VANITA VISHRAM WOMEN'S UNIVERSITY

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

BACHELOR OF SCIENCE (B.Sc.) HONOURS IN BIOTECHNOLOGY

Under Learning Outcomes Based Curriculum Framework (LOCF)

For Undergraduate (UG) Education

SEMESTER - 5

Core Courses (CC)

Syllabus applicable to the students seeking admission in the following Program

B.Sc. Biotechnology under LOCF w.e.f. the Academic Year 2021-2022

BACHELOR OF SCIENCE (B.SC.) BIOTECHNOLOGY HONOURS

SEMESTER 5

CORE COURSE PAPER 11

rDNA TECHNOLOGY

Course Objectives:

- To The objective is to impart fundamental knowledge to students about theoretical aspects and applications of rDNA technology and genetic engineering for human benefits
- To acquire adequate knowledge & necessary skills related to the different techniques involved in genetic engineering.

Course Outcome:

Students will gain knowledge of

- Players of gene cloning like DNA modifying enzymes, Cloning vector and Expression vector
- Steps of gene cloning, library preparation and screening of positive clone from library
- Advanced techniques of Recombinant DNA Technology
- Information about the few important recombinant proteins products and basics of Gene therapy techniques

BT11210 - THEORY COURSE CONTENT (4 Credits)		
UNIT 1	• Chronological development in rDNA technology. • Advantages and Limitations of Prokaryotic and eukaryotic systems. • Outline process of Gene Cloning • Molecular Tools for Gene Cloning: Enzymes (Nucleases, DNA polymerase, Terminal Transferase, Reverse transcriptase, kinase, phosphatase, DNA ligases (T4 DNA ligases & *E.coli* DNA ligase) adaptors, Linkers, Vectors. • Process of restriction digestion and ligation.	**20 Lectures**
UNIT 2	**Strategies of Genetic Engineering and Gene Cloning** • Isolation of DNA (Genome and Plasmid) to be cloned and construction of genomic library. • Isolation of RNA and construction of cDNA Library o Isolation of mRNA, reverse transcriptase, oligo dC tailing Addition of oligo G primer, Synthesis of second strand of cDNA • Insertion of foreign DNA fragment into vector; linkers, adaptors and homopolymer tailing • Methods of gene transfer in prokaryotic and eukaryotic cells: Chemical, Physical & Viral mediated DNA transfer • Transformation and growth of cells • Selection of Clones; Insertion inactivation and Blue White screening, colony hybridization techniques • Expression of cloned DNA molecules and maximization of expression: Factors affecting Expression of cloned DNA	**15 Lectures**
UNIT 3	**Advanced Techniques rDNA technology** • Recombinant selection and screening methods: o Genetic	**15 Lectures**

	○ Immunochemical ○ Blotting Techniques: Southern, Western & Northern ○ Nucleic acid hybridization: Molecular Probes and Nucleic acid labeling ○ HART, HRT • Autoradiography • Gel Electrophoresis: AGE & PAGE, • DNA sequencing • PCR: Working Mechanism and Application, define qPCR • Mutagenesis **Analysis of gene expression** • DNA fingerprinting, RAPD, RFLP, AFLP • DNA sequencing methods: Classical methods, NGS Strategies, Automated sequences genome sequencing • Methods for analysis of gene expression at RNA and protein level, large scale expression.	
UNIT 4	**APPLICATIONS OF GENETIC ENGINEERING** • Genetically Engineered Microorganisms • Recombinant protein product- Human Insulin, Interferon, Human Growth hormone, Growth factors, Monoclonal Antibodies, Therapeutic oligonucleotides, Vaccines • Applications of gene cloning techniques in Agriculture. • Single nucleotide polymorphisms, Future strategies.	**10 Lectures**

BT11220 - LAB COURSE CONTENT

(2 Credits)

1. Isolation and quantification of *E.coli* genomic DNA using Spectrophotometer.
2. PCR amplification and analysis by agarose gel electrophoresis.
3. Isolation and quantification of RNA using UV Spectrophotometer.

4. Preparation of alkaline lysis, pET-28a from *E.coli* DH5α, gel analysis and spectrophotometric analysis.
5. Restriction Digestion analysis of a given genome by *ECoR1*.
6. Preparation of competent cells and Transformation in *E.coli* with recombinant vector.

SUGGESTED READING

1. Brown, T.A., 2020. Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
2. Trevan, M.D., Boffey, S., Goulding, K.H. and Stanbury, P., 1987. Biotechnology; the biological principles. Open University Press.
3. Twyman R.M., 1998. Advanced Molecular Biology. Springer Link
4. Primrose, S.B., Twyman, R.M. and Old, R.W., 2001. Principles of gene manipulation (Vol. 6). Oxford: Blackwell Science.
5. Dubey, R.C., 1993. A textbook of Biotechnology. S. Chand Publishing.
6. Das, H.K., 2007. Textbook of biotechnology. John Wiley & Sons.
7. Singh, B.D. and Singh, A.K., 2015. Marker-assisted plant breeding: principles and practices.
8. Rastogi, V.B., 2008. Fundamentals Of Molecular Biology (2 Colour). Ane Books Pvt Ltd.
9. Russell, D.W. and Sambrook, J., 2001. Molecular cloning: a laboratory manual (Vol. 1, p. 112). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory.

BACHELOR OF SCIENCE (B.SC.) BIOTECHNOLOGY HONOURS

SEMESTER V

CORE COURSE PAPER 12

Fermentation Technology II

Course Objectives:

- To make students aware of production aspects of various primary and secondary metabolites.
- To teach students how the products of fermentation are separated, concentrated and purified that is downstream processes.
- To make students aware of various methods used to treat fermentation industry effluent.
- To teach students what are the various factors that affects the economy of fermentation industry.

Course Outcome:

Students will be able to

- Understand industrial level fermentation process and its outcomes
- Deal with various products' production purification aspects.
- Manage the factors affecting economy of fermentation industry.

BT11230 - THEORY COURSE CONTENT (4 Credits)		
UNIT 1	**Downstream processing/Recovery and Purification of Fermentation Products:** Introduction to downstream processing Removal of microbial cells and other solid matter, foam separation (floatation), precipitation, filtration, centrifugation, cell disruption, Liquid-liquid extraction, solvent recovery, two-phase aqueous extraction, reversed micelle extraction, supercritical fluid extraction, adsorption, removal of volatile products, Basics of chromatography, Membrane processes, drying, crystallization, whole broth processing	**20 Lectures**
UNIT 2	**Industrial Processes and products I** Production of organic solvents (Ethanol, acetone, butanol) Production of organic acids (citric acid, acetic acid) Production of amino acids (L-glutamic acid, L-lysine)	**20 Lectures**
UNIT 3	**Industrial Processes and products II** Production of Industrial enzymes (Amylase, lipase, protease, Penicillin acylases) Production of vitamins and antibiotics (Rifoflavin , β-lactam antibiotics)	**10 Lectures**
UNIT 4	**Fermentation Economics -**Basic objectives for development of successful fermentation process, **Industrial production of Animal products** Animal cell culture production: Recombinant product (Plasminogen activator), Biopharmaceutical (Interferon), Monoclonal antibodies. Plant cell culture production : Enzymes, Representative enzymes of primary and secondary metabolites	**10 Lectures**

BT11240 - LAB COURSE CONTENT

(2 Credits)

1. Production, recovery (distillation) and estimation of ethanol.
2. Production, recovery (ammonium sulfate) and estimation of amylase.
3. Production, recovery (filtration) and estimation of citric acid.
4. Immobilization, activity determination and comparision of free and mobilized enzymes of yeast cells
5. Bioassay of penicillin
6. Extraction and purification of Lysozyme from egg-yolk using ion-exchange chromatography (demonstration).

SUGGESTED READING

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
2. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd..

BACHELOR OF SCIENCE (B.SC.) BIOTECHNOLOGY HONOURS

SEMESTER 5

DISCIPLINE SPECIFIC ELECTIVE PAPER 1

ANIMAL BIOTECHNOLOGY

Course Objectives:

- To familiarize about the various Animal cell culture Fundamentals, Cytotoxicity and Genotoxicity, Molecular markers in animal health and production and Transgenic Animals.

Course Outcome:

Upon completion of the course, the student shall be able to comprehend

- The fundamental and concepts of Animal cell culture, Media preparation, Importance of aseptic conditions, Different types of cell culture, development of cell lines, subculturing. Cell culture techniques: media preparation, cell culture, maintenance of cell line: media change, passage, trypsinization, cryopreservation
- The concepts of cytotoxicity and Genotoxicity, Mutagenesis assay
- Molecular markers used in animal health and production, Properties of Ideal Markers, Applications of animal molecular markers
- Production techniques for transgenic animals and application of transgenic animals

BT14010 - THEORY COURSE CONTENT (4 Credits)		
UNIT 1	**ANIMAL CELL CULTURE: Fundamentals** Facilities for animal cell culture, Equipments used in animal cell culture, Contamination, aseptic conditions and sterilization Different types of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents Culture of different tissues and its application, Primary and secondary culture, continuous cell lines, suspension culture, and organ culture, Primary Culture-Primary explants, Enzymatic disaggregation, Warm Trypsinization, Cold Trypsinization, Other enzymatic procedures, Mechanical disaggregation, Separation of viable and non viable cells.	**20 Lectures**
UNIT 2	**Mechanism and metabolism of cell under culture conditions** Behaviour of cells in culture conditions, division, their growth pattern, metabolism of estimation of cell number, Hayflicks Limit Cell lines-Types of cell lines, Selection of cell lines, maintenance of cell cultures, Subculture, Cryopreservation, Stem cell Cultures Development of cell lines, characterization and maintenance of cell lines, stem cells, cryopreservation, common cell culture contaminants	**20 Lectures**
UNIT 3	**Cytotoxicity and Genotoxicity** Viability, Toxicity, and Survival Nature of the Assay Estimation of Viability by Dye Exclusion Estimation of Viability by Dye Uptake Clonogenic Assay for Attached Cells MTT-Based Cytotoxicity Assay Mutagenesis Assay by Sister Chromatid Exchange	**10 Lectures**
UNIT 4	**TRANSGENIC ANIMALS** Importance of Transgenic animal Transgenic Mice and their applications	**10 Lectures**

	Transgenic Clone-Dolly Transgenic organisms to interrupt disease cycles Use of cell culture in industry	

BT14020 - LAB COURSE CONTENT

(2 Credits)

1. Packing and sterilization of glass and plastic wares for cell culture
2. Chromosome preparation (normal karyotyping)
3. Quantification of Chick line embryo cells by Trypan Blue exclusion dye
4. Primary cell cultures : Human Lymphocyte culture
5. To study SCE assay and calculate RI (Demonstration).
6. MTT Assay (Demonstration).
7. To study Cytokinesis Blocked Micronucleus (CBMN) assay
8. To study Cytome assay
9. Histochemical localization and enzyme

SUGGESTED READING

- Freshney RI. 2005. Culture of Animal Cells. Wiley Liss.
- Mathur, S. 2009. Animal cell and tisse culture. Agrobios.
- Pörtner, R., 2007. Animal cell biotechnology. Methods and Protocols, 2nd. Edition. Humana.

BACHELOR OF SCIENCE (B.SC.) BIOTECHNOLOGY HONOURS

SEMESTER 5

DISCIPLINE SPECIFIC ELECTIVE PAPER 2

DEVELOPMENTAL BIOLOGY

Course Objectives:

- To make students aware of how the embryonic development takes place inside the body.
- To make students understand a number of advanced and basic tools in developmental biology.
- To make students competitive for CSIR NET, etc. competitive examinations.

Course Outcome:

Students will be able to

- define various development biology related terminologies.
- know how early embryo develops within the womb.
- understand the basic molecular mechanism behind different modes of differentiation.
- comprehend how various organ development takes place.

BT14030 - THEORY COURSE CONTENT (4 Credits)		
UNIT 1	**Gametogenesis and Fertilization** Definition, scope & historical perspective of development Biology, Gametogenesis –Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.	**10 Lectures**
UNIT 2	**Early embryonic development** Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.	**20 Lectures**
UNIT 3	**Embryonic Differentiation** Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.	**20 Lectures**
UNIT 4	**Organogenesis** Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.	**10 Lectures**

BT14040 - LAB COURSE CONTENT

(2 Credits)

1. Observation of living and plastic-embedded chick embryos.
2. Identification of permanent chick embryo slides.
3. Preparation of temporary mounts of 24, 48, 72, and 96 hours chick embryos.
4. Effect of caffeine on embryonic chick heart rate.
5. The effects of lead acetate on the neural development of chick embryos (Demomstartion of C. elegens).

SUGGESTED READING

1. P S Verma & V K Agarwal, Chordate Embryology Developmental Biology, S. Chand Publishers, ISBN: 9788121902618
2. S.F Gilbert & M.J.F Barresi, Developmental Biology, 11 th Edition, Sinauer Associates Inc. ISBN: 9781605356044
3. B. I Balinsky, B.C Fabian, An Introduction to embryology 5th edition (2012), Cengage India, ISBN: 978-8131517499

BACHELOR OF SCIENCE (B.SC.) BIOTECHNOLOGY HONOURS

SEMESTER 5

DISCIPLINE SPECIFIC ELECTIVE PAPER 3

PLANT BIOTECHNOLOGY

Course Objectives:

- To impart fundamental knowledge to students about theoretical aspects and applications of plant tissue culture and plant genomics in addition to that course also impart knowledge of plant molecular biology and transgenic plants
- To acquire adequate knowledge & necessary skills related to the different techniques involved in tissue culture and plant genetic engineering.

Course Outcome:

Students will be able to

- Understand basic techniques and applications of plant tissue culture.
- Gain knowledge about structural biology of plants molecules.
- Will be able to understand about application of molecular biology in creating transgenic plants.

BT14050 - THEORY COURSE CONTENT (4 Credits)		
UNIT1	**Plant tissue culture** Introduction and History of plant tissue culture, Laboratory organization Types of media Nutrient Supplements and Growth Regulators: Media Composition and Preparation of commonly used media, Inorganic salts, Carbon source, Vitamins, Amino acids and Plant growth regulators and culture conditions: Basal media, growth regulators. Suitable nutrient medium preparation, Hormone physiology and signal Transduction, Totipotency and cyto-differentiation.	**15 Lectures**
UNIT2	**Basic techniques require for tissue culture and types of in vitro cultures** Basic Techniques: Selection and Sterilization of Explants, Transfers explants onto culture medium, Growing the culture, Regeneration of plantlets, Transfer of plantlets for hardening.	**15 Lectures**
UNIT3	**Types of *in vitro* culture** Types of *in vitro* cultures (in brief) – Culture types and their application: Cell suspension culture, protoplast culture, embryo culture, Meristem culture, Callus induction and growth; Organ culture, Root culture, Shoot tip culture, Leaf culture, Flower culture, Ovary and Ovule culture, Haploid culture, Embryo culture; Anther, Pollen and Endosperm culture and Orchid propagation. organogenesis, somatic embryogenesis, Microprapogation.	**15 Lectures**
UNIT4	**Recombinant DNA and Gene transfer technology** Gene transfer technology: Vector mediated gene transfer and Virus mediated gene transfer- Direct DNA transfer, Chemical gene transfer. DNA vectors use for plant transformation, Marker gene for plant transformation: Reporter gene, Selectable marker genes, Antibiotic resistance gene. *Agrobacterium* mediated transformation; Gene transfer by biolistics method; Transient expression, Site specific recombination in plants, Particle Bombardment	**15 Lectures**

BT14060 - LAB COURSE CONTENT

(2 Credits)

1. Preparation of commonly used Plant Tissue Culture Media (MS-medium, Minimum media)
2. Explant preparation and surface sterilization
3. *In Vitro* culture of suitable Explants for induction of callus` qqq
4. Sub culturing and growth studies of callus
5. Shoot and root growth study from *in vitro* raised cultures of plant
6. Extraction and purification of genomic DNA from developing tissue by CTAB method.
7. Meristem Tip cultures for production of Virus – free Sugarcane plant (Demonstration)
8. Isolation and fusion of protoplast by enzymatic method

SUGGESTED READING

1. Pullaiah, T., Rao, M.S. and Sreedevi, E., 2017. Plant Tissue Culture: Theory & Practicals 2nd Ed. Scientific Publishers.
2. Stewart Jr, C.N. ed., 2016. Plant biotechnology and genetics: principles, techniques, and applications. John Wiley & Sons.
3. Chawla, H., 2011. Introduction to plant biotechnology (3/e). CRC Press.
4. Reinert, J., 1977. Anther culture: haploid production and its significance. Applied and fundamental aspects of plant cell, tissue, and organ culture., pp.251-267.
5. Gamborg, O.L. and Phillips, G.C., 1995. Sterile techniques. Plant Cell, Tissue and Organ Culture: Fundamental Methods, pp.35-42.
6. Kumar, U. and Kumar, U., 2011. Methods in plant tissue culture. Agrobios (India).

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SEMESTER 5

DISCIPLINE SPECIFIC ELECTIVE PAPER 4

DAIRY SCIENCE AND TECHNOLOGY

Course Objectives:

The objectives of this course are:

- To introduce students to processing of milk and its products
- To provide students with information about the importance of quality control in dairy science
- To gain a familiarity with the chemistry and biochemistry of milk from species of global importance.

Course Outcome:

Students will be able to

- develop a comprehensive understanding of Milk processing and dairy Products manufacturing
- acquire adequate knowledge & necessary skills related to the dairy processing

BT14070 - THEORY COURSE CONTENT (4 Credits)		
UNIT1	**MILK CHEMISTRY** Definition and Composition of milk Constituent of Milk Factors affecting quality and quantity of milk Nutritive value of milk Physico – Chemical properties of milk Types of milk (Flavored Milk, Toned & double toned milk, Recombined & Reconstituted milk, Sterilized milk, Imitation milk) Common micro-organism found in milk Source of microbial contamination of milk Biochemical activities of microorganisms in milk: Fermentation of milk – desirable and undesirable	**15**
UNIT2	**MILK MICROBIOLOGY** Spoilage of milk: Succession of microorganisms in milk, leading to spoilage, Color and flavor defects, Sweet curdling, Stormy fermentation, Ropiness Microbial analysis of milk: Dye reduction test, Total bacterial count, Brucella ring test and tests for mastitis, Somatic cell count Milk borne diseases Clean milk production Sources of contamination Adulteration of Milk Applications of microbial enzymes in dairy industry [Protease, Lipases] Utilization and disposal of dairy by-product – whey Treatment schemes for effluents of dairy	**15**
UNIT3	**Milk Processing& preservation of milk: Principles and practices for production of high quality milk** Milk collection, Transportation, Grading, weighing and cooling of milk	**15**

	Strainer and Straining of milk/Filter and Filtration of milk Clarifier and clarification of milk Cream separator and separation Standardization Pasteurization Homogenization Sterilization Aseptic packaging	
UNIT4	**Production of dairy products** Fermented Dairy products – Cheddar, cheese (example of soft and hard cheese), ripened and unripened cottage cheese, Curd, yoghurt,. Probiotic dairy products Fat Rich Dairy Products: Different types of cream, butter, margarine, fat Frozen Milk Products: Ice-cream and other frozen desserts Concentrated and Dried Milk Products: Condensed milk. Whole milk powder Skim milk powder.	**15**

BT14080 - LAB COURSE CONTENT

(2 Credits)

1. Methylene blue reduction (MBR) test.
2. To perform Standard plate count (SPC) from milk sample
3. Determination of acidity, pH, specific gravity and fat content of different milk Samples
4. Determination and comparison of SNF (Solid Not Fat) and TS (Total Solid) of milk Samples
5. Isolation and characterization of lactic acid bacteria from Curd.
6. Visit to a Dairy Industry

SUGGESTED READING

1. Vishweshwar, K., Krishnaiah, N. and Sunder, P.R., 2005. Quality control of milk and processing. *Ed. Reddy, S. Andra, Pradesh, India*.
2. National Dairy Regulation and Code Processing Sector Interpretive Guidelines Revised - March 2006.
3. ILRI Training Manual 1 Rural Dairy sTechnology C.B. O'Connor.
4. Fernandes, R. ed., 2009. Microbiology handbook: dairy products. Royal Society of Chemistry.
5. Tamime, A.Y. ed., 2009. Milk processing and quality management. John Wiley & Sons.
6. Jay, J.M., Loessner, M.J. and Golden, D.A., 2008. Modern food microbiology. Springer Science & Business Media.
7. Bylund, G., 2003. Dairy processing handbook. Tetra Pak Processing Systems AB.
8. Experimental Microbiology, by Rakesh J. Patel and Kiran R, Patel. Published by Aditya, Ahmedabad, Gujarat.