REGULATIONS SCHEME AND SYLLABUS

FOR

M. Sc., PLANT BIOTECHNOLOGY PROGRAMME (UNDER CSS)

AT

AFFILIATED COLLEGES OF MAHATMA GANDHI UNIVERSITY KOTTAYAM, KERALA (W.E.F. 2012-2013)

1. ELIGIBILITY & ADMISSIONS.

A Candidate seeking admission to M. Sc., Plant Biotechnology must have at least 50% marks in any of the following subjects: Botany, Zoology, Biology, Biochemistry Biotechnology, Microbiology, Agricultural science or Environmental science at the graduate level.

The admission to the M. Sc., Plant Biotechnology PG Programme shall be as per the rules and regulations of the university.

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2. CURRICULAM

The M.Sc. Plant Biotechnology Programme under the Credit of Semester system (CSS) consisting of 4 semesters shall extend Over a Period of 2 years. Semester means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each. A student has to complete a minimum of 80 credits which would be distributed as following.

Core Course (PC)

(a). Theory - 45 Credits

(b). Practicals - 16 Credits

Elective Course (PE)

(a). Theory - 12 Credits

(b)Project - 4 Credits

(c)Viva Voce - 3 Credits

'Course' means a segment of subject matter to be covered in a semester. **'Credit' (Cr)** of a course is a measure of the weekly unit of work assigned for that course in a semester. **'Course Credit'** One credit of the course is defined as a minimum of one hour lecture/ minimum of 2 hours lab /field work per week for 18 weeks in a semester. The course will be considered as completed only by conducting the final examination. No regular student shall register for more than 24 credits and less than 16 credits per semester. The total minimum credits required for completing a PG programme is 80.

'**Programme Core Course' (PC)** means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

'**Programme Elective Course' (PE)** means a course which can be substituted by equivalent course from the same subject and a minimum number of courses is required to complete the programme.

'**Programme Project** means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department/ any appropriate research centre in order to submit a dissertation on the project work as specified.

'Academic week' is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration in each day. A sequence of 18 such academic week constitutes a semester.

Zero Semester means a semester in which a student is permitted to opt out due to unfore seen genuine reasons.

Examination: To be conducted as per rules and regulations framed under credit and semester system.

- There shall be University examination at the end of each semester.
- Practical examinations shall be conducted by the University at the end of each semester.
- Project evaluation and viva voce shall be conducted at the end of the programme only. Project evaluation and viva -voce shall be conducted by two external examiners and one internal examiner.
- There shall be one end semester examination of 3 hours duration in each lecture based course and practical course
- A question paper may contain short-answer type /annotation, short essay type questions/ problems and long essay type questions. Different type of questions shall have different weightage to quantity their range. Weightage can vary from course to course depending on their comparative importance but a general pattern may be followed by the Board of studies.

EVALUATION AND GRADING

Evaluation: The evaluation scheme for each course shall contain two parts, (a) Internal evaluation and (b) external evaluation. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation, and the ratio and weightage between internal and external is 1:3 both internal and external evaluations shall be carried out using Direct- grading system.

Internal evaluation

The internal evaluation shall be based on predetermined transparent system involving Periodic written test, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/ records/ viva and attendance in respect of practical courses. The weightage assigned to various components for internal evaluation is as follows.

Component Weightage

i. Assignment..... 1
ii. Seminar.....2
iii. Attendance.....1
iv. Two Test paper.....2

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.50 to 4.00
B	Very Good	3	2.50 to 3.49
C	Good	2	1.50 to 2.49
D	Average	1	0.50 to 1.49
E	Poor	0	0.0 to 0.49

Grades for Attendance

% of attendance	Grade
<90%	A
Between 85 and 90	B
Between 80 and below 85	C
Between 75 and below 80	D
<75	E

Assignment

Component	Weight
Punctuality	1
Review	1
Content	2
Conclusion	1
Reference	1

Seminar

Components	Weights
Area/Topic Selected	1
Review/ Reference	1
Content	2
Presentation	2
Conclusion	1

Practical- Internal

Components	Weights
Attendance	1
Laboratory Investment	2

Written/Lab test	2
Record	2
Viva-Voce / Quiz	1

PROJECT EVALUATION

Internal

Components	Weights
Punctuality	1
Experimentation / Data Collection	1
Compilation	1
Content	1

External

Components	Weights
Area/Topic Selected	1
Objectives	2
Review	1
Materials & Methods	2
Analysis	2
Presentation	2
Conclusion / application	2

DIRECT GRADING SYSTEM

Direct Grading System based on a 5 point scale is used to evaluate the performance (External and internal examinations of students)

The overall grade for a programme for certification shall be based on CGPA with a 7-point – scale given below.

CGPA	Grade
3.80 to 4.00	A+
3.50 to 3.79	A
3.00 to 3.49	B+
2.50 to 2.99	B
2.00 to 2.49	C+
1.50 to 1.99	C
1.00 to 1.49	D

A separate minimum of C Grade for Internal and External are required for a pass for a course. For a pass in a programme a separate minimum grade C is required for all the courses and must score a minimum CGPA of 1.50 or an overall grade of C and above.

After the successful completion of a semester, semester grade point average (SGPA)of a student in that semester is calculated using the formula given below. For the successful completion of a semester, a student should pass all courses and score a minimum SGPA of 2.0. However a student is permitted to move to the next semester irrespective of her/his SGPA.

For instance if a student has registered for 'n' courses of credits C_1, C_2.....C_n in a semester and if she/he has scored credit points P_1, P_2.....P_n respectively in these courses, then SGPA of the student in that semester is calculated using the formula.

SGPA= $(P_I+P_2+.....+Pn)$ $(C_1+C_2+.....Cn)$
CGPA= $\{(SGPA)_1xS_1+(SGPA)_2xS_2+(SGPA)3xS_3+(SGPA)4xS_4\}/S_1+S_2+S_3+S_4$
Where S1, S2, S3and S4 are the total credits in semester 1, Semester2, Semester3 and Semester4.

Pattern of Questions

Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/she shall also submit a detailed scheme of evaluation along with the question paper. A question paper shall be a judicious mix of short answer type, short essay type/problem solving type and long essay type questions.

Weight: Different types of questions shall be given different weights to quantify their range as follows.

Sl. No	Type of Questions	Weight	Number of Questions to be answered
1	Short Answer type Questions (not exceeding one page)	1	5 out of 8
2	Short essay/Problem solving type questions(not exceeding 2 pages	2	5 out of 8
3	Long Essay type questions	5	3 out of 6

Grade Card

The University under its seal shall issue to the students, a grade card on completion of each semester which shall contain the following information. Name of the University, Name of the college, Title of the PG programme, Name of Semester, Name and Register

number of students, code number, Title and credits of each course opted in the semester. Title and credits of the project work etc.

In addition to these the grade card shall contain internal, external and total grade, Grade point (G) Letter grade and credit point (P) in each course opted in the semester, the total credit, total credit points and SGPA in the semester

The final Grade card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

Semester	Course title	Hours/ Week	Credits	Total credits
Semester I	PBT1MOO1PC1- General Biochemistry	4	4	**19**
	PBT1MOO1PC2- Microbiology and Immunology	4	4	
	PBT1MOO1PC3- Bioanalytical Techniques	4	4	
	PBT1MOO1PC4- Plant Developmental Biology	3	3	
	PBT1MOO1PP1- Laboratory course I	10	4	
Semester II	PBT2MOO2PC5- Basics of Plant Tissue Culture	4	4	**19**
	PBT2MOO2PC6- Principles of genetic engineering and recombinant DNA technology	4	4	
	PBT2MOO2PC7**-** Plant Pathology	4	4	
	PBT2MOO2PC8- Biomass and Bioenergy	3	3	
	PBT2MOO2PP2- Laboratory course II	10	4	
Semester III	PBT3MOO3PC9- Plant Metabolism	4	4	**19**
	PBT3MOO3PC10-Tissue Culture Techniques for Crop Improvement	4	4	
	PBT3MOO3PC11- Biotechnology, Environment And Intellectual Property Rights and Patenting	4	4	
	PBT3MOO3PC12- Bioprocess Technology and Engineering	3	3	
	PBT3MOO3PP3-Laboratory course III	10	4	
Semester IV (Only 3 electives should be selected by a student)	PBT4MOO4PE1-Research Methodology and Biostatistics	5	4	**23**
	PBT4MOO4PE2-Genomics and Proteomics	5	4	
	PBT4MOO4PE3-Transgenic Techniques for Crop Improvement	5	4	
	PBT4MOO4PP4- Laboratory course IV	10	4	
	Project or Dissertation	-	4	
	Viva Voce	-	3	
Additional Electives of Semester IV	PBT4MOO4PE4-Green House Management and Plant Protection	5	4	**-**
	PBT4MOO4PE5-Marine Biotechnology	5	4	
	PBT4MOO4PE6-Business Management	5	4	
	Total Credits			**80**

SEMESTER-I

PBT1MOO1PC1 General Biochemistry

Hours/week-4 Credits-4

UNIT-I

Ultra structure of typical cell, Structure and functions of cell membrane and cytoskeleton, membrane transport.

UNIT –II

Structural units, structure, chemistry and functions of carbohydrate, proteins, lipids. Digestion and absorption of proteins, carbohydrates and lipids.

UNIT-III

Chemistry and function of nucleic acids and nuclear proteins.
Chemistry and functions of plant and animal hormones.

UNIT IV

Chemistry and functions of various vitamins, pigments(in plants)
Nutritional aspects of carbohydrates, proteins lipids, vitamins and minerals.

UNIT V

Biochemistry of photosynthesis and respiration in plants. Biological oxidation.
Brief idea about electron transport and oxidative phosphorylation.
Photosynthetic electron transport and photophosphorylation.

References:

West & Todd	: Biochemistry
Lehninger	: Principles of biochemistry
White Handler & Smith I & II	: Principles of biochemistry
Lubert Stryer	: Biochemistry
Donald Voet & Gudith G Voet	: Biochemistry
Adams et al.	:The Biochemistry of Nucleic acid
S. Ramakrishna et al	: Biochemistry of Medical Students
D M Vasudevan & S. Sreekumary	: Biochemistry
Muray ed	: Harper's Biochemistry
Oser	: Hawks' Physiological Chemistry
L.L.Finar	: Organic Chemistry Vol. II

PBT1MOO1PC2 Microbiology and Immunology
Hours/week-4 Credits-4

UNIT I
History and Scope of Microbiology; Classification of Microorganisms-Bacteria, Fungi, Virus, Alga, Protozoa ; sterilization techniques, disinfectant and antiseptic agents.

UNIT II -
Bacterial cell- structure and functions of cellular components-cell wall composition of Gram positive and Gram negative bacteria, sub-cellular organizations, flagella, capsule and spores; Bacterial Staining; antimicrobial agents-antibiotics, and antibacterial agents and their mode of action; antibiotic resistance. Agricultural and Environmental Microbiology: Microbial flora of soil - influence of environmental factors viz.pH, light, organic matter, moisture and temperature. Nitrogen cycle, Carbon cycle and Phosphorous cycle - Interaction of microbes - Nitrogen fixing organisms.

UNIT III
Classification, morphology and characteristics of Virus, and Fungi - structure of DNA, RNA viruses, replication of animal viruses, bacteriophages- Lysogeny and Lytic cycle; virus like agents- satellites, viroids and prions; mode of action of antiviral and antifungal drugs.

UNIT IV
Microbial culture –continuous culture and synchronous culture; composition of culture media -solid and liquid media, chemically defined media, complex and differential media; Microbial growth, effect of pH, temperature and radiation on microbial growth.

UNIT V
Innate and acquired immunity. Structure and functions of primary and secondary lymphoid organs- Lymphoid cells (B-lymphocytes, T-lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophiles), mast cells and dendritic cell. Epitopes, haptens, adjutants and mitogens. Classification, fine structure and functions of immunoglobulins **–** Clonal selection theory - concept of antigen specific receptor**–** Agglutination, precipitation and opsonization, gel diffusion (Ouchterlony double immunodiffusion and Mancini's Radial immunodiffusion), immunoblotting, RIA, ELISA and ELISPOT, hypersensitivity (Types I, II, III, IV). Autoimmunity, immunodeficiencies.

References:

Prescott, Harley and Klein: Microbiology-5th edition; Publisher:
McGraw Hill science 2002
Gerard J. Tortora, Berdell, R. Funke, Christine L. Case: Microbiology: An Introduction.
8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
Jacquelyn G. Black: Microbiology-Principles and explorations 6th
edition: Publisher John Wiley & Sons 2004
Robert W. Bauman: Microbiology Brief edition: Pearson Benjamin Cummings 2004

PBT1MOO1PC3 Bioanalytical Techniques
Hours/week-4 Credits-4

UNIT I
Spectroscopy - Concepts of spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry. Visible and UV spectroscopy, ORD, CD, X-ray diffraction, X-ray absorption, MALDI,ESR, and NMR.

UNIT II
Chromatography – Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, adsorption and partition chromatography. HPLC and FPLC. HPTLC and GC

UNIT III
Centrifugation – Principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

UNIT IV
Electrophoretic techniques – Principles of electrophoretic separation. Types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, Pulse field gel electrophoresis. 2D electrophoresis .Isoelectric focusing (IEF)

UNIT V
Microscopy: Principles and appplications of various of Light and Electron microscopy. Dark field, Bright Field, Phase contrast, confocal, fluorescence, scanning & transmission electron microscopy, Atomic Force Microscopy Tissue Processing for Light and Electron Microscopy Micrometry

References:
Immunoassay And Other Bioanalytical Techniques Jeanette M. Van Emon
Bioanalytical Techniques M. L. Srivastava
Immunoassay and Other Bioanalytical Techniques By Jeanette M. van Emon
Publisher: CRC | ISBN: 0849339421 | edition 2006 | PDF | 536 pages | 13,1 mb
Fundamentals Of Bioanalytical Techniques And Instrumentation Ghosal & Srivastava

Bioanalysis Advanced Materials, Methods, and DevicesSeries Ed.: Vo-Dinh, Tuan

PBT1MOO1PC4 Plant Developmental Biology

Hours/week- 3 Credits: 3

UNIT I

Model plants for developmental biology: Introduction of model plants used for development studies in plant system, advantages of each system with special emphasis on model plant Arabidopsis Reproduction: Male and female gametophyte development, genetic and hormonal regulation of reproduction, pollination and fertilization

UNIT II

Embryogenesis: Basic lay out of dicot and monocot embryos, stages of embryo development, embryonic axis, cell division and pattern formation in embryo, genetic and hormonal regulation of embryo development, cell polarity in embryo Seed formation and germination

Seed formation, cotyledon, endosperm and seed coat : development. Seed dormancy and germination, seedling development, genetic regulation of vernalization

UNIT III

Shoot development: Structure and function of shoot apical meristem (SAM), initiation and maintenance of SAM, regulation of meristem size, antagonism between SAM and lateral organs, genetic regulations, axial bud formation, shoot branching Leaf development: Emergence of leaf primordium from SAM, abaxial and adaxial identity of leaf cells, leaf margin, trichome, epidermis and stomata development, vascular differentiation

UNIT IV

Root development: Root apical meristem structure and function, lateral root development, lateral and adventitious root development, root hair development, hormonal regulations in root development

UNIT V

Flower development: Transition from vegetative to reproductive stage, inflorescence meristem, floral whorls specification, ABC model and beyond, whorl boundary specification, asymmetric flower development, structure and development of monocot flowers .

References:

The Arabidopsis Book, ASPB publication (available freely at www.aspb.org)
Biochemistry and Molecular Biology of plants Ed. Buchanan, Grussem and Jones, ASP B publication.
Plant Physiology by Taiz and Zeiger, Sinauer Associate Inc. Publishers.

PBT1MOO1PP1 Laboratory course I

Hours/week -10 Credits- 4

Identification of carbohydrates, lipids & proteins.
Mixture analysis.
Estimation of sugar, proteins and amino acids.
Techniques of isolation of microbes, spare count using haemocytometer
Hanging drop motility of microbes.
Bacterial staining- gram staining and spare staining, flagella staining.
Detection of E. coli in water.
Antibiotic sensitivity tests.
Serological test for diagnosis of microbial infections.
Preparation of acetate and phosphate buffers of different strength and pH
Colorimetric quantification of proteins
Paper chromatography and TLC
Elution of nucleotides or bases from chromatograms and their estimation by Spectrophotometry.
Electrophoresis.
Autoradiography.

SEMESTER-II

PBT2MOO2PC5 Basics of Plant Tissue Culture

Hours/week- 4 Credits-4

UNIT-I

History of Tissue Culture technique. Requirements for a Cell Tissue Culture lab like Laminar Air Flow device, sterilisation scheme for culture chamber.

Totipotency of plant cells- dedifferentiation and dedifferentiation.

UNIT II

Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents, vitamins, amino acids etc. Sterilisation of the media and appliances by autoclaving.

UNIT III

Culture of plant materials- explants selection and technique of culturing the same. Growth conditions.

Methods of sub culturing and transfer of regenerated plants to the field.

UNIT IV

Micro propagation: Proliferation of axillary buds, induction of adventitious buds and bulbs, callus regeneration, somatic embryogenesis, continuous culture, immobilized cultures, estimation of growth and artificial seeds.

UNIT V

Cloning: Isolation of single cells, culturing of single cell- different methods, culture cell viability test.

Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture.

References:

Hudson T Hartmann : Plant Propagation-Principle and Practices

Chopra V L, Sharma R P & Swaminathan M S : Agricultural Biotechnology

Kalyan Kumar D : An introduction to Plant Tissue Culture

Hamish A, Collin & Sue Edwards : Plant Cell Culture

Razdan M K : An Introduction to Plant Tissue Culture

Guptha P K : Elements of Biotechnology

PBT2MOO2PC6 Principles of Genetic Engineering and Recombinant
Hours/week-4 DNA Technology Credits-4

UNIT I

An introduction to genetic engineering, Enzymes used in genetic engineering Restriction endonucleases, DNA polymerase, Reverse transcriptase, Polynucleotide kinase, DNA ligase, Terminal deoxynucleotidyl transferase, Alkaline phosphatase. Ligation of DNA fragments with vectors Homopolymer tailing, Linkers, Adaptors Characteristics of E. coli as host for cloning, Vectors for cloning - Plasmids, Bacteriophage λ, Filamentous phage vectors, cosmids, BAC and YAC vectors, Shuttle vectors, Expression vectors.

UNIT-II

Properties of yeast as host for cloning, Types of vectors designed for cloning in yeast, Vectors for cloning in animal cells– SV 40, Adenovirus, Baculovirus, Retrovirus vectors. DNA viruses that infect plants – Caulimoviruses vectors, Geminiviruses vectors, Types of vectors used in higher plants- Tumour-inducing (Ti) plasmids, binary and cointegrate vectors,.

UNIT-III

Introducing genes into prokaryotes - Natural gene transfer methods, Calcium chloride mediated transformation, Transfection with phage vectors, Methods of introduction of foreign DNA in animal system- DNA/calcium phosphate co precipitate method, Phospholipids as gene-delivery vehicles, Electroporation, Microinjection Cloning strategies- Construction of genomic and cDNA libraries, Shot gun cloning, Selection and screening of recombinant clones, Methods based on nucleic acid hybridization, Finding specific clones by functional complementation, Chromosome walking, Reporter genes

UNIT-IV

Prokaryotic expression systems- Gene expression based in bacteriophage T7 RNA polymerase, Studying of gene function through protein interactions-Two hybrid screening, Phage display libraries, RNA interference- siRNA, miRNA, Concept of gene knock out technique.

UNIT-V

Principles and methods for DNA sequencing, Advantages of automatic gene sequencers, Blotting techniques –Southern, Northern, Western, Polymerase chain reaction, Site directed mutagenesis, Transposon mutagenesis, Fluorescence in-situ hybridization, Electrophoretic mobility shift assay, DNA foot printing, Restriction mapping, DNA fingerprinting,

References:

Principles of Genetic Manipulation Authors: Primrose SB, Twyman RM and Old RW (2001) Blackwell Science Ltd, MA 02148-5020, USA

Molecular Biotechnology: Principles & Applications of Recombinant DNA Authors: Glick BR and Pasternak JJ (2003) ASM Press

Principles and Techniques of Biochemistry and Molecular Biology Edited by: Keith Wilson and John Walker (2005) CPL Scientific Publishing Services Limited

An Introduction to Genetic Engineering Edited by: Desmond S. T. Nicholl Cambridge University Press February 2002

An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology Edited by: Michael Wink (2006) Wiley

PBT2MOO2PC7 Plant Pathology

Hours/week- 4 Credits-4

UNIT-I:

Plant pathology; its scope and relationships to other sciences. Concept of plant diseases; saprophytes and parasitism (heterotrophic organisms and mode of nutrition), pathogenicity. Classification of plant diseases plant diseases control. Principles and methods. Legislative methods, cultural methods, soil and sand treatment, biological, control, chemical control, Control through resistant varieties, quarantine. Plant disease forecasting.

UNIT-III:

Pathogenesis penetration and entry, colonization of the host, factors affecting in infection, enzymes in plant diseases – cell wall degrading enzyme. Toxins in relation to plant diseases: a general account, mode of action and types.

UNIT-IV:

Plant responses to post infectional agents; alteration in growth photosynthesis, respiration, nitrogen metabolism, aromatic compounds, and growth regulators-vascular transport.

UNIT V:

Defense mechanism; Genetics of plant-pathogen interaction. Effect of environment on Diseases development. Plant diseases, epidemiology, forms of epidemics and conditions governing some of the important crop diseases.

References:

Agrios, Gergon, n 1988, Plant pathology academic press London.

Anega, KG, 1993, Experiments in microbiology, plant pathology, and tissue culture. Wishwz prakasam (Willey Eastern Limited).

Boicer, F and Cook RJ 1974 Biological control of plant pathogens, Sanfrancisco.

Braual NK and others 1980, Text book of plant pathology. Oxford publishing company New Delhi.

Bilgrani, KG and Dubey HC 1980 a Text book of modern plant pathology.

Butler EJ Jones 1986 Plant pathology periodical book agency, Delhi.

Ganulco HC and KAR, AK 1986 College Botany volume11. central book depot, Calcutta.

Holliday, P, 1980 Fungal diseases of tropical crops. Cambridge University.

Manners JG 1982 Principles of plant pathology Cambridge University Press Cambridge.

Mehrotra, RS 1979, Plant pathology 2nd Edition. Tata McGraw hill Publi. New Delhi.

PBT2MOO2PC8 Biomass and Bioenergy
Hours/week- 3 Credits - 3

UNIT I
Energy sources - General account-Nuclear energy and Fossil fuel energy, Non – Nuclear and Non – Fossil fuel energy.
Bioenergy-energy plantations, social forestry and Silvi culture energy farms.

UNIT II
Biomass and source of energy: Composition of biomass, aquatic and terrestrial biomass-production of algal and fungal biomass, Organic wastes as a renewable source of energy, sources of wastes and composition of wastes.

UNIT III
Bioenergy sources: Petrolieum plants(petro plants)- hydrocarbons for higher plants like *Hevea* and *Euphorbia.* Algal hydrocarbons.
Alcohols: Alcohols as a liquid fuel-Hydrolisis of lignocellulosic materials, Ethanol production, fermentation and recovery of ethanol.

UNIT IV
Biomass conversion: Non biological process- Direct combustion (hog fuel), pyrolysis, Gasification and Liquification.
Bilogical process: Enzymatic digestion, aerobic and anaerobic digestion

UNIT V
Gaseous fuels: Biogas and hydrogen: Biogas technology benefits from biogas plants.
Biogas production: aerobic digestion solubilization, acidogenesis, methanogenesis.
Biogas production from different feed stocks like *Salvinia* and *Eichornia.*
Hydrogen as a fuel: Photobiological process of hydrogen production. Hydrogenese and hydrogen production. Halo bacteria.

References:

Vepal S Malik & Padma Sridahar : Industrial biotechnology
Michael L Mckinney & Robert M Schoch : Environmental science-systems and solutions
Kerry Turner R : Sustainable Environment Management
Indian Institute of Ecology & Environment Publ.: International Encyclopedia of Ecology and environment Vol.1-30

PBT2MOO2PP2 Laboratory Course II

Formulation of tissue culture media-different types
Collection of explants material
Surface sterilization of explants materials
Preparation of explants and inoculation
Sub- culture of callus Regeneration of plants from callus .
Hardening techniques of Tissue Culture plantlets.
Techniques for axillary bud proliferation.
Preparation of artificial seeds.
Culture of single cells.
Technique of cryopreservation.
Rhizosphere and rhizoplane studies. Analysis of exudates Effect of chemicals in control of diseases. Laboratory testing of the efficacy of common fungicides.
Biological control - methods like Tobacco leaf extracts, turmeric, neem oil, pungam oil etc.
Extraction and purification of nucleic acids- DNA and RNS from plant materials.
Extraction of Ti plasmids, Purification of Ti plasmids Introduction of crown gall tumours using *Agrobacterium* Genetic engineering through Ti plasmids Transformation studies of chloroplast and mitochondrion genome. .. Restriction mapping- restriction cleavage gel electrophoresis; construction of restriction map. Molecular genetic maps: RFLPs and RAPD using PCR

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SEMESTER -III

PBT3MOO3PC9 Plant Metabolism

Hours/week-4 Credits-4

UNIT- I

Bioenergetics – Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change (derivations and numerical included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.

UNIT II

Introduction to Plant cells

Photosynthesis: Chloroplast structure and function; Photosynthetic pigments and light harvesting complexes, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, C4 syndrome and Crassulacean acid metabolism.

Oxidative respiration, Alternate electron pathways and Respiration rate.

Photo-morphogenesis : Phytochromes, Crypto Chromes, photo-morphogenesis

UNIT- III

Nitrogen metabolism: Physical and biological nitrogen fixation, Ammonification, Nitrification, Denitrification, Biochemistry and Genetics of nitrogen fixation and Ammonium assimilation.

Plant Hormones: Biosynthesis, Physiological effects and mechanism of action of Auxins, Gibberellic acids, Cytokinins, Abscisic acid, Ethylene, Brassinosteroids , Polyamines and Strigolactones.

UNIT- IV

Plant Stress physiology: Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress .

UNIT V

Plant Secondary Metabolism:Plant secondary products of industrial importance-alkaloids, No Protein amino acids, Amines, Cyanogenic glucosides, glucosinolates, Terpenoids, Phenolics, ; Biochemistry of major secondary metabolic pathways.

In vitro production of secondary metabolites: Plant growth regulators and elicitors; Cell suspension culture development: methodology, kinetics of growth and production formation, optimization of culture; Hairy root cultures and their cultivation; Biotransformation

References:

Mukherji, S and Gosh A. K. Plant Physiology. 2nd ed. New Central Book Agency, Kolkata, 2005.
Slater A, NW Scott, MR Fowler. Plant bio technology, 2nd ed. Oxford University Press, 2008.
Hopkins, W. G and Huner, N. P. A. Introduction to Plant Physiology. 3rd ed. John Wiley & Sons Inc. New York, 2004

PBT3MOO3PC10 Tissue Culture Techniques for Crop Improvement
Hours/week-4 Credits- 4

UNIT-I

Introduction scope and application in agriculture, methods for production of haploids and development of homozygous lines, gametoclonal variations, analytical breeding. Advantages and limitations.

UNIT-II

Protoplast culture and regeneration of plants, isolation, merits and demerits. Somaclonal variations, isolation of somaclonal variants. Molecular basis of somaclonal variation.

UNIT III

In vitro breeding: Overcoming pre-fertilisation and post-fertilisation crossing barriers in plant breeding . In vitro pollination, mentor pollen technique, Endosperm culture for polyploidy breeding, Embryo rescue. Advantages and limitations.

UNIT IV

Crop improvement by induced invitro mutations. Production of variants by physical or chemical mutagents. Production of disease resistant, stress resistant and other mutants for agronomic charachters and for efficient nutrient utilisation. Advantages and limitations.

UNIT V

Production of virus free plants- shoot meristem culture. Thermotherapy, cryotherapy and chemotherapy. Virus indexing. Maintenance of virus free stocks. Applications and limitations. Transgenic plants - insect resistant and herbicide resistant plant for crop improvement. Molecular farming.

References:

Shain- Dow Kung & Ray Wu (Ed) : Transgenic Plants
Hamish A. Collin and Sue Edwards : Plant Cell Culture
Peter M. Gresshoff : Plant Genome Analysis
Razdan M. K : An Introduction to Plant Tissue Culture
Jogdand S. N : Advances in Biotechnology

PBT3MOO3PC11 Biotechnology, Environment and Intellectual
Hours/week-4 Property Rights and Patenting Credits- 4

UNIT I

Biodiversity and its conservation, Current levels of biodiversity, alpha and beta diversity, endangered and extinction, steps to preserve biodiversity, in situ and ex situ conservation gene banks and species conservation.

UNIT II

Restoration of degraded lands: Reforestation of adverse sites, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, diverse aspects of reforestation of soils contaminated with heavy metals.

UNIT III

Seaweed biotechnology: Seaweed tissue culture - callus induction and plantlet regeneration, protoplast culture and somatic hybridisation, Genetic engineering of seaweeds. Common implication of sea weed biotechnology. Micro algal biotechnology: Microalgae, culture media, cultivation methods, growth kinetics, measurement of algal growth, harvest.

UNIT IV

Intellectual Property Right (IPR) and Protection (IPP): About Intellectual Property and Intellectual Property Right , Choice of intellectual property protection, IPR and Plant Genetic Resources (PGR), GATT and TRIPs

UNIT V

Patenting of biological material: International conventions, international corporations, obligation with, patent applications, implication of patenting of higher plants, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequences, Plant breeders right(PBRs) and Farmers Rights.

References:

Keshav Trehan : Biotechnology

Michael W Fowler & Graham S Warren(Ed) : Plant Biotechnology

Uberoi N K : Environment Management

Pandey G N : Environment management

Cornish W R : Intellectual property, patents, copy right, trade marks and allied rights

Mittal D P : Indian Patents Law

Dr. Ashk Soni : complete reference of Intellectual property rights laws- 2 vols.

TIFAC New Delhi : Intellectual Property Rights.

PBT3MOO3PC12 Bioprocess Technology and Engineering
Hours/week: 3 Credits 3

UNIT I
An introduction to fermentation processes- Range of fermentation process, microbial biomass, microbial enzyme, microbial metabolites, and transformation processes.
Microbial growth kinetics- Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture.
The isolation, preservation and improvement of industrially important and useful microorganisms.
UNIT II
Media for industrial fermentation- typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirement.
Sterilization of air and media- Media sterilization, batch and continuous media sterilization processes, sterilization of fermenter, sterilization of the feeds, sterilization of air, theory of fibrous filters, filter design.
UNIT III
The development of inoccula for industrial fermentation- development of inocula for yeast, bacteria, fungal and actinomycetes processes, the inoculation of fermenters.
UNIT IV
Design of fermenter- Basic functions of a fermenter, construction, aeration and agitation, baffles, the achievement and maintenance of aseptic conditions, valves, other fermentation vessels. Aeration and agitation- The oxygen requirements of industrial fermentation processes, determination of KLa, factors affecting KLa, fluid rheology.
UNIT V
Instrumentation and control- Control systems, manual, automatic, methods of measurements
of process variables, flow, temperature, pressure, agitator shaft power, foam sensing and control, measurement and control of dissolved oxygen, on-line analysis of process parameters, computer control of fermenters.

References:
Bioprocess technology: kinetics and reactors Anton Moser Springer-Verlag, 1988 – Science - 451 pages
Encyclopedia of Bioprocess Technology Copyright © 1999-2010 by John Wiley and Sons, Inc.
Metabolic Engineering (Biotechnology and Bioprocessing) [Hardcover] Sang Yup Lee (Editor), E. Terry Papoutsakis (Editor)
Bioprocess Engineering Principles: Pauline M. Doran

PBT3MOO3PP3- Laboratory course III
Hour/week: 10 Credits: 4

Anther-pollen and Ovary-ovule culture
Protoplast culture from friable callus, leaf cells stems, roots or hypocotyls. Protoplast fusion and somatic cell hybridization.
Production of pathogen free plants through meristem culture.
Seed and embryo culture. Mushroom culture.

SEMESTER -IV

PBT4MOO4PE1 Research Methodology and Biostatistics
Hours/week-5 Credits-4

UNIT I
General tools and techniques: Principals involved in microphotography. Printing black and white and colour photographs. Preparation of slides for projection and demonstration.

UNIT II
Principles of different chromosome techniques: Pre-treatment, fixation, staining and mounting. Processing banding techniques. Karyotype and pachytene analysis. Chromosome mapping.

UNIT III
Uses and principles of histochemical techniques: Microtomy- rotary, sledge and ultra microtome. Cellular and sub cellular manipulations- micrurgy, and cell fractionation. Staining: single, double, triple and quadruple staining.

UNIT IV
Type of research: Descriptive and experimental type. The raw data- experimental designs, measurement and recording. Collection, analysis and interpretation of data. Literature collection and report writing.

UNIT V
Biostatistics: The mean, the range, the standard deviation, standard error, student t-test, student t-distribution, chi-square test, correlation. Basic statistics-averages statistics of dispersion, coefficient of variation and analysis of variance.

References:

Langly L. L : Cell Function
Brachet J and Mirsky (Ed) : The Cell Vol. I
Conn H. J. Williams and Wilking : Biological Stains
Gray P. : Hand Book of Basic Micro technique
Lemhoff E. S. : Tools in Biology
Lewis A. E. : Biostatistics

PBT4MOO4PE2 Genomics and Proteomics

Hours/week-5 Credits-4

UNIT I

Strategies for genome sequencing: Chain termination method, automated sequencing, pyro-sequencing. Sequence assembly: Clone contig and shotgun approaches. Organization of genomes: main features of bacterial and eukaryotic genome organization. Plant genome project and its applications. Locating the genes: ORF scanning, homology searches.

UNIT II

Determination of the functions of genes: gene inactivation (knock-out, anti-sense and RNA interference) and gene over expression. Approaches to analyze global gene expression: transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), Massively Parallel Signature Sequencing (MPSS), microarray and its applications, gene tagging, Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications

UNIT III

Proteomics Introduction: Human genome - Genomes to Proteomes - HUPO –Branches of proteomics - Protein extraction Methods: Subcellular fractionation, Density gradients, Ultrafiltration, - Protein fractionation - Affinity purification –Combined Fractional Diagonal Chromatography (COFRADIC) - Removal of interfering compounds, salts, DNA, lipids, Protein solubilization methods, chaotropes, detergents, etc - Preparation of Sample - Sample handling and storage - Protein detection and quantification methods – Stable Isotope Labeling with Aminoacids in Culture (SILAC) - Chemical tagging, fluorescence, negative staining, radio-labeling –Chemical modifications..

UNIT-IV

Proteomic Techniques for Analysis: 2-D gel electrophoresis – Mass Spectrometry –Principles - MALDITOF - RP chromatography /Tandem mass spectrometry - Protein sequence analysis - N-terminal determination methods- Protein modification – Protein microarrays – Tissue microarray – Infra red Protein array with Quantitative Readout (IPAQ)- X-ray crystallography - Nuclear Magnetic Resonance - X-ray Tomography -Data Analysis algorithms - Sequence Analysis algorithms.

UNIT-V

Proteomic approach for Clinical studies: Protein Biomarker Discovery and Validation - Body fluid profiles, blood disease profiles, diabetes profiles, infectious diseases, stroke and myocardial infarction, nervous system, Alzheimer, low abundance and hydrophobic proteins. High through put techniques to identify protein molecules in sample - Emerging technologies: Proteomics in Biotechnology - Microfluidics.

References:

1. Twyman, R.M. Principles of Proteomics. BIOS Scientific Publisher, New York. 2004.
2. Liebler, D.C. Introduction to Proteomics: Tools for the New Biology. Human Press, Totowa NJ. 2002.
3. Buchanan B, Gruissem G, and Jones R (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
4. Hammes GD (2005) Spectroscopy for the Biological Sciences; Wiley Interscience, USA.
5. Harlow and Lane D (Eds.) (1988) Antibodies – A Laboratory Manual; Cold Spring Harbor Laboratory, USA.
6. Lieber DC (2006) Introduction to Proteomics: Tools for New Biology; Humana Press, NJ.
7. Pennington SR, Dunn MJ (Eds.) (2002) Proteomics: From Protein Sequence to Function, BIOS Scientific Publishers, United Kingdom.
8. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I – III, Cold Spring Harbor Laboratory, USA.
9. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA.
10. Westermeier, R and T. Naven. Proteomics in Practice: A Laboratory Manual of Proteome Analysis. Weinheim: Wiley-VCH, 2002.

PBT4MOO4PE3 Transgenic Techniques for Crop Improvement

Hours/week-5 Credits - 4

UNIT I

Genetic engineering through *Agrobacterium tumefaciense*: Ti plasmids, Structure of T-DNA.

Suitability of Ti plasmid as cloning vector. T-DNA integration into chromosomal DNA. Genetic engineering through disarmed Ti plasmids. Regeneration of plantlets.

UNIT II

Chloroplast and mitochondrial engineering: Engineering of chloroplast genome in Chlamidomonas, Transformation of chloroplast genome in higher plants.

UNIT III

Molecular maps of plant genomes: RFLP Genetic maps in plants, Linkage of major genes and QTLs to RFLPs, Uses of RFLPs maps, Cytogenetic RFLP maps using aneuploids, RAPDs and SSRs. Crop improvement and gene tagging, physical maps using in- situ hybridisation (ISH), Resolution gap. Molecular maps in Yeast and other fungi.

UNIT IV

Transgenic plants and Crop improvement: Herbicide resistant, Virus resistant, Insect resistant, Fungi and Bacterial resistant, plants, Transgenic plants with improved storage proteins, Stress- cold –drought tolerant plants, Fertility restoration and transgenic plants as bioreactors.

UNIT V

Gene banks: Importance of gene banks, Establishment of gene banks using plasmids and phages.

Risk factors involved in the release of Genetically Engineered Organism: Possible dangers of GEO's, biohazards of rDNA technology, risk evaluation and release of GEO's. GRAS. Bio safety handling of hazardous chemicals and radioisotopes. Biological containment –EL-1, EK-2 and EK-3. Physical laboratory containments- P1, P2, P3 and P4.

References:

Trevan M. D, Boffey S, Goulding K. H, Stanbury P : Biotechnology- The Biological Principles

Guptha P. K : Cell and Molecular Biology

Watson J. D : Molecular Biology of gene

Freifelder D : Essntials of Molecular Biology

Winnaker E.L : From gene to Clones

Old R. W, Primross S.B : Priciples of Gene manipulation

Lewin B : Gene VII

PBT4MOO4PP4 Laboratory Course IV

Hours/week-10 Credits-4

Preparation of DNA from prokaryotes and eukaryotes. Synthesis and sequencing of DNA. Isolation of plasmids from E.coli cells.

Agarose gel electrophoresis of plasmid and chromosomal DNA.

Restriction endonuclease digestion of plasmid and chromosomal DNA of E. coli cells.

DNA ligation methods.

Construction of recombinant DNA.

Transformation of competent E. coli cells.

Colony hybridisation.

Southern blotting.

Additional Electives
of
Semester - IV

PBT4MOO4PE4 GREEN HOUSE MANAGEMENT AND PLANT
Hours/week-5 PROTECTION Credits-4

UNIT I

Plant propagation structures; Green House, hot beds, cold frames and lath houses. Miscellaneous propagation structures- fluorescent light boxes and propagating frames Carbon dioxide enrichment in green house. Containers for propagating and growing young plants.

UNIT II

Media for propagating and growing nursery plants; Media components: Sand, peat sphagnum moss, vermiculite, pumice, perlite, synthetic plastic aggregates and compost.

Mixtures for container growing. Preplanting treatments of soil and soil mixes, heat treatments, fumigation with chemicals.

UNIT III

Sanitation, soil enrichment and other requirements of propagation: Physical propagation facilities, propagation media and plant material. Supplementary fertilizers controlled release fertilizers. Salinity in soil mixtures, water quality and soil pH. Handling of container grown plants.

UNIT IV

Plant protection from weeds: Types of weeds, crop-weed competition and weed control methods. Classification of herbicides. Working of selective weed killers. Biological and integrated weed control.

UNIT V

Plant protection from diseases and interest: Diseases of crops-definition, nature, and causes. Control of diseases by fungicides and antibiotics. Control of insect pests: Principles, physical and mechanical control, cultural control, host plant resistance, biological control, legislature or regulatory method, chemical control and other methods of insect control

References:

Hann J.J., Holley W.D. and K.L.Goldsberry : Greenhouse management

Furuta, T. : Nursery management handbook

Langhans R.W. :Green house management

PBT4MOO4PE5 MARINE BIOTECHNOLOGY
Hours/week-5 Credits-4

UNIT I
INTRODUCTION TO MARINE ENVIRONMENT
World oceans and seas – ocean currents – physical and chemical properties of sea water – abiotic and biotic factors of the sea – ecological divisions of the sea – history of marine biology – bioecochemical cycles – food chain and food web.

UNIT II
IMPORTANT MARINE ORGANISMS
Phytoplanktons – zooplanktons – nektons – benthos – marine mammals – marine algae mangroves – coral reefs – deep sea animals and adaptation – intertidal zone – fauna and flora.

UNIT III
MARINE ENVIRONMENTAL BIOTECHNOLOGY
Marine pollution – biology indicators (marine micro, algae) – biodegradation & bioremediation – marine fouling and corrosion.

UNIT IV
MARINE PHARMACOLOGY
Medicinal compound from marine flora and fauna – marine toxin , antiviral and antimicrobial agents.

UNIT V
AQUACULTURE TECHNOLOGY
Important of coastal aquaculture – marine fishery resources – common fishing crafts and gears – aquafarm design and construction.

References:

1. Recent advances in marine biotechnology volume 3 – M. Fingerman , R . Nagabhushanam Mary – Frances Thomson.
2. 2. Recent advances marine biotechnology volume 2 – M. Fingerman , R . Nagabhushanam Mary – Frances Thomson.

PBT4MOO4PE6 BUSINESS MANAGEMENT
Hours/week-5 Credits-4

UNIT I

General Management: Introduction, significance and definition of management, Administration vs. management, Functions of management: planning, organizing, staffing, directing and controlling, Levels of management, Managerial skills, motivation, communication, decision making. **Forms of business organization**: Sole ownership, joint stock company, advantages and limitations and salient features of each, cooperatives, private and public companies, government companies

UNIT II

Organization: Basic principles of organization: responsibility and authority, delegation and control, coordination, span of control. **Management structure**: line and staff and functional relationships, use of committees

UNIT III

Management Theories: Henri Fayal's principles of management, Taylor's scientific management, Max Weber's theory of bureaucracy; human relations approach; Hawthorne studies, behavioral sciences and quantitative approaches. **Personnel Management**: Recruitment, sources, selection procedure, various stages, different types of employment tests, interviewing techniques, placement, transfers and promotions, exit interviews.

UNIT IV

Marketing management: Sales vs. marketing, functions of marketing, market research, sales promotion, and advertising. **Training and development**: Types of training, methods of training, management development, on &off the job training, performance appraisal.

UNIT V

Financial management: Objectives, financial planning, functions of finance managers, sources of industrial finance.

References:

1. Chhabra, T.N. 2002. *Principles and Practice of Management.* Dhanpat Rai and Co. Pvt. Ltd., Delhi
2. Koontz, H. and Weihrich, H. 1998. *Essentials of management*. Tata McGraw Hill Pub. Co. Pvt. Ltd., New Delhi
3. Massie Joseph, L. 2000. *Essentials of Management* (4th ed.). Prentice Hall of India Pvt. Ltd., New Delhi
4. Singh, B.P., Chhabra, T.N. and Taneja, P.L. 2001. *Personnel management and Industrial Relations*. Dhanpat Rai and Co. Pvt. Ltd., Delhi
5. Terry, G.R. and Franklin, S.G. 2000. *Principles of Management*. (8th ed.). AITBS Publishers and Distributors, Delhi
6. Weihrich, H. and Koontz, H. 2001. *Management: A Global Perspective*. Tata McGraw Hill Pub. Co. Pvt. Ltd., New Delhi