SYLLABUS

BIOTECHNOLOGY

M.SC. (PREVIOUS) EXAMINATION, 2015

M.SC. (FINAL) EXAMINATION, 2016

JAI NARAIN VYAS UNIVERSITY

JODHPUR

M.Sc. Biotechnology

COURSE CONTENTS

BT: 101 Cell Biology and Biomolecules

BT: 102 Microbial Physiology and Genetics

BT: 103 Molecular Biology and Genomics

BT: 104 Biology of Immune System

BT: 105 Genetic Engineering

BT: 106 Plant Biotechnology

BT: 107 Animal Biotechnology, Bioprocess Engineering & Technology

BT: 108 Biodiversity , IPR, Biosafety and Bioethics

M.Sc. Final Project work/ Training

CALCULATION OF TEACHING LOAD

Total Number of working days per year 180 days

Total Number of teaching days 160 days

(Minus examination and preparation days)

Theory	250 Hrs
Practical	600 Hrs
Seminars	110 Hrs
Total	960 Hrs

Teaching load 6 Hrs per day

Total Teaching load 160 X 6= 960 Hrs per year

M.Sc. Biotechnology

Examination Marking Scheme for M.Sc. Biotechnology

M.Sc. Previous covering five theory papers

	Maximum Marks	Duration
BT 101	100	3 Hrs
BT 102	100	3 Hrs
BT 103	100	3 Hrs
BT 104	100	3 Hrs
BT 105	100	3 Hrs

Practicals

Board I covering theory papers BT 101, 102,103 Maximum Mark 150 (duration 6 hours).

Board II covering theory papers BT 104 and105, Maximum Marks 100 (duration 4 hours).

M.Sc. Final covering three theory paper and project work /training

	Maximum Marks	Duration
BT 105	100	3 Hrs
BT 106	100	3 Hrs
BT 107	100	3 Hrs

	Maximum marks	Duration
***Project work**	200	4 months
Training	50	

***1.** Experiments conducted during project by the candidates individually will be be evaluated by the subject experts appointed by HOD botany.

***2.** Project work done in group will not be accepted for evaluation.

***3.** Mere information regarding the institute / laboratory / methods /technique will not be considered as a project work.

***4.** It should not be a repetition of previous project / thesis / research work submitted anywhere. Project to be assigned and evaluated by subject teachers and coordinator.

*The certificate and format for Project are given as annexure I & II

Practicals

Board I covering theory papers BT 106,107,108. Maximum Marks 150 (duration 6 hours).

M.Sc. Biotechnology

BT: 101 - Cell Biology and Biomolecules

Unit I: Chemical foundations of biology-pH, pK value, acids, bases, buffers, weak bonds and covalent bonds. Principles of Thermodynamics. Amino acids and peptides reactions and physical properties. Sugars-classification and reactions. Lipids-classification, structure and functions. Proteins-classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in. structure and Ramachandran map. Separation techniques for different biomolecules.

Unit II: Diversity of cell size and shape. Cell theory, Structure of Prokaryotic and eukaryotic cells-isolation and growth of cells. Microscopic techniques for study of cells. Sub-cellular fractionation. Molecular organization of cellular organelles: plasma membrane-structure, models, sites for ATPase, ion carriers, channels, pumps and receptors. Call wallmacromolecules, architecture, molecular biology and biochemistry of cell will and its biogenesis. Tonoplast and nuclear membrane and their structural organization. Transport of nutrients, ions, and macromolecules across the membranes. Cellular energy transactions-role of mitochondria and chloroplast.

Unit III: Cell cycle: Molecular Cellular responses to environmental signals in plants and animals: mechanism of signal transduction. Structure and function of micro filaments and microtubules. Biosynthesis of proteins in Eukaryotic cell; Co and Post-translational modification.Intracellular protein traffic. Cellular bases of differentiation and development-mitosis, gametogenesis and fertilization. Introduction to necrosis, senescence apoptosis and cancer. Mechanisms of apoptosis. Biology of Cancer.

Unit IV: Metabolite pathways and its regulation(s). Glycolysis, TCA, oxidative phosphorylation and photophosphorylation. Photorespirtion. Secondary metabolites and their biosynthesis. Brief introduction to the life cycle and molecular biology of some important pathogens of AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar

Unit V: Protein localization: synthesis of secretary and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes; receptor mediated endocytosis. Development and applications of nanobiotechnology and nanosciences, nanoparticals delivery systems, biofilms/ quorum sensing, biosensors.

Practicals

1. Microscopy: Bright field, Phase contrast and Fluorescence microscopy.
2. Microtomy
3. Histo-chemical techniques.
4. Mitosis and Meiosis
5. Reactions of amino acids, sugars and lipids, including diagnostic tests.
6. Isolation, purity determination and quantitative analysis of DNA and RNA.
7. Quantitative analysis of proteins and sugars.
8. UV, visible and fluorescence spectroscopy and absorption
9. Separation techniques-centrifugation, chromatography (gel permeation, ion echange and TLC) and electrophoresis (PAGE SDS and AGAROSE).
10. Cleavage of DNA with restriction enzymes and electrophoresis of fragments.

Books

1. Molecular Biology of Celt, Alberts, B. et al.
2. Molecular Cell Biology, Lodish,H. et al.
3. Reproduction in Eukaryotic cells, Prescott, D.M. Academic Press
4. Developmental Biology, Gilbert Sinauer Associates Inc.
5. Cell in Development and Inheritance. Wilson EB, MacMilan, New York
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press
7. Fertilization, FT Longo, Chapman and Hall
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman Birkhuser.
9. Biochemical Calculations, Irwinn H. Segel, John Wiley and sons Inc.
10. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.,
11. Biochemistry, D. Voet and J.G. Voet. J. Wiley & Sons.
12. Physical Biochemistry, D.Freifilder, W. Freeman & Company.
13. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work.
14. Understanding Chemistry, C.N.R. Rao, Universities Press, Hyderabad, 1999.
15. A Biologist's guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edition, 1986.
16. Tools of Biochemistry by T.G. Cooper.

M.Sc. Biotechnology

BT: 102 -Microbial Physiology and Genetics

Unit I: History and development : of microbiology, **Microbial Evolution, Systematics and Taxonomy:** The evolution of earth and the earliest life forms; primitive organisms and their metabolic strategies and molecular coding; new approaches to bacterial taxonomy classification, including ribotyping; ribosomal RNA sequencing; characteristics of primary domains**;** taxonomic nomenclature and Bergey's -Manual**.**

Unit II : Methods in Microbiology: Pure culture techniques; different type's of sterilization; principles of microbial nutrition; Preparation of culture media. Biochemical characterization of pure culture. **Microbial Growth Kinetics :** The definition of growth, the growth curve, the measurement of ,growth and growth yields; synchronous growth; Batch culture, Fed batch culture and continuous culture; growth affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; culture collection and maintenance of cultures.

Unit III: Overview of Basic Metabolism and Microbial Nutrition. **Metabolic Diversity among Microorganisms** : Photosynthesis in. microorganisms; role of chlorophyll, carotenoids and phycobilins, Calvin cycle; chemolithotrophy; hydrogen iron nitrite oxidizing bacteria; nitrate and sulfate reduction; methanogenesis and acetogenesis; fermentations diversity syntrophy, role of anoxic decompositions; nitrogen metabolism fixation; hydrocarbon transformation.

Unit IV: Prokaryotic diversity, **Bacteria:** Purple and green bacteria; cyanobacteria; homoacetogenic bacteria; lactic and propionic acid bacteria; endospores forming rods and cocci; mycobacteria; rickettsias, chlamydias and mycoplasma. **Archaea:** Archaea as the earliest life forms; halophils; methnogens; hyperthermophilic archaea; thermplasma. **Eukarya** Algae, fungi, slime molds and protozoa. **Viruses:** The discovery _ classification, structure and genetics of viruses; positive strand, negative strand and double stranded RNA viruses; replication; examples of herpes, adenovirus, retrovirus, Bacterial, plant, animal and tumor viruses; Phage and its life cycle, RNA phages, RNA viruses; retroviruses. Viroids and prions.

Unit V: Prokaryotic Cells: Structure function: Cell walls of eubacteria (peptidoglycan) and related molecules, outer membrane of gram negative bacteria; cell wall and cell membrane synthesis; flagella and motility; cell. inclusions like endospores, gas vesicles.

Chemotherapy/Antibiotics: Antimicrobial agents; sulfa drugs; antibiotics; penicillin and cephalosporins; broad spectrum, antibiotics; antibiotics from prokaryotes; antifungal antibiotics; mode of mode; of action; resistance of antibiotics. Genes, mutation and mutagenesis: UV and chemical mutation. Bacterial Genetic system: Transformation, conjugation, transduction, recombination, plasmids and transposon, bacterial genetics map with reference *E. coli*. Genetic Systems of Yeast and Neurospora.

Practicals

1. Preparation of liquid and solid media for growth of microorganism
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of temperature.
3. Isolation of pure cultures from soil and water.
4. Growth; growth curve; measurement of bacterial population by turbidometry and serial dilutions methods. Effect of temperature. pH, carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by gram stain, acid fast stain and staining for spores.
6. Assay of antibiotics and demonstration of antibiotic resistance.
7. Bacterial transformation.
8. Biochemical characterization of selected microbes

Books

1. General al Microbiology, Stainer, R., Ingraba, J.I., Wheelis, M.I., and Painter, P.R. The McMillan Press Ltd.
2. Brock Biology of Microorganisms, Madigan, M.T., Martinko, J.M. and Parker, J. PrenticeHaO.
3. Microbiology, Pelczar, J.J., Je. Chan, E.C.S., and Kreig, N.R TataMcGrawHill.
4. Microbial Genetics, Maloy, S.R., Cronan, J.E. Je., and Friefelder, D. Jones and Bartlett Publishers.
5. Microbiology, A. Laboratory Manual, Cappuccino, J.G., and Sherman, N., Addison Wesley.
6. Microbiological Applications (A- Laboratory ' Manual in general Microbiology), Benson, H.J., W.C.B., Wm C. Brown Publishers.

BT- 103 -Molecular Biology and Genomics

Unit I: Introduction to Molecular Biology and Genetics. Genome sizes, organelle genomes. **DNA Replication:** Prokaryotic and Eukaryotic DNA replication, mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication. Genome packaging: nucleosome model, euchromatin and heterochromatin DNA. DNA damage and repair mechanism. Homologous Recombination of Holiday junction,

Unit II: Transcription : Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, regulatory elements and mechanisms of transcriptional regulations. 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. **Translation: -** Prokaryotic and Eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co and post-translation modifications of proteins.

Unit III: Oncogenes and Tumour Suppressor Genes : Viral and cellular oncogenes, tumour suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumour suppressor proteins. **Antisense and Ribozyme Technology:** Molecular mechanism of awakens molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

Unit IV: Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of Mapping population. simple sequence repeat loci, and VNTRs. Southern and fluorescence *in situ* hybridization for genome analysis, chromosome micro dissection and microcloning, molecular markers in genome analysis; RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease pathogenesis, genetic counseling, pedigree, varietals. Genomic libraries**,** YAC, BAC libraries. Transactions and recovery of clones, application of sequence information for identification of detective genes,

Unit V: Enzyme catalysis in solution kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Allosteric enzymes, mnemonical enzymes, kinetics of enzyme inhibitors. Physical and chemical methods for immobilization of small and macromolecules. Glyco and lipoprotein structure and function. **Organization of macromolecular complexes**-chromatin and ribosomes; protein denaturation. Nucleic acid hybridization-structural analysis and biological studies. Catalytic antibodies-Functional proteins structure and drug targets (enzymes and receptors). Computer Aided drug designing, computational techniques in structural analysis.

Practicals

1. Isolation of genomic DNA.
2. RFLP analysis
3. Isolation blotting
4. Northern blotting
5. Electrophoresis of proteins native and under denaturing conditions.
6. N and C terminal analysis of analysis.
7. Separation techniques HPLC, ion exchange, gel filtration and affinity chromatography.
8. Enzyme: purification and kinetic analysis.
9. Electrophoresis of DNA liner, circular and super coiled.
10. Nucleic acid hybridization.

Books

1. Molecular cloning: A Laboratory Manual, J. Sambrook, E.F., Fritsch and T. Maniatis cold spring Harbor Laboratory Press, New York. 2000
2. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & sons Ltd. New York, 1998.
3. Molecular Biology Lab fax, T.A. Brown (ed.) Bios scientific Publishers Ltd. Oxford 1991.
4. Molecular Biology of the Gene (4^{th} edition), J.D. Watson, N. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, the Bejamin/Cummings Pub. Co. Inc. California, 1987.

5. Molecular Cell Biology (2nd,.Edition), J. Darnell, H. Lodish and D. Baltimore, Scientific American Books Inc, USA 1994.
6. Molecular ' Biology of the Cell (2nd edition), B. Alberts, D. Bray, J. Lewis, M. Raft, K. Roberts, and J.D. Watson, Garland Publishing Inc., New York, 1994.
7. Gene. VIII, Benjamin Lewin, Oxford University Press, U.K., 1998.
8. Molecular Biology, and' Biotechnology, A Comprehensive Desk Reference, R.A. Meyere (ed.), VCH Publishers Inc., New York, 1995.
9. Genomes, T.S. Brown.
10. 8th Day of Creations.
11. Essentials of Molecular Biology, David Friefilder, Jones and Bartlett Publications.
12. Protein Structure and Molecular Properties, TE Creighton, WH Freeman company
13. Introduction to Protein Structure. Brandon and J. Tooze, Garland Publishing; New York.
14. Encyclopedia of Molecular' Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
15. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons.
16. Introduction to Biophysical Chemistry, R.B. Martin, McGraw Hill, New York.
17. Biophysical Chemistry, Cantor, W.H. Freeman.
18. Protein Structure, Max Peruz.

M.Sc. Biotechnology
BT: 104 - Biology of the Immune system

Unit I: Phylogeny of immune system, Innate and acquired immunity, Clonal selection theory. Organization and structure of lymphoid organs, Nature and biology of antigens and super-antigens, Antibody structure and function, Antigen-antibody, interactions.

Unit II: Major histo-compatibility complex, BCR & TCR generation of diversity, Complement system. Cells of the immune system: Hematopoiesis and different lineages of immune cells, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer cell, lymphokine activated killer cells, eosinophil, neutorphils and mast cells.

Unit III: Regulation of immune response. Antigen processing and presentation, generation of humoral and cell mediate immune responses. Activation of B and T-lymphocytes, lymphocyte trafficking. Cytokines and their role in immune regulation, T-cell regulation, MHC restriction of T cell. Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity.

Unit IV: Immunity to infectious agents (intracellular parasites, helminthes and viruses). Tumour immunology**.** AIDS and other immunodeficiencies; Hypersensitivity, Autoimmunity, Transplantation, monoclonal antibodies. Hybridoma technology .

Unit V: Techniques to study antigens and antibody : Agglutinization, Hemeagglutinization, Single and double diffusion methods, immunoelectrophoresis, Immunoblotting , ELISA, ELISPOT assay, Immunohistochemistry , FACS .

Practicals

1. Blood film preparation and identification of cells
2. Lymphoid organs and their microscopic organization
3. Double diffusion and immunoelectrophoresis
4. Radial inmuno diffusion
5. Purification of IgG from serum
6. Western blotting
7. ELISA
8. Hepten Conjugation
9. Immunohistochemistry
10. Immunodiagnostics (demonstration using commercial kits) Books

Books

1. Kuby Immunology, 4th edition, R.A. Goldsby Thomas 1. Kinds, Barbara A. Osborne (Freeman).
2. Immunology, A Short Course, 4th edition, Eli Benjamin, Rechard Coico, Geoffrey Sunshine (WileyLiss).
3. Fundamentals of Immunology, Willian Paul/
4. Immunology by Roist et al.

M.Sc. Biotechnology

BT-105 Genetic Engineering

Unit I: Scope of genetic engineering. **Milestones in genetic engineering:** Isolation of enzymes, DNA sequencing, synthesis and Mutation, detection and separation, cloning, gene expression, cloning and patenting of life forms genetic engineering guidelines. **Molecular tools and their applications:** Restriction enzymes, modification enzymes, DNA and RNA markers. Nucleic acid purification, yield analysis. Amplification of Nucleic acids and its applications.

Unit II: Gene cloning vectors: Properties of ideal cloning and expression vectors Plasmids, bacteriophages, phagemids. cosmids and artificial chromosomes. Vector delivery systems. Selection of transformed cell. Restriction mapping of DNA fragments and map construction. Nucleic acid sequencing

Unit III: c-DNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening. **Strategies of gene cloning:** Cloning interacting genes two-hybrid systems, cloning differentially expressed genes. Nucleic acid microarray. Site directed mutagenesis and protein engineering. Protein purification and refolding, characterization and stabilization of recombinant proteins.

Unit IV: DNA transaction, northern blot, primer extension, SI mapping, Rnase protection assay.**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 in plants. Processing of recombinant proteins:

Unit V: T-DNA and Transposon tagging: Role of gene tagging in gene analysis, T-DNA or transposon. **Transgenic and gene knockout technologies**: Vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Practicals

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA
3. Restriction digestion of plasmid/genomic DNA.
4. Agarose gel electrophoresis and restriction mapping of DNA.
5. Construction of restriction map of plasmid DNA.
6. Cloning in plasmid vectors.
7. Gene expression in *E.coli* and analysis of gene product.
8. Polymerase chain reaction.
9. Detection of transposition through bacterial conjugation (Bacterial transposons).
10. Reporter gene assay (Gus/CAT/GAL)

Books

1. Molecular cloning: A Laboratory Manual, J. Sambrook, E.F., Fritsch and T. Maniatis cold spring Harbor Laboratory Press, New York. 2000
2. DNA cloning : A Practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford ,1995.
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W.Wu, D.Kim and L.J. Cseke, CRC Press, Florida, 1995.
4. Methods in Enzymology, Guide to Molecular Cloning Techniques, Vol. 152, S.L. Berger and A.R. Kimmel, Academic Press Inc., San Diego, 1996.
5. Methods in Enzymology,Vol. 185, Gene Expression Technology. D.V. Goeddle, Academic Press Inc., San Diego, 1990.
6. DNA Science: A First Course in Recombinant Technology, D.A. Mickloss and G.A. Freyer, cold spring Harbor Laboratory Press, New York. 1990.
7. Molecular Biotechnology, 2nd edition, S.B. Primrose, Blackwell Scientific Publishers , Oxford, 1994.
8. Milestones in Biotechnology, Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth Heinemann, Boston, 1992.
9. Route Maps in Gene Technology. M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford,1997.
10. Genetic Engineering: An introduction to Gene Analysis and Exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific

Publishers , Oxford, 1998.

BT. 106 - Plant Biotechnology

Unit I: Conventional plant breeding, Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids. Tissue culture media (composition and preparation), Initiation and maintenance of callus and suspension culture; single cell clones. Organogenesis, somatic embryogenesis; transfer and establishment of whole plants in soil. Shoot tip culture: Rapid clonal propagation and production of virus free plants. Embryo culture and embryo rescue.

Unit II: Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, hybrids biotransformation. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Cryopreservation**,** slow growth and DNA banking for germ plasm conservation.

Unit III: Plant Transformation technology The basis of tumour formation, hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with in introns, use of scaffold attachment regions, methods, of nuclear transformation, viral vectors and their applications, multiple gene transfers.

Unit IV: Direct DNA transfer, particle bombardment, electroporation, microinjection transformation of monocots. Transgene stability and gene silencing. In planta, transformation, promoter trapping, activation tagging,Chloroplast transformation: Advantages, vectors, success with tobacco and potato.

Unit V: Application of plant transformation for productivity and performance. Herbicide resistance, insect resistance, Bt. Genes, non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, nematode resistance abiotic stress post-harvest losses, long shelf life of fruits and flowers. Male sterile lines, bar and barnase systems, terminator gene technology.

Practicals

1. Preparation of Plant tissue culture media.
2. Surface sterilization of different types of explants.
3. Organ culture
4. Callus culture, organogenesis, somatic embryogenesis

5. Transfer of plants to 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) assays
10. Protoplast fusion.

Books

1. J. Hammound. P. McGarvey and V. Yusibov eds., Plant Biotechnology; Springer Verlag, 2000.
2. TJ Fu. G**.** singh, and W.R. Curtis, eds., Plant Cell and Tissue Culture for the Production of' Food' Ingredients, Kluwer Academic Press, 1999.
3. H.S. Chawla, Biotechnology in Crop Improvement, International Book Distributing Company, 1998.
4. RJ.-Henry, Practical Application of Plant Molecular Biology,- Chapman and Hall, 1997.
5. P.K. Gupta, Elements, of Biotechnology; Rastogi and Co**.** ,Meerut , 1996

M.Sc. Biotechnology

BT: 107 - Animal Biotechnology, Bioprocess Engineering &Technology

Unit I: Structure and organization of Animal cell, Equipments and materials for animal cell culture technology, Introduction to the balanced salt solutions and simple growth medium. A brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide, Role of serum and supplements. Serum and protein free defined media and their applications.

Unit II: Basic techniques of mammalian cell culture *in vitro;* disaggregation of tissue and primary culture; maintenance of cell culture; cell separation Biology and characterization of cultured cells, measuring parameters of growth. Primary and established cell line cultures. Measurement of viability and cytotoxicity. Scaling up of animal cell culture.

Unit III: Introduction to bioprocess engineering. Bioreactors. Isolation, preservation and maintenance of industrial microorganisms, Kinetic of microbial. growth and death, Media for industrial fermentation. **Types of fermentation processes:** Analysis of batch, fedbatch and continuous, biotransformation, Stability of microbial reactors, analysis of mixes microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.) Measurement and control of bioprocess parameters. **Downstream processing:** Introduction, removal of microbial cells and solid matter foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization and effluent treatment.

Unit IV: Metabolic engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation of secondary metabolites, biodegradable plastics, edible vaccines, "Molecular marker aided breeding: RFLP maps, linkage analysis, RAPD markers, **STS,** microsatellites, SCAR (sequence characterized amplified regions), **SSCP** (single strand conformational polymorphism) AFLP, QTL, mapbased cloning molecular marker assisted selection, Arid and semiarid plant biotechnology.

Unit V: Enzyme and whole cell immobilization and their industrial applications, **Industrial production:** alcohol (ethanol), acids (citric and acetic), solvents (glycerol, acetone, butanol), antibiotics(penicillin, streptomycin,tetracycline), amino acid(lysine, glutamic acid), single cell protein. Use of microbes in mineral beneficiation and oil recovery, Introduction to food technology Elementary idea of canning and packing, Sterilization and pasteurization of food products

Practicals

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. Determination of growth curve of a supplied microorganism and also to determine substrate degradation profile.
4. Comparative studies of ethanol production using different substrates.
5. Use of alginate for cell immobilization
6. Developing RFLP and RAPD maps
7. Cell counting, cell viability and cell size determination.

Books

1. Culture of Animals Cells 3rd Edition, R. Ian Freshney, WileyLiss
2. Animal Cell Culture Practical approach, ed., John R.W. Masters, Oxford
3. Cell Growth and Division: A Practical Approach, ed., R. Basega, IRL Press.
4. Cell Culture Lab. Fax, eds., M. Butler and M. Dawson, Bios Scientific Publications Ltd.; Oxford.
5. Animal Cell Culture Techniques, eds., Martin Clynes, Springer
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, eds., Jeni P. Mather and David Barnes, Academic Press.
7. Biochemical Engineering, Aiba. S., Humphrey, A.E. and Millis, N.F., University of Tokyo Press, Tokyo.
8. Biochemical Reactors, Atkinson, B., Pion Ltd., London.
9. Biochemical Engineering Fundamentals, Baily, J.E. and ollis, D.F.,

McGrawHill Book Co., New York.

10. Bioprocess technology: Fundamentals and applications, KTH, Stockholm.

11. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engel wood Cliffs.

12. Bioprocess Engineering: Basic Concepts, Shuler, M.L., and Kargi, F., Prentice Hall, Englewood Cliffs.

13. Principles of Fermentation Technology, Stanbury, P.F., and Whitaker, A., Pergamon Press, Oxford.

14. Bioreaction Engineering Principles, Nielson, J. and Villadsen, J., Plenum Press.

15. Chemical Engineering Problems in Biotechnology, Schuler, M.L. (ed.), AICHE.

16. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.

17. Bioprocess Engineering Kinetics, Mass Transport, Reactors and Gene Expression, Vieth. W.F., John Wiley & Sons Inc.

BT 108: Biodiversity, IPR, Biosafety & Bioethics

Unit I: Definition, Historical and geographical causes for diversity. Genetic diversity-Molecular diversity, Species and population biodiversity, Quantifying biodiversity, Maintenance of ecological biodiversity, Biodiversity and centers of origins of plants, Biodiversity hot spots in India. Global warming, Climate changes, Carbon Credit and Clean Development Mechanisms-possible applications of biotechnology

Unit II: Collection and conservation of biodiversity, Assessing, analyzing and documenting biodiversity, Morphological and molecular characterization of biodiversity, Vulnerability and extinction of biodiversity, Introduction to biodiversity database: endangered plants, endemism and Red data Book, Global biodiversity information system, Intellectual property rights. (IPR)-meaning, evolution classification and forms, sovereignty rights, CBD, patenting, Concept and principle of patenting**.** patentable subject matter. General agreement on Trade and Tariffs, Indian *sui-generis* system for plant variety and farmer's rights protection act**.** WTO and Plant resources of India.

Unit III: Biosafety : Definition Requirement, Biosafety for human health and environment, Sock and ethical issues, Biosafety in relation to transgenic research and applications. Introduction-causes of unethical acts, ignorance of laws, codes, polices and procedures, personal gain, professional ethics-professional conduct. Ethical decision making, ethical dilemmas, teaching ethical values. Ethical values to scientists. Good manufacturing practices, Good Laboratory Practices, Laboratory accreditations.

Unit IV: Plant biomass (Cellulose, starch, pectin, gum materials), Animal biomass (chitin, milk whey, Slaughter house wastes), Microbial biomass (algal blooms -in fresh and sea waters, Fungal-Mushrooms, yeasts and bacterial fermentation biomass, wastes), Concepts of single cell proteins, probiotics and their applications

Unit V: Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions biosorption and bioaccumulation principles. Concepts of phytoremediation, Biofertilizers and their importance in crop productivity, Bacterial biofertilizers (rhizobial, free living N_2, fixers and phosphate solublizing bacteria), their significance and practice. Biopesticides: Bacterial (Bt pesticides), fungal *(Trichoderma)* Genetically engineered

microorganisms/plants/animals in environmental health.

Format for certificate and Project Repot

Annexure -I

CERTIFICATE

I hereby certify that this project report entitled ----------submitted by ----------embodies the original piece of work done under my supervision from-----to----------(4 months) for partial fulfillment of Master Degree in Biotechnology, Jai Narain Vyas University, Jodhpur.

No part of this project has been submitted anywhere in form of any project report.

Project Supervisor

Name and Signature with seal

- It should be verified by HOD/ Director/ Incharge of institute where the work is done/ conducted.

Annexure -II

FORMAT FOR SUBMISSION OF PROJECT REPORT

1. Project Title

Name of the candidate Name of the supervisor

2. Introduction
    - ❖ Nature and scope of proposed project
    - ❖ Review of Research and Development in the Subject
    - International status
    - National status
    - Significance of study
    - Its potential contribution towards knowledge/ society/ environment
3. Objectives
4. Methodology
5. Results and Discussion
6. Summary / Conclusion
7. References