M.Sc. Biotechnology ChoiceBased Credit System(CBCS) 2016-2017

Semester I **Marks**

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	16CBT21C1	Cell Biology	04	80	20
2	16CBT21C2	Bio molecules & Metabolism	04	80	20
3	16CBT21C3	Microbiology	04	80	20
4	16CBT21C4	Molecular Biology	04	80	20
5	16CBT21C5	Genetic Engineering	04	80	20
6	16CBT21CL1	Lab course-I (Cell Biology, Bio molecules & Metabolism) 16BT21C1, C2	04	100	
7	16CBT21CL2	Lab course-II (Microbiology, Molecular Biology, Genetic Engineering) 16BT21C3-C5	04	100	
	Total		28		

Semester II

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	16CBT22C1	Immunology	04	80	20
2	16CBT22C2	Plant Biotechnology	04	80	20
3	16CBT22C3	Environmental Biotechnology	04	80	20
4	16CBT22D1 or D2 or D3	Bioinformatics (D1)/Biologyof Infectious Diseases (D2)/Diagnostics(D3)	04	80	20
5	Open Elective	To be chosen fromthe basket of open Electives provided by the university	03		
6	Foundation Course	To be chosen fromthe basket of Foundation Course provided by the university	02		
7	16CBT22DL	Lab course-I (Immunology, Bioinformatics/Biology of Infectious diseases), 16CBT22C1, 16CBT22D1	04	100	
8	16CBT22CL	Lab course-II (Plant Biotech., Environmental Biotech.) 16CBT22C2,C3	04	100	
	Total		29		

Semester III 2017-18

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17CBT23C1	Bioprocess Engineering	04	80	20
2	17CBT23C2	Animal Biotechnology	04	80	20
3	17CBT23DA1 Or 17CBT23DA2	Molecular Human Physiology and Dev. Biology/ Molecular Plant Physiology& Development Biology	04	80	20
4	17CBT23DB1/ DB2/ DB3	Biostatistics/ Virology/Nano-Biotechnology	04	80	20
5	Open Elective	To be chosen fromthe basket of Open Electives course provided by the university	03		
6	17CBT23CL	Lab course-I 17CBT23C1, C2	04	100	
7	17CBT23DL	Lab course-II Based on 17CBT23DA1/DA2 and DB1/DB2/DB3	04	100	
		TOTAL	27		

Semester IV

Sr. No.	Course Code	Subject/Title	Credits	Theory	Int Ass
1	17CBT24C1	IPR Bio safety, Ethical, Legal , Social issues In Biotechnology	04	80	20
2	17CBT24C2	Microbial Technology	04	80	20
3	17CBT24C3	Dissertation	20	300	
	Total		28		

Total credits=112

Choice BasedCredit System

M.Sc. Biotechnology **Semester--I**

Course Title: Cell Biology ***MM.Th 80 + IA 20***

Course Code No.16BT21C1 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Diversityof cell size and shape,Cell Theory.

StructureofProkaryotic and Eukaryotic cells - Isolation and growth ofcells. Microscopic techniques for studyofcells.

Sub-cellular fractionation and criteria of functional integrity Cellular organelles- Plasma membrane, cell wall and their structural organization,

UNIT II

Cellular organelles- Mitochondria, Chloroplast; Nucleus and other organelles and their organization, Transport of nutrients, ions and macromolecules across membrane. Cellular energy transactions - role of mitochondria and chloroplast, Metabolite pathways and their regulation.

UNIT III

Cell cycle - molecular events and model systems

Cellular responses to environmental signals in plants and animals- mechanisms of signal transduction. Cell motility - cilia, flagella of eukaryotes and prokaryotes, Biologyof cancer,

UNIT IV

Cellular basis of differentiation and development - Development in Drosophila and Arabidopsis, Spatial and temporal regulation of Gene expression, Brief introduction to the Life Cycle and Molecular Biologyof some important pathogen of AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.

Practical

1.Microscopy: Bright field, phase contrast & Fluorescence Microscopy.
2.Microtomy
3.Instrumental methods for Cell Biology
4.Sub cellular fractionation andmarker enzymes.
5.Histochemical techniques
6.Mitosis &Meiosis

Suggested Readings

1.Lodish et al.,Molecular CellBiologyFreeman and Company2000.
2.Smith and Wood.Cell Biology, Chapman and Halls 1996
3.Watson et al.Molecular Biologyof the gene. PearsonPrentice Hall, USA 2003
4.Benjamin Lewin. Gene X, Jones andBarlett Publishers, 2010.

Semester—I

M.Sc. Biotechnology

Course Title**: Bio-molecules andmetabolism** ***MM. Th 80 + IA 20***

Course Code No.16BT21C2 **Time:3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Chemical foundations of Biology–pH, pK, acids, bases, buffers, stabilizing interactions (van der Waals, electrostatic, hydrogen bonding, hydrophobic interactions, weak bonds, covalent bonds). Principles of thermodynamics, Macro molecular and supra molecular assemblies. Amino acids and peptides-classification and properties, Sugar- classification and reactions.

UNIT II

Polysaccharides- Composition, structure and functions,
Proteins:Classification, hierarchyin structure, RamachandranPlot,
Nucleic acids-Classification, structure, functions

Type and classification of enzymes, coenzyme, enzyme kinetics (Michaelis-Menten equation, Km, Vmax, turnover number), LB plots, Enzyme inhibition,allosteric enzymes, Immobilisedenzymes.

UNIT III

Bio-physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV/Visible, IR, NMR, LASER, MASS-spectrometry, Fluorescence spectroscopy, X - ray Crystallography, Cryoelectrom microscopy, Isothermal Calorimetry(ITC), Surface Plasmon Resonance, Techniques in separation and characterization of protein andnucleic acid: Chromatography techniques (affinity, ion-exchange, gel filtration, HPLC, Hydrophobic electrophoresis, Iso- electric focussing,2DE, MudPIT.

UNIT IV

Protein folding: biophysical and cellular aspects

Metabolism of carbohydrate (Glycolysis, Pentose phosphate pathway, Glycogen metabolism, Gluconeogenesis, Citric acid cycle). Lipids (Alpha and beta oxidation of fatty acids, Ketobodies, fatty acid biosynthesis) Metabolism of amino acids and nucleotides, inborn errorsof metabolism; Electron transport and oxidative phosphorylation..

Practicals

1.Titration of aminoacids
2.Colorimetric determination of pK.
3.Reactions of amino acids, sugars and lipids.

4.Isolation,puritydetermination andquantitation of cholesterol, DNA and mRNA

5.Quantitationof Proteins andSugars,

6.Analysis of oils-iodine number, saponificationvalue, acid number
7.UV/Visible, IR and Fluorescence spectroscopy, Absorptionspectra,
8.Separation techniques and characterization of protein and nucleic acid: Chromatography techniques: Centrifugation,Chromatography(Ion-exchange, gel permeation, TLC etc.) andElectrophoresis,

SuggestedReadings:

1.Lehninger Principles ofBiochemistry4thEd ***By*** David L. Nelsonand Michael M. Cox, WH Freeman and Company.
2.ChemistryofBiomolecules: an Introduction(Paperback) ***By*** Richard J.Simmonds.Publisher: Royal SocietyofChemistry
3.PrinciplesofBiochemistry(Hardcover) ***By*** GeoffreyZubay. Publisher: McGrawHill College.
4.Biochemistry***By*** Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) ***By*** Trudy McKee and James R McKee. Publisher: McGraw- Hill Higher education.
6.Biochemistryand Molecularbiology ***By*** WilliamH. Elliott andDaphne C. Elliott. Oxford UniversityPress.
7.Biochemistry(Hardcover) 3rd Ed**.** ***By*** Donald J.Voet and JudithG. Voet. JohnWileyand Sons.
8.Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) ***By*** D Voet. John Wiley and Sons.
9.Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) ***By*** Donald Voet, Judith G. Voet and Charlotte W.Pratt.Publisher: Wiley.
10.Principles of Biochemistry (Paperback) ***By*** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
11.Biochemistry***By*** U. S. Satyanarayana
12.Outlines ofBiochemistry ***By*** Eric C Conn,PK Stumpf, GBrueningand RayH. Doi. John Wiley& Sons.

Semester--I

M. Sc. Biotechnology

Course Title: Microbiology **MM. Th80 +IA 20**
Course Code No.16BT21C3 **Time:3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory
UNIT I

The Beginningof MicrobiologyDiscoveryof the microbial world byAntonyvon
Leeuwenhoek: spontaneous generation versus biogenesis, Developments of microbiology in the twentieth century. Development of microbiologyas a discipline, establishment of fields of

medical microbiology, immunologyand environmental microbiologywith special reference

to the workof following *Scientists* :Joseph Lister, Paul Ehrlich, Edward Jenner,Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty. Overview of scope of Microbiology; Basic sterilization techniques in microbiology laboratory.

Systematic and Taxonomy, Microbial evolution, Systemics and taxonomy, Evolutionary chronometers, Ribosomal RNA oligonucleotide sequencing, signature sequencing and protein sequencing, Basic concept of Bergey's Manual of systemic bacteriology

UNIT II

Microbial Growth The definition of growth, mathematical expression of growth and generation time, specific growth rate, Synchronous growth; Batch and Continuous culture; Diauxic growth, Growth affected by environmental factors like temperature, pH, water availability, radiation, pressure and oxygen concentration, anaerobic culture. Determination of microbial growth by different methods.Culture collection, and preserving and stocking of pure cultures, pure culture concept, nutritional classification of microorganisms on basis of carbon, nitrogen and electron sources, Different types of bacterial culture media, Calvin cycle and Reductive TCA cycle; Hydrogen, iron and nitrite oxidizing bacteria; Nitrate and sulfate reduction

UNIT III

Prokaryotic Diversity Bacteria: Purple and green bacteria; Cyanobacteria; Homoacetogenic bacteria; Acetic acid bacteria; Buddingand appendaged bacteria; Spirilla; Spirochaetes;

Gliding and sheathed bacteria; Pseudomonads; Lactic and propionic acid bacteria; Mycobacteria: Rickettsias, Chlamydies and Mycoplasma. Archaea:

Archaea as earliest Life forms: Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma

Eukaryotic: Algae, Fungi, Slime molds andProtozoa.

UNIT IV

Viruses: Structure of Viruses: Capsid symmetry; enveloped and non-enveloped viruses. Isolation purification and cultivation of viruses, Concepts of Viroids, Virusoids, satellite viruses and Prions; life cycle of RNA phages; Lytic and lysogenic phages (lambda and P1 phage), one step multiplication curve, Salient features of TMV, T4 phages, ΦX174 , Hepatitis B virus, Retro viruses.

Prokaryotic Cells: Capsule, Glycocalyx, S-Layer, Detailed structure of Cell walls of Gram positive and Gram negative bacteria, LPS, protoplasts, spheroplasts, L -forms, Flagella and motility, Cell membranes of eubacteria and archaeobacteria, Endospores: structure , functions and stages, mesosomes, bacterial chromosomes, pili, plasmids and transposons. Different types of Mutation and. Ames test for mutagenesis. Bacterial Transformation, Conjugation, Transduction,Interrupted matingexperiments.

Genetic systems of Yeast andNeurospora; Extra-Chromosomal Inheritance

Practicals

1.Light microscope demonstration
2.Isolation of pure culturebystreaking method.
3.CFU enumeration byspread plate method.
4.Measurement of microbial growth byturbidometrymethods.
5.Effect of temperature, pH and carbon andnitrogen sources on growth.
6.Microscopic examinationof bacteria byGram stain,
7.Acidfast stainandbacterial stainingfor spores and capsule.
8.Bacterial transformation andtransduction
9.Biochemical characterization of selected microbes e.g. *E. coli*
10.Isolationof Plasmids/genomic DNA and DNA agarose gel electrophoresis

REFERENCE BOOKS

1.Atlas RM. (1997). Principlesof Microbiology. 2 nd edition.WM.T.Brown Publishers.
2.BlackJG. (2008). Microbiology: Principles and Explorations.7 th edition. Prentice Hall
3.Pelczar Jr MJ, Chan ECS,and KriegNR (2004) Microbiology. 5 th edition Tata McGraw Hill.
4.Stanier RY, Ingraham JL, Wheelis MLand Painter PR. (2005). General Microbiology. 5 th edition McMillan.
5.Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7 th edition. McGraw Hill Higher Education.

M.Sc. Biotechnology **Semester I**

Course Title: Molecular Biology ***MM. Th 80 + IA 20***

Course Code No.16BT21C4 **Time:3h**

Theory

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

UNIT I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.**Transcription:** Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing

Modifications in RNA: 5 '-Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

UNIT II

Translation : Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulationof translation, co- andpost translationalmodifications of proteins.

Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis

Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressorproteins

UNIT III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designingribozymes, Applications of Antisense andribozyme technologies

Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and' Cre/Lox recombination, RecA and other recombinases

Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map- based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissectionand micro cloning.

UNIT IV

Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease. prognosis, genetic counseling, Pedigree, varietal etc. Animal traffickingand poaching; Germplasmmaintenance, taxonomyand Bio-diversity

Genome Sequencing: Genome sizes., organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencinggenome, Packaging, transfectionandrecoveryof clones,

Applicationof Sequencingsequence information for identification of defective genes.

PRACTICALS

1.Isolation & quantificationof genomic DNA
2.Plasmid isolation & quantification
3.Southernblotting
4.RFLP analysis
5.Isolation and quantificationof RNA
6.Isolation of polyA + RNA
7.Northernblotting
8.Preparationof probes
9.*In vitro* Transcription
10.*In vitro* translation
11.Metabolic labelingof proteins and immune-precipitation

Suggested readings

1. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
2.J D Watson et al.,Biologyof Gene, 6th Edition,Benjamin Cummings publishers Inc. 2007
3.Alberts et al.,Molecular Biologyof the Cell,Garland, 2002
4.Primose SB, Molecular Biotechnology, Panima, 2001.

M.Sc. Biotechnology Semester--I

Course Title: Genetic engineering ***MM. Th 80 + IA 20***

Course Code No.16BT21C5 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting atleast onefromeach unit. All questions are of equalmarks.

Theory

UNIT I

Scope and Milestones inGenetic Engineering

Genetic engineering guidelines, Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers, Nucleic Acid Purification, Yield Analysis, Nucleic Acid Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and Cloning , mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Libraryconstructionand screening, Alternative Strategies of Gene Cloning

UNIT II

Cloning interacting genes-Two-and three hybrid systems, cloning differentially 'expressed genes. Nucleic acid microarray arrays, Site-directed Mutagenesis and Protein Engineering, How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1mapping, RNase protectionassay, Reporter assays

Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering, *in vitro* transcription and translation, expression in bacteria, expression in yeast, expression in insect cells, expression in mammalian cells, expression inplants.

UNIT III

Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
Phage Display, T-DNA and TransposonTagging

Role of gene taggingin gene analysis, Identification andisolation of genes throughT-DNA or Transposon.

UNIT V

Transgenic and gene knockout technologies Targeted gene replacement, chromosome engineering.

Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

PRACTICALS

1. Bacterial culture andantibiotic selection media. Preparationof competent cells.
2.Isolation of plasmid DNA.

3.Isolation of lambdaphage DNA.

4.Agarose gel electrophoresis and restriction mappingof DNA

5.Construction of restriction map of plasmid DNA.

6.Cloninginplasmid/phagemid vectors.

7.Preparation,of helper phage and its titration

8.Preparationof single stranded DNA template

9.DNA sequencing

10.Gene expression inE. coli and analysis of gene product

11.PCR andReporter Gene assay (Gus/CAT/b-GAL)

Suggested Readings

1.S B Primrose, R M Twyman, andR WOld. Principlesof Gene manipulation. S B UniversityPress, 2001 2.Brown TA. Genomes, 3rd Edition, Garland Science 2006.
3.J Sambrookand DWRussel, Molecular Cloning: A laboratoryManual Vols1-3.CSHL, 2001. 4.DM Glover and B D Hames, DNA cloning, Oxford1995.
5.Recent reviews in scientificjournals.

Choice BasedCredit System(2016-2017)

M.Sc. Biotechnology **Semester--II**

Course Title: Immunology ***MM. Th 80 + IA 20***

Course Code No 17BT22C1 **Time: 3h**

NOTE: **In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting atleast onefromeach unit. All questions are of equalmarks.**

Theory

UNIT I

Phylogenyof Immune System
Innate and acquired immunity
Clonalnature of immune response
Organization and structure of lymphoidorgans
Cells of the Immune system: Hematopoiesis and differentiation

UNIT II

Nature and Biology of antigens and super antigens Antibody structure and function, Antibody diversity. Antigen - antibodyinteractions
Major histocompatibilitycomplex
B-Iymphocytes, T-Iymphocytes, BCR & TCR, Complement system,
Macrophages, Dendritic cells, Natural killer and Lymphokine-activated killer cells, Eosinophils, Neutrophils and Mast Cells

UNIT III

Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune responses: Activation of B and T Lymphocytes; Cytokines and their role in immune regulation, Cell- mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, Hypersensitivity(Type Ito Type IV with at least one example)

UNIT IV

Immunological tolerance; Autoimmunity, Transplantation Immunity to infectious agents (interacellular parasites like *M. tuberculosis,* helminthes and viruses); Tumor Immunology; AIDS and other Immunodeficiencies; Hybridoma technology and applicationsof monoc1onal antibodies

PRACTICALS

1.Bloodfilm preparationandidentificationof cells
2.Lymphoid organs and their microscopic organization
3.Immunization, Collectionof Serum
4.Doublediffusion and Immune-electrophoresisRadial Immuno diffusion
5.Purificationof IgG fromserum
6.Separation of mononuclear cellsby Ficol1-HypaqueWestern-blotting
7.ELISA
8.Immunodiagnostics(demonstration usingcommercial kits) e.g. Widal test for typhoidfever.

REFERENCE BOOKS/ Suggested Readings

1.KubyImmunology(2006) byThomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby(W.H. Freeman).
2.Immunology- A short course(2009)byRichard Coico, GeoffreySunshine (Wiley Blackwell).
3.Fundamentals of immunology(1999) byWilliam Paul (Lippincott Williams & Wilkins).
4.Immunology(2001) byIvan Maurice Roitt, Jonathan Brostoff, David K. Male (Mosby).
5.Understandingimmunology(2007) byPeter John Wood,DorlingKInderseley(Pearson Education, India)
6.Immunology(2007) byKannan, I(MJP Pulishers, India).

M.Sc. Biotechnology Semester--II

Course Title: Plant Biotechnology ***MM. Th 80 + IA 20***

Course Code No 17BT22C2 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Conventional Plant Breeding, **Introduction to cell and Tissue Culture**, tissue culture as a technique to produce novel plant and hybrids. Tissue culture media (composition and preparation), Initiation and maintenance of callus and suspensioncultures; single cell clones,

Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil.Shoot-tip culture: rapid clonal propagation and productionof virus-free plants. **Wide hybridization**: Embryo culture and embryo rescue,

Somaclonal and gameto-clonal variation: causes andapplications

UNIT II

Protoplast isolation; culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids, Anther, pollen and ovary culture for**production of haploid plants** and homozygous lines, **Cryopreservation**, slowgrowth and DNA bankingfor germplasm conservation.

UNIT III

Plant Transformation Technology: basis of tumor formation, hairy root features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binaryvectors, use of 35S and other promoters, genetic Markers, use of reporter genes, reporter gene with introns, use of scaffold attachment region methods of nuclear transformation, viral vectors and their applications, multiple gene transfer, Vectors-less or direct DNA transfer, particle bombardment, electro-poration,microinjection, transformationof monocots. Transgene

stabilityand gene silencing.

ChloroplastTransformation: advantages, vectors, success with tobaccoandpotato.

UNIT IV

Basic Techniques in rDNA Technology Application of Plant Transformation for productivity and performance: Herbicide resistance, phosphoinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, Polygalacturanase,ACC oxidase, male sterile lines, bar and barnasesystems.
Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand confor- mational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.

PRACTICALS

1.Preparationof media
2.Surface sterilization
3.Organ Culture
4.Callus propagation andorganogenesis,
5.In vitro induction of roots and transplantation in soil.
6.Protoplast isolation and culture
7.Anther culture, production of Haploids
8.Cytological examination of regenerated plants
9.Agrobacterium culture, selection of transformants, reporter gene (GUS) assay.
10.DevelopingRFLP and RAPD maps

Text /References

1.Bhojwani SS & Razdan M K. Plant Tissue Culture: Theoryand Practice. Elsevier.
2.A Slater, N Scott and Mark Fowler Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, 2003
3.J Hammound, P McGarveyand V. Yusiboyeds. Plant Biotechnology, Springer and Verlag, 2000
4.P KJaiwal and RP Singheds. Plant Genetic Engineering.Vols. 1-8Studium Press LLC, USA.
5.P KGupta Plant Biotechnology, Rastogi Publication, Meerut.

Semester II

Course Title: Environmental Biotechnology ***MM. Th 80 + IA 20***

Course Code No 17BT22C3 ***Time: 3h***

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Environmental Pollution: types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations. Air pollution and its control through Biotechnology. Global Environmental Problems: Ozone depletion UV-Br green-house effect and acid rain their impact and biotechnological approachesfor management.

UNIT II

Water Pollution and its Control: Water as a scarce natural resource, .need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment-physical, chemical and biological treatment process. Microbiology of Waste Water Treatments, Aerobic Process; activated sludge, Oxidation ditches, tricklingfilter, towers, rotatingdiscs, rotatingdrumsoxidationponds.

UNIT III

Anaerobic Processes: Anaerobic digestion, anaerobic filters Up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries

UNIT IV

Microbiology of degradation of Xenobiotics in Environment Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil, pollution, surfactants, pesticides, Bioremediation of contaminated soils and waste land. Biopesticides in integrated pest management. Solid wastes; sources and management (composting wormicu1ture and methane production)

PRACTICALS

1.Detection of coliforms for determination of the purify of potable water Determination of total dissolved solids of water.
2.Determination of dissolved oxygen concentration of water sample. Determination of biological oxygen demand (BOD) of a sewage sample. Determination of chemical oxygen demand (COD) of sewage sample Isolation of xenobiont degrading bacteria by selective enrichment techniques Test for degradation of aromatic hydrocarbons bybacteria.
3.Survey of degradative plasmids in microbes growing in polluted environment Effect of sulphur dioxide on crop plants.
4.Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry Estimation of nitrate in drinkingwater
5.Studyon biogenic methane production indifferent habitats.

Suggested-Readings

1. G M Evans, J C Furlong, Environmental Biotechnology-Theoryand Applications, JohnWiley& Sons,e-book,2003.
2.Hans-Joachim Jordening, Josef Winter, Environmental Biotechnology: Concepts and Applications, John –WileyandSons, 2006.
3.Indu Shekhar Thakur, Environmental Biotechnology: Basic concepts and Applications, IK InternationalsPvt Ltd., 2006
4.A H Scragg, Environmental Biotechnology, Longman, 1999,
5.Recent reviews fromscientific journals.

M. Sc. Biotechnology — **Semester II**

MM. Th 80 + IA

Course Title: Bioinformatics — **20**

Course Code Course Code No 17BT22D1

Time:3h

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four other questions selecting atleast onefromeach unit. All questions are of equalmarks.

Theory

UNIT I

Computers: An overview of computers, architecture; generations. What is programming? Algorithms. Introduction to MS Office. MS Access, Front Page and introduction to C, Java and SQL (structured querry language). Introduction to computer networking, topology, networkingprotocol (FTP; TCP/IP), Colour, Sound &Graphics.

UNIT II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Subroutines. Applications of PERLin Bioinformatics.

UNIT III

Biological Sequence Databases: Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Various specializeddatabases like TIGR, Hovergen, TAIR, PlasmoDB, ECDC.

UNIT IV

Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch & SmithWaterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method.

Theory of scoring matrices and their use for sequence comparison; Statistical analysis and evaluation of BLAST; CLUSTAL-X/W; Molecular Phylogeny.

Practicals:

Computational analysis of genomic and proteomic data. Networksearch on genomic andproteomic databases Use of PERLprogrammingfor : i) StoringDNA sequence ii) DNA to RNA transcriptioniii) Countingnucleotides, (iv)Phylogenetic tree construction.

Suggested Readings

1.David W. Mount Bioinformatics: Sequence and Genome Analysis CSHLPress, 2004

2.A. Baxevanis and FBFOuellette, Bioinformatics: A practical guid to the analysis of genes2nd eds JohnWiley2001

3.JonathanPevsner Bioinformatics andfunctional genomics Ist Ed. WileyLiss 2003

4.P E Bourne and H. WeissigStructural Bioinformatics Wiley2003.

M.Sc. Biotechnology Semester - II

Course Title: Biology of Infectious Diseases

Course Code
No 17BT22D2

MM. Th80 +IA20

NOTE: In all Nine questions will be set, Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. Out of remaining eight questions, two questions will be set from each unit. Studentsare requiredto attempt fourquestionsi.e. anyone fromeach unit.

Theory

UNITI

Bacteria: Representative diseases to be studied in detail are - tetanus, diphtheria, cholera, typhoid, tuberculosis, leprosy, plague, and syphilis. Infectionscaused byanaerobic bacteria, spirochetes, chlamydia, rickettsiae.
Viruses: Representative diseases to be studied in detail are - viral hepatitis, influenza, rabies, polio and AIDS and viral cancers.
Fungi: Diseases to be takenupin followingcategories: superficial, subcutaneous, systemic and opportunistic mycoses.

UNITII

Protozoa:Classification, Diseases to be discussed are - amoebiasis, toxoplasmosis, trichomoniasis & leishmaniasis. Parasitic diseases, Classification: Ascariais, Liver fluke, Tape worms, Disease burden and its economic impact, Investigation of epidemics. Replication of DNA, RNA+ve andRNA-ve viruses, retroviruses

UNITIII

Viral vaccines: conventional; killed/attenuated; DNA; peptide; recombinant proteins. Sterilization techniques: biohazard hoods; containmentfacilities, BSL2, 3, 4. Bacterial andviral vectors, Biological warfareagents

UNITIV

Mode of action of antibiotics and antiviral: molecular mechanism of drug resistance(MDR)Anti-viral chemotherapy. Anti- fungal chemotherapy. Hospital-acquired infections (nosocomial), immune compromised states Modern approaches for diagnosisof infectiousdiseases:Basic concepts of gene probes,dot hybridization and PCRassays

Practicals

1.To perform primaryand secondarytest for identification andclassificationof bacteria.

*2.*To perform acid-fast stainingof *Mycobacterium smegmatis.*

3.Isolation, characterization and identification of *Staphylococcus*

4.Isolation, characterization and identification of *E. coli.*

5.To perform andinterpretstandard procedure used for isolation, characterization and identificationof *Bacillus* sp.

6.To perform andinterpretstandard procedure used for isolation, characterization and identificationof *Salmonella* sp.

7.Extraction of total viralRNA from given sample and estimation of its quantityand quality.

8.To perform the antibioticsensitivityassaywith microorganisms and to determine theirMIC and MBC .

Recommended Books

1.Jawetz, Melnick, & Adelberg's Medical Microbiology (Lange Basic Science) byGeo. F.Brooks,Janet S. Butel, Stephen A.Morse McGraw-HillMedical; 23 edition

2.Medical Microbiology: with Student ConsultbyPatrickR. MurrayPhD (Author),Ken S. Rosenthal PhDSaunders; 7 edition

3.Mims' Medical Microbiology By (author) Richard Goering, By (author) Hazel Dockrell, By (author) Mark Zuckerman, By (author)Ivan M. Roitt, By(author) Peter L. ChiodiniSaunders (W.B.)Co Ltd

M.Sc. Biotechnology Semester - II

Course Title: Diagnostics

MM.

Th 80 **Course Code No 17BT22D3** **Time:**

+IA20 **3h**

NOTE: In all Nine questions will be set, Question No. 1, which will be short answer type covering the entire syllabus, will be compulsory. Out of remaining eight questions, two questions will be set from each unit. Studentsare requiredto attempt fourquestionsi.e. anyone fromeach unit.

Theory

UNIT –I

Quality control, GMP and GLP, records. Chromosomal anomalies and disorders : Numerical (polyploidy, aneuploidy, autosomal, sex- chromosomal), Structural (deletion, duplication, translocation, inversion, isochromosome, ring chromosome). Mitochondrial genome and disorders. Genetic Disorders: Single gene Disorders (Cystic Fibrosis, Marfan's syndrome),

Multifactorial disorders (Diabetes, Atherosclerosis, Schizophrenia)

UNIT-II

Methods for genetic study in man – pedigree analysis, Pedigree construction & family study Complications in pedigree analysis (variable expressivity, heterogeneity, penetrance, anticipation,epigenetics, mosaicism)

Polyclonal and monoclonal antibodies, Karyotype analysis. G-banding, FISH, spectral karyotyping(SKY) andcomparative genomic hybridization(CGH)

UNIT- III

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real- Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR,PCR-ELISA, Ligase Chain Reaction, genetic profiling, single nucleotide polymorphism.

Applications of PCR- PCR based microbial typing: Eubacterial identification based on 16S rRNA sequences- Amplified Ribosomal DNA Restriction analysis (ARDRA)- Culture independent analysis of bacteria- DGGE and TRFLP. Molecular diagnosis of fungal pathogens based on 18S rRNA sequences- Detection of viral pathogens through PCR. RAPD for animal and plants- PCR inforensic science- AmpFLP, STR, MultiplexPCR

UNIT- IV

Cancer cytogenetics. Dynamic mutations. Biochemical diagnostics: inborn errors of metabolism, Haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders. Pre-implantation diagnosis,pre-natal diagnosis- chorionic villussampling, Amniocentesis. Genetic counselling.Introductiontopharmacogenomics andtoxicogenomics

Practicals

1.Isolation of Genomic DNA from Bloodsample.

2.To perform PCR, Reverse-PCR, MultiplexPCR and Real-time PCR with genomic DNA.

3.PCR-RFLP of Cyp gene variants.

4.C-peptide testfor diabetes.

5.Molecular weight determination bySDS-PAGE.

Recommended Books

1.Pastemak, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald, 2005. Mange and Mange, Basic Human Genetics, 2nd Edition, Sinauer Assoc,1999.
2.Lewis, Human Genetics, 7thEdition,WCB&McGraw, 2007.
3.Vogel and Motulsky, Human Genetics, 3rd Edition,SpringerVerlag, 1997.
4.Strachenand Read, Human Molecular Genetics, 3rd Edition, Garland Sci. Publishing, 2004. Maroni,Molecular and Genetic Analysis of Human Traits,1st Edition,Wiley-Blackwell, 2001. How1eyand Mori,TheHuman Genome, Academic Press, 1999.
5.Strickberger, Genetics,3rdedition,McMillan, 1985.
6.Snustad &Simmons, Principlesof Genetics,4thEdition, Wiley, 2005. Griffithsetal,Modern genetic analysis, 2nd Edition,Freeman, 2002.
7.Hartl andJones, Genetics-Principlesand Analysis, 4thEdition,Jones &Bartlett, 1998. Albertset al,Molecular Biologyof TheCell, 2nd Edition, Garland 2007.

M.Sc. Biotechnology **Semester—III**

Course Title: BIOPROCESS ENGINEERING **MM. Th80 + IA20**

Course Code No.17BT23C1 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

Unit–1 Bioreactors

Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles,impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bedreactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit – 2 Mass Transfersin Reactors

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit – 3 Fermentation Process

Growth of cultures in the fermenter, Importance of media in fermentation, media formulation and modification. 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 kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flaskto industrialfermentation.

Unit – 4 DownstreamProcessing

Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purificationbydifferent methods.

Concentrationbyprecipitation, ultra-filtration, reverse osmosis.Dryingand crystallization.

PRACTICALS

1.Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase) and improvement of strain for increase yield bymutation.
2.Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
3.[a] Determination of growthcurve of a suppliedmicroorganism and alsodetermines substrate degradation profile.
[b] Compute specific growth rate (m), growth yield (Y x/s) from the above.
4.Extraction of Citric acid/Lactic acid bysalt precipitation.
5.Monitoringof dissolved oxygen duringaerobicfermentation.
6.Preservation of industriallyimportant bacteria bylyophilization.
7.Product concentrationbyvacuum concentrator
8.Celldisruptionsfor endoenzymes bysonication.

Suggested readings /References

1.Principlesof Fermentation TechnologybyStanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.
2.Fermentations - A practical approach. IRL.
3.Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4.Biochemical Reactors byAtkinsonB., Pion,Ltd. London.
5.Biotechnology- A Text Bookof Industrial MicrobiologybyCruger.
6.Fermentation Biotechnology: Industrial Perspectives byChand.
7.Biochemical Engineering Fundamentals byBaileyand Ollis, Tata McGraw Hill, N.Y.
8.Biotechnology. Volume 3. Edited byH. J. Rehmand G. Reed. VerlagChemie. 1983.
9.Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.
10.Biotechnology- A textbookof Industrial MicrobiologybyCreuger and Creuger, Sinaeur Associates.
11.Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
12.Applied MicrobiologySeries.
13.Industrial MicrobiologybyL.E. Casida, WileyEastern

14.Bioseparation: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L. and Hu, W.S., John Wiley and Sons, N.Y.
15.Separation processin BiotechnolgybyAsenjo,J.A. Eds. Marcel Dekkar, N.Y.
16.BioprocessEngineeringPrinciples byDoran, Acad. Press, London.
17.Bioreaction EngineeringPrinciples byNielsen, J. and Villadsen,plenum Press, N.Y.
18.Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wileyand Sons, N, Y.

Semester III

Course Title: Animal Biotechnology

MM. Th 80 + IA 20

Course Code No.17BT23C2

Time: 3hrs.

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Structure and organization of animal cell, Equipments and materials used for animal cell culture technology, Asepatic Technique, Balanced salt solutions and simple growth medium, Chemical, physical and metabolic functions of constituents of culture medium, Role of carbon dioxide, Role of serum and supplements, Serum & protein free defined media and their application, Primaryand established cell line cultures, Subculture and Cell Line

UNIT II

Measurement of viability and cytotoxicity, Biology and characterization of the cultured cells, Measuring parameters of growth, Basic techniques of mammalian cell culture in vitro disaggregation of tissue and primary culture maintenance of cell culture cell separation, Scaling- up of animal cell culture, Cell synchronization, Cell cloningand micromanipulation,

UNIT III

Stem cell cultures, Somatic stem cells, Embryonic stem cells and their applications. Cell transformation. Cell culture based vaccines. Transgenic animals, Hybridoma Technology. Production and application of polyclonal and monoclonal antibodies. Applicationsof animal cell culture.

UNIT IV

Somatic cell genetics, Organ and histolytic cultures, Measurement of cell death Apoptosis, Three dimensional culture & tissue engineering. Applicationof somatic cell genetics. Factor affectingthe celldeath.

Practicals:

1.Preparation of tissue culture mediumand membrane filtration
2.Preparation of single cell suspensionfrom spleen and thymus
3.Cell countingand cell viability
4.Macrophage monolayer from PEC, and measurement of phagocytic activity
5.Trypsinization of monolayer and sub culturing
6.Cryopreservation and thawing
7.Measurement of doublingtime
8.Role of serum in cell culture
9.Preparation of metaphase chromosomes from cultured cells
10.Isolation of DNA and demonstration of apoptosisof DNA laddering
11.MTTassayfor cell viabilityand growth
12.Cell fusionwith PEG

Suggested Readings

1.Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher:Wiley-Liss, 2005 ISBN: 0471453293 |
2.Nigel Jen, Animal Cell Biotechnology:Methods andprotocols, Humana Press

MM. Th 80 +IA

M.Sc. Biotechnology **20**

Course Title: **Molecular Human Physiologyand Developmental Biology**

Course Code No.17BT23DA1 Time: 3h

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Sight and perception, hearing and balance, smell, taste, touch, pain, analgesics. Skin, hair. Muscles movement, rheumatoid disorders.

Heart and blood circulation, blood clotting, microvasculature. Lungsurfactants. Bodyfluids, fluidbalance, parenteral solutions.

UNIT II

Hormones: andhomeostasis.

Digestive system, reproductive system, nervous system.

Diseases of the digestive system, breathing, circulation, Mechanisms of drugaction

UNIT III

Structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg- surface targeting, ovulation and hormonal control in mammals, contraception

Molecular biology, cytology and biochemistry of ovogenesis: transcription on lampbrush chromosomes .Molecular and cellular biologyof fertilization:acrosome reaction and signal transduction, monospermyand species-specificity.

Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus.

UNIT V

Implantation and formation of the placenta in mammals, Gastrulation inmammals-formation of primitive streak, morphogenetic movements and neural induction. Organogenesis and foetal development, Pattern forming genes and expression in Drosophila and mammalian embryos Development of the mammalian brain-cerebralcortex-cell lineages, Lens development- fibre differentiation,programmed cell death (apoptosis). Erythropoeisis, myelopoeisis, Ageing

PRACTICALS

1.Culture in *vitro* of chickembryo byNew's technique andneural inductionbytransplantedHensen'snode.

2.Filter-paper ringculture of chickembryos.

3.Chickembryo limb bud organ culture and observation of celldeath ininterdigital regions byneutral red staining.

4.Sex-linked inheritance in Drosophila.

5.Non-allelic and allelic interaction inDrosophila.

6.Linkage studyin Drosophila.

7.Allelic and heterozygotic frequencies in human populations.

8.Analysis of quantitative traits: frequencydistribution, standard deviation and variance.

9.Karyotypinghuman cells and chromosomal in situ localization of genes.

10.Celldivision: mitosis andmeiosis.

11.Mutants of Drosophila. Sexliked lethals in Drosophila

Suggested readings

1.Richard W. Hill, Gordon A. Wyse, Margaret Anderson

Animal Physiology. 2nd edition. 2008. Sinauer Associates: Sunderland, Massachusetts. 770p. ISBN: (Hardcover) 978-0878933174.

2.Christopher D. Moyes, Patricia M. Schulte, Principles of Animal Physiology. Benjamin Cummings Publisher, 2008

3.Knut Schmidt-Nielsen, Animal Physiology: Adaptation and Environment. Cambridge UniversityPress.

4.Gilbert, Developmental Biology,

5.Tortora, Anatomyand Physiology

M.Sc. Biotechnology **Semester—III**

Course Title: Molecular Plant Physiologyand Developmental Biology,

Course Code No.17BT23DA2 **MM. Th80+ IA20 Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT I

Increasing crop productivity:

Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO 2 fixation-C3 , C 4 and CAM pathways. Biotechnological strategies for improving photosynthetic CO 2 assimilation in plants: ImprovingRubisco activity,

Photorespiration: photo respiratorypathway, Molecular Strategies of bypassingphotorespiration.

Nitrogen and Sulphate Metabolism: Nitrate and ammonium assimilation; molecular biology of Nodulation and Nitrogen fixation,uptake, transport and assimilation of sulphate.Improvingnitrogen use efficiencies (NUE).

UNIT II

Improving productivity under Climate change Stress Physiology: Impact of global climate change on agricultural production, reduced green house gas emission from agri- practices, UV-B radiation, Ozone depletion; Green house effect; effect of increased CO 2 and high O 3 on crop productivityand target for crop biotechnology, Physiological and molecular responses of plants to drought, salinity, high temperature and cold stress, Ionic and osmotic homeostasis; Stress perception and stress signaling pathways, Oxidative stress and reactive oxygen species scavenging, functional genomics & metabolomics of stress; Overcomingstress: breedingefforts, marker assisted breeding, transgenic approaches.

UNIT III

Improving quality of Cropplants:

Genetic manipulation primary and secondary metabolites: Genetic manipulation of composition and content of starch, amino acids (lysine and sulfur containing) and oil. Vitamin (vit. A) and minerals (Iron and Zinc), Plants as biofactories, biodegradable plastics,

Genetic manipulation of flavonoid and terpenoid pathways in plants and their value addition with significance in horticulture, agriculture and medicine, edible vaccines.

UNIT IV Developmental Biology

Polarity, Cell – Cell communication and interaction, Embryonic Pattern Formation – Embryogenesis and early pattern formation in plants. **Post-**

embryonic Development – Regeneration and totipotency; Organ differentiation and development; Maternal gene effects; Zygotic gene effects; Homeoticgene effects inplants;

Oraganisaion of shoot apicalmeristem (SAM), cytological and molecular analysis of SAM. Organization of root apical meristem, plant stem cells, leaf initiation, phyllotaxy, differentiationof epidermis (with special reference to stomata and trichomes) and mesophyll. **Molecular biology** of Flower initiation and development,

Practicals

1.Extraction and separation ofchlorophyll bychromatography. Absorption and action spectra ofchlorophyll.

2.Demonstration of Hill reaction and Oxygen evolved during photosynthesis Isolation and separation of amino acids by chromatography.

3.Estimation of enzymes related to nitrogen assimilation.

4.In vitro pollen germination and pollen tube length measurement. Experiments related to physiological effects of abiotic stresses.

Suggested Readings

1.Lincoln Taiz, Eduardo Zeiger, Plant Physiology, Sinauer Associates, 2010.

2.Bob Buchanan, WilhelmGruissem, Russell Jones,Biochemisrtryand Mol Biol Of Plants.John Wileyand Sons, 2002.

3.V. Raghuvan, DevelopmentalBiologyof Flowering Plants. Springer

4.Patterns inplantdevelopmentbySteeves TA and SussexIM.

5.Molecular plantdevelopment: fromgene to plant byPeter Westhoff,Oxford Univ. Press.

M. Sc. Biotechnology **Semester--III**

Choice Based Paper

MM. Th80 +

Course Title: Biostatistics **IA20**

Course Code No.17BT23DB1 **Time: 3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

Unit I

Sample size estimation and Design of experiments, randomization, replication local control, completelyrandomized and randomized blockdesign.Types of data, tabular and graphical

presentation of data. Measures of location, dispersion and correlation. Measures of central tendency. Mean, mode, median, quartiles,Measures of dispersion—range, standarddeviation

and error, Regression Analysis, Analysis of variance (ANOVA) for one and two way classification, Probability and statistical inference.

Unit II

Concept and probability distribution. Normal distribution—densitycurves, applications and statistical tables. Concept of significance tests, tests for proportion, students t and Ftests

Contingencytables of $\chi 2$

(Chi square), Random Variables and Distributions, Binomial, Poisson,

Exponential and Normal Distributions and their applications, Correlation: Simple, Partial and Multiple Correlation, Methodsof averages and least squares, polynomial fitting.

Unit III

Permutation and Combination, Functions, limits and continuity, Exponential and Logarithmic functions, Vector and Matrices, Algebra of matrices, Determinants and their simple properties, Rank of matrix, Consistency of system of linear equations andsolution of linearsystem of equations.Characteristic equation, Eigen values andEigen vectors,

Unit IV

Differential Calculus, Rules of differentiation, Derivatives of implicit functions, Parametric differentiation, Higher derivatives, Maxima and minima, Partial differentiation Integration, Integration by parts, Definite integral, Properties of definite integrals, Differential Equations,

Separable variable, homogenous, exact and linear equationsof secondorder.

PRACTICALS

1.Calculationfor statistical significance in the given datafor Studentpaired andunpaired t- test.

2.Applying ANOVA to the given set of concentration Vs time data of two drug formulations to comment about theirbio-equivalence.

3.ApplyingANOVA to the given set of treatments Vs cultivar data of agricultural crops for statistical significance.

4.ApplyingDuncan's multiplerange test (DMRT) and/or Tukey's test on given set of data.

5.Construction of diagrams and graphs (line andbar graphs) forstatisticallysignificant population ingiven set of data.

BOOKS

1.Statistical Analysis of Non normal data, By: J.V. Deshpande, A.P. Gore, A. Shanubhogue, New Age International Publishers Ltd.

2.Statistical methods inAnimal Sciences, By: V.N. Amble, Indian SocietyAgricultural Statistics (New Delhi)

3.Statistical Procedure for Agricultural Research By: Kwanchai A Gomes Arturo A.Gomez, John Wileyand Sons.

4.A text bookof Agricultural Statistics. By: R. Rangaswamy, New Age International Pvt. Ltd.

5.Statisticsfor Agricultural Sciences.By: G. Nageswar Rao,Oxford and IBH PublishingCo.

6.SP Gupta, Statistical Methods S Chand and Sons2004.

7.B LAgarwal, Basic Statistics, New Age. 2003.

M.Sc. Biotechnology	**Semester—III**
Course Title: VIROLOGY	**MM. Th80 +IA20**
Course Code No.	
17BT23DB2	**Time:3h**

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Unit 1:Introduction

Introduction: History and principles of virology, virus taxonomy, introduction to replication strategies. Structure and morphology of animal and plant viruses, **Infrastructure for virology**: Principles of bio-safety, containment facilities, maintenance and handlingof laboratoryanimals and requirements of virological laboratory.

Unit 2: Virological methods

Culture: Cultivation andpurification of viruses; estimationofyields, methodsforpurification.

Diagnostic methods: Immnuodiagnosis, haemagglutination and haemagglutinationinhibition tests, Complent fixation,flow-cytometryand imuno-histochemistry. **Microscopic techniques**: Fluorescence, confocal and electron microscopic techniquesprinciples and applications. **Nucleic acid based diagnosis**: Nucleic acid hybridization, polymerase chain reaction, Real Time PCR,RT-LAMP microarrayand nucleotide sequencing.

Unit 3:Antiviral and ViralVaccines

Viral Vaccines: Conventional vaccines killed and attenuated, modern vaccines—recombinantproteins, subunits, peptides, DNA vaccines. **Antiviral:** Interferons, designing and screening for antivirals, mechanisms of action, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. **Modern approaches of virus control**: Antisense RNA, siRNA, ribozymes, in silico approachesfor drugdesigning.

Unit 4:Virus Group

Clinical features, epidemiology, diagnosis and treatment of following viral group: Viral Cancers (HPV & EBV), **Viral Hepatitis** (HAV, HBV, HCV & HEV), **Respiratory Viral Diseases** (Influenza, Bird Flu, RSV and WNV), **Viral** PIV), **Viral Haemorrhagic Fevers (**Dengue & Chikungunya**), Viral Encephalitis** (JEV & **Enteric Diseases** (Rota virus & Polio), **Rabies and HIV/AIDS**.

Practical forVirology

1)Glassware decontamination, washing, sterilization,packingand sterile handling.
2)Media andreagents preparation, sterilitychecks.
3)Sample collection, transportandprocessingfor virus isolation.
4)Maintenance ofcell cultures.
5)Preparationofprimarycell culture.
6)ELISA for virus detection.
7)Direct and indirect Immunoflourescence assay(DFAand IFA) for the virus detection.
8)Heamagglutination assay&. Heamagglutination Inhibitionassay(HA& HI) for the virus detection.
9)PCR & RT-PCR for virusdetection.
10)Complement Fixation test for virus detection.
11)Rapid test for virusdetection.

Suggested readings

1. Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.),3rd Edition. Lippincott-Raven,Philadelphia,PA
2.Diagnostic Procedures for Viral, Rickettsial, and Chlamydial Infections. Edwin H. Lennette (Editor), David A. Lennette, Evelyne T. (Eds.) Lennette, Evelyne T. Lennette (Editor). Latest edition / Pub. Date: January 1995. Publisher: American Public Health Association Publications.
3.Antiviral Agents, Vaccines, and Immunotherapies. Stephen K. Tyring. Latest edition / Pub. Date: October 2004. Publisher: Marcel Dekker.
4.Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor). Latest edition / Pub. Date: July2005. Publisher: Wiley, John
&Sons, Incorporated.
5.Viral Hepatitis andLiver disease, A.J. Zuckerman.

M. Sc. Biotechnology **Semester-III**

Course Title: Nano-biotechnology

Course Code No.17BT23DB3 **MM. Th80 +IA 20**

Time:3hrs.

Note: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory

UNIT-I

Bionanotechnology: An OverviewFrombiotechnologyto Bio-nanotechnology.

Bio-nanomachines in actions, Molecular recognition & cellular communication NaturalBio-nanomachinery, Protein folding, self assemblyand self- organization

UNIT-II

Bio- Nanotechnology: Synthesis, Properties & characterization

Carbon Nanotubes, Gold-, Silver- and Zinc oxide - nanoparticles, Physical, Optical, magnetic, chemical, antimicrobial properties of Nanoparticles and there characterization with XRD, SEM/TEM, UV-Visible spectroscopy techniques, FTIR, Photoluminescence spectroscopy, etc.

UNIT-III

Advances in Biomolecular Design: Molecular Modeling and Biomolecular structure determination, DNA- Protein Nanostructures, DNA directed immobilization, Chip Based DNA detection assays, Microarray Technologies, Luminescent quantumdots for Biological Labeling.

Unit-IV

Bio-nanotechnology Applications: Agricultural Productivity Enrichment; Disease Diagnosis and Screening; Pharmacy & DrugDeliverySystems: Food Processingand Storage; Vector and pestdetection andcontrol.

Practicals

Chemical Synthesis of Goldnanopartices.
Chemical synthesis of Zinc oxide nanopartices.
Green synthesise of Silver nanopartices.
Green synthesise of Zinc oxidenanopartices.
Characterization of Goldnanopartices.
Characterization of Zincoxidenanopartices.

SUGGESTED BOOKS

1.Gero Decher, JosephB. Schlenoff, Multilayer Thin Films, Wiley- VCH Verlag, GmbH & Co. KGaA, 2003.
2.David S. Goodsell,Bionanotechnology: Lessons from Nature, 1st Edition,Wiley-Liss, 2004.
3.Neelina H. Malsch,Biomedical Nanotechnology, 1st Edition,CRC Press,2005

M. Sc. Biotechnology **Semester-IV**

Course Title: IPR, BIOSAFETY, ETHICAL, LEGAL & SOCIAL ISSUES IN BIOTECHNOLOGY
Course Code No.17CBT24C1 **MM. Th80 +IA 20**
Time:3hrs.

NOTE: In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.

Theory:

UNIT I

IPR - patents and copyrights. Patentability of life forms with special reference to Microorganisms, Pharmaceutical industries, Biodiversity, Naturally occurring substances. GMO, Human genome and IPR. Issue on IPR in Public- Private partnership. Availabilities of Patent facilitating funds, Substantive Patent Law Treaty (SPLT), World patent, European Patent

UNIT II

Social- genetic discrimination: insurance and employment, human cloning, foeticide, sex determination.

Ethical: somatic and germ line gene therapy, clinical trials, ethical committee function.Social and ethical issues

UNIT III

Bio-safety- Definition, Requirement, Bio-safetycontainment facilities, biohazards, genetically modified organisms (GMOs), living modified organisms (LMOs), Biosafety for human health and environment designing and management of laboratoryand culture room as per the norm of GLP, GMP and FDA.

UNIT IV

Management-Planning, Organizing, Leading & Controlling; Concepts and characteristics of information; Importance of MIS; Communication - type, channels & barriers; Financial management, planning and *control,* Characteristics of agricultural products; Problems of processed food marketing; Procurement & distribution systems; Location factors and other problems in processingof agricultural products.

Suggested Reading

1.Peter Dabrock, Jochen Taupitz , Jens Ried (Editor) Trust in Biobanking: Dealing with Ethical, Legal and Social Issues in an EmergingField ofBiotechnology. Springer, 2012.
2.Robert A. Bohrer, A Guide toBiotechnologyLaw and Business, Carolina Academic Press, 2007.
3.Richard Sherlock & JD Morrey, Ethical Issues in Biotechnology, 2002. 4.Selected papersfromscientific journals and websites

M.Sc. Biotechnology **Semester-- IV**
MM. Th 80 + IA
Course Title: Microbial Technology ***20***
Course Code No.17CBT24C2 ***Time: 3h***

NOTE: **In all nine questions will be set, two from each unit and one compulsory question of short answer type covering all the units. Students are required to attempt one compulsory question and four others selecting at least one fromeach unit. All questions areof equal marks.**

Theory

UNIT I

Microbes in food industries, Preservation of foods by different methods such as high temperature, low temperature, chemical additives and irradiation. Basic concepts of D-value,Z- value, 12-D concept and F-value. Biochemical changes caused by microorganisms, Spoilage of various types of food product (Milk, meat, bread, fruits and vegetables). Food poisoning

(Botulism, *Staphylococcal aureus* infection , Salmonellosis, Shigellosis, Food infections caused by*C. jejuni, H. pylori, Y. enterocolitica, V. cholerae, V. parahaemolyticus, B. cereus*)and microbial toxins, microbial standards for different foods.

UNIT II

Basic concepts of upstream and downstream processes, Different parts of Bioreactor; aeration and agitation system (e.g. baffles, spargers, impellers); pH, temperature, redoxpotential and oxygen measurement and its control in a bioreactor; Use of computers in a bioreactor; Microbial production and uses of antibiotics like penicillin, streptomycin, tetracycline, immunosupressor, enzymes like proteases, amylases, cellulases, lipases, glucose isomerases, glucose oxidases, bacterial insecticides and Xanthan gum; Basic conceptof Immobilized enzyme technology.

UNIT III

Microbial production of anti-cancer agents and antioxidant drug: production of CoQ10, beta- caretonid, astaxanthine, demethylated colchicines; and its derivative, glucosamine, Steroid transformation, Microbial production of Industrial alcohol , Microbial production of beer, ale, wine, whisky, rum, vodka, brandy, champagne, Microbial production of methanol and unsaturated fatty acid, Microbial production and uses of riboflavin, Vitamin B12, L-lysine and Glutamic acid production, Use of microbes in mineral recovery.

UNIT IV

Biological warfare agents; Mode of action of antibiotics (acting on cell walls, cell membranes, protein biosynthesis and nucleic acid biosynthesis); antiviral chemotherapy; Anti-fungalchemotherapy, Mechanism of drug-resistance and multiple drug-resistance; Bacterial vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins and edible vaccines; Various sterilization techniques:biohazard hood, BSL1, 2,3,4.

REFERENCE BOOKS

1)Principles of fermentation technology, Stanbury P.F. et al, Butterworth-HeinemannLtd, Oxford Industrial MicrobiologybyCasida.
2)Industrial MicrobiologybyCruger Food MicrobiologybyFrazier.

M. Sc. Biotechnology **Semester-IV**

Course Title: Dissertation **Marks : 300**

Course Code No.17CBT24C3 **(Dissertation:200+ Viva voce100)**

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