Syllabus for B.Sc.(Biotechnology)
SEP-2024

SemesterI								
Sl. No	**Course Code**	**Title of the Course**	**Category of Courses**	**Teaching Hours per Week**	**SEE**	**IA**	**Total Marks**	**Credits**
1		Cell Biology and Genetics	Theory	4	80	20	100	3
2		Cell Biology and Genetics practical	Practical	4	40	10	50	2
Semester II								
3		Biochemistry and Biophysics	Theory	4	80	20	100	3
4		Biochemistry and Biophysics Practical	Practical	4	40	10	50	2
SEMESTER III								
5		Microbiology and Immunology	Theory	4	80	20	100	3
6		Microbiology and Immunology practical	Practical	4	40	10	50	2
SEMESTER IV								
7		Molecular Biology and Recombinant DNA Technology	Theory	4	80	20	100	3
8		Molecular Biology and Recombinant DNA Technology Practical	Practical	4	40	10	50	2
ELECTIVE COURSES - III								
9		Biotechnology in Daily life	Theory	2	40	10	50	2
ELECTIVE COURSES - IV								
10		Applications of Biotechnology in Agriculture	Theory	2	40	10	50	2

Core Courses

SEMESTER-I

Code :CELL BIOLOGY AND GENETICS 56 hours

Course Outcomes: After successful completion of this Course, students will be able to:
CO 1. Understand concepts of Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology, genetics, biochemistry, microbiology, and molecular biology
CO 2. Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton
CO 3. Understand phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and cell cycle regulation.
CO 4. Comprehend organization and structure of chromosomes, and Mendelian laws of inheritance, deviations and exceptions to these laws.
CO 5. Describe mutations at the molecular level, types of mutations, genetic or hereditary disorders and concepts in population genetics

UnitI (14 hours)

Discovery of cell, the cell Theory, classification of cell types. Levels of organization in cell biology: cell, tissue, organs and organism. Ultra structure of a eukaryotic cell- (Both plant and animal cells),Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes. Cellular Organelles: Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments)

UnitII (14 hours)

Chromosomes and cell division: General Introduction, Discovery, Morphology and structural organization –chromatids, Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Nucleosome organisation. Special type of chromosomes: Salivary gland and Lamp brush chromosomes.
Cell Division: Cell cycle, phases cell division. Mitosis and meiosis, regulation of cell cycles cell cycle checkpoints. Significance of cell cycle,synaptonemal complex.Cell Senescence and programmed cell death.

UnitIII (14 hours)

Mendelian laws of inheritance - dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance, complementary, supplementary and interaction of genes (13:3 ratio), epistasis, polygenic inheritance and multiple alleles.
Maternal Inheritance: Extrachromosomal inheritance, mitochondria and chloroplast genetic systems.Sex-linked inheritance, Chromosome theory of inheritance.
Sex determination in plants and animals: Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types.

UnitIV **(14 hours)**

Finestructureof gene-recon,mutonand cistron.

Mutations: Types of mutations, Spontaneous and induced mutations, Mutagens chemicalandphysicalmutagens,inducedmutationsin plants and microbes and its applications.

Structural and numerical aberrations of chromosomes; evolutions of wheat, and cotton

Hereditary defects: Kleinefelter, Turner, Cri-du- Chat and Down syndromes. Analysis of mutations in Biochemical pathways, one gene - one enzyme hypothesis. Population genetics: Hardy- Weinberg equilibrium, gene, genotypes and gene frequencies.

References

DaleJW.1990.*Molecular genetics of Bacteria*.John Wileyand Sons.

DeRobertisEDPandDeRobertisEMF.1995.*CellandMolecularBiology*.8th edition, BI Waverly Pvt.Ltd., New Delhi.

Gardner*etal*.2003.*PrincipleofGenetics*-8th edition.JohnWileyandSons,New York.

GuptaML.andML.Jangir.2002.*CellBiology-FundamentalsandApplications*. Argosies, Jodhpur, India.

Lewin B.1994. *GenesVII*5th edition. Oxford University Press,London.

PowarCB.*CellBiology*3rd edition.HimalayaPublishingHouse,Mumbai.

Rajeshwari S Setty and V.Sreekrishna.2002.*Biotechnology*-2(Cellbiology, Genetics, Microbiology). New Age International Publishers, New Delhi.

TaylorDJ.GreenNPOandStoutGW.1998.*BiologicalScience*3rd Edition, Cambridge edition, Cambridge University Press, UK.

Sub Code :CELL BIOLOGY AND GENETICS PRACTICAL

1. Study and maintenance of simple and compound microscope
2. Use of Micrometer and calibration, measurement of onion epidermal cells
3. Study of divisional stages in mitosis from onion root tips
4. Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
5. Salivary gland chromosome isolation and staining.
6. Buccal smear – Barr bodies
7. Counting of RBC/WBC by Haemocytometer.
8. Karyotype analysis
9. Isolation of chloroplast.
10. Study of drosophila.
11. Separation of drosophila eye pigment by paper chromatography
12. Simple genetic problems based on theory

SEMESTER–II

Sub Code :BIOCHEMISTRY AND BIOPHYSICS 56 hours

Course Outcomes (COs): At the end of the course the student should be able to:

CO 1. Acquire knowledge about types of biomolecules, structure, and their functions

CO 2. Will be able to demonstrate the skills to perform bioanalytical techniques

CO 3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Unit I ` **(14 hours)**

Aimsand scopeof biochemistryand biophysics

General classification, structure and functions of biomolecules: carbohydrates, proteins,lipids and nucleic acids. Detailed structure and general properties of monosaccharides, glycosidic bond; structural polysaccharides - cellulose, chitin, peptidoglycans; storage polysaccharides - starch, glycogen. Classification of standard amino acids, peptide bonds, general properties of amino acids, titration curve. Protein structure - primary, secondary, tertiary and quaternary with examples.

UnitII **(14 hours)**

Enzymes: History, general properties, active site, Michelis Mentonequation,allosteric enzymes; nomenclature and classification. Enzyme inhibition types- reversible, non-competitive and uncompetitive with examples. Multienzyme and isoenzyme with examples. Brief account of applications enzymes: enzymes in genetic engineering - restriction enzymes and polymerases; enzymes in clinical significance - LDH, SGOT, SGPT and diagnostic kits.

UnitIII **(14 hours)**

Structure and function of water, pH impact on biomolecular reactions, Handerson and Hasselbach's equation with applications. Buffers- types and applications. Laws of thermodynamics, free energy, ATP as biological energy currency.

Lambert - Beer's law, absorption spectrum, absorption maxima. UV-Vis spectroscopy; mass spectroscopy, atomic absorption spectroscopy with applications. Brief account of principles and applications to understand the structure of molecules: X-ray crystallography and NMR.

UnitIV **(14 hours)**

Microscopy: Magnification, Resolution power, Optical - Bright field, dark field, phase contrast and fluorescence; Electron microscopy - TEM and SEM. Partition coefficient, Paperandthinlayerchromatography-principle,methodology,applications and significance of Rf value. Gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performance liquid chromatography. Principle, procedure and applications of electrophoresis- agarose and polyacrylamide gel electrophoresis. Centrifugation: differential, density gradient and ultra - principle, instrumentation and applications

References

AroraMP.2007.*Biophysics.*Himalaya PublishingHouse,NewDelhi.

Bialek W. 2012. *Biophysics: Searching for Principles*. Princeton University Press.

DaSkoogeHolt-Saunders.1985.*Principlesofinstrumentalanalysis*.HoltSaunders.

LeningerAL,NelsonDLandCoxMM.1993.*PrincipleofBiochemistry.*CBSPublications. Nickolas CPL.1982. *Fundamentals of Enzymology*. Oxford Publishers.

StryerL.1988.*Biochemistry*3rdedition,Freeman&Co,New York.

Trevor.Enzymebiochemistry,BiotechnologyandClinicalChemistry.HarwoodPublishers.

UpadhyayandUpadhyay A.2000.*BiophysicalChemistry-PrinciplesandTechniques*. HimalayaPublishers,NewDelhi,

ZubayJ.1988. *Biochemistry*2ndedition.MacMillanPublishingCompany,NewYork.

Sub Code :BIOCHEMISTRY AND BIOPHYSICS PRACTICAL

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Microscopy
3. Preparation of standard buffers– Citrate and phosphate, determination of pH of solution using pH meter.
4. Qualitativetestsforcarbohydrates-monosaccharides,disaccharidesandpolysaccharides.
5. Qualitative tests for proteins.
6. Estimation of maltose by DNS method
7. Determination of α-amylase activity by DNS method
8. Estimation of proteins by Lowry's and Biuret method
9. Lambert – Beer's law
10. Absorption maxima of a solution
11. Paper chromatography
12. Thinlayerchromatography
13. Gel Electrophoresis

SEMESTER–III

Sub Code :MICROBIOLOGY AND IMMUNOLOGY 56 hours

After successful completion of this Course, students will be able to:

CO 1. Understand Historical prospective and scope Microbiology

CO 2. Experiment with various methods of sterilization in microbiological work

CO3. Prepare different types of media, perform culture methods, preservation of microorganisms for isolation, characterization of microbes

CO 4. Handle and use antimicrobial agents and perform anti-microbial assays

CO 5. Demonstrate the Laboratory skills in basic and applied microbiology with reference to technological aspects.

CO6.Demonstrate comprehension of the underlying structure and function of the immunesystem and related disorders.

CO 7. Demonstrate an understanding of the role of cells and molecules in immune reactions and responses

CO8. Demonstrate technical skillsin immunological tools and techniques

CO 9. Explain the fundamental concepts of immunity, and the contributions of the organs and cellsin immune responses.

CO 10. Realize how the MHC molecule's function and host encounters an immune insult.

CO 11.Understand the antibodies and complement system

CO12. Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences

UnitI (14 hours)

Aim, scope and historical perspectives of microbiology. Contributions of early microbiologists: Leeuvenhoek, LouisPasteur,RobertKoch andEdwardJenner.General classification of microbial kingdom - classical, nutritional and molecular approaches. Conceptsof sterilization and disinfection: dry heat, moist heat, radiation, chemical and filtration. Introductive concepts in virology- classification, structure and life cycle - lysogenic and lytic cycle.Antibiotics:classification and mode of action.

UnitII (14 hours)

Prokaryotic and eukaryotic microbesand theircharacteristics.Structureand functions of microbial cell wall, lipopolysaccharides, flagella, capsules, endospores, pili (fimbriae), cell membranes and cell inclusions.

Culture Media: Components of media, natural and synthetic media, selective, differential, indicator, enriched media.

Pure culture methods: Serial dilution and plating methods (pour, spread, streak); maintenance and preservation/stocking of pure cultures

Microbes in extreme environments- thermophiles, psychrophiles, acidophiles, alkaliphiles, halophiles and barophiles. Microbe -microbe interactions.

UnitIII (14 hours)

Historical perspectives in immunology, Origin and diversity of immunology. Classificationofimmunity:innateandadaptiveimmunity. Immune systems:organs,cells ofimmune system. Role of B cell and T cell in humoral and cell mediated immunity.Majorhistocompatibilitycomplexes(MHCs)-types,structureandtheir functions.Structure, types and functions of antigens. Haptenes and adjuvants, Structure, types and functions of antibodies.

UnitIV (14 hours)

Antigen-antibodyreactions - precipitin test, agglutination test, complement fixation (or complement cascade) reaction and ELISA. Immunoblot - types, principle and applications. Immunological disorders -autoimmune diseases - Brief descriptions of two autoimmune diseases- Rheumatoid arthritis and myasthenia gravis. Acquired immunodeficiency syndrome: description of causative agent, and briefly description of mechanisms. Hypersensitivity and allergy. Vaccines-classical and modern.

References

AbbasA, Lichtman AHand Pillai S. 2015.*Cellular and Molecular Immunology.*Elsevier Saunders Co.

BrockTBandMadigon.1988.*BiologyofMicroorganisms*.PrenticeHall,NewJersey. Cassida, L.E. 1968. *Industrial Microbiology*John Wiley & Sons.

Ivan Riott JonathanBrostoffandDavidMale.*Immunology*3rdedition.MosbyPublishers. Janeway and Travers.*Immunobiology* 3rd edition. Churchill Livingstone Publications.

KubyJ. 2000. *Immunology*.Freemanand CompanyPublishers.

Maloy SR. Friefelder 1994. Microbial Genetics. Jones and Bartlett Publishers.PelczarJ.andChanECS.1993.*ElementofMicrobiology*MacGrawHill,NewYork.

PelczarMJ,ReidRDandChanECS.1997.*Microbiology,dynamicsanddiversity*.Haricot Brace College Publishers.

PrescottLM,HarleyJKandOxfordDA.1993.*Microbiology*.WMCBrownPublishers, USA.

SchlegelHarisG.1988.*GeneralMicrobiology*6thedition. CambridgeUniversityPress, UK.

Sharma PD.1991.*Microbiology*, Rastogi Publications, Meerut.

Subba Rao N.S. 1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi

Torture GJ, Frank BR, and CaseCL.1992. *Microbiology- An Introduction.*Communing Publishing Company Inc, California.

Sub Code :MICROBIOLOGY AND IMMUNOLOGY PRACTICAL

1. Instrumentation and microscopy with special reference to microbiology andimmunology.
2. Sterilization techniques – dry heat sterilization with hot air over, wet heat sterilization with autoclave, membrane filtration and assessment for sterility
3. Preparation of culture media for bacteria, fungi and their cultivation
4. Plating technique –pour plate and spread plate
5. Isolation of microorganisms - air, water, human body and soil.
6. Study of bacterial colony characteristics.
7. Purification of bacterial and fungal cultures using streak plate technique/mycelial bit transfer
8. Culture preservation techniques – slant and stab culture
9. Staining of microorganisms - Gram staining, capsule staining, spore staining, negative staining.
10. Biochemical activitiesofmicroorganisms -indole,methyl red,VogesProskauerandcatalase tests.Starch hydrolysis, Catalase test, Gelatin hydrolysis
11. Antibioticsensitivityof microorganisms. .
12. Blood grouping and Rh factor determination.
13. Studyofdifferenttypesofleucocytes.
14. Immunodiffusionstudies.
15. Dot ELISA

SEMESTER-IV

Sub Code :MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
56 hours

Course Outcomes (COs): At the end of the course the student should be able to:

CO 1. Study the advancements in molecular biology with latest trends.

CO 2.Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.

CO 3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

CO 4. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.

CO 5. Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.

CO 6. Perform laboratory procedures and develop practical skills in genetic engineering techniques.

CO 7. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.

CO 8. Stay updated with recent advancements in genetic engineering, critically evaluate emerging trends, and assess their potential impact on various fields.

UnitI **(14 hours)**

Discovery, structure and types of DNA and RNA. Experiments on DNA as genetic material. ReplicationofDNAinprokaryotesandeukaryotes.– Enzymes and proteins involved in replication, Theta model and rolling circle model. Polymerases and all enzyme components.Mechanisms of DNA recombination in prokaryotes and eukaryotes. DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair.

UnitII **(14 hours)**

Structureofprokaryoticandeukaryotic genes.Cerntral dogma of molecular biology. Transcription in prokaryotes RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, mechanism of transcription initiation, promoter clearance, elongation and termination. Post transcriptional modification. RNA splicing and processing: Genetic code and its characteristics, Translation- in prokaryotes and eukaryotes.Prokaryoticgeneexpression- *lac* And*trip*..

UnitIII **(14 hours)**

Aims, objectives and scope of gene cloning and steps involved recombinant DNA technology. Isolation and purification of DNA from bacterial, plant and animal cells. Tools of DNA modification: restrictionenzymes-properties,classification,typeswithexamples;ligation,DNAmodifying enzymes.DNA vectors: plasmids, bacteriophages,cosmids, BAC, YAC,plant and animal viruses. Gene transfer technique.

UnitIV **(14 hours)**

Genomic and cDNA libraries: features, construction and application. Screening and selection of recombinants by selection media, insertional inactivation. PCR- principle, protocol and applications. DNA sequencing- Sanger's, next generation sequencing. Gene editing techniques principle and applications. Blotting techniques: Southern, Northern and Western-principle and applications. Probes - types, preparation and application. DNA finger printing-principle and applications. Hazards and biosafety measures for recombinant DNA technology and GMOs.

References

Alberts B, Bray D, Lewis J, Raff M, Roberts K and Watson JD. 2002. *Molecular Biology of the Cell* 4th edition. Garland Publishing, Inc., New York.

Cooper GM. 2000. *The Cell - A Molecular Approach* 2nd edition. Sunderland (MA): Sinauer Associates, Inc.

De Robertis EDP and De Robertis EMF. 1995. *Cell and Molecular Biology*. 8th edition, BIWaverly Pvt.Ltd., New Delhi.

JogdandSN. 2004.*GeneBiotechnology.* HimalayaPublishingHouse,Bangalore,New Delhi.

Karp, G. 1999. *Cell and Molecular Biology* - Concepts and experiments. 2nd edition. Wiley& Sons, New York

Lodish H, Berk A, Zipursky SL, Paul Matsudaira and David Baltimore. 2000. Molecular cell Biology, 4th edition. WH. Freeman and Company, New York.

Old RW andPrimrose SB. 1994. *Principles of gene manipulation*: an introduction to genetic engineering5th edition.Blackwell Scientific Publishers, Oxford, Boston.

PrimroseSB,RichardM.TwymanRMandOldRW.2002.*PrinciplesofGeneManipulation* 6th edition.Blackwell Publishers.

Watson JD, Gilman M, Witkowski J and Zoller M. 1992. *Recombinant DNATechnology* 2nd edition.Scientific American Books, New York.

WatsonJD*etal*.1987.*MolecularBiologyofgene*.4th edition.BenjaminCumming Publishers,

WilsonK.andWalkerJ.2005. *Principls andTechniquesofBiochemistryandMolecular Biology*6th edition. Cambridge UniversityPress.

Sub Code :MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY PRACTICAL

1. Preparation of DNA model
2. IsolationofDNAfrombacteria,plantandanimaltissues.
3. Isolation of RNA
4. TestsforDNA/RNA/proteinsisolatedfromtissues
5. Estimation of DNA by DPA method
6. Estimation of RNA by Orcinol method
7. Column chromatography – gel filtration (Demo)
8. Agarose gel electrophoresis to separate DNA
9. SDSPAGE
10. ligation
11. Restriction digestion
12. Bacterial transformation
13. Western blotting technique

Syllabus for B.Sc.(Biotechnology)
CBCS-2025
ELECTIVE COURSES

SEMESTER III

BSCBTOE283: BIOTECHNOLOGY IN DAILY LIFE **28 hours**

Unit I **(14 hours)**

Definition and History of Biotechnology, Scope and Importance of Biotechnology. Microbial world, fermentation. Applications of Biotechnology in Industry: Production of citric acid, alcoholic beverages, Enzymes like proteases, lipases and amylases. Plant biotechnology- GM crops, gene transfer technology, bioreactors, disease control through Bt genes. Applications of Biotechnology in Agriculture: Biofertilizers, Biopesticides, Transgenic plants, Mushroom production

Unit II **(14 hours)**

Applications of Biotechnology in Medicine and pharmaceuticals: Insulin therapeutic molecules like tPA, factor VIII, antibiotics. Animal biotechnology – transgenic animals, test tube babies (*In-vitro* fertilization), ethical issues, animal bioreactors, stem cells, stem cell therapy, Environmental biotechnology- composting, biodegradation, biotransformation, biomining. Applications of Biotechnology in Environmental pollution control: Municipal Solid waste management, sewage and industrial effluent treatment, biofuels, Petroleum degradation.

References

Brock TB and Madigon. 1988. *Biology of Microorganisms*. Prentice Hall, New Jersey.

Bajaj YPS. 2007. *Biotechnology in Agriculture and Forestry*. Springer Verlag Publishers.

Chawla HS. 2004. *Introduction to Plant Biotechnology*. Science Publications. Inc.

Houdebine LM.2003.*Animal Transgenesis and Cloning*. John Wiley &Sons.

Ian Freshney R.2000.*Culture of Animal Cells*: A Manual of Basic Technique 4th edition. Wiley-Liss.

Jay JM, Loessner MJ and Golden DA. 2005. *Modern Food Microbiology*. Springer Publication, New York.

Jogdand SN.2010. *Environmental Biotechnology*. Himalaya Publishing House, Bangalore, New Delhi.

Jogdand SN. 2004. *Gene Biotechnology.* Himalaya Publishing House, Bangalore, New Delhi.

PannoJ.2005.*Animal Cloning*: The Science of Nuclear Transfer. Facts on File Inc.

Prave P. *et al*. 1987. *Fundamentals of Biotechnology*.Wiley-Black well Publications.

Russell, G.E. 1988. *Biotechnology of Higher Plants*. Intercept Publications.

Subba RaoN.S.1974. *SoilMicrobiology*, 4th edition, Oxford & IBH Publishers, New Delhi

SEMESTER IV

BTC 302APPLICATIONSOFBIOTECHNOLOGY INAGRICULTURE

28 hours

Course Outcomes:

After successful completion of this Course, students will be able to:

CO1.Understand the biotechnological applications in agriculture

CO2.Understandtheimportanceofbiotechnologicalmethodssuchasplanttissueculture

CO 3.Comprehend the pros and cons of GM crops and their plant products

CO4.Appreciatethebiotechnologicalapplicationsforeffectivepestcontroland crop improvements

Unit I (14hours)

Agricultural Biotechnology: Concepts and scope of biotechnology in Agriculture. Plant tissue culture, micro propagation, entrepreneurship in commercial plant tissue culture. Banana tissue culture–primary and secondary commercial setups, Small scale bioenterprises: Mushroom cultivation.

UnitII (14hours)

Transgenic plants: The GM crop debate–safety, ethics, perception and acceptance of GM crops GM crops case study: Bt cotton, Bt brinjal. Plants as biofactories for molecular pharming; edible vaccines, plantibodies, nutraceuticals.

Genetic engineering for quality improvement: Seed storage proteins, Flavours- capsaicin, vanillin.

References:

Chrispeels M.J. and Sadava D.E.(1994) Plants, Genes and Crop Biotechnology, 2nd Ed., Jones and Bartlett Publishers, Boston.

Gamborg O.L. and Philips G.C.(1998) Plant cell, tissue and organ culture, 2nd Ed., Narosa Publishing House. New Delhi.

Gistou, P. and Klu, H.(2004). Hand book of Plant Biotechnology (Vol.I&II).John Publication.

Hammond J., McGarvy P. and Yusibov.V.(2000). Plant Biotechnology, Springer Publ.

Heldt.H.W.(1997).Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

Kyte,L., Kleyn,J., Scoggins, H., and Bridgen M.(2003) Plants from test tubes. An introduction to micropropagation, 4th Ed., Timber Press, Portland.

Murray D.R. (1996) Advanced methods in plant breeding and biotechnology. Panima Publishing Corporation.

Nickoloff, J.A. (1995). Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana Press Incorp, USA.

Sawahel, W.A.(1997). Plant genetic transformation technology. Daya Publishing House, Delhi.