West Bengal State University

DRAFT

SYLLABUS FOR THREE-YEAR DEGREE COURSE IN

MOLECULAR BIOLOGY (General) UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from the session 2018-2019)

B.Sc. (GENERAL) IN MOLECULAR BIOLOGY

Semester (20 credit each)	**Discipline Specific Core Course: DSC (6 credits each) Or, Generic elective course (GEC): (6 credits each)**	**Ability Enhancement Compulsory Course: AECC (2 credit each)**	**Skill Enhancement Course: SEC (2 credits each)**	**Discipline Specific Elective Course: DSE (6 credits each)**
I	MLBGCOR01T/P OR MLBHGEC01T/P: MOLECULAR BASIS OF LIFE	English/ Hindi/Mil communication/ Environment Sc.		
II	MLBGCOR02T/P OR MLBHGEC02T/P: PROTEINS, ENZYMES AND METABOLISM	English/ Hindi/Mil communication/ Environment Sc.		
III	MLBGCOR03T/P OR MLBHGEC03T/P: FUNDAMENTALS OF MOLECULAR BIOLOGY		MLBGSEC01: ECS/ General Interest / Hobby/ Sports / NCC/ NSS /Related courses on its own. (FUNDAMENTALS OF BIOSTATISTICS AND BIOINFORMATICS)	
IV	MLBGCOR04T/P OR MLBHGEC04T/P: PHYSICOCHEMICAL TECHNIQUES AND MICROBIAL GENETICS		MLBGSEC02: ECS/ General Interest / Hobby/ Sports / NCC/ NSS /Related courses on its own. (BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT)	
V				MLBGDSE01T/P: FUNDAMENTALS OF MOLECULAR SIGNALLING OR MLBGDSE02T/P: GENERAL MICROBIOLOGY
VI				MLBGDSE03T/P: RECOMBINANT DNA TECHNOLOGY AND FUNDAMENTALS OF IMMUNOLOGY OR MLBGDSE04T/P: VIROLOGY AND EPIDEMIOLOGY

COURSE DETAILS

Discipline Specific Core Course (DSC): 6 credits each
Or, Generic elective course (GEC):6 credits each

- MLBGCOR01T/P OR MLBHGEC01T/P: Molecular Basis of Life
- MLBGCOR02T/P OR MLBHGEC02T/P: Proteins, Enzymes And Metabolism
- MLBGCOR03T/P OR MLBHGEC03T/P: Fundamentals of Molecular Biology
- MLBGCOR04T/P OR MLBHGEC04T/P: Physicochemical Techniques and Microbial Genetics

Discipline Specific Elective (DSE): 6 credits each

- MLBGDSE01T/P: Fundamentals of Molecular Signalling
  OR
- MLBGDSE02T/P: General Microbiology
- MLBGDSE03T/P: Recombinant DNA Technology and Fundamentals of Immunology
  OR
- MLBGDSE04T/P: Virology and Epidemiology

Skill Enhancement Course (SEC): 2 credits each

- MLBGSEC01: Fundamentals of Biostatistics And Bioinformatics
- MLBGSEC02: Biotechnology in Sustainable Development

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Discipline Specific Core Course (DSC): 6 credits each
Or, Generic elective course (GEC):6 credits each

MLBGCOR01T OR MLBHGEC01T: MOLECULAR BASIS OF LIFE (THEORY), SEMESTER –I

(Total Hours: 60, Credits: 4)

Unit 1: Cell Biology: (15 hrs)

Cells as basic functional unit of life-Prokaryotes and Eukaryotes.

Structure of prokaryotic cell, Gram staining, bacterial cell wall (gram positive & gram negative), prokaryotic cell membranes, cytoplasm, ribosomes, nucleoid.

Membrane structure of eukaryotic cells (Fluid Mosaic model) and its function. Structure and functions of different cell organelles: Cytoskeleton, Nucleus, Endoplasmic reticulum, Golgi apparatus, Mitochondria, Chloroplast, Lysosome and Peroxisome.

Unit 2: Molecules of Life (30 hrs)

pH and Buffer: Iionization of water, Lowry Bronsted theory of acids and bases, pH and buffers, Henderson Hasselbalch Equation, Biological buffers, Importance of buffers in living system.

Carbohydrates: Open chain and ring structures (Haworth projection formula) of Monosaccharides: Hexoses and Pentoses (Ribose and 2- deoxyribose), D- and L- configuration, Mutarotation, Anomers, and Epimers, Reactions of Glucose – oxidation (bromine water, nitric acid), reduction (sodium amalgam, hydrogen iodide and red P), osazone reaction, enediol formation. Reducing and Non-reducing sugars, Disaccharides (sucrose, lactose, maltose), Structure of homo-polysaccharides (glycogen, starch and cellulose).

Lipids: Classification of lipids, Nomenclature and structure of Saturated and Unsaturated Fatty acids, delta and omega-system; Essential fatty acids. Saponification number, Iodine number, Acetyl number of fats. Structure and Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit 3: Microscopy (15 hours)

Optical microscopy: the nature of light—its particle and wave character. Ray diagrams and image formation.
Simple and compound microscopes, Applications of optical microscopes, Numerical Aperture (NA), Resolution, Contrast, magnification, Spherical aberration, Chromatic aberration of optical system (definitions only). Mathematical expression for limit of resolution in terms of Rayleigh criteria. Empty magnification. Basic principles of oil immersion microscope. Limitations of optical microscopes.
Electron microscopy---Basic working principle of TEM and SEM. Advantages of electron microscope over optical microscope, Electrostatics and magnetostatics electron microscopes, Relation between the applied voltage and wavelength of electrons.

MLBGCOR01P OR MLBHGEC01P: MOLECULAR BASIS OF LIFE (PRACTICAL), SEMESTER –I

(Total Hours: 60, Credits: 2)

1. Preparation of phosphate buffer and measurement of pH.
2. Qualitative tests for reducing and non-reducing sugars, polysaccharide, and lipid.
3. Separation of lipids by TLC.
4. Measurement of refractive index of a biological solution with the help of travelling microscope.

SUGGESTED READING

1. Rastogi SC. (2012) Cell and Molecular Biology. New age international publication.
2. Sharma VK. (1991) Techniques of microscopy. Tata McGraw Hill publication.
3. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
4. De Robertis, EDP and De Robertis EMF. (2006) Cell and Molecular Biology. 8th edition.. Lipincott Williams and Wilkins, Philadelphia.
5. Cooper GM and Hausman, RE. (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C., Sinauer Associates, MA.
6. Tymoczko JL, Berg JM and Stryer L. (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman.
7. Berg JM, Tymoczko JL and Stryer L. (2011) Biochemistry, W.H.Freeman and Company.
8. Nelson DL and Cox MM. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
9. Willey MJ, Sherwood LM & Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill.
10. Voet D and Voet JG. (2004) Biochemistry 3rd edition, John Wiley and Son.
11. Reimer L and Kohl H. (1984) Transmission electron microscopy, Springer.

MLBGCOR02T OR MLBHGEC02T: PROTEINS, ENZYMES AND METABOLISM (THEORY) SEMESTER –2

(Total Hours: 60, Credits: 4)

Unit 1: Amino acids and Proteins (15 hrs):

General structure and classification of Amino Acids. Essential and non-essential amino acids. Zwitterionic structure, Acid-Base properties, Biphasic Titration Curve and Isoelectric point. Reactions

of carboxyl and amino groups, formation of Peptide bond, Determination of N-terminal amino acid (Edman's method) and C–terminal amino acid (hydrazinolysis). Structural organization of proteins (primary, secondary, tertiary & quaternary), Covalent and Non-covalent interactions that stabilize the three-dimensional structures of proteins.

Unit 2: Enzymes (20 hrs):

IUB classification, active site, cofactors, coenzymes and prosthetic groups, activation energy and transition state, catalytic efficiency, activity, specific activity and turnover no. Principles of Enzyme kinetics: Michaelis-Menten Equation, Significance of K_m and V_{max}, Determination of K_m and V_{max}, Double reciprocal Plot, Effect of temperature, pH and Inhibitors (Reversible Inhibition: competitive, un-competitive and non-competitive and Irreversible Inhibition), Allosteric Enzymes and Feedback Inhibition, Isozymes.

Unit 3: Bioenergetics and Metabolism (25hrs):

Bioenergetics: Importance of Gibb's free energy in living System, High energy compounds, Energy currency of the cell, Electron Transport Chain (ETC), Idea of Redox Potential, Chemiosmotic Hypothesis and Oxidative Phosphorylation, Inhibitors and Uncouplers.

Carbohydrate metabolism: Catabolism and Anabolism, Glycolysis, Fermentation (only lactate and ethanol), TCA cycle, Gluconeogenesis, Pentose phosphate pathway, Emphasis on reactions, enzymes, metabolites, cellular location and physiological significance. Overview of Glycogenesis and Glycogenolysis.

Catabolism of fatty acids: Transport of fatty acids into Mitochondria, β-oxidation of saturated fatty acids (Reactions and Energetics), Ketogenesis.

Catabolism of amino acids: Amino acids- Essential, non-essential, glucogenic and ketogenic, Transamination and oxidative deamination, Central role of Glutamic acid, Removal of nitrogen waste from the body, Urea cycle (Reactions, enzymes, location, connection with TCA cycle).

MLBGCOR02P OR MLBHGEC02P: PROTEINS, ENZYMES AND METABOLISM (PRACTICAL), SEMESTER –2

(Total Hours: 60, Credits: 2)

1. Qualitative Tests of amino acids and proteins.
2. Formol titration of Glycine.
3. Quantitative Estimation of protein (Lowry Method).
4. Determination of Km and Vmax by Lineweaver Burk Plot.

5. Determination of R_f value and separation of amino acids by paper chromatography.

SUGGESTED READING

1. Das D. (1978) Biochemistry. Academic Publishers.
2. Conn EE and Stumpf PK. (1972) Outline of Biochemistry. John Wiley Publishers.
3. Tymoczko JL, Berg JM and Stryer L. (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman.
4. Nelson DL and Cox MM. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
5. Voet D and Voet JG. (2004) Biochemistry 3rd edition, John Wiley and Son.
6. Berg JM, Tymoczko JL and Stryer L. (2011) Biochemistry, W.H.Freeman and Company.

MLBGCOR03T OR MLBHGEC03T: FUNDAMENTALS OF MOLECULAR BIOLOGY (THEORY), SEMESTER –3

(Total Hours: 60, Credits: 4)

Unit 1: Structure And Organization Of The Genetic Material (20hrs):

Nucleic acids: Structure of Nucleotides, Nucleotides as source of energy, component of coenzymes, second messengers. DNA structure – Watson-Crick model. A, B & Z forms of DNA, Supercoiled and relaxed DNA, quardruplex DNA, denaturation and renaturation of DNA, melting temperature (Tm), UV absorption and hyperchromic effect. Nucleosome structure and Genome organization. Structure of major types of RNA.

DNA as a store of information: Genes are mutable units, one gene-one protein hypothesis, DNA is the almost universal genetic material (Griffith's experiment, Avery, MacLeod and McCarty's experiment, Hershey-Chase experiment), Central Dogma of Molecular Biology.

Unit 2: Replication of DNA (8 hrs):

Semiconservative nature of DNA replication (Messelson and Stahl's experiment), Mechanism of bidirectional DNA replication in prokaryotes, Bacterial DNA Polymerases, Pre-priming proteins, Primosome and Replisome.

Unit3: DNA Damage, Repair And Mutation (15 hrs):

Definition of mutation, gain of function and Loss of function mutation, Forward and Reverse mutation, Point mutation (Transitions, transversions, Missense mutation, Nonsense mutation, silent mutation, Frame shift mutation), Spontaneous mutation and Induced mutation, Mutagen – physical (Ionizing radiation, UV radiation), chemical (Base analogs, Nitrous acid, Acridine dyes, Alkylating agents), Ames test.

Causes and types of DNA damage, DNA repair-Photo reactivation, mismatch repair, base excision and nucleotide excision repair, SOS repair.

Unit 4: Gene Expression And Regulation (17 hrs):

Transcription: Transcription in prokaryotes with *E. coli* as model system: RNA polymerase, initiation, elongation and termination of transcription, rho dependent and independent termination. Inhibitors of transcription Actinomycin D and α- Amanitin.

Genetic code: Features of Genetic code, Wobble hypothesis.

Translation in prokaryotes: Role of m-RNA, t-RNA and r-RNA in protein synthesis, ribosome structure and assembly, Charging of t-RNA, aminoacyl t-RNA synthetases, initiation, elongation and termination of protein synthesis in bacteria, Action of antibiotics that act as protein synthesis inhibitors - Streptomycin, Tetracyclin, Kanamycin, Chloramphenicol and Puromycin.

Regulation of transcription: Operon model of gene regulation, negative and positive regulation in prokaryotes, *lac* operon.

MLBGCOR03P OR MLBHGEC03P: FUNDAMENTALS OF MOLECULAR BIOLOGY (PRACTICAL), SEMESTER –3

(Total Hours: 60, Credits: 2)

1. Quantitative estimation of DNA by diphenylamine reaction using colorimeter.
2. Quantitative estimation of RNA by orcinol method using colorimeter.
3. Study of absorption spectra of DNA and protein using UV-Visible spectrophotometer.
4. Extraction of chromosomal DNA from *E. coli* or from plant tissue.
5. Determination of Purity of DNA using UV-Visible spectrophotometer (A260/ A280 measurement).

SUGGESTED READING

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. (2014) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Alberts B and Jhonson AD. (2014) Molecular Biology of the Cell, 6th edition, Garland Science.
3. Krebs J, Goldstein E, Kilpatrick S. (2013) Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
4. Gardner EJ, Simmons MJ, Snustad DP. (2008) Principles of Genetics. 8th Ed. Wiley-India.
5. Brown TA. (2007) Genomes-3. Garland Science Publishers.
6. Rastogi SC. (2012) Cell and Molecular Biology. New age international publication.

MLBGCOR04T OR MLBHGEC04T: PHYSICOCHEMICAL TECHNIQUES AND MICROBIAL GENETICS (THEORY), SEMESTER –4

(Total Hours: 60, Credits: 4)

Unit1: Diffusion (6 hours)

Diffusion in fluids, Fick's laws (Statement and explanation) Facilitated diffusion e.g. gas exchanges in lungs.

Unit 2: Osmosis (4 hours)

Definition, contrast with diffusion, Tonicity and isotonic solutions. Effect of tonicity on R.B.C. Cell nutrition.

Unit 3: Viscosity (10 hours)

Definition, Laminar and turbulent flow, Concept of Reynolds number, Newton's law of viscosity, Newtonian and non- Newtonian fluids, Coefficient of viscosity, Relative viscosity and fluidity. Measurement by Ostwald's viscometer. Dependence of viscosity on temperature and other factors e.g. size and shape of solutes (general idea), Viscosity of human blood (general idea).

Unit 4: Centrifugation (5 hours)

Theory of ultracentrifugation, Relative centrifugal force (RCF), Sedimentation rate sedimentation coefficient, Isopycnic (equilibrium) sedimentation (discussion with example e.g. Meselson and Stahl Experiment).

Unit 5: Spectrophotometry (6 hours)

Electromagnetic spectrum, Introduction to concepts of absorption and emission spectroscopy, Absorption of light, Transmittance, Absorbance (Optical density), Lambert-Beer's law and its limitations, Concept of Molar extinction co-efficient, Study of absorption spectra of Proteins and Nucleic Acids, Analysis of Proteins and Nucleic Acids using UV and Visible spectroscopy, Colorimetry.

Unit 6: Chromatography (10 hours)

Partition co-efficient, paper chromatography and its applications (including 2-D), Thin layer chromatography. Column packing and fraction collection, Gel filtration chromatography, Ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 7: Electrophoresis (4 hours)

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Agarose gel electrophoresis.

Unit 8: Microbial Genetics (15 hours)

Structure of prokaryotic gene, Genome organisation in prokaryotes, Extrachromosomal inheritance, Plasmids (copy No and compatibility), Episomes.

Genetic recombination in bacteria: Mechanism of bacterial transformation, conjugation (Discovery, F factor, *Hfr* and *F/* strains) and transduction (Generalized transduction and specialized transduction).

MLBGCOR04P OR MLBHGEC04P: PHYSICOCHEMICAL TECHNIQUES AND MICROBIAL GENETICS (PRACTICAL) SEMESTER –4

(Total Hours: 60, Credits: 2)

1. Measurement of viscosity/fluidity of biological sample by Ostwald viscometer.
2. Separation of sugars by paper chromatography.
3. Separation of proteins by SDS- PAGE.
4. Determination of bacterial growth using turbidometry.

SUGGESTED READING

1. Freifelder D. (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W. H. Freeman.
2. Wilson K and Walker J. (2010).Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
3. Nelson DL and Cox MM. (2008) Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
4. Hallett FR, Speiglet PA and Stinson RH. (1982) Physics for the biological sciences. Chapman and Hall.
5. Stanly RM, Cronan JE Jr, Freifelder D. Microbial Genetics. 2nd Ed. Narosa Publication.
6. Gardner EJ, Simmons MJ, Snustad DP. (2008) Principles of Genetics. 8th Ed. Wiley-India.

DISCIPLINE SPECIFIC ELECTIVE

MLBGDSE01T: FUNDAMENTALS OF MOLECULAR SIGNALLING (THEORY) SEMESTER –5

(Total Hours: 60, Credits: 4)

Unit 1: Signalling molecules: (6 hrs)

Structure and function of Second messengers - cAMP, cGMP, IP3, diacyl glycerol, Ca^{2+}, NO and their role in signal transduction.

Unit 2: Cellular communication and mechanism of Signalling: (8 hrs)

General principle of cell communication, cell adhesion, Gap junction extracellular matrix, integrins. Brief idea of cell cycle and apoptosis. General principles of cell signalling, Hormones and Chemical signals and cellular receptors.

Unit 3: Neurobiophysics: (15 hours)
Neurons, Resting Membrane potential (Gibbs-Donnan effect; Nernst potential). Threshold potential. Characteristics of Action potential. Axonal conduction and speed of propagation. Synaptic transmission (chemical**).**

Unit 4: Electrical signals from the heart – Electrocardiogram (ECG): (4 hours)
Blood circulation in the heart. Physical basis of electrocardiography. Recording of ECG. Einthoven's triangle, measurement of Heart beat.

Unit 5: Physics of vision: (12 hours)
Optical elements of the human eye. Mechanism of image formation by Human eye (Its accommodation, refractive power, defects of human vision and their rectification). Visual acuity and its testing. Retina and photoreceptors. Mechanism of rod and cone vision. Colour blindness.

Unit 6: Physics of audition: (15 hours)
Nature of sound. Values of sound velocity in air, water, iron, human body. Energy, power and intensity of sound wave (definitions only). Sound impedance (qualitative idea). Loudness, pitch and quality of sound (definitions). Intensity level. Values of intensity level of some standard sounds. Human ear and the process of hearing. Echolocation by bats (qualitative discussion).

MLBGDSE01P: FUNDAMENTALS OF MOLECULAR SIGNALLING (PRACTICAL) SEMESTER –5

(Total Hours: 60, Credits: 2)

1. Determination of heart rate of a human being from the ECG records.
2. Interpretation of ECG.
3. Determination of blood pressure.
4. Detection of colour blindness with the help of Ishihara chart.
5. Interpretation of visual acuity by Snellen's chart.

SUGGESTED READING

1. Srivastava PK. (2005) Elementary Biophysics: An Introduction. 2nd Ed. Alpha Science International.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. Cooper GM and Hausman, RE. (2009) The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C., Sinauer Associates, MA.
4. Alberts B and Jhonson AD. (2014) Molecular Biology of the Cell, 6th edition, Garland Science.

MLBGDSE02T: GENERAL MICROBIOLOGY (THEORY) SEMESTER –5

(Total Hours: 60, Credits: 4)

Unit 1: Introduction to Microbiology: (10 hrs)

General concepts on microbes and their distinctive characters, Whittaker's Five kingdom classification concept. Bacterial systematics – overview according to Bergey's Manual of Determinative Bacteriology.

Unit 2: Morphology of Bacteria: (10 hrs)

Bacterial cell size and shape, bacterial cell wall – structural components and functional properties. Bacterial cell appendages and cell inclusions – Overview to introduce the terms and working /functions of each appendage.

Unit 3: Bacterial growth and its dependence on environment (8 hrs)

Nutritional types of bacteria. Physical conditions required for growth (temperature, oxygen, and pH).

Unit 4: Bacterial reproduction: (8 hrs)

Binary fission, fragmentation and budding. Bacterial growth curve.

Unit 5: Algae and Fungi (9 hrs)

General characteristics of algae and fungi. Morphology and mode of reproduction (asexual and sexual)

Unit 5: Control of microorganisms: (15 hrs)

Fundamental of control. Definition of physical agents (high and low temperature, radiation, filtration) and chemical agents (phenol and phenolic compounds, alcohol, Chemotherapeutic agents). Introduction to antibiotics, mode of action of antibiotics like – penicillin, streptomycin, and chloramphenicol. Antibiotic resistance in microbes.

MLBGDSE02P: GENERAL MICROBIOLOGY (PRACTICAL) SEMESTER –5

(Total Hours: 60, Credits: 2)

1. Preparation of different media: Nutrient Agar & broth, Luria broth.
2. Simple staining of bacteria.
3. Gram staining of bacteria.
4. Isolation of pure cultures of bacteria by streaking method.k

SUGGESTED READING

1. Atlas RM. (1997) Principles of Microbiology. 2nd edition. WM.C.Brown Publishers.
2. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004) Microbiology. 5th edition. Tata McGraw Hill.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005) General Microbiology. 5th edition McMillan.
4. Tortora GJ, Funke BR, and Case CL. (2008) Microbiology: An Introduction. 9th edition Pearson Education.

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

MLBGDSE03T: RECOMBINANT DNA TECHNOLOGY AND FUNDAMENTALS OF IMMUNOLOGY (THEORY), SEMESTER –6

(Total Hours: 60, Credits: 4)

Unit 1: Introduction to Molecular Cloning: (30 hrs)

Vectors: Characteristics of cloning vectors, Plasmids (pSC101, pBR322, pUC18/I9), Bacteriophage lambda insertion and replacement vectors, M13 based vectors, Cosmids, YACs and Ti plasmid. Shuttle vectors and Expression vectors: *E.coli lac* and T7 promoter-based vectors.
Enzymes used in Molecular Cloning: Restriction enzymes. Types I, II and III, nomenclature, use of Type II restriction enzymes in cloning, Isoschizomers and Neoschizomers, Restriction Mapping, Restriction Fragment Length Polymorphism (RFLP).
DNA ligases, Terminal deoxynucleotidyl transferase, Polynucleotide Kinase, Phosphatases and Reverse Transcriptase.
Cloning strategies: Construction of recombinant DNA: Joining of cohesive ends and blunt ends, c-DNA synthesis and cloning. Transformation of *E.coli* host by Calcium chloride method and electroporation.
Methods used in Molecular Cloning: Agarose gel electrophoresis of DNA, Southern, Northern and Western blotting.

Unit 2: PCR Techniques: (5 hrs)

Principle of Polymerase Chain Reaction, RT-PCR, Real-Time PCR and their applications.

Unit 3: Immunology (25 Hrs.)
Immune response – An overview, Primary and secondary immune response, Cells and molecules involved in innate and adaptive immunity (Stem cell, T-cell, B-Cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell). Antigens, antigenicity and immunogenicity, Epitope, Immunoglobulin or antibodies (basic ideas), Monoclonal and polyclonal antibody, Humoral and cell-mediated immunity, Antigen-antibody reaction (basic ideas), detection by agglutination, precipitation, ELISA, MHC molecules, Vaccination, hypersensitivity and autoimmunity (basic concept).

MLBGDSE03P: RECOMBINANT DNA TECHNOLOGY AND FUNDAMENTALS OF IMMUNOLOGY (PRACTICAL) SEMESTER –6

(Total Hours: 60, Credits: 2)

1. Isolation of plasmid DNA.
2. Agarose Gel Electrophoresis of plasmid DNA.
3. Preparation of competent cells for transformation by calcium chloride method.
4. Transformation of *E.coli* host cell with plasmid DNA.

5. Digestion of plasmid DNA using restriction enzymes and analysis by agarose gel electrophoresis.
6. Detection of blood group.

SUGGESTED READING

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

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

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

4. Kindt TJ, Osborne BA and Goldsby RA. (2006) Kuby Immunology, 6th Edition. W. H. Freeman & Company.

5. Lydyard PM, Whelan A and Fanger MW. (2000) Instant Notes in Immunology, BIOS Scientific publishers).

MLBGDSE04T: VIROLOGY AND EPIDEMIOLOGY

(THEORY) SEMESTER –6

(Total Hours: 60, Credits: 4)

Unit 1: General properties of viruses: (7 hrs)

Structure of Viruses (Capsid symmetry, enveloped and non-enveloped), Classification of bacterial, plant and animal viruses. Concept of viroids, virusoids, satellite viruses and Prions.

Unit 2: Bacteriophages: (10 hrs)

Diversity of bacteriophages and their classification. Lytic (T4) and lysogenic phages (lambda), Concept of early and late proteins.

Unit 3: Viral Replication: (15 hrs)

Attachment, entry, un-coating, replication, assembly and release of viruses. Replication of DNA and RNA viruses.

Unit 4: Prevention & control of viral diseases: (8 hrs)

Antiviral compounds and their mode of action, Host immune response to viruses, Viral vaccination.

Unit 6: Viral Epidemiology: (20 hrs)

Endemic, Epidemic and Pandemic diseases, Characteristic features of viral diseases: Incubation period, Period of infectivity, Morbidity and Mortality. Viral Transmission Patterns: Horizontal Transmission, Vertical Transmission and Zoonotic Transmission. Basic idea of viral diseases- AIDS, Polio, Small Pox and influenza.

MLBGDSE04T: VIROLOGY AND EPIDEMIOLOGY (PRACTICAL) SEMESTER –6

(Total Hours: 60, Credits: 2)

1. Plaque assay of bacteriophages from standard teaching kit.
2. Isolation and enumeration of bacteriophages (PFU) from water sample using double agar layer technique (demonstration only).
3. Project work.

SUGGESTED READING

1. Dimmock NJ, Easton, AL, Leppard, KN. (2007) Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V. (2007) Virology: Principles and Applications. John Wiley and Sons.
3. Wagner EK, Hewlett MJ. (2004) Basic Virology. 2nd edition. Blackwell Publishing.
4. Sastry AS and Bhat SK. (2016) Essentials of Medical Microbiology. Jaypee brothers.
5. Mathews. (2004) Plant Virology. Hull R. Academic Press, New York.

Skill Enhancement Course (SEC): 2 credits each

MLBGSEC01: FUNDAMENTALS OF BIOSTATISTICS AND BIOINFORMATICS

(Total Hours: 30, Credits: 2)

Unit 1: Introduction to Biostatistics (8 hrs):
Keywords and terms used in biostatistics. Concept of frequency distribution (frequency distribution table, simple and group frequency distribution, data presentation), mean, median, mode, standard deviation; Simple problems on mean, median, mode and standard deviation.

Unit 2: Statistical Distribution (7 hrs):
Normal, binomial, poisson's distribution.

Unit 3: Introduction to Bioinformatics (15hrs):
Idea of Computational Biology and it's need in biological study.
Nucleic acid and protein sequence database and information retrieval; sequence file formats - FASTA & GENBANK. Sequence alignment - pairwise and multiple sequence alignment. Pairwise alignment

tool - BLAST and multiple sequence alignment tool - Crustal W. Protein and nucleic acid structure database: The Protein Database (PDB); information retrieval from structural database.

SUGGESTED READING

1. Mariappan P. (2010) Biostatistics. Pearson.
2. Banerjee PK. Introduction to Biostatistics. S. Chand.
3. Rashidi H, Buehler KL. (2005) Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press/Taylor & Francis Group.
4. Lesk MA. (2002) Introduction to Bioinformatics. Oxford University Press.

MLBGSEC02: BIOTECHNOLOGY IN SUSTAINABLE DEVELOPMENT

(Total Hours: 30 ,Credits: 2)

Unit 1: Biofertilization, Phytosimulation, Bioinsecticides (12 hours):
Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers.

Unit 2: Secondary Agriculture Biotechnology (10hours):
Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters.

Unit 3: GM crops (8 hours):
Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

SUGGESTED READING

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
3. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
4. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
5. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
6. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.