Course Code	HM-BT601					
Category	Humanities and Social Science and Management Course					
Course title	Project Management and Entrepreneurship					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	2	0	0	2	30	
Pre-requisites/ Co-requisites (if any)	- Fundamentals of Management, Elementary Mathematics					

Course Objective:

The objectives of the course are:

1) To impart among students, the concept of project, its characteristics, and its management subject to given constraints to successfully deliver the agreed outcomes of the project.
2) To imbibe students with the knowledge of effective project planning, project evaluating, and project scheduling with optimal resource allocation.
3) To impart among students, the legal aspect and quality aspect of project management.
4) To familiarize the students with the concept of entrepreneurship, its theoretical and practical approach.

Course Content:

MODULE-I [10 Lectures]

Project Management Concepts: Concept and Characteristics of a Project, Types of Projects, Project Management (Need, Knowledge Areas, Project Manager, Project Management Triangle, Project Scope and Scope Creep, Importance of Project Management).

Project Management Life Cycle: Project Management Life Cycle Phases, Project Management Process (Project Process, Process Group, Process Interactions, Customization, Process Group and Knowledge Area Matrix)

Project Planning: Planning Need, Importance of Planning, Planning Process, Work Breakdown Structure and Organization Breakdown Structure, Roles, Responsibility and Team Work, Feasibility Studies.

MODULE-II [10 Lectures]

Project Evaluation: Investment Analysis of Projects (Time Value of Money, Interest Rates, Compounding/Discounting, Payback Period, Average Rate of Return, Net Present Value, Profitability Index, Internal Rate of Return), Sources of Finance.

Project Scheduling: Importance of Project Scheduling, Scheduling Techniques (Gantt Chart and Line of Balance, Network Analysis – CPM/PERT, Slack and Float).

Project Cost Control: Direct and Indirect Cost, Normal Cost and Crash Cost, Time– Cost Trade-off Analysis - Optimum Project Duration, Resource Allocation and Leveling.

MODULE-III [4 Lectures]

Legal and Quality Aspects of Project Management: Project Contract (Types of Contract, Sub-Contracting, Tenders, Payment to Contractors), Project Audit.

IT in Projects: Overview of types of Software for Projects, Major Features of Project Management Software like MS Project, Criterion for Software Selection.

MODULE-IV [6 Lectures]

Entrepreneurship: Meaning & Concept of Entrepreneurship, Conditions needed for Entrepreneurship (Social Factors, Economic Factors, Psychological Factors, Legal Factors, Education & Technical Knowhow, Financial Assistance), Qualities of a Prospective Entrepreneur.

Entrepreneurial Motivation: McClelland's N-Ach Theory (Need for Affiliation, Need for Power, Need for Achievement), Self–Analysis, Personal Efficacy, Culture & Values, Risk-taking Behaviour, Technology Backup.

Entrepreneurial Skills: Creativity, Problem Solving, Decision Making, Communication, Leadership Quality.

Textbooks:

1. P. Gopalkrishnan and R. M. Moorthy; Text Book of Project Management, Macmillan
2. K. Nagarajan; Project Management, New Age International Publishers; 5th Edn.
3. P. Chandra; Projects; Tata McGraw Hill; 6th Edn.
4. J. M. Nicholas; Project Management for Business and Technology – Principles and Practice; Prentice Hall India; 2nd Edn.
5. H. Maylor; Project Management; Pearson; 3rd Edn.
6. D. F. Kuratko and R. M. Hodgetts; Entrepreneurship; Thomson Learning; 7th Edn.
7. R. Roy; Entrepreneurship; Oxford University Press.

Reference Books:

1) S. A. Kelkar; Software Project Management: A concise Study; Prentice Hall India; 2nd Edn.
2) F. K. Levy, J. D. Wiest; A Management Guide to PERT/CPM with GERT/PDM/DCPM and other networks; Prentice Hall India, 2nd Edn.
3) J. Mantel, J. R. Meredith, S. M. Shafer, M. M. Sutton, M. R. Gopalan; Project Management: Core Text Book, Wiley India, 1st Indian Edn.

4) L. C. Jhamb; Industrial Management-II; Everest Publishing House; 10th Edn.
5) S. N. Chary; Production and Operation Management; Tata McGraw Hill
6) Clements, Gido; Effective Project Management; Thomson Learning
7) C. F. Gray, E. W. Larson; Project Management; Tata McGraw Hill; 3rd Edn.
8) S.C. Sharma & T.R.Banga, Industrial Engineering & Management, Khanna Book Publishing Co. (P) Ltd.

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Learn** general concept of a project and project management, the importance of project life cycle and essential elements of project planning.
2. **Analysis** of project evaluation, project scheduling as well as project cost control through application of financial and mathematical tools.
3. **Learn** details of legal and quality aspects of project management to face various issues.
4. **Study and demonstrate** the features of different project management softwares with special emphasis on "MS Project" and can able to select the best PMS subject to desired requirements.
5. **Develop skills** of entrepreneurship both theoretical and practical approach and can take initiative of starting a new business.
6. **Align** the successful approach of entrepreneurship in undertaking large investment projects for the necessity and benefit of the society.

Course Code	PC-BT601					
Category	Professional Core					
Course title	Recombinant DNA Technology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	3	0	0	3	40	
Pre-requisites/ Co-requisites (if any)	- Microbiology - Genetics - Molecular Biology					

Course Objective:

The objectives of the course are:

1. To be familiar with the tools that forms the basis for recombinant DNA technology.
2. To demonstrate use of modern techniques for manipulation and analysis of genomic sequences.
3. To make students learn the application of recombinant DNA technology in the field of biomedical, agriculture and environment.

Course Content:

Module I: 10L Tools of Recombinant DNA technology

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Linkers; Adaptors

Cloning and expression vectors: Plasmids; Bacteriophages; M13 vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors: pET-based vectors; Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Module II: 10L Techniques in Recombinant DNA Technology

Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation

DNA sequencing methods (Maxum & Gilbert, Sangers, pyro-sequencing, Next generation Sequencing methods); Site-directed mutagenesis

Mod-III: Gene Cloning Methods

Polymerase chain reactions (PCR) and modified PCR. Construction of libraries (Genomic and cDNA); Expression cloning; Chromsome walking and Jumping, Gene transfer methods, Gene tagging: Transposons and gene targeting; Screening and expression of cloned gene

Module IV: 10L Application of rDNA technology

Recombianat DNA products for therapeutic and agricultural applications; Gene knockouts and Gene therapy, Gene silencing techniques: siRNA, miRNA; Gene Editing. Large scale Gene expression analysis (Microarray for DNA and protein). Molecular markers (RFLP, RAPD, AFLP, SNP) for trait identification; Biosafety

Textbook:

1.Old and Primrose, Principles of Gene Manipulation, 3rd Ed, Blackwell ScientificPublishers.2
2. J. Sambrook and D. W. Russel, Cloning Methods: A laboratory Manual, Vols 1-3 CSHL 2001.
3. T. A Brown, Genomes, 3rd Ed, Garland Science 2006.

Reference books:

1). D.M. Glover, Genetic Engineering, Cloning DNA, Chapman and Hall, New York, 1980
2. B. R. Glick and J.J. Pasternak ; Molecular Biotecnology: Principles and Applications of Recombinant DNA, ASM press
3.Watson, J.D., Gilman, M., Witkowski, J., Zoller, M. - Recombinant DNA, Scientific American Books, New York, 1992.
4. H.K. Das, Text Book of Biotechnology, 1st ed, 2004, Wiley Publishers
5.Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992

Course outcome:

After successful completion of this course, the student will be able to:

1. **Understand, define** and **explain** the tools in recombinant DNA technology.
2. **Understand** techniques in recombinant DNA technology.
3. Designing cloning experiments for applications in various genomic and proteomics studies.
4. **Identify**, **select** and **implement** the PCR and its types in molecular biology and recombinant DNA technology.
5. **Apply** knowledge of genetic engineering in current applications of biotechnology.
6. **Comprehend** and **analyze** the impact of Human Genome Project in genetic engineering programme.

Course Code	PC-BT602					
Category	Professional Core					
Course title	Immunology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	3	0	0	3	40	
Pre-requisites/ Co-requisites (if any)	- Microbiology - Biochemistry - Genetics					

Course Objective:

The objectives of the course are:

1. To gain knowledge about the components of the human immune response that work together for the protection of the host.
2. To understand the occurrence of diseases as either an outcome of deficiency of immune-components or excess activity as hypersensitivity along with the exposure of immune-based diagnostic techniques.

COURSE CONTENT:

Module 1: 12L Introduction to Immunology:

The origin of Immunology: History and evolution of immune system; Primary and secondary immune response, Components of Innate immunity and Adaptive/Acquired immunity, Macrophage and other Antigen Presenting Cells (APCs), Humoral and cell-mediated immunity, Active and Passive form of immunity, Primary and secondary lymphoid organs, Development and Maturation of B cell and T cell.

Module II: 15L Molecular basis of Immunology:

Structure and function of Antigen; Concept of Epitope, B cell and T cell; Structure and function of Antibody; Concept of Isotype, Allotype and Idiotype, Molecular basis of antibody and T cell receptor diversity: DNA rearrangements; variations arising out of V, D, J joining; somatic hypermutation, Class switching; synthesis of antibody and secretion; Polyclonal and monoclonal antibody, Complement: Antigen antibody reaction, Basic concepts of Immunodiffusion, RIA, ELISA and application of these techniques, Vaccinology.

Module III: 5L Major Histocompatibility Complex (MHC):

Antigen processing and presentation, HLA, laws of graft rejection, graft versus host reaction, Development of Inbred mouse strain, Blood group classification and Rh factor, Cytokines and other co-stimulatory molecules.

Module IV: 8L Immune response and tolerance:

Regulation of immune response; Immune tolerance, T cell anergy and T cell elimination, Hypersensitivity, Introduction to Autoimmunity, AIDS and immunodeficiency and Tumour biology.

Text Book:

1. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
2. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H,Oxford,UK
3. The Elements of Immunology, 1/e, (2009) Fahim Halim Khan, Pearson Education.
4. Immunology and Immune Technology by A. Chaktraborty, Oxford Univ. Pub.

Reference books:

1. K.A. Abbas, Immunology, 4th ed, W.B. Saunders& Co.
2. Immunology: An Introduction. Tizard Cengage Learning India (P) Limited
3. Weir, Immunology, 8th ed, W.B. Saunders& Co.
4. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008

Web Reference:

1. NPTEL : http://nptel.ac.in/courses/104108055/

Course Outcome:

By the end of this course student will be able to:

1. **Describe, relate and compare** the components of innate and adaptive immune responses to fight invading pathogens.
2. **Identify** problems and **apply** the knowledge of basic Immunology to **formulate solutions** for the protection of human health.
3. **Understand**, **select** and **implement** different immunological techniques efficiently to scientific research, health care, forensic sciences, drug industries for **formulation** of newer medicines etc.
4. **Explore** strategies to **improve** existing vaccines.
5. **Investigate** and **design** what immunomodulatory strategies can be used to enhance immune responses or to suppress unwanted immune responses during transplantations.
6. **Interpret** and **analyze** results of scientific experiments involving *in vivo* models used in different researches including tumor and cancer biology, autoimmune diseases, immunodeficiency diseases etc.

Course Code	PC-BT603					
Category	Professional Core					
Course title	Plant Biotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	3	0	0	3	40	
Pre-requisites/ Co-requisites (if any)	- Biochemistry - Microbiology - Genetics					

Course Objective:

The objectives of the course are:

1. To make the students aware of the principles, practices and application of the plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants being confident at the end of the course in all above mentioned areas.
2. To realize the importance of plant biotechnology with its applicative value in pharmaceutical and food industry, agriculture and ecology.

Course Content:

Module I: [15 Lectures]

Plant tissue culture – Theory and Techniques:
Brief history of plant tissue culture, composition of media, nutrient and hormone requirement, micro-propagation– somaclonal variation, callus culture, haploid culture, protoplast &cell suspension culture, somatic embryogenesis &techniques for immobilization of plant cells

Module II: [5 Lectures]

Secondary metabolite production:
Primary and secondary metabolic products (phytochemicals) of plant cells, role of Plant Tissue Culture techniques involved in commercially production of secondary metabolites, optimization tissue culture parameters, Elicitors, Hairy root culture, biotransformation, Immobilization, use of Bioreactor in plant secondary metabolite production (an overview).

Module III [5 Lectures]

Plant genomes:
Structure and organization of plant genome and gene expression-regulation (transcriptional, translational and post transcriptional regulation), chloroplast and mitochondrial genome (Arabidopsis should be taken as the model for study of plant genome).

Module IV [15 Lectures]

Plant Genetic engineering:
Agrobacterium mediated transformation, direct transformation by particle gun bombardment, choice of promoters for expression of transgene, selectable and screenable markers, co-integrated and binary vector.
Strategies for the development of herbicide resistance, insect resistance plant, plant enriched food products (Golden rice) and molecular farming as well as marker free transgenic.

Textbooks:

1. Chawla, H. S. (2000). Introduction to plant biotechnology. Enfield, NH: Science.
2. Razdan, M. K. (2003). Introduction to plant tissue culture. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant biotechnology: The genetic manipulation of plants.

Reference books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology of plants.Chichester, West Sussex: John Wiley & Sons.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: An Introduction to Genetic Engineering. Oxford: Oxford University Press.
3. Primrose, S. B., &Twyman, R. M. (2006). Principles of gene manipulation and genomics. Malden, MA: Blackwell Pub.
4. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub.

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/
2. ePgPathshala:http://epgp.inflibnet.ac.in/ahl.php?csrno=3

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Understand** the **use** of different plant tissue culture (PTC) techniques for PTC Industries as well as research.
2. **Identify**, **select** and **construct** different plant tissue culture media for various PTC techniques.
1. **Understand** the role of PTC in secondary metabolite production and **identify** the appropriate bioreactor for commercial secondary metabolite production.
2. **Understand** the structure and organization of genes & complexity of plant genome and able to **identify** the tools for gene identification.
3. **Understand**, **identify and illustrate** the different modern tools & techniques of plant genetic manipulation for crop improvement and sustainable agriculture.
4. **Analyze** the impact of plant biotechnology on future crop production and also able to **judge** the intellectual property, environmental, societal issues specific to transgenic crops.

Course Code	PC-BT604					
Category	Professional Core					
Course title	Bioseparation Technology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	3	0	0	3	40	
Pre-requisites/ Co-requisites (if any)	- Structure of Biomolecules - Biochemistry - Microbiology - Industrial Microbiology and Enzyme Technology					

Course Objective:

The objectives of the course are:

1. To understand the importance of the Bioseparation process, economics and process design criteria for various classes of bio products.
2. To make the student understand the importance of Bioseparation processes like Cell disruption, Filtration, Sedimentation and Extraction, Product Resolution, Product Crystallization and Drying and process economics.

Course Content:

Module I: [6 Lectures]

Introduction to Bioseparation Process
Basic concepts of bioseparation technology, RIPP/CIPP scheme, Importance of bioseparation in biotechnological processes, Problems and requirements of bioproduct purification, some case studies/flow sheets, Analysis of purity, Mass balance, Heat Balance, Capital and operating cost analysis, Non-mechanical and mechanical cell disruption methods, empirical equations.

Module II: [6 Lectures]

Solid-Liquid Separation Techniques for Biomass and Particulate/Debris
Pre-treatment strategies, Flocculation, Foam-fractionation, Mechanical separation processes: Filtration at constant pressure and at constant rate, empirical equations for batch and continuous filtration, dead-end and cross-flow filtration; Centrifugation- basic principles, design characteristics; ultracentrifuges: principles and applications, centrifugal filtration and its applications.

Module III: [10 Lectures]

Isolation of Products
Adsorption: Adsorption isotherms, adsorption-desorption processes, batch adsorption, packed bed adsorption; Extraction: batch and continuous extraction, aqueous two-phase extraction; Precipitation: Principle and methods of precipitation mediated by pH, salts, organic solvents, polymers; Membrane based separations: Theory of micro filtration, ultra filtration and reverse osmosis, concentration polarization, rejection, flux expression; design and applications of membrane separation equipment-membrane modules.

Module Iv: [18 Lectures]

Purification of Bioproduct and Formulation
Chromatography: Common theory and principle, Normal phase chromatography and reversed phase chromatography, Hydrophobic interaction chromatography, Ion exchange chromatography, gel permeation chromatography, Chromatofocusing, bioaffinity and pseudo affinity chromatography, HPLC. Electrophoretic separation techniques: NATIVE and SDS-PAGE (Polyacrylamide and Agarose Gel), methods, case studies; Polishing of Bioproducts by Crystallization and Drying.

Text Book:

1. Bio-process Engg. Schuler & Kargi, PHI
2. Bioseparations - principles and techniques, B Sivasankar, Prentice Hall of India, N Delhi, 2005, pp 280
3. Bioseparation & Bioprocessing (2nd Ed.) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)
4. Biotransformations & Bioprocesses, Mukesh D, Gaikar V and Anil Kumar Marcell Dekker, New york,(Feb 2004).
5. "Bioseparation Science and Engineering"Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, Oxford University press, 2003.

Reference Books:

1. Principles of Bioseparations Engineering by Raja Ghosh. World Scientific Publishing Co
2. Biochemical Engg. Fundamentals, Bailey & Olis, McGraw-Hill, 1990
3. Membrane Handbook, Ho, W.S.W. & K. K. Sirkar, Van Nostrand Reinhold, N.Y. (1992)
4. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L. Hu, W.S (1988), Wiley, New York.
5. Bioseparation Engineering: Principles, Practice and Economics, Ladisch, M.R., (2001), Wiley, Interscience.
6. Unit Operation of Chemical Engineering, McCabe, W. L., Smith, J. C. and Harriott, P., McGraw-Hill

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102106022/

2. NPTEL: http://nptel.ac.in/courses/102106048/
3. NPTEL: http://nptel.ac.in/courses/102103044/
4. NPTEL: http://nptel.ac.in/courses/104104066/
5. NPTEL: http://nptel.ac.in/courses/102107028/
6. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1204
7. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=1354

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Comprehend the necessity** of bioseparation processes in biotechnology.
2. **Accomplish the knowledge** on primary isolation and concentration of desired product.
3. **Acquire the knowledge** to implement suitable techniques for product purification.
4. **Analyze the quality** and characteristics of the purified product.
5. **Ability to formulate** the product to meet marketable standards.
6. **Explain, recommend and demonstrate** the suitable bioseparation approaches comprising of new concepts and emerging technologies that are likely to benefit product recovery for small and large scale in the future.

Course Code	PE-BT602					
Category	Professional Core Elective					
Course title	Animal Cell Culture & Animal Biotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	3	0	0	3	40	
Pre-requisites/ Co-requisites (if any)	- Microbiology - Molecular Biology - Recombinant DNA Technology					

Course Objective:

The goal of Animal Cell Culture & Animal Biotechnology course is for students to acquire the necessary theoretical skills for both the arena. First, it provides detailed insights regarding the isolation of animal cells for *in vitro* studies, maintenance of animal cells *in vitro*, manipulation of animal cells *in vitro*, application of molecular techniques to *in vitro* situations.

The second objective of this course is to introduce students to cutting edge biotechnologies that can be used for animal and human health and research. In this course we will analyze and discuss the primary literature on stem cells, cloning, large animal models for disease and development of therapies and treatments. This class will cover basic cellular and molecular biology techniques involved in animal biotechnology and their applications in a real world research setting.

Course Content:

Module I: 10L Animal cell culture and its application:

History of animal cell culture and development, Culture media and growth conditions, Cell type and characterization, Stem Cells, Germ Cells, and Amniocytes, Origin of animal cell line, Differentiation of cancerous cells and role of protooncogenes; Development of primary culture, Development of cell line by enzymatic disaggregation. Cryopreservation; Common cell culture contaminants. Cell cloning and selection; Transfection and transformation of cells. Marker gene characterization. Application of animal cell culture in: Cytotoxicity and viability assays; Transient Recombinant Protein Expression in Mammalian Cells; Production of human and animal viral vaccines and pharmaceutical proteins. Overview of Cell Culture Engineering for the Insect Cell-Baculovirus Expression Vector System.

Module II: 10L Growth and scale up of animal cell:

Animal cell growth characteristics and kinetics; Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Micro-carrier attached growth; Cell culture in continuous, perfusion and hollow fibre reactor; Microencapsulation; Growth monitoring; Mass transfer in mammalian cell culture.

Module III: 10L Animal Biotechnology

Animal breeds; Embryo transfer: Artificial insemination, Superovulation, Embryo transfer, In vitro fertilization-Pregnancy diagnosis-Sexing of embryos, Embryo splitting; Cryopreservation of embryo; Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; transgenic animals and stem Cells; Transgenesis and Xenotransplants, Transgenic fish; Animal as bioreactors.

Module IV: 10L Application of Animal Biotechnology:

Organ culture technology; Tissue engineering and its application –production of complete organ - kidney – eyes - heart – brain; Immune system in health and disease, tissue and organ transplant, Vaccinology, Regenerative medicine. Biotechnology in animal production: Manipulation of Growth hormone -Somatotropic hormone-Thyroid hormone; Manipulation of lactation –Lactogenesis galactopoiesis- Manipulation of wool growth-Manipulation of rumen microbial digestive system. Stem cell: types, properties and their applications in animal cloning, therapeutics.

Textbook:

1. J.M. Davis. Basic Cell Culture Second Edition, Oxford University Press. (First Indian Edition, 2005)

2. Animal cell culture by R.I. Freshney.

3. Animal Biotechnology by P. Ramadas.

4. In vitro cultivation of Animal cells by Dr. C.K. Leach, Butterworth and Heinnmamm Ltd.1994.

5. Animal cell Biotechnology: Methods and protocols – Nigel Jenkins (Ed), Humana press, New Jersy, 1999.

Reference books:

1. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (Eds.), Concepts in Biotechnology, University Press, 1996.

2. Das.H.K. Text Book of Biotechnology, First Edition 2004,Wiley Dreamtech.

3. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000

4. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991

5. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. **Explain** the various components of cell and tissue culture media as well as establishment and optimization of media for particular purposes in different species and cell lines.

2. **Explain, design, analyze** and **perform** the common cell culture techniques, cytotoxicity and viability assays for toxicological and pharmacological studies.

3. **Design** the experiment for development of primary established cell culture and characterize the various cell lines used in mammalian tissue culture in relation to their origins and uses.

4. **Describe, analyze** and **design** the criteria in consideration for scale up of cell culture as well as the appropriate cell model for a large scale process involved in the production of human and animal viral vaccines and pharmaceutical proteins.

5. **Explain, assess** and **design** the strategies involved in embryo transfer & *In vitro* fertilization, transgenic animal technology, hormone biotechnology, vaccinology and regenerative medicine as well as **analyze** important social & environmental problems regarding genetically modified cell and organ models and identify ways to contribute to the solutions, including professional, economic and ethical considerations in social, industrial, medical & agricultural fields.

6. **Explain, assess** and **coalesce** the multidisciplinary need of animal biotechnology with the solution provided by the optimized and modernized animal tissue culture techniques at lab scale, pilot scale and ultimately industrial scale level as well as be able to **communicate** efficiently by preparing proper technical plans through meticulous reports at the end followed by sound oral explanations.

Course Code	PC-BT691					
Category	Professional Core					
Course title	Recombinant DNA Technology Lab					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VI
	0	0	3	1.5	36	
Pre-requisites/ Co-requisites (if any)	- Microbiology - Genetics - Molecular Biology					

Course Objective:

The objectives of the course are:

1. Students will learn practical knowledge of selected Molecular Biological techniques.
2. Course covers the basic techniques of recombinant DNA technologies including PCR.

Course content:

1. Restriction enzyme digestion of plasmid DNA or lambda DNA
2. Gel purification of RE digested DNA
3. Ligation of DNA fragments with cloning vector pUC18 or pBR322.
3. Preparation of competent cells and Transformation into *E.coli* with recombinant vector.
4. Isolation of recombinant plasmid and confirmation of insert DNA in vector by restriction digestion.
5. Primer design for PCR
6. Amplification of DNA by PCR.

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Demonstrate** and **explain** restriction enzyme digestion of plasmid DNA or lambda DNA.
2. **Understand** the process of gel purification of RE digested DNA fragment.
3. **Understand** the process ligation of DNA fragments with cloning vector pUC18 or pBR322.
4. **Learn, demonstrate** and **explain** the methodology of competent cell preparation and Transformation into *E.coli* with recombinant vector.
5. **Understand** and **explain p**rimer design for PCR and amplification of DNA by PCR.
6. **Demonstrate** and **explain** the working principle of Southern Hybridization.

Course Code	PC-BT692					
Category	Professional Core					
Course title	Immunology Lab					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VI
	0	0	3	1.5	36	
Pre-requisites/ Co-requisites (if any)	Microbiology					

Course Objective:

The objectives of the course are:

To Develop a working knowledge of the principles and procedures of serology and introduction to some basic immunologic techniques commonly used in immunology research laboratories like Precipitation, Agglutination, ELISA and Western blotting.

COURSE COTENT:

1) Staining of Blood film (Total RBC count, Total WBC count, Differential count)

2) Blood grouping.

3) Determination of Erythrocyte Sedimentation Rate (ESR) for detection of infection (inflammation) in body

4) WIDAL test

5) Immunodiffusion in Agar gel

6) ELISA- qualitative

7) Western blot technique.

Reference :

Laboratory Manual

COURSE OUTCOMES:

1. **Illustrate** components of the immune system and **explain** their functional interactions and physiology as it relates to immunity, disease states and disorders.

2. **Plan and organize** a variety of serologic assays using basic principles of antigen-antibody reactions.
3. **Apply** major methodology used to diagnose immunological disorders including agglutination, preceipitation, electrophoretic techniques, Immunoassays (ELISA, Western blot).
4. **Formulate, compile** and present a well-organized and concise report of the experimental findings, **evaluate** clinical data, **interpret** results, and **compare and correlate** abnormal results with disease states.
5. **Develop** communication skills in the presentation of scientific material and **evaluate, understand and interpret** the methods described in the related scientific journal articles.
6. **Demonstrate** laboratory practice standards in safety, professional behavior and ethical conduct and maintain a safe laboratory environment

Course Code	PC-BT693					
Category	Professional Core					
Course title	Plant Biotechnology Lab					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VI
	0	0	3	1.5	36	
Pre-requisites/ Co-requisites (if any)	-					

Course Objective:

The objectives of the course are:

1. To learn different aseptic techniques for establishment of an aseptic *in vitro* culture.
2. To study and prepare the different composition of plant tissue culture media (e.g. MS, B5, N6, WPM etc.).
3. To develop the skills in the different plant tissue culture techniques (Callus culture, Shoot tip culture, Anther culture etc.)
4. To learn the protocols of plant gene transfer technology.

Course Content:

1. Introduction to plant tissue culture laboratory and its organization
2. Different aseptic culture techniques for establishment and maintenance of cultures
3. Preparation of stock solutions of various plant tissue culture medium (e.g. MS, B5, N6, WPM etc.) and plant growth regulator
4. Germination of seeds *in vitro*
5. Effect of Plant growth regulators in Plant Tissue culture (shoot, root, callus induction)
6. Micropropagation (horticultural/ medicinal/ agriculturally important plant)
7. Hardening
8. Plant regeneration from embryo/ meristem/callus culture
9. Anther culture
10. Demonstration of *Agrobacterium* mediated plant transformation (crown gall/ hairy root/GUS gene transfer)

Reference books:

1. J. Reinert, M.M. Yeoman (1982) Plant cell and tissue culture: a laboratory manual. Published: Berlin, Springer-Verlag.
2. H.S. Chawla (2003) Plant Biotechnology: Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt Ltd., New Delhi.

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Define and recall** the various components of plant tissue culture.
2. **Describe, discuss and explain** various aseptic culture techniques for establishment of plant tissue culture.

3. **Calculate** the composition of various plant tissue culture media and prepare it (e.g. MS, B5, N6, WPM etc.).
4. **Design** the experiments to develop the mass propagation of plants from different explants (e.g. rooting, shooting, callus development etc).
5. **Understand and explain** the various modern tools used in *in vitro* culture techniques for large scale propagation of plants in PTC-Industry.
6. **Establish** a lab for *in vitro* plants tissue culture as well as the lab for mass propagation of plants.

Course Code	**PC-BT694**					
Category	**Professional Core**					
Course title	**Fermentation Technology and Bioseparation Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester:**
	0	**0**	**3**	**1.5**	**36**	**VI**
Pre-requisites/ Co-requisites (if any)	- **Basic concepts in Chemistry and Biology** - **Structure of Biomolecules** - **Biochemistry** - **Microbiology** - **Industrial Microbiology and Enzyme Technology**					

Course Objective:

The objectives of the course are:

1. This course helps the students to acquire knowledge about fundamentals practical knowledge of fermentation technology.
2. Provides an opportunity to gain practical experience on bioproduct recovery and purification techniques.
3. Gives an opportunity to experimentally check the theoretical concepts related to Bioseparation Technology.
4. Provides a basic understanding of the types of fermentation process, bioprocess, and the preparation of media etc.

Course Content:

1. Batch Fermentation, Recovery (solvent mediated extraction) and Assay of Antibiotics (Penicillin/Streptomycin or any enzyme of the institutions choice).

2. Production of Alcohol (Fermentation and Recovery)
    (i) Using Molasses/ Sugarcane Juice (Batch)
    (ii) Using Immobilized Microbes (Batch and Continuous)
3. Batch Fermentation of Organic Acid
4. Batch and Immobilized Fermentation of Bacterial/Fungal Enzymes (Amylases / Proteases or any enzyme of the institutions choice) (Fermentation, Recovery, Purification and Assay).
5. Solid State Fermentation (Molds/ Fungus).
6. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.
7. Mechanical cell disruption – Ultrasonication/ High pressure homogeneizer.
8. Separation of insoluble by filtration –determination of specific cake resistance.
9. Flocculation and conditioning of broths.
10. Protein precipitation, recovery and concentration by ammonium sulphate/ TCA pptn.- centrifugation, reconstitution and dialysis.
11. Subcellular fractionation: Isolation: chloroplast/mitochondria etc. by Centrifugation (differential/ percoll density gradient).
12. Chromatography (GFC/IEX/RPC) and demonstration of HPLC.
13. Separation of proteins/enzymes/DNA by electrophoresis.

Course Outcome (CO):

After successful completion of this course, the student will be able to:

1. **Educate the students** about microorganisms, development of media, and **to impart knowledge** about enzyme kinetics, fermenters, and industrial biotechnology.
2. **Make the students understand** the fermentation process using modern tools and its combination of bioprocess engineering.
3. **Provides an opportunity to experimentally** verify the theoretical concepts already studied.
4. **Understand** the theoretical principles in a more explicit and concentrated manner.
5. **Get exposure** on various Bioseparation process such as Cell disruption techniques, Product enrichment techniques and Product purification methods.
6. **Describe** current knowledge in biological and biochemical technology and to **assess** power requirements in bioreactors; modeling of bioprocesses.

COURSE CODE	HM-BT691					
CATEGORY	Humanities and Social Science and Management Course					
COURSE TITLE	Seminar (Review and Presentation by PPT)					
SCHEME AND CREDITS	L	T	P	Cr. Points	Lab. Hrs.	Semester:
	0	0	2	2	30	VI
Pre-requisites/ Co-requisites (if any)	-					

Course Objectives:

The objectives of the course are:

1. How research papers are written.
2. How to read such papers critically and efficiently
3. How to summaries and review them.
4. How to judge the value of different contributions
5. How to identify promising new directions.

Course Outcomes:

1. Find the best examples of research papers in Biotechnology which have had impact – in whatever terms you think are important.
2. Identify the most promising recent research papers, likely to find application in the future.
3. Choose a thesis topic which will change the world.
4. Become a seasoned, critical, cynical reader of scientific literature.
5. Expand knowledge in preparation of effective PowerPoint presentation.
6. Develop communication skills and personality.