Vocational Biotechnology Syllabus Structure

Semester I

EC 101	**BT – 101**	Cell Biotechnology Lab: Cell culture techniques

Semester III

EC 201	**BT - 201**	Plant and Animal Biotechnology Lab: Plant Tissue Culture

Semester IV

EC 202	**BT - 202**	Environmental, Industrial and Entrepreneurial Biotechnology Lab: Environmental & Industrial BT techniques

Semester V

EC 301	**BT - 301**	Genetics Lab: Genetics and Immunological Techniques

Semester VI

EC 302	**BT - 302**	Recombinant DNA Technology Lab: Techniques of Recombinant DNA technology

The Course also includes Summer Trainings in the First and the Second Year

Detailed syllabus of Vocational Biotechnology

First Year

Semester I

EC 101 **BT – 101** Cell Biotechnology
Lab: Cell culture techniques

Unit I:

- Introduction to cell and its organelles;
- Cell division: Stages of mitosis and meiosis;
- Cell cycle – regulation, cell synchrony and its applications;
- Cell differentiation in plants and animals;
- Cell locomotion
    - i) Amoeboid movement
    - ii) Flagella and cilia
    - iii) Movements in muscle and nerve cells
- Cell senescence and death;
- Basic concepts of cancer.

Unit II:

- Cell – cell interaction;
- The cell surface;
- Cell junctions (Tight junctions, gap junctions, septate junctions);
- Extracellular matrix:
    - i) Collagen chemistry and biosynthesis (endomembrane system with NPC),
    - ii) Glycosaminoglycans and proteoglycans,
    - iii) Other structural matrix proteins
    - iv) Plant cell walls;
- Intracellular aggregation, recognition and communication:
    - i) Cell recognition and aggregation,
    - ii) Chemical signals in intracellular communication,
    - iii) Intracellular receptors and steroid hormone action,
    - iv) Cell surface receptors and second messengers.
- Light reception by plants, animals and microbes

Unit III:

- Basics terms and definitions in plant tissue culture;
- Introduction to *in vitro* cultures;
- Laboratory set up;
- Sterilization techniques;
- Media:
    - i) Various kinds of media,

ii) Composition and significance of media components;
iii) Plant growth regulators;

- Micropropagation:
  1. Axillary bud
  2. Shoot tip
  3. Meristem culture

Unit IV:

- Basics of animal cell culture: Terms and definitions
- History of development of cell culture;
- Laboratory set up;
- Simulating natural conditions for growth of animal cells;
- Media:
  i) Significance of media components;
  ii) Importance of growth factors like EGF, PGDF, FGF, IL -1, IL – 2, NGF, erythropoeitin and serum;
- Metabolic capabilities of animal cells;
- Anchorage dependence and contact inhibition.

Laboratory sessions

1. Study of laboratory techniques
2. Simple staining and study of cells
3. Media preparation and sterilization
4. Isolation of microbes from air
5. Isolation of microbes from water
6. Isolation of microbes from soil
7. Growth curve studies.
8. Viable cell count
9. Study of different cell division stages.

Reference Books

1. Cell and Molecular Biology – Scheeler P and Bianchi D, 3rd Ed., John Wiley
2. Molecular Biology of the Cell – Bruce Alberts, 4th / 5th Ed.
3. Microbiology – Prescott, 4th Ed
4. Plant Tissue Culture, Theory and Practice, Rev Ed – S. S. Bhojwani, M.K. Razdan
5. Animal Cell Culture and Technology– M Butler
6. Freshney's Culture of Animal Cells

Semester II EC 102 Environment studies

Second Year

Semester III

EC 201 **BT - 201** Plant and Animal Biotechnology
Lab: Plant Tissue Culture

Unit I:

- Types of Plant Cultures: Introduction to organogenesis
- Production of haploid plants and their applications
    - i) Ovary and ovule culture
    - ii) In vitro pollination and fertilization
    - iii) Pollen culture
    - iv) Anther culture
- Embryo culture: History and methodology
    - i) Embryo rescue after wide hybridization
    - **ii)** Applications
- Somatic embryogenesis
- Endosperm culture and production of triploids
- Single cell suspension cultures and bioreactors
- Protoplast isolation and culture
- Meristem, axillary and shoot tip culture: micropropagation

Unit II:

- Applications of Plant Tissue Culture
- Somaclonal variation and applications
- Somatic Hybridization and its applications
- Virus free plants
- Germplasm conservation
- Synthetic seeds
- DNA transformation methods in plants and applications.
- Hairy root culture
- Secondary metabolite production

Unit III:

- Types of Animal cell culture
- Organ culture
- Primary explant cultures
- Established cell lines
- Commonly used cell lines: origin and characteristics
- Growth kinetics and cells in culture
- Bioreactors for large scale culture of cells
- Cell fusion
- Transplantation of cultured cells (Grafting)

Unit IV:

- Applications of animal cell culture
- Limitations and ethical issues
- Transfection and transgenic animals
- Expressing cloned products in animal cells
    - i) The need to express in animal cells
    - **ii)** Over production and processing of chosen protein
- Production of special secondary metabolites/ products (insulin, growth hormone, interferon, t – plasminogen activator, factor VIII etc)
- Production of vaccines using animal cell culture
- Production of monoclonal antibodies and its applications
- In vitro fertilization

Laboratory sessions

- Study of laboratory equipments
- Stocks and Media preparation
- Sterilization techniques in plant tissue culture
- Explant selection, treatment and inoculation
- Subculture of initiated cultures
- Acclimatization of cultures
- Extraction of proteins from plants and its estimation
- Extraction of DNA/RNA from plants and its estimation
- Estimation of peroxidase activity in plants
- Study of β – amylase enzyme from germinated pulses.
- Demonstration of animal cell culture technique

References

1. Plant Tissue Culture, Theory and Practice, Rev Ed – S. S. Bhojwani, M.K. Razdan
2. Animal Cell Culture and Technology– M Butler
3. Freshney's Culture of Animal Cells
4. Biotechnology – B.D. Singh

Semester IV

EC 202	**BT - 202**	Environmental, Industrial and Entrepreneurial Biotechnology Lab: Environmental & Industrial BT techniques

Unit I:

- Introduction to biophysical methods using in Biotechnology
- Generation and reception of sonic vibrations – ultrasonicator
- Ultrasound and is application

- X-ray crystallography
- CAT Scan
- NMR and its imaging (MRI)
- Raman Spectra
- Electrical potential
- EEG
- Optical filters and endoscopy

Unit II:

- Introduction to Environmental Biotechnology
- Biofuels
    1. Biogas production using methanogenic bacteria
    2. Microbial hydrogen gas production
    3. Ethanol production and its use as fuel, eg. Gasohol
    4. Cellulose degradation for combustible fuel
    5. Photosynthetic pigments as solar energy convertors
    6. Plant based petroleum industry
- Xenobiotic degradation – pesticide degradation, herbicide degradation etc. by microbes
- Biopesticides, thuringiensis toxin as a natural pesticide, Bt plants etc.
- Biofertilizers
    i. Nitrogen fixing microorganisms enriching the soil with assimilable nitrogen
    ii. Phosphate solubilizers
    iii. Vermicompost
    iv. Plant growth promoting rhizobacteria
- Bioremediation and phytoremediation
- Bioleaching: Enrichment of ores by microorganisms
- Wasteland reclamation

Unit III:

- Introduction of Industrial Biotechnology
- Industrial microorganisms and their metabolites
    i. Primary and secondary metabolites
    ii. Strain development
    iii. Substrates(C and N sources) for industrial fermentation
- Methods of fermentation
    i. Fermentation process
    ii. Fermenter system
    iii. Unit operation in product recovery
    iv. Products of fermentation
- Downstream processing
    i. Removal of insolubles
    ii. Product isolation

iii. Product purification
iv. Product polishing

Unit IV:

- Starting an enterprise: Entrepreneur
- Setting up business plan:
  - (a) Business idea,
  - (b) Executive summary, Vision statement, Mission statement
  - (c) Product offering and SWOT analysis,
  - (d) Management team,
  - (e Marketing: Analysis of the market and competition – Market research, Choosing target market, Marketing strategy: 4P strategy,
  - (f) Financial planning: Balance sheet, Profit and loss statement, Breakeven analysis, Sources of capital.
- Intellectual Property rights

Laboratory session

- Estimation of total hardness of water samples
- Determination of pH, carbonates and nitrates in soil
- Estimation of Dissolved oxygen and Biological oxygen demand
- Estimation of chemical oxygen demand
- Alcoholic fermentation, purification and estimation
- Bioremediation
- Strain development

References:

1. Practical Biochemistry, Wilson and Walker, Latest edition
2. Human Physiology, Guyton
3. Microbial Biotechnology, Glazer, 2nd edition
4. Principles of Fermentation, Whittaker

Third Year

Semester V

EC 301 **BT - 301** Genetics
Lab: Genetics and Immunological Techniques

Unit I:

- Introduction to genetics
- Mendelian Genetics
  - i) History of Mendelian genetics
  - ii) First Law of Inheritance

iii) Second Law of Inheritance
iv) Test Cross and Back cross

- Chromosomal theory of inheritance and inheritance patterns
- Incomplete Dominance, codominance
- Multiple alleles: ABO blood group and incompatibility, Rh incompatibility
- Epistasis : Dominant and Recessive epistasis
- Non epistatic inter allelic gene interactions
- Gene Lethality
- Sex linkage, non-disjunction as proof of chromosomal theory of inheritance

Unit II:

- Chromosomes: Chemical composition and structural organization of chromatids
- Centromeres and Telomeres
- Chromatin and nucleosome organization: eu- and heterochromatin
- Special banding patterns in human chromosomes
- Chromosomal aberrations: structural and numerical
- Evolution of wheat, cotton and rice
- Linkage and crossing over
- Gene mapping
- Interference and coincidence in prokaryotes and eukaryotes

Unit III:

- Organization of bacterial genomes
- Bacterial replication
- Conjugation
- Transduction; bacteriophages
- Transformation
- Isolation of auxotrophs and replica plating
- Induced mutations in microbes, plants and animals and its economic benefits
- Analysis of mutations in biochemical pathways: one gene – one enzyme hypothesis

Unit IV:

- Extrachromosomal inheritance
- Mitochondrial equilibrium and evolution
- Evolution of chloroplast DNA and its inheritance
- Population genetics:
  i. Hardy Weinberg theory
  ii. Factors affecting Hardy Weinberg theory
  iii. Gene and genotypic frequencies
- Pedigree analysis
- Epigenetics
- Evolutionary genetics

Laboratory session

- Formulating and testing genetic hypothesis: problem solving
- Preparation of antigens
- Immunization methods
- Single and Double radial immunodiffusion techniques
- Immunoelectrophoresis
- Rocket immunoelectrophoresis
- 2 – D Cross immunoelectrophoresis
- Purification of IgG using ion-exchange chromatography

Reference Books

1. Genetics, Strickberger
2. Principles of Genetics, Snustad, 5th Edition
3. Introduction to Genetic Analysis, Griffith

Semester VI

EC 302 **BT - 302** Recombinant DNA Technology
Lab: Techniques of Recombinant DNA technology

Unit I:

- What is gene cloning and why do we need to clone a gene?
- Introduction to recombinant DNA technology
    i. Vehicles of genomic DNA
    ii. Handling of DNA, RNA, cDNA and Restriction enzymes
    iii. Laboratory requirements
    iv. Safety measures and regulations for rDNA work
    v. Choice and selection of the tools and techniques
- Vehicles
    i. Plasmids
    ii. Bacteriophages and viruses
    iii. Phagemids
    iv. Cosmids
- Purification of DNA from bacterial, plant and animal cells
- Manipulation of purified DNA
- Introduction of DNA into living cells

Unit II:

- To obtain a clone of a specific gene
    i. Direct selection
    ii. Selection using hybridization
    iii. Genomic DNA library
    iv. cDNA library
- Probe designing and labeling

- Identification of clones using alternative methods
- Studying gene location
    - **i.** Hybridization techniques
    - **ii.** In situ hybridization
- Studying gene structure – DNA sequencing
- Polymerase Chain reaction

Unit III:

- Cloning vectors for E. coli
- Cloning vectors for yeast
- Cloning vectors for fungi and plants
- Transcript analysis
- Studying gene expression
- Regulation of gene expression
- Studying translated product of a cloned gene
- Studying protein –protein interactions
- Expression vectors
- Promoters used in expression vectors of bacteria
- Expression in systems other than bacteria

Unit IV:

- Applications of gene cloning
- Production of pharmaceutical compounds
- Production of recombinant insulin
- Production of recombinant vaccines
- Production of diagnostic reagents
- Gene therapy
- DNA Fingerprinting

Laboratory sessions

- Genomic DNA isolation
- Plasmid DNA isolation
- Assessment of quality and quantity of DNA
- Agarose gel electrophoresis to visualize DNA
- Restriction digestion
- DNA ligation
- DNA transformation
- PCR

Reference Books

1. Gene Cloning – T.A. Brown
2. Principles of Gene Manipulation – Old and Primrose
3. Molecular Cloning - Sambrook