

New Curriculum of UG Programme

FOR

B.Sc. (Agril. Biotechnology)

(Layout and Syllabus)

for

**VII to VIII Semester
(Cafeteria Courses & Hands on Training)**



**Associate Dean & Principal
College of Agril. Biotechnology
Latur-413512
Maharashtra**

Lay out of the syllabus of VIIth And VIIIth Semester

B. Sc. (Agril. Biotechnology)

- Degree programme : B. Sc. (Agril. Biotechnology)
- Duration : 4 years-8 Semesters
- Layout of the syllabus :
 - Ist to VIth semester - Course work 120 credits (APPROVED)

 - VIIth semester – Seminar : 1 credits
Cafeteria courses : 20 credits
(10 credits from major department
10 credits from 2 minor department)

 - VIIIth semester – Hands on training 20credits

 - Total Credits : 167 credits

 - Non credit courses : NCC/ NSS : 0+1 credits
: English : 1+1 credits
: Physical Education :0+1credit

 - Deficiency course : Math : 2+0 credits

 - Grand total : 173 credits

Department –wise courses

SEMESTER: VII

A. Cafeteria courses for Department of Biochemistry & Molecular Biology

Sr. No.	Course No.	Title of cafeteria courses	Credits
1	BIO 4710	Advances in Recombinant Technology	1+3=4
2	BIO 4711	Secondary Metabolites of Commercial Importance	1+3=4
3.	BIO 4712	Immunological techniques and its Application	1+3=4
4	BIO 4713	Proteins and Proteomics	1+3=4
5.	BIO 4714	Enzyme Technology	1+3=4
		Total Credits	5+15=20

B. Cafeteria courses for Department of Plant Biotechnology

Sr. No	Course No.	Course Title	Credits
1	PB 4711	Advances in Plant Tissue Culture	0+4=4
2	PB 4712	Techniques in Genetic Transformation	1+3=4
3	PB 4713	PCR Techniques and its Application	1+3=4
4	PB 4714	Legal issues in GMO' s and LMO's	1+3=4
5	PB 4715	Plant Genomics	1+3=4
		Total Credits	4+16=20

C. Cafeteria courses for Department of Crop Science

Sr. No	Course No.	Course Title	Credits
1	CS 4713	Seminar	0+1=1
2	CS 4714	Bio-pesticides: Production Technology	1+3=4
3	CS 4715	Bio-fertilizer production technology	1+3=4
4	CS 4716	Vermiculture and Organic Farming	1+3=4
5	CS 4717	Seed Production Technology	1+3=4
6	CS 4718	Protected cultivation of Flowers and vegetables	1+3=4
		Total Credits	5+16= 21

D. Cafeteria courses for Department of Post Harvest and Food Biotechnology

Sr. No.	Course No.	Course Title`	Credits
1	FB 478	Cereal Biotechnology	2+2=4
2	FB 479	Fruit and Vegetable Biotechnology	2+2=4
3	FB 4710	Brewing Technology	1+3=4
4	FB 4711	Wine Technology	1+3=4
5	FB 4712	Patenting Inventions in Food Biotechnology	2+2=4
		Total Credits	8+12=20

E. Cafeteria courses for Department of Animal Biotechnology

Sr. No	Course No.	Course Title	Credits
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1	AB 477	Techniques in Animal Cell Culture	1+3=4
2	AB 478	Transgenic for improvements in animals	1+3=4
3	AB 479	Artificial Insemination techniques	1+3=4
4	AB 4710	Advances in Dairy Microbiology	1+3=4
5	AB 4711	Probiotics in milk and milk products	1+3=4
		Total Credits	5+15= 20

SEMESTER: VIII

HANDS ON TRAINING: (0+20)

A research project will be allotted to individual student and evaluated as under:

Sr.No.	Particulars	Credits
1	Outline of Research Work	01
2	Introduction	01
3	Review of Literature	03
4	Materials and Methods	03
5	Result and Discussion	05
6	Viva Voce and Presentation	05
7	General Performance	02
	Total credits	20

Course Contents (Syllabus)

A. Cafeteria courses for Department of Biochemistry & Molecular Biology

BIO- 4710 Advances in Recombinant Technology

1+3

Theory :

Introduction to genetic engineering and cloning, Restriction enzymes in cloning. Restriction endonucleases, types, properties and nomenclature, DNA ligase and

cofactors. Techniques in recombinant DNA technology, shot gun methods, Instrumentation ,PCR, UV transilluminator. Gel electrophoresis (PAGE,SDS-PAGE) Southern, Northern and Western blotting. Dot and slot blots. Cloning vectors- plasmid: pBR322, Ti and cosmid, viruses: CMV. Bacteriophages.

Isolation, sequencing and synthesis of gene. Isolation of gene of interest, fragmentation, reverse transcription method. Sequencing-sequencing of gene, (Maxam Gilbert & Sanger's Dideoxy method) synthesis of gene. Organo-chemical synthesis of RNA, precursor of RNA and interferon gene selection, screening and analysis of recombinants, Use of selectable and scorable reporter gene, expression of cloned gene. Application of recombinant DNA technology. Transgenic crops – resistance to herbicides, insecticides, viruses and pathogens, nif gene

Practicals:

1. Isolation of genomic DNA/ RNA (plant)
2. Isolation of DNA from plasmid/bacteria/yeast/ blood
3. Restriction enzyme digestion
4. Ligation of DNA fragment
5. Agarose gel electrophoresis of DNA
6. Quantification of DNA and RNA
7. Conjugation & Transformation
8. Maintenance of cultures
9. Preparation of competent cells

References :

- 1) An introduction to genetic engineering (II Edition) by Desmond S.T.Nicholl (studies in Biology series) I South Asian Edition 2002, Cambridge University Press.
- 2) DNA technology, the Awesome skill II edition by Alcamo, I.E.(2000) Harcourt/ Academic Press.
- 3) Genomes, Brown, T.A. (1999), Bios Scientific Publishers, Oxford.

4) Cell and Molecular Biology, II Edition by Gupta. P.K. , Rastogi Publication.

BIO-4711 Secondary Metabolites of commercial importance 1+3

Theory :

Introduction to secondary metabolites like phenols, tannins, quinolic compounds flavonides and all these are including pathways involve in plant metabolism.

Pigments : Like carotenoids, terpenoids, lycopene, chlorophyll, Curcumin, anthocyanine their importance, uses, their role in plant metabolism. Plant acids : Details of oxalic acid, their role in metabolism use and function. Alkaloids : Details of alkaloids their role, uses in relation to plant metabolism.

Practicals :

1. Estimation of total phenols
2. Separation and detection of phenol by paper chromatography
3. Estimation of tannins, flavonoids, lignins, terpenoids.
4. Estimation of chlorophyll
5. Separation of different pigments by paper or thin layer chromatography
6. Estimation of oxalic acid

References :

1. A.Mahadvan and R. Sirdhar (1986) Methods in physiological plant pathology 3rd Edition.
2. S.Sadasivam and A. Manikam (1992), Biochemical methods for Agricultural Sciences. Wiley Eastern Ltd. New Delhi.
3. Hand book of phytological methods, Cambridge Uni.Press, London

BIO- 4712 Immunological Techniques and Its Applications 1+3

Theory :

Introduction to immunology, innate immunity, acquired immunity, immune response, Antigen and antibodies ; structural organization and their properties, receptors for antigen. Immunological methods and applications, detection and quantification of antigen by antibody. Immunodetection of antigen in cell and tissues. The primary interaction with antigen.

Identifying B-cells epitopes on a protein . Specificity and cross reactivity of antibodies. The major Histocompatibility complex (MHC) , and their classes I and II (MHC), control mechanism. T-cell regulation, Activation induced cell death, apoptosis. Effect of diet, exercise, trauma and age on immunity. Vaccines: Passive acquired immunity, Vaccination, vaccines against parasitic disease, bioterrorism, immunization against cancer. Immunodeficiency: Primary and secondary immunodeficiency syndrome (AIDS) ELISA :The scope of autoimmune diseases, T-helper cells, diagnostic value of autoantibody tests, Treatment of autoimmune disorders.

Practicals:

1. To study the structure and function of the immunoglobulin classes.
2. Immunodiffusion
3. To study the major histocompatibility complex
4. ELISA
5. To study the antigen-antibody reactions
6. Purification of antigen and antibodies by affinity chromatography
7. Immunofluorescence microscopy
8. Radioimmunoassay (RIA)
9. Immunocytochemical Techniques
10. Agglutination reaction, precipitation reaction, CFT, Serum-blood separation
11. Molecular basis of immune responses.

References :

1. Roitts Essential of immunology, XIth Edition, Peter J.Delves, Seamus J.Martin, Dennis R. Burton and Iran M.Roitt.
2. Kubys Essential of immunology, Ist Edition. Kuby.

Theory:

Introduction. Proteomics and functional genomics; Protein structure, functions and properties; protein synthesis; Protein separation techniques; Protein interactions. Protein Identification and Analysis, Protein preparation and separation; Two-dimensional gel electrophoresis, Limitations of two-dimensional gel electrophoresis, Protein fractionation prior to electrophoresis, Protein Digestion Techniques, Mass Spectrometers for Protein and Peptide Analysis, Protein Identification by Peptide Mass Fingerprinting, Protein identification by mass spectrometry; Basics of mass spectrometry analysis, Ionization of biological macromolecules Tandem mass spectrometry, Peptide Sequence Analysis by Tandem Mass Spectrometry, Protein Identification with Tandem Mass Spectrometry Data, Multidimensional liquid chromatography and tandem mass spectrometry Identification of post-translational modifications; Identification of phosphorylated Proteins, Protein chips, arrays and functional proteomics : Different types of protein chips; Antibody arrays, Antigen arrays, Broad-specificity capture chips, Functional protein chips, Manufacture of protein chips, Detecting and quantifying proteins bound to protein chips, Emerging protein chip technologies; Bead and particle arrays in solution, Cell and tissue arrays Applications of proteomics : Proteomics and plant biotechnology; Proteomics in plant breeding and genetics, Proteomics for the analysis of genetically modified plants, Proteomics and the analysis of secondary metabolism.

Practical:

1. Protein isolation & purification by different techniques
2. SDS-PAGE analysis
3. Two dimensional gel electrophoresis.
4. Western Blotting. Capillary blotting and electrophoretic blotting .
5. Protein identification by mass spectrometry.
6. Protein analysis by liquid chromatography.

7. Protein analysis by gas chromatography.
8. Protein motif sequence analysis.

References:

1. Introduction to Proteomics: Tools for the New Biology, By Daniel C. Liebler, Humana Press Inc. Totowa, New Jersey, 2002
2. PROTEOMICS by Timothy Palzkill, Kluwer Academic Publisher, New York, 2002
3. Principles of Proteomics: Advanced Text, by Twyman, Richard M., Garland Science/BIOS Scientific Publishers, 2004
4. Protein Arrays, Biochips, and Proteomics: The Next Phase of Genomic Discovery by Joanna S. Albala and Ian Humpheiy-Smith, by Marcel Dekker, Inc., New York, 2003

BIO 4714: Enzyme Technology

1+3

Theory:

Large scale production and purification of enzymes Production of enzymes on an industrial scale, Large scale purification of enzymes, Synthesis of artificial enzymes, Immobilized enzymes: Preparation of immobilized enzymes, properties, application, enzyme utilization in industry, application in food drink and other industries, use of microorganisms in brewing and cheese making, use of microorganisms in organic chemicals, use of isolated enzymes in industrial processes, clinical aspects of enzymology, introduction to enzyme inhibitors and drug design, enzyme therapy, Indigenous enzymes of Bovine Milk: lipases, proteinases and phosphatases, exogenous enzymes used in dairy industry.

Practicals:

1. Enzyme assays, measurement of catalytic activity of enzymes.
2. Purification of enzyme by different methods like Dialysis, Ammo.sulphate precipitation, Gel filtration, and ion exchange chromatography etc.

3. Preparation of Immobilized enzyme
4. Use of immobilized enzyme for production of HFCS
5. Use of immobilized yeast for production of alcohol
6. Production of enzymes using various microorganisms.
7. Production of taq. Polymerase using microorganism on laboratory scale.

Reference Books:

1. Advances in Enzymology, Vol. 1-10 Nord, F.F. (ed.) 1941-50. Interscience Publisher, New York.
2. Principles of Enzymology for the Food Sciences by Whitaker, J.R. 1972. Marcel Dekker, New York.
3. Enzymes in Food Processing by G. Reed 1975. Academic Press, London.
4. Industrial Enzymology by Godfry, T. and J.R. Relchelt, (2nd edn.) 1997. MacMillan Publishing Co., London.
5. Fundamentals of Enzymology by Price N.L. and L. Stevens. 1993. Oxford Scientific, Oxford.
6. Biochemistry by Stryer, L. 1994. Fourth Edition W.H. Freeman and Company New York.
7. Food Biotechnology by K.Shetty CRC publication.

B. Cafeteria courses for Department of Plant Biotechnology

PB 4711 Advances in Plant Tissue Culture 0+4=4

Practical:

1. Sterilization and culturing of seeds, bulbs, leaves, stems, roots, suckers, and flower buds etc.
2. Seed germination, Embryo culture and embryo rescue after wide hybridization.

3. Meristem tip culture for virus elimination.
4. *In Vitro* pollination and Fertilization.
5. Cell suspension culture.
6. Organogenesis and embryogenesis.
7. Protoplast isolation and fusion (Somatic hybrid production).
8. Secondary metabolite production,
9. Somaclonal Variations,
10. Agrobacterium mediated gene transfer,
11. Gene transfer by biolistic method.

References:

1. An introduction to plant biotechnology by H. S. Chawala.
2. Biotechnology in crop improvement by H. S. Chawala, International book distributing co. Lukhnow.
3. Plant Biotechnology – Practical Mannual by C. C. Giri and Archana Giri, I. K. International Publishing house, Mumbai.
4. Biotechnology by B. D. Singh, Kalyani publishers.

PB 4712

Techniques in Genetic Transformation

1+3=4

Theory:

Definition, introduction and history of genetic transformation, Need of genetic transformation, Agrobacterium mediated gene transfer Ti plasmid and Ri plasmid, Infection of wounded plants with Agrobacterium strains, Co cultivation, Leaf disc method, Advantages of Agrobacterium gene transfer. Direct gene transfer Particle gun/microprojectile/biolistic method, Chemical method, Electroporation, Lipofection, Microinjection method, Macroinjection method, DNA delivery via growing pollen tubes, Direct DNA uptake by mature zygotic embryos, etc, Expression of induced genes by using selectable and scorable markers (Reporter genes). Application of genetic transformation in production of transgenic plants with various resistance characters and other improved qualities.

Practicals:

1. Induction of transformed Hairy roots using wild strains of
2. *Agrobacterium rhizogenes* and production of secondary metabolites.
3. Induction of transformed shoots using wild specialized strains of *Agrobacterium tumifaciens* and production of secondary metabolites.
4. Introduction of foreign DNA into plants by using Particle bombardment/
5. Microprojectile/ Biolistic method.
6. Transformation of Chloroplast genome in higher plants by using *Agrobacterium* and particle gun method.
7. Regeneration of transformed plants.
8. Study of transformed plants for regulated gene expression.

References:

1. An introduction to plant biotechnology by H. S. Chawala.
2. Biotechnology in crop improvement by H. S. Chawala, International book distributing co. Lukhnow.
3. Plant Biotechnology – Practical Mannual by C. C. Giri and Archana Giri, I. K. International Publishing house, Mumbai.
4. Genetic engineering and its applications by P. Joshi, Student Edition, Jodhpur.
5. Biotechnology by B. D. Singh, Kalyani publishers.
6. Elements of biotechnology by P. K. Gupta, Rastogi Publication.

PB 4713 PCR Techniques and its Application**1+3=4****Theory:**

Introduction, History, Stages and components of the PCR, Working principle, Thermo stable DNA polymerases used in PCR, Primer design in PCR, Sensitivity of PCR, Variants of PCR Inverse PCR, Anchored PCR, PCR for site directed mutagenesis, Asymmetric PCR for DNA Sequencing, RT-PCR, Overlap Extension PCR, Nested PCR,

Touch down PCR, Hot Start PCR, ARMS PCR, etc. Analysis of PCR products, Applications of PCR in biotechnology Study of DNA polymorphism using PCR, PCR & RAPD markers, PCR & VNTR loci, PCR & SSR loci, Molecular Mapping using PCR, Gene tagging using PCR, PCR for the conformity of the presence of transferred gene DNA fingerprinting using PCR, Gradient PCR.

Practicals:

1. Amplification of DNA.
2. Study of DNA polymorphism.
3. Cultivar identification using PCR,
4. Studying genetic diversity using PCR,
5. DNA fingerprinting by using PCR,
6. Screening of varieties for characterization,
7. Detection of transgene by using PCR,
8. RAPD, AFLP, SSR analysis.
9. Primer Designing

References:

1. PCR, second edition by C. R. Newton and A. Graham, Bios Scientific publishers.
2. Molecular Biology and biotechnology, Fourth edition by J. M. Walker and R. Rapley, Panima publishing house.
3. Biotechnology by B. D. Singh, kalyani publishers.
4. Elements of biotechnology by P. K. Gupta, Rastogi Publication.

PB 4714 Legal Issues of GMO's and LMO's

1+3

Theory:

Biosafety and risk assessment issues , Regulatory framework, DBT = Department of Biotechnology; GEAC = Genetic Engineering Approval Committee; RCGM = Review Committee for Genetic Modification (constituted by DBT); ICAR = Indian Council of Agriculture Research; MEC = Monitoring & Evaluation Committees (constituted by

GEAC and RCGM). National biosafety policies and law, the Cartagena Protocol on Biosafety, WTO and other international agencies.

Practicals:

The International Food Code or the Codex Alimentarius, Guidelines for GMO -Recombinant DNA Safety Guidelines, 1990 by Department of Biotechnology, field trials and commercial applications; Revised Guidelines for Research in Transgenic Plants, 1998 by Department of Biotechnology; Protocols for Food and Feed Safety Assessment of GE Crops, 2008 by Department of Biotechnology; 1 Guidelines for the Safety Assessment of Foods Derived from Genetically Engineered Plants, 2008 by Indian Council of Medical Research (ICMR); Guidelines and Standard Operating Procedures (SOPs) for Confined Field Trials of Regulated, Genetically Engineered (GE) Plants, 2008 by Department of Biotechnology and Ministry of Environment and Forests. IBSE Guidelines and application forms.

References:

1. Biotechnology by Singh, B. D. 2000. Kalyani Publishers, Ludhiana.
2. Food Biotechnology by K. Shetty, 2006, CRC publication.
3. Plant Biotechnology by Chawla, 2002, Oxford IBH, ND
4. Web sites:
 - 1) www.agbios.com
 - 2) www.dbt.nic.in,
 - 3) www.bcil.nic.in,

PB 4715

Plant Genomics

1+3=4

Theory:

Mapping of Eukaryotic genomes-

- Construction of linkage maps with molecular markers
- Gene libraries

- Screening of libraries
- Constructing contigs Sequencing

Gene location in DNA sequences

- Sequence inspection and Hybridization tests
- Southern hybridization Northern Hybridization Detection/ Autoradiography

Requirement:

Vertical electrophoresis unit, Softwares for linkage maps (mapmaker), Contigs

Sequencer, Hybridization chamber, Dark Room

Practical:

1. Construction of linkage maps with molecular markers like RAPD, SSR, AFLP etc.
2. Construction of gene libraries by using suitable vector.
3. Southern hybridization
4. Northern Hybridization
5. Use of suitable softwares for analysis of DNA polymorphism.

C. Cafeteria courses for Department of Crop Science

CS 4713	Seminar	0+1
CS 4714	Bio-Pesticides: Production Technology	1+3

Theory

Defination, scope and importance of Biological control Microbial control, Definition and concept Production of biopesticide based on Fungi, bacteria, Viruses and Nematodes Important industries producing biopesticides Safety testing and registration New technologies and microbial control Promising plant species for pest control.

Practicals:

Importance terms related to the course

Mass production technique of white muscardine fungus *Beauveria bassiana*

Mass production technique of green muscardine fungus *Metrhazium anisoplae*

Mass production technique of *Verticillium lecanii*

Mass production technique of *Trichoderma spp.*

Mass production and standardization of *Bacillus thuriengensis*

Mass production of HaNPV and SLNPV

Mass production and standardization of G.V

Mass production technique of Neoplectina Spp.(DD-136)Nematode

Packaging and Labelling of Biopesticide.

Reference books

1. New direction in biological control by baker,R.R and P.E.Dann(EDS)1990,Wiley-lies,New York.
2. Biological control by Natural enemies by Debach,P and Rosen,D,1991,Cambridge Universitypress,Cambridge,U.K.
3. Principles of Insect Pest Management by Dhaliwal,G.S and Arora,R.2006, Kalyani Publisher,New Delhi.
4. Botanicals and Biopesticides by Parmar,B.P and C.Devakumar,1993,Westvill publishing house.New Delhi.
5. Principles of Insect Pest Management by Dhaliwal,G.S and Arora,R.2006, Kalyani Publisher,New Delhi.

Theory:

Distribution of soil microflora Biological properties of soil and factors affecting biological properties, Role of soil microorganisms in maintenance of soil fertility and productivity Biochemistry of humus formation Biochemistry of nitrogen fixation, Phosphate solubilization –mechanism. Organic matter decomposition. Types and scope of biofertilizers Quality control of biofertilizers, Use of Genetically Engineered Microorganisms for improvement of biofertilizers.

Practical:

Introduction to different microorganisms used in biofertilizer production

Introduction, definition, types, scope of biofertilizers

Isolation of Phosphate solubilizing micro-organisms from rhizosphere

Isolation of *Rhizobium* from root nodules of leguminous crop

Isolation and purification of *Azotobacter* from soil

Isolation and purification of *Beijerinckia* form soil

Isolation of *Azospirillum*

Isolation Blue Green Algae from soil

Isolation of organic matter decomposing microorganisms

Mass multiplication of *Rhizobium*, *Azotobacter*, and *Azospirillum* inoculum

Production and application of blue green algae

Production of Azolla biofertilizers

Methods of application of biofertilizers

Standards for commercial production of biofertilizers- Quality control of biofertilizers.

References:

1. Soil microorganisms by N.S.Subba Rao, Oxford and IBH Publication Co. New Delhi
2. Advances in Agril. Microbiology by N.S. Subbarao, Oxford and IBH Publication Co, New Delhi

3. Bergy's manual of systematic bacteriology by Krieg N.R. and J.G. Holt, 1984, Williams and Witkins, Baltimore, U.S.A.
4. Agricultural Microbiology by Rangaswamy G. and D.J. Bhagyaraj 1988, Oxford and IBH Publication Co. New Delhi.

CS 4716 Vermiculture and Organic Farming

1+3

Theory

Introduction, initiation of vermiculture in India. Materials for vermicomposting. Selection and basic characteristics of suitable species. Advantages and types of vermicomposting. Physical properties of soil and criteria of essentiality of nutrients. Organic Farming- Definition, Scope and Importance of Chemical Farming Vis-à-vis Organic farming. Soil health and its importance, Component of organic farming system Manures: compost, FYM, biogas slurry, sewage and sludge, green manures, biofertilizers. Compost making and the process of decomposting. Role of manures, crop rotation, green manuring. Socio-economic constraints in organic farming, Integrated nutrient management.

Practicals:

Analysis of organic manures-organic carbon, total NPK and C: N ratio

Fertilizer analysis-Urea, Ammonium sulphate, Pottassium nitrate, Murate of potash and Rock phosphate for their respective nutrients

Plant tissue testing

Study of materials required for vermicomposting

Study of requirements for vermicomposting

Preliminary treatment for composting material

Preparation of vermin beds

Setting up of a vermin wash unit

Harvesting and economics of vermin composting

Chemical composition of vermin compost

Reference books:

1. Earthworm Cinderella of organic farming by Radha D Kale, Prism books Pvt Ltd. Bangalore
2. Vermiculture and organic farming by T.V. Sathe, Daya publishing house, New Delhi
3. Vermiculture –The Biology of Earthworm by Sultan A Ismail, Orient Longman, Hyderabad
4. Organic farming for sustainable Agriculture by A.K Dahama, Agribios (India) Jodhpur
5. Plant and soil analysis by Piper C.S Hans Publisher, Bombay
6. Soil fertility, Theory and Practices by Kanwar S.S, ICAR, New Delhi
7. Manures and Fertilizer by Yawalkar K.S., J.P. Agarwal and S. Bond, Agril. Horticulture publication house, Nagpur, India
8. Soil fertility and fertilizers by Tisdale S.L, W.L. Nelson and I.D. Beaton, Mcmillan Publishing company, New York.
9. Analytical Agricultural chemistry by Chopra S.L and J.S. Kanwar, Kalyani Publisher, Ludhina.

CS 4717

Seed Production Technology

2+1

Theory:

The Indian Seed Act (1966). Classes of quality seed, Breeder seed, Foundation seed, certified seed. Requirements for certified seed genetic purity, physical purity, germination percentage. Seed production: Isolation, seed crop cultivation. Seed processing: drying, cleaning, gading, testing, treating, bagging and labeling. Seed Certification: Field inspection, seed tests, sampling, purity tests, germination tests, moisture control. Maintenance of improved seed. Seed production organizations.

Practical:

Seed Tests: - Sampling, Purity test, germination test, moisture content, physical purity.

Grow out tests: - Breeding of new varieties. Certified seed production of selected crops,

Isolation distance, Cultural Practices, Planting, Plant Protection, Detaselling, Roughing, Harvesting, Dying of Hybrid Maize/Wheat/ Jowar/Chickpea/ Pigeonpea/ Onion/ Chilli/ Brinjal/Tomato/ Cotton, etc.

References:

1. Techniques in Seed science and Technology by Agrawal, P. K and Dadlani, M 1987, South Asian Publishers, New Delhi.
2. Principles of plant breeding by Allard, R. W. 1960, John Wiley and Sons Inc., New York.

CS 4718 Protected cultivation of Flowers and vegetables 1+3

Theory:

Types of Protected structures- glass house, poly house, shade house, rainshade structures, climate control structures, etc. Cultivation of flower crops like roses, carnation, gerbera, orchids, anthurium etc. and vegetables like capsicum, cucumber, tomato, cherry tomato. Propagation methods for various flowers and vegetables crops. Methods of controlling environmental factors in polyhouse. Varieties of flowers and vegetable crops Harvesting, grading, post harvest handling and packaging and storage of flowers and vegetables

Practicals:

Layout of Green house

Control of environmental factors in greenhouses.

Study of media and preparation of beds

Cooling system and ventilation for green houses

Study of root substrates

Methods of sterilization of media

Containers used for protected cultivation

Methods of propogation

Special horticultural practices in cultivation of different cut flowers and vegetables.

Irrigation systems and fertigation for greenhouse crops

Harvesting, grading, post harvest handling, packaging and storage of cut flowers.

Preparation of pulsing and holding solution

Identification and control measures of pest and diseases

Export standards for cut flowers and vegetables

Economics of production of one vegetable or one flower crop

Visit to Hi-Tech project.

Reference books :

1. Greenhouse Management of Horticultural Crops by S. Prasad and U. Kumar, Kalyani Publishers.
2. Greenhouse Technology and Management by Manohar. 2006. International Book Distribution Co., Lucknow.
3. Greenhouse Environment by Mastalez, J. W. 1977. John-Wiley and Sons, New York.
4. Greenhouse Management : Forcing of Flowers, Vegetables and Fruits by Taft, L. R. 2001. Daya Publication House, New Delhi.
5. Green House Operation & Management by Nelson, 2007.
6. Green House and Shelter structure for tropical regions/FAO by Zbeltitis.
7. Protected Cultivation by A. S. Jadhav, P. V. Patil and M. T. Patil.
8. Commercial Protected Floriculture by M. T. Patil and P. V. Patil

D. Cafeteria courses for Department of Post Harvest and Food Biotechnology

FB 478 : CEREAL BIOTECHNOLOGY

2+2

Theory:

Introduction, Genetic transformations of wheat, barley, rice and maize. Problems and future trends in genetic transformation, Commercial targets for cereal biotechnology, using biotechnology to add value to cereals: weed control, Disease resistance, improved

nutritional properties, improved processing properties, improved cereal quality control, Deployment of molecular markers, current practice in milling, baking, malting, brewing and distilling. Risk assessment and legislative issues.

Practical:

1. Isolation of DNA from Wheat, Barley, Rice and Maize.
2. Isolation of Protoplast.
3. QTLs detection.
4. Preparation of gene cassette: Cloning vector, Gene of interest, Promoter, Terminator, Marker gene.
5. Gene transformation via *Agrobacterium*, *Biolistic*, *Electroporation* and *Micro-injection* method

References books:

1. Cereal Biotechnology by Peter C. morris and James H. Bryce, Woodhead publishing Limited, publication 2000.
2. Food Biotechnology by Dietrich Knorr, Dekker publication 2005.
3. Biotechnology by B. D. Singh, Kalyani publication, 2000.

FB 479 FRUIT AND VEGETABLE BIOTECHNOLOGY 2+2

Theory:

Introduction, the nutritional importance of fruits and vegetables. Strategies for nutritional enhancement: The application of traditional breeding methods for selection of varieties, a reduction in the content of anti-nutritional factors, the use of genetic manipulation to introduce new traits. Nutritional health benefits through biotechnology. Relationship of structure to nutritional quality (Bioavailability). Nutritional enhancement versus food fortification. Constraints on innovation, further trends in food biotechnology. Food safety. Case studies to improve Nutritional quality and shelf life of fruits and vegetables- e.g. Potato, tomato, Grape etc. Case studies of grape, tomato, papaya and other fruits and vegetables,

Practicals:

1. Biochemical analysis of nutritionally important fruits and vegetables.
2. DNA isolation.
3. DNA fingerprinting of fruits and vegetables.
4. Identification of novel gene(s) related to nutritional character by using various markers.
5. MAS for the quality characters.

References books:

1. Plant cell tissue and organ culture: fundamental methods by C. L. G. C. Philips and L.R. Wetter 1995. National Research council, Canada, PRL, Saskatoon.
2. In vitro embryogenesis in plants by Trevor Thorpe A.1995. Kluwer Academic press London.
3. Plant Tissue Culture Theory and Practices by Bhojwani & Razdan,2008, Elsevier, India.
4. Introduction to Plant Tissue Culture by Razdan, 2007, Oxford IBH.
5. Plant Cell Culture by Dixon, 2004, Panima New Delhi.
6. An introduction to Plant Tissue Culture by Kalyani Kumar De.
7. Fruit and Vegetable Preservation principals and practices 3rd revised and enlarged edition by R. P. Srivastava and Sanjeev Kumar.

FB 4710**BREWING TECHNOLOGY****1+3****Theory:**

Introduction, History of brewing, Malts, Mash tun adjuncts and brewing liquor. Milling and mashing in, Mashing and wort separation systems. The hop-boil and copper adjuncts,

wort clarification, cooling and aeration. Fermentation process development, scale of up process.

Practicals:

1. Biochemical analysis of nutritionally important fruits and vegetables used in brewing.
2. Media preparation and instrument required for brewing.
3. Preparation of mother culture and starter culture for alcohol production.
4. Preparation of Beer / alcohol.
5. Contamination of beer during processing and effect of contaminants on quality of beer.
6. Sensory evaluation of Beer.
7. Removal of protein from beer by hydrolysis, precipitation and adsorption method.
8. Major problems in Beer production.
9. Defects in Beer
10. Studies on factors affecting quality of beer.

References books:

1. Brewing Science and Practice by Briggs, Boulton, Brookes and Stevens 2004, Woodhead Publishing Limited, USA.
2. Food Biotechnology edited by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin, Taylor & Francis Group 2006.
3. Biotechnology by B. D. Singh, Kalyani publication, 2000.

FB 4711

WINE TECHNOLOGY

1+3

Theory:.

Introduction, Grape cultivars and wine types: Vitis vinifera cultivars, white cultivars, red cultivars, Advance techniques in production, Genetic engineering in wine grapes, clonal

selection and somaclonal selection, Biotechnology in Viti culture, Genetic engineering for Yeast fermentations, Ideal Yeast; Yeast breeding and wine quality. Wine as a functional food, Factors affecting during storage or aging of wine.

Practicals:

1. White wine production and recommended varieties.
2. Red wine production and recommended varieties.
3. Production of wines other than grapes.
4. Techniques of testing wine:- Selection of glass, serving temperature, Design of room for wine testing
5. Timing of testing wine, test the wine on the basis of senses (Vision, smell / aroma and palate structure).
6. Sensory evaluation and score card:- Rose worthy score card, Devis score card and sparkling wine score card.
7. Visit to the winery
8. Production of wines on lab scale / industrial scale.
9. Tartarate and bitartarate stability test / cold stability test
10. Determination of acetaldehyde / phenol content of wine.
11. Spoilage and Adulteration of wine.
12. Studies on factors affecting quality of wine.

References books:

1. Fermentation a practical approach by McNeil and L M Harvey, published in the Practical Approach Series, Indian publication, 2007.
2. Food Biotechnology edited by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin, Taylor & Francis Group 2006.
3. Biotechnology by B. D. Singh, Kalyani publication, 2000.

FB 4712 PATENTING INVENTIONS IN FOOD BIOTECHNOLOGY 2+2

Theory:

Nature of patent, patent application, patent ability, official examination, Re-examination, Features of US patent application, Conflicting patent application, Duration of patent,

Enforcing patent, Licensing patent, Types of biotechnology patents: Food products and biological products (naturally occurring substances, micro-organisms, plants, animal breeds, DNA and RNA sequences), Patenting in biotechnology: Microbiological inventions, Descriptions of micro-organisms, Availability of the deposit, Patent for GM foods.

Practical:

1. Application formats for patenting.
2. Patenting of various strains.
3. Patenting of various proteins.
4. Patenting of extracted proteins.
5. Patenting of sweeteners.
6. Patenting of various genetically modified cultivars.
7. Enforcing patent.
8. Licensing and duration of patent.

References books:

1. Food Biotechnology edited by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin, Taylor & Francis Group 2006.
2. Biotechnology by B. D. Singh, Kalyani publication, 2000.
3. Food Biotechnology edited by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin, Taylor & Francis Group 2006.

E. Cafeteria courses for Department of Animal Biotechnology

AB 477

Techniques in Animal cell culture

1+3

Theory:

Development of primary, secondary cell culture and cell lines. Cell characterization by cell morphology, chromosome analysis, DNA content , enzyme activity and antigenic

markers. Scaling up of cells for production of vaccines, diagnostic antigen and other pharmaceuticals agents. Cytotoxicity assay.

Practical:

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primary culture of chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Cultivation of continuous cell lines.
6. Quantification of cells by trypan blue exclusion dye.
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Study of effect of toxic chemicals on cultured mammalian cells
9. Study of effect of virus on mammalian cells.
10. Suspension culture technique
11. Cryopreservation of cell primary cultures and cell lines.

Suggested Readings:

1. Freshney RI. 2005. *Culture of Animal Cells*. Wiley Liss.
2. Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.
3. M. Butler, BIOS Scientific, 2004, *Animal Cell Culture and Technology*.
4. J. Davis, ed., *Basic Cell Culture: A Practical Approach*, Oxford University Press, 2002.

AB 478

Transgenic for improvement of Animals

1+3

Theory:

Status and current issues in animal biotechnology. In vitro fertilization , sexing embryos, cloning transgenic methods. Objectives of gene transfer, transgenic animals using egg and cultured stem cells, targeted gene transfer, transgenic animals (mice, sheep, pigs, rabbits, goat, cow). vectors, mammalian virus vectors. Gene constructs. Recovery of the transformed animal cells. Expression and detection of cloned proteins in animal cells.

Practicals:

Preparation of chicken embryo fibroblast.

Preparation of lamb kidney cells.

Lymphocyte culture.

Subcultivation of cell culture .

Cell viability count.

Preparation of inoculums for virus isolation.

Virus isolation- egg inoculation I

Virus isolation- egg inoculation II

Virus inoculation-cell culture.

Cytopathic effect staining.

Extraction of RNA by trizol method.

Extraction of RNA by phenol-isoamyl alcohol method.

RNA PAGE.

Extraction of DNA by Chelax method.

Agarose gel electrophoresis.

Restriction endonuclease analysis.

Quantitation of nucleic acids.

Amplification of Canine Distemper virus VP2 gene.

Amplification of ND F-gene.

Amplification of PPR virus N gene.

Suggested readings:

1. Elements of biotechnology by Gupta P. K. 2008, Gangotri publications , New Delhi India.
2. Biotechnology expanding horizons by B.D.Singh 1st edition 2003, Kalyani publications, New Delhi India.
3. Cell and molecule biology b y P.K. Gupta 3rd edition, Rastogi publication, New Delhi India.

AB 479

Artificial Insemination

1+3

Theory:

Introduction, history and development of artificial insemination, Advantages and limitation of artificial insemination. Methods of semen collection in various species, factors affecting semen collection, examination and evaluation of semen, Dilution of semen, Cryopreservation of semen. Transport of semen, Insemination techniques for chilled and frozen bovine semen. Planning organization of artificial insemination centre, Selection, care, management and training of breeding bull for semen collection. Factors influencing fertility during artificial insemination. Recording systems in artificial insemination.

Practical:

1. Layout of artificial insemination and semen collection centre.
2. Care, sterilization and upkeep of artificial insemination equipments.
3. Collection of semen.
4. Evaluation of semen.
5. Study of bacteriology of semen.
6. Dilution of semen.
7. Cryo preservation of semen.
8. Progeny testing, sire index.
9. Thawing of semen.
10. Transport of semen.
11. Study of artificial insemination techniques.

Suggested Readings:

1. Reproduction in domestic animals – Hafiz.
2. Reproduction in farm animals by Sane, Deshpande, Velhankar and Hukeri.
3. Textbook of animal husbandry by G.C. Banerjee.
4. Artificial insemination in farm animals –Enos J. Perry.
5. Manual of fertility and artificial insemination by Miller and Ross.

AB-4710

Advances in Dairy Microbiology

1+3

Theory:

Milk and milk constituents, factors influencing composition of milk, microorganisms associated with milk and milk products. Microbiology of fermented milk, microbiology of Cheese, role of starter and non starter organisms during cheese making, role of enzymes in cheese making, microbiological quality of milk: milk pathogens *Staphylococcus aureus*, *Salmonella*, *Coliforms*, *Listeria monocytogens*.

Practical:

1. Collection and examination of milk.
2. Grading of milk on the basis of dye reduction test.
3. Bacteriological examination to determine quality of water (MPN index).
4. Test for Pasteurization (phosphatase test).
5. Microbiological analysis of milk and milk products.
6. Detection of antibiotics residues in milk and milk products.
7. Test for detection of mastitis milk.
8. Use of biopreservatives in milk and milk products.

Suggested readings:-

1. Comprehensive dairy microbiology by J.S.Jadhav, Sunita Grover, V.K. Batish 2nd edition, Metropolitan publication, New Delhi India.
2. Dairy microbiology by Robinson R.K., Applied science publication, London, NJ.
3. Milk and milk products by Uarence Henry Eckles, Willes Barnes Combs, Harold Macy

AB 4711

Probiotics in milk and milk products

1+3

Theory-

Types of starter culture, single strain, mixed strain, multiple. Methods of propagation of starter culture. Factors affecting starter activities. Concept of Probiotic- Probiotic starter organisms, nutritional and therapeutic importance. Technology of manufacturing of

Probiotic Dahi, cheese, Lassi, Shrikhand, acidophilus milk, Kefir, Kumiss and Cultured butter milk. Certain aspects of Dahi –A Fermented traditional milk products in India. Fermented foods and Their Benefits. Probiotics and gut Health and Health Promoting Functional synbiotics. Probiotic cheese –A novel concept. Functional Foods: Their role in disease prevention and Health Prmotion.

Practicals-

Sampling milk and milk products for different tests.

Plate form Tests

Study of cream separation

Activation of Probiotics starter culture

Propagation Probiotics starter culture

Examination of purity of Probiotic starter culture liquid culture and freezing

Preparation of Probiotics Lassi Chhach.

Preparation of Probiotics Dahi Yoghurt, Butter, Chakka, Shrikhand

Preparation of Kumiss, Kefir, Acidophillus milk, and cultured butter milk

Preparation of Probiotics Ice cream, Kulfi.

Prpration of Probiotic cheese.

Suggested Readings:-

- 1) Yadav, J.S Grover's and Batish, V K (2004) A comprehensive Dairy Microbiology Metropolitan Book Co. Pvt. Ltd.Delhi.
- 2) Foster, E.M. (1958) Dairy microbiology, Mac millan and Co. Ltd. London.
- 3) Robinson, R. K.(1981) Dairy Microbiology, Vol II , Microbiology of milk products, Applied Science publisher, London.
- 4) Davice, F.L.and Law, B.A. (1984) advances in Microbiology and biochemistry of Cheese and fermented milk Elger Applied Sci. London.
- 5) Aneja R.P; Mathur, B.N.; Chandan R.C. andBanerjee A. K. (2002) Technology of Indian Milk Products.

- 6) Sukumar De (2006) Outline of Dairy Technology, Oxford Univ, Press, New Delhi.

SEMESTER: VIII

HANDS ON TRAINING: (0+20)

A research project will be allotted to individual student and evaluated as under:

Sr.No.	Particulars	Credits
1	Outline of Research Work	01
2	Introduction	01
3	Review of Literature	03
4	Materials and Methods	03
5	Result and Discussion	05
6	Viva Voce and Presentation	05
7	General Performance	02
	Total credits	20

