. Restriction digestion
11. Problems on gene transfer mechanisms
12. Problems on viral genetics
13. Cancer genetics- Demonstrations

CIA: Agarose gel electrophoresis

MICROBIAL BIOCHEMISTRY

MS.MIC.1.03.PR

1. Preparation of buffers
2. Determination of pK and PI value for an amino acid
3. Extraction of total lipids
4. Isolation of cholesterol and lecithin from egg yolk
5. Identification of fatty acids and other lipids by TLC
6. Determination of degree of unsaturation of fats and oils
7. Isolation of lactose from bovine milk
8. Estimation of total sugars by phenol-sulphuric acid method
9. Isolation of glutamic acid from gluten
10. Determination of molar absorption coefficient (ϵ) of l-tyrosine
11. Determination of the isoelectric point of the given protein
12. Estimation of polyphenols/ tannins by Folin- Denis method
13. Diffusion studies of molecules across sheep RBCs
14. Preparation of liposomes (Demonstration)
15. Adaptation of *E. coli* to anaerobiosis
16. Chemotaxis of *Pseudomonas*
17. Effect of temperature and water activity on swarming of *Proteus*
18. Different bacteriolytic response associated with addition of lysozyme and salt.

CIA: Analytical biochemistry

IMMUNOLOGY

MS.MIC.1.04.PR

1. Collection of human blood & separation of mononuclear cells by Ficoll hypaque density gradient centrifugation, counting of viable cells by trypan blue.
2. Study of virulence factors-Phagocytosis & Phagocytic index.
3. Immunoelectrophoresis of proteins – Human serum
4. Determination of ABO & Rh – Antibody titre
5. Major and Minor cross matching of blood.
6. SRID: For detection of immune deficiency and Complement deficiency.
7. Immunodiagnosis by ELISA
8. Industrial visit

CIA: Immunohematology

References:

Paper 1:

1. Textbook of Microbiology –Ananthnarayan& Paniker-9th edition,2013
University press
2. Principles of Virology –Flint,S.J.; Enquist,L.M.; RacanielloV.R.;andSkalka,A.M. 3rd
ed. 2009, Vol I & II, ASM.
3. Understanding Viruses – Teri Shors., 2009, Jones and Bartlett publishers.
4. Basic Virology, Wagner E,K; Hewlett, M.J, Bloom, D.C., Camerini, D,
3rded, 2008, Blackwell Publishing
5. Molecular Biology of the Cell – Albert,B.; Johnson,A; Lewis,J; Raff,M.;
Roberts K. &Walter P; 5thed, 2008, Garland Science, Taylor & Francis Group
6. Molecular Cell Biology - Lodish,H; Berk,A.;Kaiser,C.A. Krieger,M.; Scott,M.;
Bretscher,A; Ploegh,H.; and Matsudaira,P; 6th edition, W.H Freeman and Company
7. The Cell: A Molecular Approach, Geoffrey Cooper, Robert Hausman, 5thedition,
2009 ,ASM Press
8. Genes X, Lewin, B., 2008,Jones and Bartlett Publishers
9. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th
edition, Pearson Education
10. General Virology – Luria,S.E., Darnell,J.E.; Baltimore, D; Campbell,A; 3rd ed.;
1978, John Wiley and Sons
11. Molecular Biology, Freifelder, David; 2nded, 1987, Narosa Publishing H.
12. Microbial Genetics, Maloy, S.R.; Cronan, J.E.; Freifelder, David 2nd ed, 1994,
Jones and Bartlett Publishers.
13. Microbiology, Davis, B.D; Dulbecco,R; Eisen, H.N.andGinsberg,H.S.; 3rd ed.
1980 Harper International edition. NY.

Paper 2:

1. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th
edition, 2007, Pearson Education
2. Principles of Genetics, Snustad& Simmons, 6th edition, 2012, John Wiley & Sons Inc
3. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
4. Genetics: A Conceptual Approach, Benjamin Pierce 3rd edition, 2008, W. H. Freeman
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5. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson
International edition
6. Concepts of Genetics, Klug & Cummings, 7th edition, 2007, Pearson Education
7. Recombinant DNA by J.D. Watson, 2nd edition, 1992, Scientific American Books
8. Fundamental Bacterial Genetics, Trun, Trempy, 1st edition, 2004, Blackwell Publishing

Paper 3:

1. Laboratory manual in biochemistry by Jayaraman J., 1981, New Age International
Publishers
2. An introduction to practical biochemistry 3rd edition, 1998, David T Plummer, Tata
McGraw Hill edition
3. Experimental biochemistry –A student companion, B Sashidhar Rao, Vijay
Deshpande, S. Deshpande, 2005, IK international Pvt. Ltd.

4. Laboratory manual in Biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A., 2007, Tata McGraw Hill edition
5. Source of Experiments for teaching Microbiology, Primrose and Wardlaw
6. Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach, David White, 1998
7. Principles and techniques of practical biochemistry, 4th edition (1998), Wilson K. and Walker J.(Ed.) Cambridge University Press, 1994
8. Biochemical calculations, Segel I.R., 2nd edition, 2004, John Wiley and Sons

Paper 4:

1. Textbook of Medical laboratory technology- by P B Godkar,1994, Bhalani Publishing House
2. Immunology-Essential &Fundamental-Sulbha Phatak &Urmi Palan-3rd edition.2012, Capital Publishing Company.
3. Clinical Immunology – Principle & Practice 3rd ed. 2008 (Part -11 –Clinical diagnostic immunology).



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 2nd Semester Courses in **Microbiology** (January 2015 onwards)

Contents:

Theory Syllabus for Courses:

MS.MIC.2.01 - **CELL BIOLOGY**

MS.MIC.2.02 - **GENETICS AND BIOINFORMATICS**

MS.MIC.2.03 - **MICROBIAL BIOCHEMISTRY II**

MS.MIC.2.04 - **MEDICAL MICROBIOLOGY**

Practical Syllabus for Courses:

MS.MIC.2.01.PR: **CELL BIOLOGY AND BIOINFORMATICS**

MS.MIC.2.02.PR: **MOLECULAR BIOLOGY**

MS.MIC.2.03.PR: **MICROBIAL BIOCHEMISTRY II**

MS.MIC.2.04.PR: **MEDICAL MICROBIOLOGY AND MATHEMATICS**

Title: CELL BIOLOGY

Course: MS. MIC. 2.01

LEARNING OBJECTIVES

1. Understand the structure and function of cell organelles involved in energy generation
2. Understand various aspects of cell division and cell communication
3. Understand developmental biology and stem cells

Number of lectures: 60

UNIT 1: CELL BIOLOGY: ENERGY-CONVERTING ORGANELLES, CYTOSKELETON, AND CELL JUNCTIONS **15 LECTURES**

LEARNING OBJECTIVES

1. Understand the structure and function of the energy producing organelles and the cytoskeletal filaments
2. Study aspects of Cell Junctions and Cell Adhesion

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- | | |
|--|-----------|
| 1. Mitochondria | 2L |
| <ul style="list-style-type: none">● Structure● Electron-transport chains and proton pump | |
| 2. Chloroplasts | 2L |
| <ul style="list-style-type: none">● Structure● Energy capture from sunlight | |
| 3. Cytoskeleton | 7L |
| <ul style="list-style-type: none">● Cytoskeletal filaments● Microtubules● Microfilaments, Actin regulation● Intermediate filaments● Molecular motors● Cell behavior | |
| 4. Cell Junctions and Cell adhesion | 4L |
| <ul style="list-style-type: none">● Extracellular matrix (ECM): components and ECM examples- Basal lamina and connective tissue ECM● Types of cell-ECM junctions<ol style="list-style-type: none">i. Focal adhesionsii. Hemidesmosomes● Types of cell-cell junction<ol style="list-style-type: none">i. Adherens junctionii. Desmosomesiii. Tight junctioniv. Gap junction● Cell-cell junctions in plants –plasmodesmata. | |

UNIT 2: CELL COMMUNICATION

15 LECTURES

LEARNING OBJECTIVES

Understand principles of Cell communication

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|---|-----------|
| 1. General Principles of Cell communication | 2L |
| <ul style="list-style-type: none">● Extracellular signal molecules● Intracellular signaling Proteins● Classes of cell-surface receptor proteins | |
| 2. Signaling through G-protein-coupled cell surface receptors | 5L |
| <ul style="list-style-type: none">● G-protein relay signals● c-AMP and Protein Kinases● Inositol Phospholipid Signaling Pathway● Intracellular mediators and their effects | |
| 3. Signaling through enzyme coupled cell surface receptors | 6L |
| <ul style="list-style-type: none">● Receptor Tyrosine Kinases● Ras● MAP kinase● PI-3 kinase● TGF● Bacterial chemotaxis | |
| 4. Signaling in plants | 2L |
| <ul style="list-style-type: none">● Receptor Serine / Threonine kinases● Role of ethylene● Phytochromes | |

UNIT 3: CELL CYCLE, CELL DEATH AND CELL DIVISION

15 LECTURES

LEARNING OBJECTIVES

1. Understand the concepts of cell division and cell death
2. Study aspects of germ cells and fertilization

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- | | |
|---|-----------|
| 1. Mechanism of cell division | 6L |
| <ul style="list-style-type: none">● Cell cycle and cell cycle control system● S-phase● Mitosis● Cytokinesis● Control of cell division and cell growth | |
| 2. Apoptosis | 4L |
| <ul style="list-style-type: none">● Programmed cell death● Extrinsic Pathway of apoptosis | |

- Intrinsic Pathway of apoptosis

3. Germ cells and fertilization

5L

- Overview of Sexual Reproduction
- Meiosis
- Eggs
- Sperm
- Fertilization

UNIT 4: DEVELOPMENTAL BIOLOGY AND STEM CELLS 15 LECTURES

LEARNING OBJECTIVES

1. Understand the types of stem cells and ethics involved in their use
2. Understand the development of multicellular organisms

1. Stem cells

5L

- Types of stem cells
 - i. Embryonic stem cells
 - ii. Adult stem cells
 - iii. Induced pluripotent stem cells
- Applications of stem cells in
 - i. Regenerative medicine
 - ii. Cancer therapy
- Ethical considerations of stem cell therapy

2. Development of multicellular organisms

10L

- Universal Mechanisms of Animal cell development
- The Process of Development in Animals
 - i. The Embryonic Cleavage Divisions and Blastula Formation
 - ii. Gastrulation and Morphogenesis
- *Caenorhabditis elegans* and *Drosophila* as model organisms
- *Caenorhabditis elegans* : Development from the perspective of the individual cell
- Molecular Analysis of genes involved in *Drosophila* development
 - i. Maternal-Effect Genes
 - ii. Determination of the Dorsal-Ventral and Anterior-Posterior Axes Body Segmentation
 - iii. Specification of cell types
 - iv. Organ formation
- Homeobox Genes in other Organisms
- The Genetics of Flower Development in *Arabidopsis*
- Programmed Cell Death in Development
- Evo-Devo: The Study of Evolution and Development

CIA: Paper Presentation

References:-

Unit 1

1. Molecular Biology of the Cell – Albert, B.; Johnson, A; Lewis, J; Raff, M.; Roberts K. & Walter P; 5th ed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology - Lodish, H; Berk, A.; Kaiser, C.A. Krieger, M.; Bretscher, A; Ploegh, H.; Amon, A. and Scott, M., 7th edition, 2013, W.H Freeman & Company, New York
3. The Cell: A Molecular Approach, Cooper, G.; Hausman, R., 5th edition, 2009, ASM Press

Unit 2

1. Molecular Biology of the Cell, Albert, B.; Johnson, A; Lewis, J; Raff, M.; Roberts K. & Walter P; 5th ed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology, Lodish, H; Berk, A.; Kaiser, C.A. Krieger, M.; Bretscher, A; Ploegh, H.; Amon, A. and Scott, M., 7th edition, 2013, W.H Freeman & Company, New York
3. The Cell: A Molecular Approach, Cooper, G; Hausman, R, 5th edition, 2009, ASM Press
4. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers
5. Molecular Biology of the Gene, Watson, J.D.; Baker, T.A.; Bell, S.P.; Gann, A.; Levine, M.; Losick, R.; 5th edition, 2007, Pearson Education

Unit 3

1. Molecular Biology of the Cell, Albert, B.; Johnson, A; Lewis, J; Raff, M.; Roberts K. & Walter P; 5th ed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology, Lodish, H; Berk, A.; Kaiser, C.A. Krieger, M.; Bretscher, A; Ploegh, H.; Amon, A. and Scott, M., 7th edition, 2013, W.H Freeman & Company, New York
3. The Cell: A Molecular Approach, Cooper, G; Hausman, R, 5th edition, 2009, ASM Press
4. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers
5. Molecular Biology of the Gene, Watson, J.D.; Baker, T.A.; Bell, S.P.; Gann, A.; Levine, M.; Losick, R.; 5th edition, 2007, Pearson Education

Unit 4

1. Stem Cells: Basics and Applications, Deb K., 2009, Tata McGraw Hill.
2. Molecular Biology of the Cell, Albert, B.; Johnson, A; Lewis, J; Raff, M.; Roberts K. & Walter P; 5th ed, 2008, Garland Science, Taylor & Francis Group
3. Principles of Genetics, D. Peter Snustad & Michael J. Simmons, 6th edition, 2012, John Wiley & Sons Inc.

Title: GENETICS AND BIOINFORMATICS

Course: MS. MIC. 2.02

LEARNING OBJECTIVES

1. Understand the tools available for molecular biology
2. Understand the concepts of population genetics
3. Understand the applications of genetic technology and the ethics involved
4. Understand the use of bioinformatics for biological data analysis

Number of lectures: 60

UNIT 1: MOLECULAR TOOLS FOR GENETICS

15 LECTURES

LEARNING OBJECTIVES

Understand the significance of molecular tools used in recombinant DNA techniques

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- | | |
|---|-----------|
| 1. Molecular tools for genetics | 9L |
| <ul style="list-style-type: none">● Labeled tracers (autoradiography, phosphorimaging, liquid scintillation counting, non-radioactive tracers)● Overview of Nucleic acid hybridization, In situ hybridization, DNA sequencing, Restriction mapping● Mapping and quantifying transcripts (S1 mapping, primer extension, run-off transcription)● Measuring transcription rates in vivo (Nuclear run – on transcription, reporter gene transcription), Assaying DNA –protein interactions (filter binding, gel mobility shift, DNase and DMS footprinting, knockouts) | |
| 2. Rational Mutagenesis | 4L |
| <ul style="list-style-type: none">● Oligonucleotide directed mutagenesis - with M13● Oligonucleotide directed mutagenesis - with plasmid DNA● PCR amplified oligonucleotide directed mutagenesis● Random mutagenesis - with degenerate oligonucleotide primer● Random mutagenesis - with nucleotide analogues● Error-prone PCR● DNA shuffling● Mutant proteins with unusual amino acids | |
| 3. Variations/ Modifications of PCR | 2L |
| <ul style="list-style-type: none">● PCR Hot- Start, Multiplex, Nested, RT-PCR, Broad Range, arbitrarily primed, Quantitative, Real time | |

UNIT 2: POPULATION GENETICS

15 LECTURES

LEARNING OBJECTIVES

1. Understand the concepts involved in population genetics and epigenetics
2. Learn the application & analysis based on concepts of population genetics

1. Population genetics

7L

- Population and gene pool
- Genotypic and Allelic frequencies
- Calculation of Genotypic frequencies and Allelic frequencies for autosomal and X linked loci
- Problems – calculation of allelic and genotypic frequencies
- Hardy-Weinberg Law, genotypic frequencies at HWE
- Implications of the H-W Law
- H-W proportions for multiple alleles
- X-linked alleles
- Testing for H-W proportions and problems
- Genetic ill effects of in-breeding
- Changes in the genetic structure of populations
 - i. Mutation
 - ii. Migration and gene flow
 - iii. Genetic drift
 - iv. Natural selection
 - v. Simple problems based on the natural forces

2. Epigenetics

8L

- The Nucleosome: Chromatin's Structural Unit
- Higher order chromatin structure
- Histone : Modifications and Epigenetic Information
- Chromatin Remodelling
- Silencing of gene expression
- Genomic imprinting, Dosage compensation

UNIT 3: APPLICATIONS AND ETHICS OF GENETIC TECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES:

1. Understand molecular mapping of human genes
2. Understand diagnosis and therapy of genetic disorders
3. Understand concepts of recombinant DNA technology
4. Understand the ethical issues concerning the use of recombinant DNA technology

1. Mapping Human Genes at the Molecular Level

2L

- RFLPs as Genetic Markers
- Linkage Analysis Using RFLP - Huntington's diseases, Cystic fibrosis

- Positional Cloning: The Gene for Neurofibromatosis
- The Candidate Gene Approach: The Gene for Marfan Syndrome
- Fluorescent in Situ Hybridization (FISH) Gene Mapping

2. Genetic Disorders: Diagnosis and Screening **3L**

- Prenatal Genotyping for Mutations in the β - Globin Gene
- Prenatal Diagnosis of sickle-Cell Anemia
- Single Nucleotide Polymorphisms and Genetic Screening
- DNA Microarrays and Genetic Screening

3. Treating Disorders with Gene Therapy **4L**

- Gene Therapy for Severe Combined Immunodeficiency (SCID) - Overview
- Problems and Failures in Gene Therapy
- The Future of Gene Therapy: New Vectors and Target-Cell Strategies
- Ethical Issues of Gene Therapy

4. DNA Fingerprints **2L**

- Minisatellites (VNTRs) and Microsatellites (STRs)
- Forensic Applications of DNA Fingerprints

5. The Human Genome Project **2L**

- An overview
- The Ethical, Legal, and Social Implications (ELSI) Program

6. Pharmacogenetics and toxicogenomics **2L**

UNIT 4: BIOINFORMATICS

15 LECTURES

LEARNING OBJECTIVES

1. Understand and access various types of data relating to molecular biology available on internet portal
2. Understand the concept of sequence alignment of biological macromolecules

1. Study of biological databases with examples **3L**

- Types of databases
 - i. Primary
 - ii. Secondary
 - iii. Sequence
 - iv. Structure
 - v. Metabolic (KEGG)
- Biological data retrieval
- Study of data formats

2. Nucleotide sequence analysis **6L**

- Pairwise alignment and scoring matrices
- Multiple sequence alignment

- Phylogenetic analysis
- Sequence logo (WebLogo) and consensus sequences
- Analysis of plasmids and other vectors using a software

3. Protein analysis **4L**

- Using 3D structure viewers (Rasmol, PDB)
- CATH and SCOP classification

4. Reference management software **2L**

- Making a reference library
- Adding references from the library into a word document

CIA: Assignment

References:

Unit 1:

1. Molecular Biology, R. F. Weaver, 4th edition, 1999 McGraw-Hill
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
3. Recombinant DNA, J.D. Watson, 2nd edition, 1992, Scientific American Books
4. Principals of Genetics, Snustad & Simmons, 6th edition, 2012, John Wiley & Sons Inc
5. Genetics: A Conceptual Approach, Benjamin Pierce 3rd edition , 2008, W. H. Freeman & Co
6. Concepts of Genetics, Klug & Cummings, 7th edition, 2007, Pearson Education

Unit 2:

1. Chromatin and Gene Regulation Mechanisms in Epigenetics, Bryan M. Turner, 2001 Blackwell Science.
2. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th edition, 2007, Pearson Education
3. iGenetics, A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International Edition
4. Concept of Genetics, William S. Klug & Michael R. Cummings, 7th edition, 2007, Pearson Education

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1. Concept of Genetics, William S. Klug & Michael R. Cummings, 7th edition, 2007, Pearson Education
2. Recombinant DNA, J.D. Watson, 2nd edition, 1992, Scientific American Books
3. iGenetics, A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International Edition

Unit 4:

1. Bioinformatics and Functional Genomics, Pevsner J., May 2009, Wiley-Blackwell
2. Introduction to bioinformatics, Attwood T.K., Parry- Smith D.J., Phukan Samiron, Pearson Education 2007

Title: MICROBIAL BIOCHEMISTRY II

Course: MS. MIC. 2.03

LEARNING OBJECTIVES

1. Understand various methods of analytical biochemistry
2. Understand enzyme kinetics, regulation and mechanism of enzyme action
3. Understand the metabolism of one and two carbon compounds
4. Understand the biosynthesis of macromolecules

Number of lectures: 60

UNIT 1: ANALYTICAL BIOCHEMISTRY

15 LECTURES

LEARNING OBJECTIVES

Study the purification techniques and analytical methods for bio molecules

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1. **Extraction, purification and analysis of proteins, carbohydrates and lipids. 15L**
 - General methods of extraction
 - Purification methods and determination of purity
 - Mass determination
 - i. Ultracentrifuge
 - ii. MS
 - Structure determination
 - X-ray diffraction
 - Imaging techniques for protein localization
 - Qualitative and quantitative analysis

UNIT 2: ENZYMOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Understand the basic aspects of enzyme kinetics
2. Study the regulation of enzymes with specific examples
3. Study the catalytic mechanism of action of enzymes
4. Understand enzyme bioinformatics

-
1. **Enzyme kinetics 5L**
 - Kinetics of one substrate reactions
 - Equilibrium assumptions
 - Steady state assumptions
 - Lineweaver-Burk, Hanes- Woolf, Eadie- Hofstee equations and plots
 - Kinetics of enzyme inhibition.
 - Competitive, non-competitive and uncompetitive inhibition
 - Effect of changes in pH and temperature on enzyme catalysed reaction
 - Kinetics of two substrate reactions
 - Pre steady state kinetics
 - Problem solving
 2. **Enzyme catalysis 5L**
 - Catalytic mechanisms

- i. Acid–Base Catalysis
 - ii. Covalent Catalysis
 - iii. Metal Ion Catalysis
 - iv. Electrostatic Catalysis
 - v. Catalysis through Proximity and Orientation Effects
 - vi. Catalysis by Preferential Transition State Binding
 - Type examples, catalytic mechanisms and testing –
Serine proteases and Lysozyme
 - Problem solving.
- 3. Enzyme regulation** **3L**
- Allosteric enzyme- general properties, Hill, Adair, MWC and KNF models.
 - Covalent modification by various mechanisms.
 - Regulation by proteolytic cleavage- blood coagulation cascade.
 - Regulation of multi-enzyme complex- Pyruvate dehydrogenase
 - HIV enzyme inhibitors and drug design
 - Problem solving
- 4. Enzyme Bioinformatics** **2L**
- Data bases
 - Sequence analysis, applications
 - Enzyme function studies
 - Enzyme docking

UNIT 3: METABOLISM OF ONE AND TWO CARBON COMPOUNDS
15 LECTURES

LEARNING OBJECTIVES

Understand the metabolism of one and two carbon compounds

-
- 1. Metabolism of one carbon compounds** **11L**
- **Methylotrophs**
 - i. Oxidation of methane, methanol, methylamines
 - ii. Carbon assimilation in methylotrophic bacteria and yeasts
 - **Methanogens**
 - i. Methanogenesis from H₂, CO₂, CH₃OH, HCOOH, methylamines
 - ii. Energy coupling and biosynthesis in methanogenic bacteria
 - **Acetogens**
Autotrophic pathway of acetate synthesis and CO₂ fixation
 - **Carboxidotrophs**
Biochemistry of chemolithoautotrophic metabolism
 - **Cynogens and cynotrophs**
Cynogenesis and cyanide degradation
- 2. Metabolism of two-carbon compounds** **4L**
- **Acetate**

- i. TCA and Glyoxylate cycle, modified citric acid cycle
- ii. Carbon monoxide dehydrogenase pathway and disproportionation to methane
- **Ethanol**
Acetic acid bacteria
- **Glyoxylate and glycolate**
 - i. Dicarboxylic acid cycle
 - ii. Glycerate pathway
 - iii. Beta hydroxyaspartate pathway
- **Oxalate as carbon and energy source**

UNIT 4: BIOSYNTHESIS AND ITS REGULATION

15 LECTURES

LEARNING OBJECTIVES

1. Understand the biosynthesis of amino acids, ribonucleotides and fatty acids, its link to other metabolic pathways and its regulation
2. Understand the biosynthesis of components of gram positive and gram negative cell wall: peptidoglycan and LPS

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|--|-----------|
| 1. Biosynthesis of aminoacids: | 5L |
| <ul style="list-style-type: none">● Ammonia incorporation through glutamine synthetase and its regulation● Overview of aminocid families grouped by metabolic precursors● Biosynthesis of aminoacids from oxaloacetate● Link to the TCA cycle● Anaplerotic reactions | |
| 2. Biosynthesis of ribonucleotides and deoxyribonucleotides | 3L |
| <ul style="list-style-type: none">● The de novo pathway● Regulation by feedback mechanisms● Recycling via the salvage pathway | |
| 3. Biosynthesis of saturated fatty acids and PHB | 4L |
| <ul style="list-style-type: none">● Biosynthesis of Palmitate● Regulation of fatty acid synthesis● Biosynthesis of PHB● Overview of production of eicosanoids, membrane lipids and cholesterol from fatty acids | |
| 4. Biosynthesis of peptidoglycan and LPS | 3L |

CIA: Tests

References: -

Unit 1

1. Principles of Biochemistry, Horton, R. and Moran, L., 5th edition, 2011, Prentice Hall

2. Biochemistry, Mathew, Van Holde and Ahern , 3rd edition , 1999, Pearson Education
3. Principles of Biochemistry, Zubay, G., 4th edition, 1998, Wm.C. Brown Publishers
4. Principles of Biochemistry, Lehninger A.L., Cox and Nelson, 4th edition, 1994, CBS publishers and Distributors Pvt. Ltd.

Unit 2

1. Biochemistry, Berg J.M., Tymoczko J.L. and Stryer L., 7th edition, 2012, W. H. Freeman and co.
2. Biochemistry, Voet D. and Voet J.G., 4th International student edition, 2011, John Wiley and sons.
3. Biochemistry- A Problem Approach, Wood W. B. Wilson J.H., Benbow R.M. and Hood L.E. 2nd edition, 1981, The Benjamin/ Cummings Pub.co.
4. Biochemical calculations, Segel I.R., 2nd edition, 2004, John Wiley and Sons
5. Fundamentals of Enzymology, Price N.C. and Stevens L. 3rd edition, 1999 Oxford University Press.

Unit 3

1. Microbial Biochemistry, Cohen. G.N., 2nd edition, 2011, Springer
2. Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a. , 1984, Biotransformations, Verlag and Chemie
3. Bacterial metabolism, Gottschalk, G., 2nd edition, 1985, Springer-Verlag

Unit 4

1. Principles of Biochemistry, Lehninger A.L., Cox and Nelson, 4th edition, 1994, CBS publishers and Distributors Pvt. Ltd.
2. The physiology and biochemistry of prokaryotes, White D., 4th edition, 2011, Oxford University Press.

Title: MEDICAL MICROBIOLOGY

Course: MS. MIC. 2.04

LEARNING OBJECTIVES

1. Study significant emerging/reemerging infections and the microbial pathogens involved
2. Understand basic principles of Epidemiology
3. Understand clinical research and modern diagnostics

Number of lectures: 60

UNIT 1: ADVANCES IN MEDICAL MICROBIOLOGY- BACTERIAL

15 LECTURES

LEARNING OBJECTIVES:

Study some significant bacterial pathogens and their associated emerging/ re-emerging infections with special emphasis on advances in diagnostics, prophylactic measures, therapeutics and epidemiology

1. Study of significant bacterial emerging/re-emerging infections- with emphasis on advances in diagnostics, therapeutics and epidemiology **15L**

- Listeriosis
- VRE (Vancomycin Resistant Enterococci)
- Leptospirosis
- Drug resistant Tuberculosis
- MOTT (Mycobacteria Other Than TB)
- Cholera caused by *V.cholerae* 0139
- Conditions caused by *Helicobacter pylori*, *Campylobacter* and MRSA

UNIT 2: ADVANCES IN MEDICAL MICROBIOLOGY- NON-BACTERIAL

15 LECTURES

LEARNING OBJECTIVES

Study some significant non-bacterial pathogens and their associated emerging/ re-emerging infections with special emphasis on advances in diagnostics, prophylactic measures, therapeutics and epidemiology

1. Study of significant non-bacterial emerging/re-emerging infections - with emphasis on advances in diagnostics, prophylactic measures, therapeutics and epidemiology **15L**

- Dengue
- AIDS
- SARS
- Chickungunya
- Hepatitis non A infection
- Swine flu

- Ebola
- Malaria

UNIT 3: EPIDEMIOLOGY OF INFECTIOUS DISEASES

15 LECTURES

LEARNING OBJECTIVES

1. Get familiar with the history of epidemiology of infectious diseases
2. Get an overview of the principles of epidemiology
3. Know the measurements of risk
4. Understand the significance of public health surveillance and the methods used

| | |
|--|-----------|
| 1. Historical aspects-definition | 1L |
| 2. Descriptive Epidemiology-aims and uses | 2L |
| 3. Epidemiological principles | 4L |
| ● Herd immunity | |
| ● Carrier status | |
| ● Co-evolution of host-parasite | |
| ● Control of epidemics | |
| i. Methods directed against reservoir | |
| ii. Methods directed against transmission | |
| iii. Pathogen eradication | |
| 4. Measures of risks: | 4L |
| ● Frequency measures | |
| ● Morbidity frequency measures | |
| ● Mortality frequency measures | |
| ● Natality(birth) measures | |
| ● Measures of association | |
| ● Measures of public health impact | |
| 6. Public health surveillance: | 4L |
| ● Purpose and characteristics | |
| ● Identifying health problems for surveillance | |
| ● Collecting data for surveillance | |
| ● Analyzing and interpreting data | |
| ● Disseminating data and interpretation | |
| ● Evaluating and improving surveillance | |

UNIT 4: CLINICAL RESEARCH & MODERN DIAGNOSTICS

15 LECTURES

LEARNING OBJECTIVES

1. Get familiar with the guidelines, ethical aspects and regulatory requirements with respect to clinical research
2. Get an overview of the clinical research methodologies and management

3. Understand the statistics used in clinical research
4. Acquire knowledge of advanced techniques used in diagnosis

1. Introduction to Clinical Research **10L**

- What is a clinical trial, history, phases and need.
- Good Clinical practice Guidelines
- Ethical aspects of Clinical Research
- Regulatory Requirements in clinical research
- Clinical Research Methodologies, Statistics and Management
- Case studies

2. Modern Diagnostic Methods **5L**

- Advances in Molecular and Immunological Techniques
- Microarrays
- Advances in Fluorescence Technology

CIA: Presentation

References:-

Unit 1 & 2

1. Clinics in laboratory medicine, Emerging Infections and their causative agents. September 2004 vol. 24 no. 3.
2. Textbook of Microbiology, Ananthanarayan & Paniker, 9th edition, 2013, University press
3. Koneman's color Atlas & Textbook of Diagnostic Microbiology, Winn, C. W., Allen, D. S., Janda, M. W., Koneman, W. E., Schreckenberger, C. P., Procop, W. G. and Woods, L. G., 6th edition, 2005, Lippincott Williams & Wilkins.

Unit 3

1. Principles of epidemiology in public health practices 3rd edition
www.cdc.gov/training/products/ss1000
2. Basic lab methods in medical bacteriology, WHO Geneva.
3. Medical Laboratory Technology, Godkar, P. & Godkar, D., 2nd edition, 2006, Bhalani Publishing House.
4. Handbook of Epidemiology- Ahrens, W., Pigeot, I., 2005 Springer- Verlag Berlin Herdelberg.
5. Epidemiology for Public Health Practice- Friis, H. R., & Sellers, A. T., 4th edition, 2009, Jones & Bartlett publishers.
6. Park's Textbook of Preventive and Social Medicine, Park, K., 16th edition, 2000, M/S Banarsidas Bhanot
7. Infectious disease surveillance, Nikuchia, N., 2005, Blackwell Publishing.

Unit 4

1. Fundamentals of clinical trials, 4th edition, Friedman, L. M., Furberg, C. D., DeMets, D. L., 2010, Springer.

2. Handbook for good clinical research practice (GCP): Guidance for implementation, World Health Organization, 2002.
3. Ethical guidelines for biomedical research on human participants, Indian Council of Medical Research, New Delhi, 2006.
4. Guidelines for good clinical laboratory practices, Indian Council of Medical Research, New Delhi, 2008.
5. Textbook of clinical trials, Machim, D., Day, S. and Green, S., 2nd edition, 2007, John Wiley & Sons.
6. Management of Data in Clinical Trials, McFadden, E., 2nd edition, 2007, John Wiley & Sons.
7. Koneman's color Atlas & Textbook of Diagnostic Microbiology, Winn, C. W., Allen, D. S., Janda, M. W., Koneman, W. E., Schreckenberger, C. P., Procop, W. G. and Woods, L. G., 6th edition, 2005, Lippincott Williams & Wilkins.

MICROBIOLOGY

MS.MIC.2.PR

Practicals semester II

CELL BIOLOGY

MS.MIC.2.01PR

1. Mitosis in onion root tip
2. Meiosis in *Tradescantia*
3. Isolation of mitochondria and chloroplast
4. Understanding PubMed databases
5. Introduction to National Center for Biotechnology Information (NCBI)
6. Analysis of protein sequence from protein databases
7. Analysis of nucleotide sequence from nucleotide databases
8. Similarity search using the Blast and interpretation of the results
9. Getting the gene sequences by exploring and querying the nucleic acid databases
10. Pair-wise sequence alignment by using BLAST and ClustalW
11. Multiple sequence alignment by using ClustalW
12. Phylogenetic analysis using web tool
13. Tertiary protein structure analysis using Rasmol
14. Understanding of KyoEncyclopedia of Genes and Genome (KEGG) database for biological pathways, metabolism, cellular process, genetic information processing

CIA: Bioinformatics assignment

MOLECULAR BIOLOGY

MS.MIC.2.02PR

1. Genomic DNA isolation
2. Primer designing
3. PCR
4. Restriction digestion
5. Ligation in a suitable vector for cloning
6. Transformation in bacteria
7. Plasmid isolation
8. Agarose gel electrophoresis at each of the above stages.
9. Isolation of RNA
10. Conjugation in bacteria
11. Problems on population genetics

CIA: Molecular biology technique

BIOCHEMISTRY II

MS.MIC.2.03PR

1. Purification of an extracellular enzyme (β -amylase) by salting out and dialysis.
2. SDS PAGE to be done at each stage of purification
3. Native PAGE and activity staining to be done at the end of purification step.
4. Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH, temperature and inhibitors on enzyme activity with Amylase.
5. Demonstration of proteolytic activity
6. Determination of glucose isomerase present intracellularly in *Bacillus* sp.

CIA: Enzymology experiment

Paper 4:

MEDICAL MICROBIOLOGY AND MATHEMATICS

MS.MIC.2.04PR

1. Case studies in epidemiology
2. Problem solving exercises in medical microbiology with appropriate tests for the diagnosis of diseases:
 - i. Diagnosis by ELISA
 - ii. Diagnosis for Swine flu-H1N1: Hemagglutination & Hemagglutination inhibition test
 - iii. AFB staining
 - iv. Diagnosis for *Vibrio cholerae* 0139- Cholera red test, String test, Oxidase test, Biochemical tests, & isolation on TCBS medium for identification of *Vibrio cholerae*
3. Mathematics in biology
 - i. Limits, derivatives and integration
 - ii. Vectors and matrices
 - iii. Basic Algorithms

CIA: Diagnostic technique

References:

Paper 1:

1. Molecular Biology of the Cell – Albert,B.; Johnson,A; Lewis,J; Raff,M.; Roberts K. &Walter P; 5thed, 2008, Garland Science, Taylor & Francis Group
2. Molecular Cell Biology - Lodish,H; Berk,A.;Kaiser,C.A. Krieger,M.; Scott,M.; Bretscher,A; Ploegh,H.; and Matsudaira,P; 6th edition, W.H Freeman and Company
3. The Cell: A Molecular Approach, Geoffrey Cooper, Robert Hausman, 5thedition, 2009, ASM Press
4. Genes X, Lewin, B., 2008, Jones and Bartlett Publishers.
5. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 5th edition, Pearson Education
6. Bioinformatics and functional genomics, J. Pevsner, 2ndedition, 2009, Wiley-Blackwell publishers
7. Introduction to bioinformatics, T. Attwood, 1stedition, 2001, Benjamin Cummings publishers

Paper 2:

1. iGenetics- A Molecular Approach, Russell, P.J., 2010 Third Edition, Pearson International Edition
2. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, Fifth Edition, Pearson Education (LPE)
3. Fundamental Bacterial Genetics, Trun, Trempy, 2004, Blackwell Publishing

4. Principles of Genetics, Snustad & Simmons, Third Edition, John Wiley & Sons Inc
5. Recombinant DNA, Watson, Gilman, Witkowski, Zoller, Second Edition, Scientific American Books
6. Concepts of Genetics, Klug & Cummings, Seventh Edition, Pearson Education (LPE)
7. Genetics- A Conceptual Approach, Pierce, B.A., Second Edition, W. H. Freeman & Co.
8. Genes-X, Lewin, B., 2008, Jones and Bartlett Publishers
9. Molecular Cloning: A Laboratory Manual (3 Volume Set), J. Sambrook, E. F. Fritsch, T. Maniatis, 2nd edition, 1989, Cold Spring Harbor Laboratory Pr.

Paper 3:

1. Principles and techniques of practical biochemistry, 4th edition (1998), Wilson K. and Walker J. (Ed.) Cambridge University Press.
2. Biochemical calculations, Segel I.R., 2nd edition, 2004, John Wiley and Sons
3. Laboratory manual in biochemistry by Jayaraman J., 1981, New Age International Publishers
4. An introduction to practical biochemistry 3rd edition, 1998, David T Plummer, Tata McGraw Hill edition

Paper 4:

1. Immunology-Essential & Fundamental-Sulbha Phatak & Urmi Palan, 3rd edition, 2012, Capital Publishing Company
2. Textbook of Medical laboratory technology- by P B Godkar, 1994, Bhalani Publishing House
3. Koneman's color Atlas & Textbook of Diagnostic Microbiology, Winn, C. W., Allen, D. S., Janda, M. W., Koneman, W. E., Schreckenberger, C. P., Procop, W. G. and Woods, L. G., 6th edition, 2005, Lippincott Williams & Wilkins
4. Clinical Immunology – Principle & Practice 3rd ed. 2008 (Part -11 –Clinical diagnostic immunology)
5. Bailey & Scott's – Diagnostic microbiology- Betty Forbes et al, 11th edition, 2003, Mosby, Inc., St. Louis, Missouri



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 3rd Semester Courses in **Microbiology** (June 2015 onwards)

Contents:

Theory Syllabus for Courses:

MS.MIC.3.01 - RESEARCH METHODOLOGY AND BIOSTATS

MS.MIC.3.02 - TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS

MS.MIC.3.03 - ADVANCES IN BIOTECHNOLOGY - 1

Practical Syllabus for Courses:

MS.MIC.3.PR EXTERNAL PROJECT

M.Sc. II

Course: MS.MIC.3.01

Title: RESEARCH METHODOLOGY AND BIOSTATS

LEARNING OBJECTIVES

Understand the overall process of designing a research study from its inception to its report.

Number of lectures: 60

UNIT 1: RESEARCH FUNDAMENTALS AND TERMINOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. To know how to identify a research problem
2. Understand importance of educational research
3. Understand basics of research design

1. Meaning and Objective of research

5L

- Features of a good research study
- Scientific method

2. Study designs and variations

10L

- Basic, applied, historical, exploratory, experimental, ex-post-facto
- Case study, diagnostic research
- Crossover design, case control design, cohort study design, multifactorial design

UNIT 2: DEFINING A RESEARCH PROBLEM AND DATA COLLECTION

15 LECTURES

LEARNING OBJECTIVES

Understand concepts of quantitative and qualitative data collection

1. Hypothesis, theory and scientific law

2L

Difference between hypothesis, theory and scientific law
Formulation of hypothesis

2. Methods and techniques of data collection

13L

- Types of data

Methods of primary data collection (observation/ experimentation/ questionnaire/
interviewing/ case/ pilot study)

Methods of secondary data collection (internal/ external), schedule method

- Use of computers in data collection- Literature survey using web, handling search engines

UNIT 3: DATA ANALYSIS AND REPORT WRITING

15 LECTURES

LEARNING OBJECTIVES

1. Understand how to analyze data
2. Be able to distinguish between the writing structure used for a quantitative study and one used for a qualitative study.
3. Know the different conventions for scholarly/ report writing

1. Experimental data collection and data processing

5L

- Processing operations, problems in processing
- Elements of analysis in data processing
- Software for data processing

2. Report writing and presentation

10L

- Types of research reports, guidelines for writing a report, report format, appendices
- Miscellaneous information
- Poster and oral presentations (use of software)
- Project proposal

UNIT 4: BIOSTATISTICS

15 LECTURES

LEARNING OBJECTIVES

1. Understand how to conduct a statistical test of a hypothesis.
2. Know the criteria that can be used to select an appropriate statistical test to answer a research question or hypothesis.

1. Sampling, Sampling Distributions & Sampling Errors

2L

- Simple random sampling, systematic sampling, stratified random sampling, cluster sampling
- Non random sampling
- Sampling Errors

2. Correlation & Regression

3L

- Types of Correlation
- Degree of Correlation

- Linear Regression Analysis
- Regression Lines & Regression Equations

3. Chi Square Test **2L**

- Test of Independence
- Test of Homogeneity

4. Test of Significance **3L**

- Null Hypothesis, Alternate Hypothesis, Type I & Type II errors
- Level of Significance, one tailed & two tailed test
- Concept of Standard error

5. Comparison of means of 2 samples **2L**

- t test
- z test

6. Comparison of means of 3 or more samples **3L**

- 1-way ANOVA
- 2-way ANOVA

CIA: Problem Solving- Biostatistics, Literature Survey

References:-

Units 1, 2, 3:

1. Research Methodology - Methods and Techniques, Kothari, C.R., 2004 (2011), New Delhi, Wishwa prakashan.
2. Research Methodology, (2nd.ed.), Bhattacharya, D.K., 2006, New Delhi, Excel Books.
3. Research methods in biosciences, Holmes D., 2006, Oxford university press
4. Research Methodology: A Handbook, Misra R.P., 1989, New Delhi, Concept Publishing Company
5. Introduction to biostats and research methodology, Sunder Rao P. S. S., 4th edition, 2006, Prentice-Hall Pvt. Ltd.
6. <http://www.cebm.net/wp-content/uploads/2014/06/CEBM-study-design-april-2013.pdf>
7. <http://www.cebm.net/study-designs/>

Unit 4:

1. Fundamentals of Biostatistics, Khan, Irfan Ali, 2008, Ukaaz Publications
2. Methods in Biostatistics, Mahajan B. K., 7th edition, 2010, JPB publishers.
3. Fundamentals of Biostatistics, Rosner B.A., 2011, Cengage Learning
4. Statistical methods, Gupta S.P, S. Chand Publications, Delhi
5. Biostatistics The Bare Essentials, Norman G.R., Streiner D.L., 3rd edition, 2008, B. C. Decker Inc

6. An introduction to biostatistics, Gurumani N., 2004, MJP Publishers
7. Statistics for biologists, Campbell R.C., 1974, Cambridge university press

M.Sc II

Course: MS.MIC.3.02

Title: TOOLS AND TECHNIQUES: BIOMOLECULAR ANALYSIS

LEARNING OBJECTIVES

Understand principles and applications of bioanalytical techniques

Number of lectures: 60

UNIT 1: MICROSCOPIC TECHNIQUES AND X-RAY DIFFRACTION 15 LECTURES

LEARNING OBJECTIVES

Understand the principles, methods and applications of Microscopic techniques and X-ray diffraction

1. Advanced microscopic techniques: principles and applications 11L

Scanning Probe Microscopes - scanning tunneling microscope (STM), magnetic force microscope (MFM), scanning near field microscope (SNOM)
Electron Microscopy

2. Diffraction techniques 4L

X-ray diffraction (XRD)

UNIT 2: SPECTROSCOPIC TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand principles, working and applications of different spectroscopic and electrophoretic techniques

1. UV-visible spectroscopy 2L

- Beer- Lambert's Law, Instrumentation, operation, calibration, accuracy and applications

2. Infra red spectroscopy 4L

- Principles, Instrumentation, operation, calibration, accuracy and applications

3. Electron Spin Resonance (ESR) Spectrometer: principle and application 2L

4. Atomic Absorption Spectroscopy 3L

- Principles, Instrumentation, operation, calibration, accuracy and applications

5. Circular Dichroism (CD) and Optical rotator Dispersion (ORD) 4L

- Theory and application

UNIT 3: CHROMATOGRAPHIC & ELECTROPHORETIC TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand principles, working and applications of different chromatographic techniques

1. Gas Chromatography 5L

- Principles, Instrumentation, operation, calibration, accuracy and applications

2. High Performance Liquid Chromatography 5L

- Principles, Instrumentation, operation, calibration, accuracy and applications

3. Supercritical Liquid Chromatography 2L

- Properties of SFE/SFC, Instrumentation, operation, advantages and applications

4. Electrophoretic techniques 3L

UNIT 4: OTHER ANALYTICAL TECHNIQUES 15 LECTURES

LEARNING OBJECTIVES

Understand different methods and principles used in analytical techniques.

1. Centrifugation 3L

- Overview of preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications

2. Radioisotopic techniques 5L

- Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications.
- Dosimetry.

3. Mass spectroscopy 5L

- Instrumentation

- Various detection systems including MALDI-TOF

4. NMR spectroscopy

2L

- Basic Principles of NMR, Chemical shift, Intensity, Line width

CIA: Assignment, Test

References: -

Unit 1:

1. Bioimaging: current concepts in light and electron microscopy, Chandler D.E. and Roberson R.W. 2009, Singapore, Jones and Bartlett Publishers
2. Handbook of Physics in Medicine and Biology, edited by Robert Splinter, 2010, CRC Press
3. Principles of Physical Biochemistry 2nd Edition, van Holde, E. Kersal, W.C. Johnson, H. P. Shing, 2006, New Jersey, Pearson Prentice Hall

Unit 2:

1. Fundamentals of Molecular Spectroscopy, 4th Ed., Banwell, C.N. and McCash, E.M., 2012, New Delhi, Tata McGraw Hill Education Pvt. Ltd.
2. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
3. Introduction to Instrumental Analysis, Braun R., New York, McGraw Hill Book Company
4. Principles of Instrumental Analysis, 5th Ed. Skoog, Holler and Nieman, Australia, Thomson Brock/Cole
5. Biophysics (2nd Ed.) Pattabhi V. and Gantham N. 2002, Springer
6. Atomic absorption and plasma spectroscopy, Dean J.R., 1997 (2008), Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
7. http://faculty.sdmiramar.edu/fgarces/labmatters/instruments/aa/AAS_Theory/AAS_Theory.htm

Unit 3:

1. Gas Chromatography, Fowles I. A., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
2. HPLC, Lindsay S., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
3. Basic Gas Chromatography, McNair H. M. and Miller J. M., 2009, Wiley International
4. Electrophoresis, Melvin M., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
5. Molecular cloning: A laboratory Manual, Sambrook J., Fritsch, Maniatis T, 2nd edition,

1989, Cold Spring Harbor Laboratory Pr

Unit 4:

1. Biophysical Chemistry: Principles and Techniques, Upadhyay, Upadhyay and Nath, 2014, Mumbai, Himalaya Publishing House
2. NMR spectroscopy, Williams D. A .R., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
3. Mass spectroscopy, Barker J., 2008, Wiley India Pvt. Ltd. (Analytical Chemistry by Open Learning series)
4. Centrifugation : a practical approach, edited by D. Rickwood,1984, Oxford
5. http://www.brynmawr.edu/chemistry/Chem/mnerzsto/The_Basics_Nuclear_Magnetic_Resonance%20_Spectroscopy_2.htm

M.Sc. II

Course: MS. MIC.3.03

Title: ADVANCES IN BIOTECHNOLOGY-I

LEARNING OBJECTIVES

Understand applications of Biotechnology

Number of lectures: 60

UNIT 1: PLANT AND AGRICULTURAL BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Understand advanced technologies involved in plant biotechnology.
 2. Understand applications of transgenic plants.
-

1. Plant Transformation Technology

7L

- *Agrobacterium* mediated gene transfer, *Agrobacterium* based vectors, viral vectors
- Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, Molecular breeding, plant selectable markers, Reporter genes, Positive selection, Selectable marker elimination
- Transgene silencing, Strategies to avoid transgene silencing

2. Plant Genetic Engineering for Productivity and Performance

6L

- Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, *Bt* toxin, Disease Resistance, Virus resistance
- Abiotic Stress Tolerance-- Drought, Flooding, Salt and temperature.
- Manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency
- Quality Improvement-Protein, Lipids, carbohydrates, vitamins and minerals.
- Biosafety concerns of transgenic plants

3. Plants as bioreactors

2L

UNIT 2: MARINE BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know marine microbes and their applications
-

1. Marine environments and biodiversity

2L

- Extreme environmental conditions
- Marine life forms - Marine bacteria, marine archaea
Environmental research in marine environment

2. Biofouling, Bioremediation and Biodeterioration in marine environment and the role of microorganisms in these processes **3L**

3. Methods in Marine Microbiology –
2L

- Detection of microorganisms and microbial activity, Metabolic diversity, Marine Genomics and Marine Proteomics

4. Marine bioprospecting

1L

Isolation of Marine Natural Products

5. Diversity of marine derived compounds

7L

Alkaloid, Terpenoids and steroides, nucleoside, aminoacids, peptides, depsipeptide, polyketide, Macrolide

Marine Enzymes- protease, lipase, chitinase, glucanase

Marine biominerals; Biomineralized structures

Biocomposites

Biopolymers - polysaccharides, chitin, marine collagens

Biomimetic materials, new class of pharmaceuticals, industrial products and processes

Vaccines, diagnostics and analytical reagents

Bioactive compounds

Biomaterials

UNIT 3: FERMENTATION PROCESSES IN BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

Understand concepts of microbial fermentation and downstream processing

1. Bioreactor

7L

- Basic configuration, features, measurement and control of bioprocess parameters
- Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.

- Agitation
- Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases
- Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetic

2. Upstream processing **2L**

- Media formulation and modification
- Inoculum development and storage of cultures
- Scaling up of process from shake flask to industrial fermentation.

3. Downstream processing **2L**

- Biomass separation by centrifugation, filtration, flocculation and other methods
- Cell disintegration: Physical, chemical and enzymatic methods
- Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis, drying and crystallization

4. Microbial Fermentations **4L**

- Metabolic pathways and metabolic control mechanisms, industrial production of citric acid, enzymes (e.g. proteases), acetone- butanol, amino acids (e.g. lysine)

UNIT 4: ADVANCES IN BIOPROCESSES

15 LECTURES

LEARNING OBJECTIVES

Know the advance methods of microbial bioprocesses.

1. Modern trends in microbial production **4L**

- Bioplastics (PHB, PHA), Bioinsectices (Entomopathogenic e.g. *Bacillus thuringensis*, Antifungal e.g. *Trichoderma spp*, Antibacterial e.g. *Pantoea agglomerans*, phages), Biopolymer (dextran, alginate, xanthan, pullulan), Biofertilizers (nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms), Single Cell Protein

2. Microbial production of therapeutic compounds **4L**

- Rifamycin, Biotransformation of steroids, Riboflavin fermentation and Interferon

3. Biofuels **3L**

- Biogas production (biomethanation)
- Production of bioethanol from sugar, molasses, starch and cellulosic materials
- Ethanol recovery
- Microbial production of hydrogen gas, biodiesel from hydrocarbons.

4. Immobilization techniques

2L

- Whole cell and enzyme immobilization
- Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries.

5. Microbial strain improvement

2L

- Screening and isolation of microorganisms
- Use of genetic manipulation for strain improvement
- Problems associated with strain improvement
- improvement of characters other than products

CIA: Assignment, Test

References:-

Unit 1:

1. Molecular Biotechnology, Principles and Applications of recombinant DNA, Glick and Paternak, 4th edition, 2009, ASM Press
2. Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford.
3. Introduction to Plant Biotechnology, H.S. Chawla, 3rd Ed, 2002, Oxford and IBH publishers
4. H. K. Das, Textbook of Biotechnology, 2004, Wiley India

Unit 2:

1. Marine Biotechnology: Volume 1, Attway D. H. & Zabosky O. R., Plenum Press, (1993).
2. Marine microbiology: bioactive compounds and biotechnological applications edited by Se-Kwon K., 2013, Wiley-VCH Verlag GmbH & Co.

Unit 3:

1. Fermentation Technology Vol. 1 Upstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
2. Fermentation Technology Vol. 2 Downstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
3. Microbial Technology Volume 1 and 2, Pepler H. J. and Perlman D., Academic Press New York (1970)
4. Principles of Fermentation Technology, Stanbury P.F., Whitaker W. & Hall S. J., Aditya Books (P) Ltd., New Delhi, 1997.
5. Fermentation Microbiology and Biotechnology, El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
6. Industrial Microbiology, Casida L.E. Jr, 1994 (reprint), Wiley Eastern Limited.

Unit 4:

1. Fermentation Technology Vol. 1 Upstream Fermentation Technology, Modi H. A., Pointer Publisher, Jaipur India (2014)
2. Biotechnology, A textbook of industrial Microbiology, Creuger and Creuger, Sinaeur associates.
3. Industrial Microbiology, Casida L.E. Jr, 1994 (reprint), Wiley Eastern Limited.

SEMESTER 3:

PRACTICALS: EXTERNAL PROJECT (THREE TO FOUR MONTHS)

CIA

3.01: Biostatistics-Problem solving

3.02: Project Proposal

3.03: Rough Draft of Dissertation

3.04: Oral Presentation



St. Xavier's College – Autonomous Mumbai

M.Sc. Syllabus For 4th Semester Courses in **Microbiology** (June 2015 onwards)

Contents:

Theory Syllabus for Courses:

**MS.MIC.4.01 - APPLIED AND ENVIRONMENTAL MICROBIOLOGY, MONITORING
AND MANAGEMENT**

MS.MIC.4.02 –FOOD MICROBIOLOGY

MS.MIC.4.03 - PHARMACEUTICAL MICROBIOLOGY

MS.MIC.4.04 - ADVANCES IN BIOTECHNOLOGY – 2

Practical Syllabus for Courses:

MS.MIC.4.PR

M.Sc. II

Course: MS.MIC.4.01

Title: APPLIED AN ENVIRONMENTAL MICROBIOLOGY, MONITORING AND MANAGEMENT

LEARNING OBJECTIVES

1. Understand microbial communities in various habitats and their adaptations
2. Understand the techniques needed to study microbial ecology
3. Know biofilm formation in various environments.
4. Understand the bioremediation process, its feasibility and various methods.
5. Understand sewage & sludge treatment and disposal methods with plant loading criteria.
6. Know the types of pollution, its monitoring and control
7. Understand waste management, biohazard and biosafety standards.

Number of lectures: 60

UNIT 1: MICROBIAL DIVERSITY & ADAPTIONS TO DIVERSE HABITATS

15 LECTURES

LEARNING OBJECTIVES

1. Understand microbial biodiversity in different habitats
 2. Know the adaptations of microorganisms to extreme environmental conditions and application of the adaptations
 3. Understand the role of microorganisms in biofilm formation and biogeochemical cycling
-

1. Principles of microbial ecology

2L

- Ecological concepts –Concepts, Niche, Habitat, Ecosystem
- Interactions between microorganisms with emphasis on any two examples of each
- Ecological succession

2. Microbial ecosystems and biogeochemical cycling

13L

- Environments and microenvironments
- Biofilms
 - i. Structure, properties and models of biofilms
 - ii. Formation of biofilm , Regulation of Initial Attachment, Biofilm Formation Processes via Multiple Convergent Genetic Pathways, Early Attachment Events, Maturation of the Biofilm , Detachment and Return to the Planktonic Growth Mode
 - iii. Study of Quorum Sensing in biofilm formation
 - iv. Biofouling associated microbial biofilms
 - v. Prosthetics associated biofilms

- vi. Gut associated Biofilms
- vii. Control of biofilms
- Freshwater habitat
- Marine habitat
- Soil habitat
 - i. Soil composition
 - ii. Soil formation
 - iii. Soil as a microbial habitat
 - iv. Deep subsurface microbiology
- Plant microbial ecosystems
 - i. Rhizosphere
 - ii. Phylosphere
 - iii. Plant pathogens
- Animal associated microbes: Rumen associated microbes
- Extreme environments: Study of Thermophiles, Psychrophiles, Halophiles, Piezophiles, Acidophiles, Alkaliphiles, Xerophiles, Radiation resistant organisms
- Biogeochemical cycling:
 - i. Biogeochemical cycles for Carbon Nitrogen, Sulphur and Oxygen
 - ii. Concept of Carbon credits

UNIT 2: TECHNIQUES IN MICROBIAL ECOLOGY

15LECTURES

LEARNING OBJECTIVES

1. Understand the techniques used for studying ecological habitats
-

1. Environmental sample collection and processing

1L

- Soils and Sediment
- Water
- Air

2. Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment Cultural Methods

14L

- Cultural methods for isolation & enumeration of bacteria
- Physiological Methods
 - i. Measuring microbial activity in pure culture
 - ii. Carbon respiration
 - iii. Stable isotope probing
 - iv. Use of radioisotopes as tracers
 - v. Adenylate energy charge
 - vi. Enzyme assays
- Immunological methods: Immunoassays
- Nucleic acid based methods of analysis

- i. Obtaining Nucleic acids from Environment
- ii. Use of Gene probes
- iii. FISH, ISRT FISH, CARD FISH
- iv. Microarrays
- v. PCR- RTPCR, qPCR, ICC PCR, PCR-fingerprinting
- vi. RFLP
- vii. ARISA, ARDRA
- viii. Denaturing /Temperature gradient Gel electrophoresis
- ix. Sequencing
- x. Metagenomics
- xi. Reporter genes.

UNIT 3: BIOREMEDIATION, BIODEGRADATION & WASTE DISPOSAL

15 LECTURES

LEARNING OBJECTIVES

1. Understand the bioremediation process and its feasibility.
 2. Learn the various methods of bioremediation.
 3. Learn the various methods of sewage sludge treatment.
-

1. Introduction to Bioremediation

3L

- Factors affecting bioremediation: Nutrient sources, environmental conditions, Bioavailability, adsorption/desorption kinetics
- Needs and Limitations
- Strategies for bioremediation
 - i. Intrinsic and Enhanced : Indigenous and bioaugmentation, Use of surfactants
 - ii. *In situ* bioremediation: Bioremediation on land, land farming, Bioventing, Biosparging, Bioaugmentation
 - iii. *Ex situ* bioremediation: Composting, Biopile process, Bioreactors, Novel technologies
 - iv. Molecular methods for bioremediation

2. Bioremediation in Soil of BTEX hydrocarbons

2L

- Significance of BTEX contamination
- Concept of aerobic and anaerobic processes of breakdown

3. Petroleum contamination

2L

- Metabolism of alkanes and aromatic compounds
- Genetics of petroleum degradation

4. Polycyclic Aromatic hydrocarbons

3L

- Sources, Toxicity and Persistence

- Microbial metabolism of PAH (by bacteria, algae, ligninolytic- and non ligninolytic-fungi)
- Methods of bioremediation: Solid phase, Bioreactor and *in situ* methods, advantages and disadvantages of these methods.

5. Bioremediation and biodegradation of Xenobiotics **1L**

- Nitro aromatic compounds
- PCB
- Chlorinated Phenols
- Chlorinated aliphatic compounds.

6. Sewage & Sludge treatment and disposal methods **4L**

- Aerobic processes
- Anaerobic processes
- Various plant loading criteria eg. MLSS, TSS, HRT, MCRT and F:M
- Disposal methods

UNIT 4: ENVIRONMENTAL & NATURAL RESOURCES MANAGEMENT, SAFETY STANDARDS, POLLUTION CONTROL AND MONITORING **15 LECTURES**

LEARNING OBJECTIVES

1. Understand pollution of various resources and their effects.
2. Understand pollution monitoring, assessment and control.
3. Understand solid, hazardous and biomedical waste management.
4. Know the biohazards and biosafety levels.

1. Introduction to Pollution and types of pollution, Pollution Control and Monitoring, Natural and anthropogenic pollution. Role of government and public in pollution control **3L**

2. Solid waste management **3L**

- Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non biodegradable waste like plastics, glass, metal, scrap and building materials, plastic and metal recycling

3. Harardous waste management **2L**

- Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce this waste through Common Effluent Treatment Plants

4. Biomedical waste management **2L**

5. Biohazards **2L**

- Introduction, levels of biohazards, risk assessment, proper cleaning procedures

6. Biosafety

3L

- Historical background and introduction
- Need of biosafety levels, biosafety guidelines for GMOs and LMOs. Role of Institutional biosafety committee
- RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs
- Overview of national regulations and relevant international agreements. Ecolabelling, IS 22000, Generally Recognized as Safe (GRAS)

CIA: Quiz, Test

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Unit 1:

1. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 12th ed, 2009 Pearson Intl Ed
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Unit 2:

1. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 12th ed, 2009, Pearson Intl Ed.
2. Environmental Microbiology, Maier R.M., Pepper. L. and Gerba C. P., 2010, Academic Press
3. Microbes and Microbial Technology, Rastogi & Sani, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the

- Environment *in* Microbes and Microbial Technology: Agricultural and Environmental Applications, Iqbal Ahmad, Farah Ahmad, John Pichtel, 2011, Springer
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Unit 3:

1. A Textbook of Biotechnology, Dubey R.C., Illustrated Revised edition, 2010, S Chand and company
2. Environmental Biotechnology. Fulekar, M.H., 2010, CRC Press and Science Publishers
3. Environmental Microbiology, Maier R. M., Pepper I. L. and Gerba C. P., 2nd edition, 2009, Academic Press
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7. Bioremediation of BTEX hydrocarbons, Prenafeta-Boldu, F.X. *et. al* Biodegradation, 15:59-65. 2004
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9. Biotechnology, B.D.Singh, 2002, Kalyani Publishers
10. Exploitation of Micro-organisms, edited by Jones, D.G., 1993, Chapman and Hall, London.

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M.Sc.II

Course: MS.MIC.4.02

Title: FOOD MICROBIOLOGY

LEARNING OBJECTIVES

1. Understand significance of microbes in food and their control
2. Understand concepts of Food Safety, quality management and regulation in the food industry
3. Know the varied applications of microbes in food
4. Apply concepts of sampling, QA, QC, GMP and HACCP in food industry

Number of lectures: 60

UNIT 1: MICROBES IN FOODS

15 LECTURES

LEARNING OBJECTIVES

Understand the incidence of microbes in food and their role in food spoilage.

- | | |
|--|-----------|
| 1. Current status of Food microbiology | 1L |
| 2. Sources of microbes in food & characteristics of predominant microorganism | 3L |
| 3. Normal microbiological quality of food and significance | 2L |
| 4. Factors influencing microbial growth in food | 3L |
| • Intrinsic | |
| • Extrinsic | |
| 5. Microbial food spoilage | 4L |
| • Important factors in Microbial food spoilage | |
| • Spoilage of specific foods, | |
| • New spoilage bacteria in refrigerated food | |
| • Indicators of Microbial Food spoilage | |
| 6. Predictive Modeling of Microbial Growth in food | 2L |

UNIT 2: CONTROL OF MICROBES IN FOOD

15 LECTURES

LEARNING OBJECTIVES

Know the principles of techniques used in food preservation to control the access and growth of microorganisms in food

| | |
|---|-----------|
| 1. Control of access of microbes in foods | 1L |
| 2. Control by physical removal, heat, low temperature, reduced Aw, low pH and organic acids, modified atmosphere, antimicrobial preservatives, irradiation | 8L |
| 3. Novel processing technologies of food preservation | 3L |
| 4. Control by combination of methods (Hurdle concept) | 3L |

UNIT 3: BENEFICIAL USES OF MICROBES AND OTHER FORMULATIONS IN FOOD **15 LECTURES**

LEARNING OBJECTIVES:

1. Understand general production methods of fermented foods from milk, meat, vegetable and cereals.
2. Know the other applications of microbes and microbial products in the food industry
3. Understand functional foods especially nutraceuticals.

| | |
|--|-----------|
| 1. Microbiology of fermented foods | 4L |
| • Cheese – Swiss and Blue cheese | |
| • Fermented meat product – Sausage | |
| • Fermented vegetable products – Pickles, soy product, Sauerkraut | |
| • Bread and Idli | |
| 2. Food additives of microbial origin | 3L |
| • Enzymes | |
| • Biopreservatives | |
| • Sweetners , flavours and colors | |
| • Probiotics and Prebiotics | |
| 3. Nutraceuticals | 4L |
| • Introduction to Nutraceuticals - definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals. | |
| • Microbes and production of nutraceuticals like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols | |
| • Applications of fibers from food sources | |
| • Microbial fructooligosaccharides | |
| 4. Packaged Drinking water | 4L |
| • Types of bottled water | |
| • BIS /regulations regarding the production of packaged waters with respect to final quality | |

of product

- Potential chemical and microbiological hazards in the bottles depending on the type of water , the type of bottle and the bottling procedure
- The application of HACCP in the bottling plants

UNIT 4: METHODS FOR FOOD SAFETY

15 LECTURES

LEARNING OBJECTIVES

1. Understand conventional, modern and rapid methods of detection of microbes and their products in food.
 2. Be able to apply concepts of sampling, QA, QC, GMP, ISO 22000 and HACCP in Food industry
 3. Understand Laboratory Accreditation criteria.
-

1. Microbial Foodborne diseases

2L

- Important facts in food borne diseases
- Food Borne infections
- Food Borne intoxicants
- Foodborne Toxico-Infections
- Opportunistic pathogens
- New and emerging food pathogens
- Indicators of Bacterial Pathogens

2. Methods for detection of microbes and their products

9L

- Conventional Microbiological Methods
 - i. Sampling for microbial analysis
 - ii. Microbial enumeration in food
 - iii. Qualitative Methods for detection of microbes and their toxins in food
 - iv. Sampling, sample processing approaches for analysis of foods implicated in outbreaks with measurement of uncertainty for mycotoxic fungi, pathogenic bacteria (EPEC, *Vibrio*, Salmonellae) and viruses (Hepatitis A , Norwalk) in meat/fish products as perBIS/ISO/APHA standards
- Chemical Methods
 - i. DNase test
 - ii. LAL test
 - iii. Tests with Fluorogenic and Chromogenic Substrates
- Immunological Methods
 - i. FAT
 - ii. ELISA
 - iii. RIA
 - iv. Hemagglutination
- Molecular Methods

- i. PCR
- ii. Lux Gene Luminescence
- iii. Fingerprinting methods
- Physical Methods
- Biosensors: Use of biosensors and enzymatic/ thermal techniques for food analysis

3. Controlling the Microbiological Quality of food/food safety 4L

- Quality and Criteria
- Sampling Schemes
- QC using microbiological control
- Control at source
- Codes of GMP , Codex Alimentarius and FSSAI
- HACCP/ISO 22000
- Laboratory Accreditation
- Biofilm control

CIA: Presentation, Test

References:

Unit 1:

1. Fundamental Food Microbiology, 5th Ed., Bibek R. and Bhunia A., 2014, CRC Press
2. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
3. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing
4. Fundamentals of food microbiology, Fields M., 1979, AVI Publishing

Unit 2:

1. Fundamental Food Microbiology, 5th Ed., Bibek Ray and Arun Bhunia, 2014, CRC Press
2. Modern Food Microbiology, 7th Ed., Jay J., Loessner M. and Golden D., 2005, Springer
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Unit 3:

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2. Prescott and Dunn's Industrial Microbiology, Reed G., 4th Ed. CBS Publishers, 2004
3. Functional Foods – Concept to Product, Gibson GR & William CM., 2000, Woodhead Publishing
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M.Sc.II

Course: MS.MIC.4.03

Title: PHARMACEUTICAL MICROBIOLOGY

LEARNING OBJECTIVES

1. Understand concepts of QA and validation in pharmaceutical and cosmetic products.
2. Understand modern methods of drug discovery.

Number of lectures: 60

UNIT 1: PRINCIPLES AND APPLICATIONS OF GMP IN PHARMACEUTICALS AND COSMETICS **15 LECTURES**

LEARNING OBJECTIVES

Understand GMP and its significance

| | |
|--|-----------|
| 1. Principles – Applications and Definitions | 2L |
| 2. The concept of Quality | 2L |
| 3. The regulatory factors | 2L |
| 4. QC, QA and GMP | 2L |
| 5. Quality assurance beyond GMP | 2L |
| 6. ISO | 2L |
| 7. Sanitary practices in cosmetic manufacturing | 3L |

UNIT 2: QUALITY MANAGEMENT AND REGULATORY ASPECTS **15 LECTURES**

LEARNING OBJECTIVES

Know the different aspects of quality management

| | |
|--|-----------|
| 1. Premises and contamination control, location, design, structure, layout, services and cleaning | 3L |
| 2. Personnel management, training, Hygiene and health | 2L |

- | | |
|--|-----------|
| 3. Documentation for quality management | 2L |
| 4. Quality control and GCLP | 2L |
| 5. Sterile and non-sterile products | 3L |
| 6. Global regulatory and toxicological aspects of cosmetic preservation | 3L |

UNIT 3: ANALYTICAL ASPECTS FOR PHARMACEUTICAL AND COSMETIC PRODUCTS **15 LECTURES**

LEARNING OBJECTIVES

Understand the analytical aspects of QA and validation in pharmaceutical and cosmetic products.

- | | |
|---|------------|
| 1. Analytical Aspects of QC and GCLP for Pharmaceuticals. | 10L |
| <ul style="list-style-type: none">● Assurance of quality in the manufacture of sterile products.● Validation: concepts, principles, analytical methods and applications. | |
| 2. Cosmetic microbiology- testing methods and preservation | 5L |
| <ul style="list-style-type: none">● Antimicrobial preservation efficacy and microbial content testing● Validation method for cosmetics● Preservation strategy● Evaluation of antimicrobial mechanism | |

UNIT 4: DRUG DISCOVERY **15 LECTURES**

LEARNING OBJECTIVES

1. Understand modern methods of drug discovery.
 2. Understand concepts of Pharmacokinetics and Pharmacodynamics.
-

- | | |
|---|-----------|
| 1. Drug Discovery Tools | 9L |
| <ul style="list-style-type: none">● Pharmacokinetics and Pharmacodynamics, Natural products for lead identification, High Throughput Screening, Combinatorial Chemistry● Concept of Pharmacognosy | |
| 2. Modern Methods of Drug Discovery | 6L |
| <ul style="list-style-type: none">● Cheminformatics, in silico-modelling, Molecular Modeling, Structure Prediction, Rational Drug Designing, Drug Development, Proteomics, protein 3D structures in the drug discovery process, microbial genome mining | |

CIA: Presentation, Test

References:-

Unit 1:

1. Quality in the manufacture of medicines and other healthcare products, Sharp J., 2000, Pharmaceutical Press.
2. Guidelines on cGMP and quality of Pharmaceutical products, Iyer S., 2003, D K Publishers Mumbai.
3. Cosmetic Microbiology a practical approach, Geis P. A., Taylor and Francis,.2nd Ed, 2006, CRC Press

Unit 2:

1. Hugo and Russell's Pharmaceutical Microbiology, Denyer S. P., Hodges N. A., Gorman S. P. And Gilmore B., 8th Edition, 2011, Blackwell Publishing.
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Unit 3:

1. Cosmetic Microbiology a practical approach, Geis P. A., Taylor and Francis,.2nd Ed, 2006, CRC Press
2. Quality in the manufacture of medicines and other healthcare products, Sharp John, 2000, Pharmaceutical Press.

Unit 4:

1. Modern Methods of drug discovery, Hillisch A. and Hilgenfeld R., 2009, Springer International Edition
2. Principles of Medicinal Chemistry, Kadam S. S., Mahadik K. R. and Bothara K. G., 2009, Vol II, Nirali Prakashan Pune
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4. Principles of pharmacology: the pathophysiologic basis of drug therapy by Golan D. E., 2nd Edition, 2007, Lippincott Wiliams and Wilkins

M.Sc. II

Course: MS.MIC.4.04

Title: ADVANCES IN BIOTECHNOLOGY – 2

LEARNING OBJECTIVES

1. Know the applications and advances in the field of Animal, plant, molecular and nano biotechnology.
2. Understand the concepts of IPR in the field of biotechnology
3. Understand the concepts of bioethics and entrepreneurship

Number of lectures: 60

UNIT 1: ANIMAL BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know the concept and techniques in animal tissue culture.
2. Understand generation and applications of transgenic animals.

| | |
|---|-----------|
| 1. Animal Tissue Culture | 2L |
| • Primary culture, Organ culture, Embryo Culture, Established Cell lines | |
| 2. Scale up, Cryopreservation, Culture Collections | 2L |
| 3. Risks and Safety, Bioethics | 2L |
| 4. Stem Cell Technology, Cloning techniques, Applications | 1L |
| 5. Methods of generation of transgenic mice | 4L |
| • Retroviral method | |
| • DNA microinjection method | |
| • Engineered Embryonic Stem cell method. | |
| 6. Transgenics and knockouts: Transgenic cattle, Transgenic birds, Transgenic fish | 4L |

UNIT 2: PLANT TISSUE CULTURE & NANOBOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know the concept and techniques in plant tissue culture.
 2. Understand synthesis and properties of nanostructures and their applications.
-

- 1. Plant Tissue Culture for crop improvement** **5L**
- Initiation and maintenance of Callus and Suspension culture, Direct and Indirect Organogenesis, Micropropagation, Artificial seeds, Anther culture and dihaploids, Protoplast isolation culture and fusion, Production of haploids, Somaclonal variations, Germplasm conservation, Somatic hybrids, Cybrids
- 2. Production of secondary metabolites from plant cell cultures** **2L**
- Technology of plant cell culture for production of chemicals
 - Bioreactor systems and models for mass cultivation of plant cells
- 3. Nanoscale systems and Synthesis of nanostructures** **3L**
- Nanoparticles, nanowires, thin films and multilayers
 - Physical, chemical and biological methods
- 5. Nano-biosensors** **1L**
- Cantilevers: types and applications
 - Electrochemical nanosensors
- 6. Manipulation of biomolecules using nanotechnology** **2L**
- Optical tweezers
 - Dielectrophoresis
 - Micro and Nanofluidics
 - Chip technologies
- 7. Medical nanotechnology** **2L**
- Drug and gene delivery systems
 - Nanoimaging
 - Nanomedicine and Cancer diagnostics and treatment.

UNIT 3: IPR, ETHICS AND ENTERPRENEURSHIP IN BIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES:

1. Understand IPR and its role in biotechnology
2. Understand the concept of bioethics and its relevance in biotechnology
3. Understand the concept of entrepreneurship in biotechnology and obtain a preliminary knowledge of its components

-
- 1. Biotechnology and Intellectual Property Rights** **8L**
- Intellectual Property Rights (IPR) and Protection (IPP)
 - Biotechnology and IPR-Rationale of Patent in Research and Scientific Innovations
 - Biotechnological Patents

- Requirements for Patentability- Patentable subject matter, Novelty, Invention in Biotechnological Research, Industrial Applicability, Enablement Requirement.
- Patent Specifications and Basic Component of License Agreement, In IP System
- Categories of Biotechnological Patents-Patenting in New Era of Genomics, Proteomics and Microbiology, Examples of Patents granted by USPTO, Concerns over Biotechnology Patents.
- Patenting in Biotechnology-European Scenario, US Scenario, Australia Scenario, Indian Scenario, Non Patentable IP and Patentable IP in Indian Patent Act

2. Biotechnology and Bioethics **4L**

- Bioethics and cross-cultural bioethics.- Autonomy, Rights, Beneficence, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Decision-Making
- Perceptions of Ethical Biotechnology, Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about consuming products of GMOs.
- Future 'Bioethical Conflicts' in Biotechnology. - Changing perception of Nature, Human Genetic Engineering

3. Entrepreneurship in biotechnology **3L**

- Introduction
- Case Studies in Entrepreneurship
- Entrepreneurial Skills
- Initiating a Venture
- Planning a Venture
- Financing a Venture

UNIT IV: ADVANCES IN MOLECULAR BIOTECHNOLOGY **15 LECTURES**

LEARNING OBJECTIVES:

Learn the different methodologies involved in molecular biotechnology

1. Chemical synthesis and sequencing of DNA **2L**

- Phosphoramidite method, Uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Using Phage M13 as a sequencing vector

2. Manipulation of Gene Expression in Prokaryotes **3L**

- Gene expression from strong and regulatable promoters, Fusion proteins, unidirectional tandem gene arrays, Increasing protein stability, protein folding, DNA integration into host chromosome

3. Heterologous protein production in eukaryotic cells **2L**

- Expression systems like *Saccharomyces cerevisiae*, *Pichia pastoris*, Baculovirus-Insect cell, mammalian cell

4. Rational Mutagenesis **4L**

- Oligonucleotide directed mutagenesis with M13, Oligonucleotide directed mutagenesis with plasmid DNA, PCR amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide primer, Random mutagenesis with nucleotide analogues, Error-prone PCR, DNA shuffling, Mutant proteins with unusual amino acids

5. Protein Engineering **3L**

- Adding disulfide bonds, Changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, Increasing enzymatic activity, Modifying metal cofactor requirement, Decreasing protease sensitivity, Modifying protein specificity, Increasing enzyme stability and specificity, altering multiple properties

6. Synthetic Biology **1L**

- Introduction, types, mechanisms, applications in industry

CIA: Assignment, test

References:-

Unit 1:

1. Culture of Animal Cells, Freshney I., 2011, John Wiley and Sons.
2. Basic Cell Culture, Davis J. M., 2nd.Ed 2007, Oxford press
3. Animal Cell Culture, Gangal S., 2010, Universities press.
4. Molecular Biotechnology, Glick and Pasternak, 4th edition, (2010) ASM press.

Unit 2:

1. Introduction to plant tissue culture, Razdan M. K., 2003, Science Publishers.
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3. An introduction to Plant Tissue Culture, Kalyan Kumar De, 1992, New Central Book Agency
4. Fundamentals of Nanotechnology, Hornyak D., Moore J., Tibbals H., Dutta J., 2008, CRC press.
5. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology, Nalwa H. S., 2005, American Scientific Publishers
6. Nanobiotechnology, Niemeyer C. M. and Mirkin C. A., 2005, Wiley Interscience

Unit 3:

1. Biodiversity, Biotechnology & Traditional Knowledge- Understanding Intellectual Property Rights, Aravind Kumar, Govind Das, 2010, Narosa Publishers.

2. A textbook of Biotechnology, Dubey R. C., 2001, S. Chand Publishers.
3. Biotechnology, 2nd Edition-Volume 12- Legal, Economic and Ethical Dimensions, Volume Editor-D. Brauer (A multi-Volume Comprehensive Treatise), Rehm H. J. and Reed G., Puhler A., Stadler P. (1995) VCH Publishers.
4. Patent It Yourself, 9th Edition, Pressman D., 2002, Nolo
5. Ethics in Biotechnology - an executive guide:
www.BiotechEthics.ca/tools/biotech_guide_1_0.pdf

Unit 4:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R. Glick, Jack J. Pasternak, 4/e (2010), ASM Press
2. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology, edited by Wink M., 2006, Wiley VCH
3. Molecular biotechnology: Principles and practices, Channarayappa, 2006, Universities Press
4. Synthetic Biology, Benner S., Sismour A. M., 2005, Nature Reviews Genetics, v6, p533-543.

**M.Sc. II
Practicals semester IV**

Course: MS.MIC.4.PR

INTERNAL PROJECT

MS.MIC.4.01.PR

Group based Research Projects to study industrially important microbes/ microbial processes using microbial diversity rich environmental sample (e.g. mangrove soil).

**APPLIED AN ENVIRONMENTAL MICROBIOLOGY, MONITORING AND
MANAGEMENT**

MS.MIC.4.02.PR

1. Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content.
2. Biofilm visualization by staining of a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environment).
3. Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to planktonic cells) quantified using crystal violet assay
4. Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.

FOOD AND PHARMACEUTICAL MICROBIOLOGY

MS.MIC.4.03.PR

Food Microbiology

1. Microbiological study of fermented food: Idli batter
2. Quality Assessment and Analysis of packaged foods: Milk, Salad, Juice, Yogurt (ISI standards)
3. Farm to fork: identifying the sources of cross contamination, mitigation strategies.

Pharmaceutical and cosmetic Microbiology

1. Sterility testing and reporting (as per Pharmacopia)
2. Microbial load of cosmetic product
3. Efficacy testing of preservatives like parabens
4. Efficacy of preservation and shelf life study.
5. Preparation of cosmetic product and study of its preservation

ADVANCES IN BIOTECHNOLOGY

MS.MIC.4.04.PR

1. Terminology, Laboratory design of Animal tissue culture laboratory
2. Preparation of complete medium, Sterilization and sterility checking.
3. Chick embryo fibroblast culture, viable staining
4. Lymphocyte, viable staining and haemocytometer count.
5. Preparation of Nanosilver By Wet reduction Method(Chemical),using Neem Extract(plants) & Bacteria(Microbiological)
6. Characterisation of Nanosilver by UV spectrometry methods

7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.
8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria
9. Alcohol fermentation and assessment of efficacy

CIA:

MS.MIC.3.01: Project Conduct

MS.MIC.3.02: Rough draft of internal Project Report

MS.MIC.3.03: Lab experiment

MS.MIC.3.04: Lab experiment