M.Sc. MICROBIOLOGY

CBCS COURSE STRUCTURE & SYLLABUS

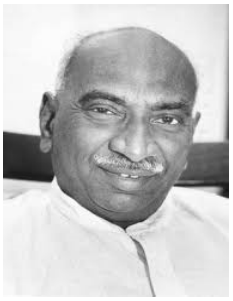
(2020-2022)

SCHOOL OF BIOLOGICAL SCIENCES

MADURAI KAMARAJ UNIVERSITY

MADURAI - 625 021, INDIA

SCHOOL OF BIOLOGICAL SCIENCES
MADURAI KAMARAJ UNIVERSITY
M.Sc. BIOCHEMISTRY; CHOICE BASED CREDIT SYSTEM (CBCS)
Course structure and Syllabus (2020-2022)



SEMESTER I

S. No	Course Code	Course Title	Credits	Scheme of Examination		
				Int.	Ext.	Total
1	MIB 11 C	Advanced Microbiology	3	25	75	100
2	MIB 12 C	Medical Microbiology	3	25	75	100
3	MIB 13 C	Microbial Biochemistry	3	25	75	100
4	MIB 14C	Molecular Biology and Molecular Genetics	3	25	75	100
5	MIB 15C	Lab in General Microbiology and Biochemistry	4	40	60	100
	MIB 16C	Lab in Molecular Biology and Molecular Genetics	4	40	60	100
Elective Subjects						
6	MIB 17E	Biostatistics & Biocomputing	4	25	75	100
SSS Course - 1						
8	SSS1		2	25	75	100

SEMESTER II

S. No	Course Code	Course Title	Credits	Scheme of Examination		
				Int.	Ext.	Total
1	MIB 21C	Immunology	4	25	75	100
2	MIB 22C	Environmental Microbiology & Metagenomics	4	25	75	100
3	MIB 23C	Bioprocess Technology	4	25	75	100
4	MIB 24C	Lab in Molecular Cloning & Genome Engineering	4	40	60	100
5	MIB 25C	Lab in Food, Diary Microbiology and Bioprocess Technology	4	40	60	100
Elective Subjects						
6	MIB 26E	Cell & Developmental Biology	4	25	75	100
7	MIB 27 E	Molecular Cloning & Genome Engineering	4	25	75	100
8	MIB 28 E	Metabolic Engineering	4	25	75	100
	MIB 29 E					
SSS Course - 2						
9	SSS 2		3	25	75	100

SEMESTER III

S. No	Course Code	Course Title	Credits	Scheme of Examination		
				Int.	Ext.	Total
1	MIB31C	Food Microbiology	4	25	75	100
2	MIB32C	Virology	4	25	75	100
3	MIB33C	Computational Biology	4	25	75	100
4	MIB34 C	Functional Genomics	4	25	75	100
5	MIB35C	Lab in Genomics, Proteomics & Metabolomics	4	40	60	100
Elective Subjects						
6	MIB 36E	Lab in Computational Biology	4	40	60	100
7	MIB 37E	Pharmaceutical Microbiology	4	25	75	100
8	MIB 38E	Vermi-composting & Microbial composting	4	25	75	100
SSS Course - 3						
9	SSS 3		2	25	75	100

SEMESTER IV

S .No	Course Code	Course Title	Credits	Scheme of Examination		
				Int.	Ext.	Total
1	MIB 41C	Project work in Microbiology Leading to New Knowledge / Technology / Resource	4	25	75	100
2	MIB42EE	Real-world problem-solution: A practice	4	25	75	100
3	MIB 43E	Plant physiology	4	25	75	100
SSS Course – 4						
3	SSS4		3	25	75	100

Core subject: 64 Credits Elective: 16 credits SSC: 10 credits Total: 90 credit

SSS course to opt from other Schools

- Bioinstrumentation: Certification training on i) FACS, ii) Mass spec, iii) NGS platforms, and iv) Genomic data Analysis
- NET Training from the I semester onwards
- 75 % Gravity to Hands-on-Sessions

MIB11C - Advanced Microbiology

Unit–I

Introduction to Microbiology: History and Scope of microbiology, Evolution of Microorganisms – Members of the microbial world; Microbial diversity - Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese. Structure and functions of bacterial cells. Branches in Microbiology. Microscopes: Bright field microscope; Dark field microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope, Atomic Force Microscopy (AFM), Scanning Probe Microscopy techniques (SPM).

Unit-II

Classification of bacteria and Archaea according to the Bergey's Manual of Systematic Bacteriology. Tools for Systematics: Numerical taxonomy, Phylogenetic analysis, Polyphasic approach; Modern methods of studying microbial diversity; Microbial culture collections. Phyla of Archaea, Significance of Archaea, Evolutionary developments of Archaea, Cell structure Archaea, Metabolism and energetics of Archaea (*Thermoplasma*, *Sulfolobus*, *Pyrococcus)*. Phycology: Algal and Cyanobacterial diversity and distribution. Specialized cell structures (heterocyst of cyanobacteria, endospores, hormogonia, etc).

Unit–III

General characters of fungi Fungal diversity and distribution; Cell structures, growth and development, nutrition, reproduction, life cycle; Classification of fungi, Major taxonomic groups of fungi; Identification; Cultivation; Phylogeny; Yeasts: General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of Yeasts; Protozoa: Classification, Morphology, reproduction, modes of nutrition, modes of transmission, locomotory organelles, Life cycle, Cultivation of Protozoa. Structure and significance: *Leishmania, Trichomonas, Entamoeba, Plasmodium.* Structure and Multiplication of Virus; Types of viral infections; Viriods, Virusoids and Prions

Unit–IV

Extremophiles: Extreme Microbial Habitats. Early Microbial Life: Stromatolites. Microbial Mats (biofilm). Microbes in Hydrothermal Vents, Hot & Cold Hydrocarbon Seeps, The Deep Subsurface, Arctic Microbes, Microbial heterotrophs & starvation artist, Methanogenic bacteria, Sulfur oxidizing and reducing bacteria. Survival strategies - starvation, adaptive mechanisms in thermophilic, alkalophilic, osmophilic and psychrophilic environments. Microbial response to Global Change.

Unit–V

Control of Microorganisms in the environment: Pattern of microbial death, Physical and chemical methods, Biological control of microorganisms. Antimicrobial agents: Natural and

synthetic substances. Pathogenicity and Host response-Host parasite relationship; Process of infection; Virulence-Pathogenicity islands, virulence factors, Resisting host defense, toxins, mycotoxins, Measuring virulence. Overview of specific and non-specific host resistance. Factors influencing the effectiveness of antimicrobial drugs, Drug resistance mechanism.

References

1. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
2. Jacquelyn G Black (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall.
3. Nester, Anderson, Roberts, Pearsall and Nester. Microbiology: A human perspective. Third Edition (2001). McGraw Hill. ISBN 0-07-231878-1.
4. Madigan MT, and Martinko JM. (2006). Brock Biology of Micro-organisms. 8th edition. Parker J. Prentice Hall International, Inc.
5. Pelczar Jr.J.J., Chan ., E.C.S and Kvieg .R. , 2003. Microbiology, McGraw Hill. New York.
6. Presscott, L.M., Hariey, J.P. and Klein, D.A., 2001. Microbiology, Wm. C Brown Publication Lowa. U.S.A.
7. Atlas, R.M., 2001 Principles of Microbiology, Moshbyyear book Inc. Missouri Ananthanarayan, R., Jayaram Paikar, C.K., 2004.Text Book of Microbiology. Orient Longman limited, Chennai.
8. Meynell, G.G and Meynell, e., 1975. Theory and practice in experimental Bacteriology. Cambridge university press, Cambridge.
9. Steriff, R.M and Lester, J.. 1988 microbiology for environmental and public Health Engineers. E. and F.N. Spon., London
10. Wilson, K. and Goulding, K.H.1986.A Biologist's Guide to Principles, and Techniques of practical Biochemistry, ELBS, London.

MIB12 C - Medical Microbiology

Unit-I

Basics in Medical microbiology: Infectious diseases overview. Medically important microbes. Microbial diseases - sources, route of transmission. Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. **Diagnosis of microbial diseases** -Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.

Unit-II

Epidemiology: Concept of Infections: epidemic, endemic and pandemic, acute, chronic, morbidity, mortality, prevalence, incidence, Reservoirs, Carriers. Stages of disease progression. Immunity against microbial diseases. Mechanisms of microbial resistance to host cellular and humoral defenses. Microbial virulence and virulence factors Molecular basis of microbial pathogenicity. Molecular Koch's postulates, Pathogenicity Islands, bacterial toxins. Active and Passive immunization: different types of vaccines (live attenuated, killed, subunit, recombinant DNA vaccine); Role of r-DNA technology in vaccine production; Reverse vaccinology. Antimicrobial Agents; Generation of antibiotics, Mechanism of Action of: Streptomycin, Griseofulvin; synthesis of Antibiotics by recombinant microorganisms, Multi-drug Resistance.

Unit-III

Medical Bacteriology: Characteristics, classification, pathogenesis, pathology, diagnosis, treatment and control of diseases caused by Staphylococci, Streptococci, Bacillus, Clostridium, Corynebacterium, Escherichia, *Bacillus*, Salmonella, Shigella, Klebsiella, Proteus, Vibrio, Pseudomonas, Mycobacteria, Spirochaetes, Rickettsia. **Medical Mycology:** Pathogenesis, diagnosis and Chemotherapy of fungal infections: Dermatophytes, Sporothrix and ~~Other~~ Superficial and Subcutaneous Fungi - candida, Aspergillus and ~~Other~~ Opportunistic Fungi: Cryptococcus, Histoplasma, Coccidioides and ~~Other~~ Systemic Fungal Pathogens.

Unit-IV

Medical Virology: Structure, multiplication, classification and medical importance of DNA viruses - Pox, Herpes, Hepatitis, Adeno; RNA viruses - Picorna, Orthomyxo, Paramyxo, Rabdo and HIV virus. Viral vaccines and antiviral agents. Viral infection and transmission, **Mechanism of viral pathogenesis**: Cytopathic effect, immune pathogenesis and immune escape**,** Forms of viral infection, viral persistent infection **Emerging viral infections-SARS virus, Nipha virus, ebola virus, Zika virus.** Viral infection and tumors.

Unit-V

Medical Parasitology - Medical importance parasites: of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory diagnosis of parasites infections. Nematodes infections – Intestinal and Tissue focusing on soil transmitted nematodes Brugia, Cestodes – focusing on Taenia, Hymenolepis and Echinococcus Laboratory diagnosis of neurocysticercosis and hydatid disease,Trematodes – enumerate the liver, lung, gastrointestinal and blood flukes.

Reference books:

1. Medical Mycology. Kwon-Chung K.J and Bennett JE. 1992. Lea and Febiger, Philadelphia, USA.
2. Bailey and Scott's Diagnostic Microbiology- 11th edition: Eds: Forbes BA, Sahm DF, Weissfeld AS. 2002, Mosby, St. Louis, USA.
3. Medical Microbiology, 3rd edition. Eds: MIMS and others. 2004 Mosby, Spain.
4. Topley& Wilson's Microbiology and Microbial infections. 10th edition. Volumes 1-6: 2008 Arnold, London.
5. Medical Parasitology. Rajesh Karyakarte & Ajit Damle, Books & Allied (P) Ltd., 2003.
6. Medical Immunology, 9th edition Eds: Stites DP, Terr AI and Parslow TG.1997, Appleton & Lange, Stamford, USA.
7. David Greenwood. Mike Barer, Richard Slack and Will Irving. Medical Microbiology. A Guide to Microbial Infections: Pathogenesis, immunity, Laboratory investigation and Control, 18th edition, Churchill Livingstone. 2012.
9. Ananthanarayanan R and Jeyaram Panicker CK. Textbook of Medical Parasitology. 5th Ed. Jay Pee brothers Medical publisher, Pvt Ltd., New Delhi. 2004.

MIB13 C – Microbial Biochemistry

Unit-I

Introduction to Basic Biochemistry: Fundamental principles governing life; Structure of atoms and molecules-water; Acid-base concept and buffers – pH, Molecular interactions - Hydrogen bonding, Covalent, Hydrophobic, Electrostatic and Vander Waals forces. Thermodynamic principles and biological processes; Bioenergetics. Basic methods to analyse biomolecules structure. ATP Production-Chemiosmotic theory.

Unit-II

Microbial Nutrition: Nutritional categories of microorganisms based on carbon; energy and electron sources: Phototrophs, Chemotrophs, Autotrophs, Heterotrophs, Lithotrophs and Organotrophs. Metabolite transport: Diffusion: Passive and facilitated; Primary and secondary active transport; Group translocation (phosphotransferase system) electro neutral transport; transport of Iron. Photosynthesis - oxygenic- anoxygenic photosynthesis; fixation of CO_2- Calvin cycle - C3-C4 pathway. Significance of Energy metabolism. Chemolithotrophy – methanogenesis. Chemotaxis.

Unit-III

Carbohydrate & Energy metabolism: Structure, properties and classification of Carbohydrates. Anabolism-Catabolism- Embden-Mayer Hoff pathway - Entner Doudroff(ED) pathway - glyoxalate pathway - Krebs cycle – oxidative and substrate level phosphorylation - reverse TCA cycle; HMP shunt; Electron transport chain, homo and heterolactic fermentation. Uncouplers and inhibition of oxidative phosphorylation.

Unit-IV

Proteins and Nucleic acids structure & metabolism: Structure, properties and classification of Proteins and Nucleic acids. Proteins- primary- secondary- tertiary and quaternary structure- Ramachandran plot- super secondary structures-Domains and Motifs, Protein modification, Protein transport. Structure and metabolism of amino acids. Nucleic acids - Structure-biosynthesis (de-nova) and catabolism of nucleotides. Vitamins - A, B-complex, C, D, E and K- structure and function- Biosynthesis of vitamins and their regulation.

Unit-V

Microbial Enzymes & Lipid metabolism: Properties of enzymes- physical, chemical and biological. Methods of isolation and purification-enzyme units-substrate specificity. Enzyme kinetics-Catalytic efficiency-Bisubstrate reactions- Rate equations. Regulation of enzyme activity – allosteric & enzyme inhibition (inhibitors). Structure, properties and classification of Lipids. Oxidation of Fatty acids, Biosynthesis of MUFA and PUFA and their regulation. Structure and properties of Cholesterol.

Reference Books:

1. Nelson.D.L, Cox. M. M. Lehninger s Principles of Biochemistry, 5th ed. Freeman, 2008.
2. Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6th ed.Freeman, 2006.
3. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper s Biochemistry. 27th ed. McGraw Hill, 2006.
4. Voet and Voet. Biochemistry. 4rd ed. John Wiley, 2010.
5. Smith, Hill, and Lehman.Principles of Biochemistry. 7th Edition, Mc Graw – Hill Publishers.
6. Lubert Stryer, Bery, Jeremy M. John Tymoczkq. Biochemistry.5th Edition. W. H. Freeman and Co
7. Robert Murray, Darryl K Granner, Peter A Mayes Victor and W. Rodwell Harper's Illustrated Biochemistry. 7th Edition. Mc Graw - Hill Publishers
8. Richard A. Harvey (Ph. D.), Richard A. Harvey, Denise R. Ferrier Lippincott Williams & Wilkins, 2011 Biochemistry.
9. Robert K. Murray David Bender Kathleen M Botham , Peter J. Kennelly Victor W. Rodwell , P. Anthony Weil, 2015,Harpers Illustrated Biochemistry 30th Edition.

MIB14 C: MOLECULAR BIOLOGY AND MOLECULAR GENETICS

UNIT I:

Introduction to Molecular Biology & Genetics – Molecular basis for life – DNA, DNA replication. Origin of spontaneous mutations – Luria and Delbruck's classic experiment – Fluctuation test – inference of function of genes based on isolation of mutations – various types of mutations – missense – nonsense – frameshift, Conditional Lethal etc., - mutagens – physical and chemical agents – Mode of action of important mutagens (5BU, 2AP, NTG, Hydroxylamine, Nitrous acid) – use of mutagenic chemicals in isolation of mutants and their advantages – dominant and recessive nature of mutations with examples – DNA damage and repair.

Gene transfer in bacteria – transformation – discovery and its significance – process of transformation – competence development and competent factors – joint transformation and its uses – conjugation – discovery – F^+ , F^- , etc., and F' states of *E.coli*, generation of Hfr Strains, chromosome transfer by Hfr and its uses in genetic mapping –Zygotic induction– generalized transduction – P1 transduction – origin of transducing particles –pre and post Zygotic exclusions, co-transduction and its uses in genetic mapping –ratio test and mutation order-lambda mediated specialized transduction.

UNIT II:

Gene expression – RNA polymerase, sigma factors, and involvement of other factors in the regulation of gene expression, operon model, the molecular basis of regulation of expression of gene expression from well-studied operons – *lac, trp, ara* operons. Translation process, codons – elucidation of genetic code – *T4rII* mutants and their uses in the elucidation of code – translation of in *vitro* synthesized RNA and their uses in elucidation of genetic code – Wobble hypothesis – suppression of missense – nonsense – frameshift mutations intrageneic and extragenic suppression and their molecular basis.

UNIT III:

EUKARYOTIC GENOME ORGANIZATION AND REPLICATION:Eukaryotic genome organizations - Chromatin structure - Nucleosomes- Heterochromatin repeat sequences – Histone variants produce alternative nucleosomes - DNA structure varies on the nucleosomal surface - Positions of nucleosomes - Nucleosomes are displaced and reassembled during transcription - DNase Sensitivity detects changes in chromatin structure. Introns & Exons – Differences and Patterns of Evolution.

Centromeres: DNA sequences & protein complex – Telomeres: repeating sequences & function in chromosomal ends - End replication problem and consequences - Meiotic chromosome pairing.

Eukaryotic Replication – Topoisomerase & various enzymes - Creating the replication forks at the Origin oriC - Mechanisms to prevent premature reinitiation of replication - Each Eukaryotic chromosome contains many replicons - Coordinating Synthesis of the Lagging and Leading Strands - Recombining meiotic chromosomes and synaptonemal complex Extrachromosomal replicons - Homologius Recombinations.

UNIT IV:

EUKARYOTIC TRANSCRIPTIONAL REGULATION: Eukaryotic RNA Polymerases-subunits, types; Transcription factors-types-general and specific, Domains-DNA binding, oligomerization, transcription regulation, NLS; promoters-core, proximal, distal-enhancers, Silencers, Insulators, Locus control regions (LCR), mechanism of action of activators and repressors; Pre initiation complex formation; Process-Initiation, elongation and termination; Post-transcriptional modification- 5' cap formation, 3' end processing and polyadenylation, RNA splicing-canonical, Alternate, Exonic Intronic, trans, tRNA splicing; RNA editing; RNA modifications; nuclear export of mRNA; RNA degradation-pathways and enzymes; Processing of tRNA and mRNA transcripts; Inhibitors of transcription.

Regulation-chromatin (histone) modification and chromatin remodeling, DNA methylation-imprinting- Yeast GAL genes: A model for activation and repression, Regulation of gene expression by steroid hormones; Riboswitch; Regulatory RNAs- Noncoding RNAs, MicroRNAs, Mechanisms of RNA interference

UNIT V:

Mendelian genetics – Molecular biology of classical Mendelian Traits -Mendelian traits in human – chromosomal basis of inheritance – gene segregation and Meiosis – sex chromosome – sex linkage – sex determination – non- disjunction – extensions of Mendelian genetic principles – multiple alleles – modifications of dominance relationships – gene interactions and epistasis – lethal alleles – gene expression and environment – quantitative genetics – chromosomal aberrations – Structure & function of Centromeres and Telomeres - extrachromosomal inheritance – maternal inheritance – developmental genetics.

Gene mapping in eukaryotes – linkage and crossing over – construction of genetic map – tetrad analysis – mitotic recombination – Molecular Biology of Recombination -mapping human genes – Heterochromatin and Euchromatin: Molecular differences – Repetitive Elements: LINE, SINE & Transposons – Associated Disorders -Regulation of gene expression in eukaryotes – chromatin remodeling- activators and coactivators – gene silencing and genome imprinting – post-transcriptional control – RNA interference – cancer genetics – relationship of cell cycle to cancer – oncogenes – tumor suppressor genes.

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References:

1. Lewin's Genes XII (2017) - Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Jones and Bartlett Publishers

2. iGenetics – A Molecular approach, 3rd edition (2016) – Peter J Russell, Pearson Benjamin Cummings, Sanfrancisco, USA

3. Molecular Genetics of Bacteria, 4th Edition – (2013) - Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness. ASM press.

4. Molecular Genetics 2nd Edition (2002) – Gunther S Stent and Richard Calender. San Francisco : W. H. Freeman and Co.

5. Microbial Genetics, 2nd Edition (1994) – Stanley R. Maloy, John E. Cronan, David Freifelder. Jones and Bartlett Publishers, Inc.

6. DNA Repair and Mutagenesis, 2006, Errol C. Friedberg, Graham C. Walker, Wolfram Siede, D. Wood Richard, A. Schultz Roger, Ellenberger Tom. ASM Press

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MIB 15C: LAB IN MICROBIOLOGY AND BIOCHEMISTRY

LAB IN MICROBIOLOGY:

1. Laboratory precautions.
2. Preparation of cleaning solutions.
3. Antiseptics and disinfectants.
4. Principles of aseptic techniques.
5. Methods of sterilization.
6. Serial dilution using various environmental samples.
7. Pure culture techniques - pour plate, spread plate and Streaking.
8. Cultural characteristics of microorganisms-colony morphology on nutrient agar slants, nutrients broth.
9. Enumeration of bacterial cells.
10. Biochemical Analysis- as per the methods of Bergey's Manual of Systematic Bacteriology and API analysis.
11. Staining of microorganisms - Simple, Negative, Gram, Spore and LPCB.
12. Microscopy.
13. Maintenance and preservation of cultures.
14. Genotypic characterization and *in-silico* analysis of the selected strains.
15. Biofilm formation, Quorum sensing.
16. Demonstration of blood culturing system - BACTEC.
17. Observation of representative forms of viruses, fungi and protists
18. Bacterial species identification by rRNA sequencing

LAB IN BIOCHEMISTRY:

1. *Good Laboratory Practices*
2. Importance of Personal Protective Equipment (PPE)
3. Maintenance of Laboratory and workspace
4. Waste management
5. Maintenance and calibration of lab Instruments
   Buffers and Solutions
6. Need and uses of Buffers in laboratory
7. Concepts of pH and pKa
8. Types of buffers and their range of operation

9. Concepts of Molarity, Molality and Normality
10. Mass Percentage (%w/w)
11. Volume percentage (%v/v)
12. Stock solution and standards preparation
13. Preparation of Acid solutions

Basic principles and techniques in Biochemical Estimations

14. Measurement of pH
15. Centrifugation
16. Chromatography
17. *Types of Chromatographic Techniques*
18. Spectrophotometry
    a. Beer Lambert's law
    b. UV-VIS spectrum
    c. Fluorescence Spectroscopy
    d. Luminometer

Extraction and Estimation of Biomolecules

19. Estimation of Carbohydrates
    - Various methods of Estimation
    - Estimation by Anthrone Test
20. Estimation of Proteins and amino acids
    - Various methods of Estimation
    - Estimation by Lowry's method
21. Estimation of Cholesterol
    - Various methods of Estimation
    - Estimation by Zak's method
22. Estimation of molecules of Clinical Value
    - SGOT/SGPT, ALT
    - CK-MB, Lipid Profile

Extraction and Estimation of Nucleic Acids

23. Extraction of DNA from various sources
    - Membrane nature of Eukaryotic cell (Animal tissue/plant tissue) and Prokaryotic cell
    - Reagents used to extract DNA from various sources
    - Quantification of DNA
    - Spectroscopically & Calorimetrically.
    - Visualization of DNA by Electrophoresis
    - How to safely Store & Transport DNA

Extraction and Estimation of RNA from different sources

24. Reagents used to extract RNA
    - Detergents used to disrupt membranes
    - RNA integrity and precautions before isolation

- Different extraction protocols
- Quantification of RNA
- How to safely Store & Transport DNA

25. Qualitative Estimation of DNA, RNA and protein
26. Southern blotting
    - Preparation of samples
    - Blotting and detection
27. Northern Blotting
    - Preparation of samples
    - Blotting and detection
28. Western Blotting
    - Sample preparation
    - SDS-PAGE
    - Blotting and detection
29. Purification of enzyme proteins by salt precipitation
30. Purification of enzyme proteins by Dialysis
31. Purification of enzyme proteins by Ion exchange / Gel filtration chromatography
32. Determination of soluble constituents in cell system by TLC
33. Determination of soluble constituents in cell system by HPLC

References

1. SBS, MKU, NRCBS Manuals, 2010-2018.
2. Wilson and Walkers, Principles and techniques of biochemistry and molecular biology 8th Ed (2018), Cambridge University Press.
3. Irwin H Segel, Biochemical Calculations, 2nd Ed, 2010, Wiley Publishers.
4. James G. Cappuccino and Natalie Sherman 2004 (6th edition), Microbiology A laboratory Manual- Pearson Education.
5. Beister, L.1996. Microbiology in Pratice (6th edition) Adeland Wesley, Langman, New York.
6. Benson, J.H. 1996. Mocrobiological applications: A laboratory Manual in General Microbiology (8th edition) Wn. C. Brown Publication IOWK USA
7. James G.C and Sharman, N 1996. Microbiology: A laboratory Manual (4th Edition) The Benjamin/ Cummings Publishing Company, International USA.
8. Patrick R. Murray, Ken S. Rosenthal, Micheal A. Pfaller. Medical Microbiology, (5th Edition) (Philadelphia: Elsevier/Mosby, 2005).
9. James G. Cappuccino and Natalie Sherman 2004 (6th edition), Microbiology A laboratory Manual- Pearson Education.
10. Beister, L.1996. Microbiology in Pratice (6th edition) Adeland Wesley, Langman, New York.
11. Benson, J.H. 1996. Mocrobiological applications: A laboratory Manual in General Microbiology (8th edition) Wn. C. Brown Publication IOWK USA

12. James G.C and Sharman, N 1996. Microbiology: A laboratory Manual (4th Edition) The Benjamin/ Cummings Publishing Company, International USA.
13. Patrick R. Murray, Ken S. Rosenthal, Micheal A. Pfaller. Medical Microbiology, (5th Edition) (Philadelphia: Elsevier/Mosby, 2005).

MIB 16C: LAB IN MOLECULAR BIOLOGY AND GENETICS

MOLECULAR BIOLOGY

1. Isolation and quantitation of genomic DNA from microbial, plant and animal samples
2. Quantitative and Quality analysis of DNA
3. Hyperchromic shift of DNA
4. Isolation and quantitation of genomic RNA from microbial, plant and animal samples
5. Quantitative and Quality analysis of RNA
6. Agarose gel electrophoresis of DNA
7. Agarose gel electrophoresis of RNA
8. Isolation of Protein
9. Quantitation of Protein
10. Western Blot analysis
11. Plasmid DNA extraction by alkali lysis method
12. Plasmid DNA extraction by boiling method
13. Isolation of plasmid using magnetic beads
14. Isolation of RNA from body fluids
15. Determination of molecular weight of plasmid DNA.
16. PCR amplification of desired gene
17. Restriction digestion of DNA
18. Restriction mapping of DNA
19. Isolation of viral genome
20. Mapping of a viral genome
21. Preparation of competent cells and transformation of plasmid DNA in *E. coli.*
22. cDNA synthesis from total RNA
23. RT-PCR amplification of gene of interest
24. Quantitation of Genes by Real time PCR– Optimization of qPCR
25. Absolute quantification, relative quantification, analysis of data
26. Restriction analysis of plasmid DNA and evaluation of restriction sites
27. Primer designing
28. 5 Types of PCRs
29. Genotyping by PCR
30. DNA sequencing
31. Sequence analysis – Coding & non-coding regions, ORF's, translation, aminoacid sequence analysis

MOLECULAR GENETICS

1. Isolation of single colony: i) Serial dilution & ii) Streaking
2. Determination of mutation rate by fluctuation analysis
3. Survival curve analysis by Physical & Chemical methods

4. Isolation of spontaneous and induced mutations (Physical/ Chemical/ Biological) in *E. coli:* i) Drug resistance & ii) Lac system
5. Isolation of conditional lethal mutants: Temperature sensitive mutations
6. Ampicillin enrichment and isolation of auxotrophs from a mutagenized culture of *E. coli*
7. Preparation of a T7 phage lysate and determination by plaque assay.
8. Preparation of P1 lysate
9. P1 transduction and determination of linkage based on cotransduction
10. Bacterial conjugation-determination of gradient gene transfer in Hfr x F^- cross
11. $CaCl_2$ mediated transformation
12. Transformation: TSS method
13. Analysis of gene expression by induction of *lac* operon using IPTG and determining the efficiency of induction by β–galactosidase.

References

1. A short Course in Bacterial Genetics 1992 – Jeffrey H. Miller.
2. Molecular Cloning, A Laboratory Manual, 3rd Edition – volume I, II, III – Joseph Sambrook, David W. Russell.
3. MKU, SBS, NRCBS Research Manuals, 2010-2017

MIB 17E: BIOSTATISTICS & BIOCOMPUTING

UNIT I :

Definition, scope, androle of statistical methods in biological research. Basic principles of experimental designs- principle of replication, randomization and local control. Informal and formal experimental designs- completely randomized design, randomized block design, Latin square design and factorial designs.

Statistical population, sampling from population –simple random sampling and complex random sampling. Parameters and statistics. Data collection – types of biological data; data processing, classification, and categorization- simple and complex tables, pictorial presentation, graphic presentation of data.

UNIT II:

Basic statistics: measures of central tendencies- mean (arithmetic, harmonic and geometric) median and mode; frequency of distribution; measures of dispersion- range, quartiles, standard deviation, coefficient of variation and standard error. Concept of probability – Probability distributions- binomial, Poisson and normal distribution.

UNIT III:

Tests of statistical significance – Hypothesis testing Student 't'test one tailed and two tailed one sample and two sample ; multi-sample One way analysis of variance, two – way analysis of variance and multivariate analysis of variance. Multiple comparisons-the Tukey test, The Newman-Keuls test and Duncans multiple range test.

UNIT IV :

Regression and correlation – scatter diagram, simple linear regression, correlation and correlation coefficient; Karl Pearson's correlation coefficient ; Spearman's rank correlation. Chi-square test. Use of computer resources (Excel, available statistical softwares and other web resources) in data processing, statistical analysis and presentation.

UNIT V:

Introduction to R package; Installation in windows/Mac/Linux environment - Basics of R Programming for Data Science - Use of commands like read.table, read.csv, write.table to read/write data in R console -Essentials of R Programming - Data Types and Objects in R - Control Structures (Functions) in R - Useful R Packages.

Graphical Representation of Variables, Basic statistics (Mean, standard deviation, correlation coefficient and p-value) in R -Operators and assignments in R, Use of loops - Exercises in Looping concept - Generating simple plots on screen or/and in pdf/png/jpg files.

R based data handling with specific examples for i) Summary statistics, ii) Distribution (discrete & continuous), iii) Negative binomial experiments with coin and die, iv) Parametric statistical testing(t-test), v) ANOVA test, vi) X2 test and Fisher's test, vii)Non-parametric test (Wilcoxon signed-rank test and Mann-Whitney test), viii) Machine learning in R (Naïve Bayes and Decision Tree), ix) Linear and multiple linear regression, Logistic regression, x) Clustering (k-means and hierarchical clustering) -Bioconductor in R; Bioconductor packages.

References:

1. Zar, J.K. (2014). Biostatistical Analysis, 5th edition, Prentice-Hall, International, INC, Englewood cliffs, New Jersey.
2. Daniel WW (2013). Biostatistics, 10th edition, John Wiley and Sons, NewYork, USA.
3. Kothari,C.R (2013). Second Edition Research Methodology : methods & techniques. 2nd edition New Age International (P) ltd., Publishers, New Delhi. 459p.
4. Sharma,A.K. (2005).Textbook of Biostatistics, I. Discovery Pub., New Delhi. 459 p.
5. Rastogi,V.B. (2011).Fundamentals of Biostatistics. Ane's Books. New Delhi. 438p.