COURSE PATTERN – M.Sc. BOTANY

Sem.	Code	COURSE	Hrs	Credit
I	16PBO1101	Plant Diversity-I (Thallophytes and Bryophytes)	6	5
	16PBO1102	Laboratory Course 1	4	3
	16PBO1103	Plant Diversity-II (Pteridophytes, Gymnosperms and Paleobotany)	6	5
	16PBO1104	Plant Anatomy, Embryology and Morphogenesis	6	5
	16PBO1105	Laboratory Course 2	4	3
	16PBO1201A	Core Elective – 1: Ecology & Phytogeography (online) OR	4	4
	16PBO1201B	Core Elective – 1: Forestry and Wood Science (online)		
		Total for Semester I	**30**	**25**
II	16PBO2106	Plant Physiology	5	5
	16PBO2107	Laboratory Course 3	3	3
	16PBO2108	Genetics	5	4
	16PBO2109	Research Methodology	5	5
	16PBO2110	Laboratory Course 4	4	3
	16PBO2202A	Core Ele. – 2: Biophysics and Instrumentation OR	4	4
	16PBO2202B	Core Ele. – 2: Plant Pathology		
	16PBO2401	IDC-1: Soft Skills	4	4
		Total for Semester II	**30**	**28**
III	16PBO3111	Plant Systematics	6	5
	16PBO3112	Laboratory Course 5	4	3
	16PBO3113	Biochemistry	5	5
	16PBO3114	Laboratory Course 6	3	3
	16PBO3203A	Core Ele. – 3: Cell and Molecular Biology (online) OR	4	4
	16PBO3203B	Core Ele. – 3: Pharmacognosy (online)		
	16PBO3402	IDC-2: WS Bioprocess Technology	4	4
	16PBO3403	IDC-3: BS Horticulture and Landscaping	4	4
		Total for Semester III	**30**	**28**
IV	16PBO4115	Microbiology and Immunology	6	5
	16PBO4116	Genetic Engineering and Biotechnology	6	5
	16PBO4117	Laboratory Course 7	4	3
	16PBO4118	*Comprehensive Examination*	--	2
	16PBO4119	*Self-paced Learning:* Plant Breeding and Evolution	--	2
	16PBO4120	Project Dissertation & *Viva Voce*	14	7
		Total for Semester IV	**30**	**24**
I-III	16PBO4601	Community work (SHEPHERD) & Gender Studies		5
		Total for all Semesters	**120**	**110**

WS – IDC within School BS – IDC between Schools

PLANT DIVERSITY - I

(Thallophytes and Bryophytes)

Semester – I **Hours/week: 6**

16PBO1101 **Credits: 5**

Assurance of Learning:

1. To understand the major groups of cryptogramic plants and their characteristics.
2. To trace their interrelationships and study their evolutionary trends.

Unit – I: Algae

Introduction and history of phycology. Algology in India (Contributions of eminent Indian Algologists.), Criteria used in algal classification (Fritsch & De Silva) - Life cycles and mass culture of algae - General characteristics, thallus variations, reproduction, distribution and economic importance of major groups of algae. Cyanophyta: *Oscillatoria* and *Scytonema.*

Unit – II:

Chlorophyta: *Chlamydomonas, Volvox, Cladophora, Coleochaete, Ulva, Caulerpa, Oedogonium,* and *Spirogyra.* Phaeophyta: *Ectocarpus, Padina* and *Sargassum.* Rhodophyta: *Batrachospermum, Gracillaria and Polysiphonia. Centric* and *Pinnate Diatoms.*

Unit – III: Fungi

General features, occurrence and distribution; Classification of fungi (Ainsworth, 1973; Alexopoulos and Mims, 1983), General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Ecology of fungi, Reproduction (vegetative, asexual and sexual), Spore dispersal mechanisms. Economic importance of fungi.

Unit – IV:

Heterothallism; heterokaryosis; parasexuality; sex hormones in fungi; degeneration of sex. Phylogeny and interrelationship of Myxomycetes, Oomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.

Lichens: Classification of Lichens (Hale, 1969). Occurrence and interrelationship of phycobionts and mycobionts, structure and reproduction in common lichens (*Usnea*). Lichens as indicators of Pollution. Economic importance of lichens.

Unit – V: Bryophyta

Classification, general and reproductive characters of major classes - distribution of bryophytes - comparative study of gametophytes and sporophytes of major classes. Hepaticopsida: *Marchantia, Porella,* Anthocerotopsida: *Anthoceros, Notothyllus*. Bryopsida: *Sphagnum* and *Polytrichum*. Economic importance of bryophytes.

Books:

1.Singh, Pande and Jain. 1998.A text book of Botany, Rastogi Publication, Meerut.
2.Venkataraman, *et al*., 1974, Algae-Form & Function. Today and Tomorrow, Pub. Co.
3. Prem Puri, 1973. Bryophytes - a broad perspective. Atma Ram & Sons, New Delhi.

Reference:

1. Delevoryas, T., 1977, Plant Diversification. Holt, Rinehart & Wintson, New York.
2. Chapman, V.J. & Chapman,D.J. The Algae. ELBS & MacMillan, London
3. Srivastava, H.N., 1999, Fungi. Pradeep Publications, Jalandhar
4. Hale, Jr. M.E., 1983, Biology of Lichens. Edward Arnold, Mayland.
5. Alexopoulus, C. J. and Mims, C. W. (1979). Introductory Mycology. Wiley Eastern Ltd., NY
6. Bessey, E. A. 1979. Morphology and Taxonomy of Fungi. Vikas Pub, New Delhi.
7. Bold, H. C. 1980. Morphology of Plants and Fungi. Harper and Row Publishing Inc., NY
8. Burnet, J. H. 1971. The Fundamentals of Mycology. ELBS Publications, London.
9. Mehrotra, R. S and Aneja, K. R. 1990. An Introduction of Mycology. Wiley Eastern, New Delhi.
10. Vashishta, B. R. and Sinha, A. K. (2007). Botany for Degree Students - Fungi. S. Chand, New Delhi.
11. Cavers F. 1911. The interrelationship of Bryophytes. New Phytologist.

LABORATORY COURSE – I

(Plant Diversity-I – Thallophytes and Bryophytes)

Semester – I **Hours/week: 4**
16PBO1102 **Credits: 3**

Algae

Ulva, Caulerpa, Padina, Sargassum, Batrachospermum, Gracilaria, Nostoc and *Oscillatoria*.

Fungi

Plasmodiophora, Rhizopus, Pilobolus, Xylaria, Phyllochora, Aspergillus, Penicillium, Agaricus and *Fusarium.*

Lichen

Usnea.

Bryophytes

Reboulia, Anthoceros, Pogonatum and *Polytrichum*

Field Trip and Report submission.

PLANT DIVERSITY – II

(Pteridophytes, Gymnosperms and Palaeobotany)

Semester I **Hours/week: 6**

16PBO1103 **Credits: 5**

Assurance of Learning:

1. To understand the major groups of lower vascular plants and their characteristics.
2. To trace their interrelationships and study their evolutionary trends.

Unit – I:

Peridophytes - General characters - Reimer's classification (1954), life cycle. Theories of origin of sporophyte. Telome concept. Sporangium development – eusporangiate type and leptosporangiate type. Range of structure, reproduction and evolution of the gametophytes– sex organs. Apogamy and Apospory. Detailed account on stelar and soral evolution. Heterospory and seed habit.

Unit – II: Diversity in Pteridophytes

Morphology, anatomy, reproduction and evolution of the gametophytes and sporophytes of the following genera *Psilotum, Lycopodium, Selaginella, Equisetum, Alsophila* and *Marsilea.*

Unit – III: Gymnosperms

General characters. Classification of gymnosperms (Sporne, 1965). Phylogeny and economic importance of gymnosperms. Comparative study of Cycadopsida, Coniferopsida, and Gnetopsida. Salient features of Pteridospermales, Bennettitales, Pentaxylales, Cycadales, Cordaitales, Coniferales and Gnetales.

Unit – IV:

A general account of distribution, morphology, anatomy, reproduction and life cycle of the following genera: Cycadopsida - *Cycas*, Coniferopsida- *Biota*- Gnetopsida - *Gnetum.*

Unit – V: Palaeobotany

Geological time scale, fossilization and types of fossil. Carbon dating. Detailed study of the fossil forms - Pteridohytes: *Rhynia, Lepidodendron* and *Calamites.* Gymnosperms: *Lyginopteris, Williamsonia, Cordaites.*

Books:

1. Vasista PC, Sinha AK and Anilkimar. 2005. Botany for degree students, Gymnosperms, S Chand, New Delhi.
2. Pandey BP. 1998. A Text Book of Botany Vol. II. S Chand, New Delhi.

Reference:

1. Pandey, S.N., S.P. Misra and P.S. Trivedi. 2002. A Textbook of Botany Volume II. Vikas Publishing House Pvt Ltd, New Delhi.
2. Rashid.A. 2007. An Introduction to Pteridophyta – Vikas publications, New Delhi.
3. Johri , RM, Lata S , Tyagi K (2005), A text book of Gymnosperms , Dominate pub and Distributer, New Delhi
4. Sporne, K.R. (1975). The Morphology of Pteridophytes, Hutchinson and Co., London.
5. Sporne, K.R. (1967). The morphology of gymnosperms, Hutchinson and Co., London.

PLANT ANATOMY, EMBRYOLOGY AND MORPHOGENESIS

Semester I **Hours/week: 6**
16PBO1104 **Credits: 5**

Assurance of Learning:

1. To understand the basic principles of differentiation of cell types.
2. To know the process of growth and development through totipotency.

Unit – I:
Structural diversity and specialization of xylem and phloem elements, distribution, structure and significance of transfer cells. Vascular differentiation in primary body of stem, root and leaf. Development of cambium in root and stem. Cell type in vascular cambium. Seasonal activity in cambium, cambium in wound healing (Traumatin).

Unit – II:
Vascular cambium and cork cambium (phellem, phellogen and phelloderm), economic importance of cork cambium, periderm formation. Vascular Cambium : Structure and Modification of the common type of vascular cambium-Function of the vascular cambium. Types of vascular cambia (Discontinuous, unidirectional and bidirectional). Anomalous secondary growth in *Bignonia* and *Aristolochia*.

Unit – III:
Pollen morphology, exine sculpturing, pollen kit, Viability of pollen grains. Microsporogenesis. Pollen germination, growth and nutrition of pollen tube. Male gametophyte, Structure and development, Female gametophyte, Ovule: Structure, ontogeny and types. Megasporogenesis. Embryosac – development, types, ultrastructure and nutrition of embryosac.

Unit – IV:
Double fertilization; Monocot and Dicot embryogenesis, different types of embryo. Endosperm structural, functional and evolutionary significance. types of endosperm, haustorial behavior of endosperm. Xenia and metaxenia. Polyembryony, Apomixis and Parthenogenesis – types, causes and uses.

Unit – V:
Morphogenesis and organogenesis in plants: Molecular basis of morphogenesis, polarity. Organization of shoot and root apical meristems; shoot root and leaf development, phyllotaxy; transition of flowering, floral meristems and floral development.

Text Books

1. Bhojwani, S.S., (1981) Embryology, of Angiosperms, Vikar & Bhatnagar, S.P.Pulication house Pvt. Ltd., New Delhi.1981
2. Fahn.A. (1989) Plant Anatomy. Maxwell, Macmillan, Singapore.

Reference

1. Clowes, F.A.L., (1961) Apical Meristems. Blackwell scientific, Oxford.
2. Cutter, E.G., (1978) Plant Anatomy. Edward Arnold Ltd., London.
3. Esau, K., (1953) Plant Anatomy. Jon Willey & Sons Inc, New York.
4. Maheshwari, P.,(1988) An Introduction to the Embryology of Angiosperms, McGraw-Hill
5. Raghavan, V., (1976) Experimental Embryogenesis in Vascular Plant, Academic press, London.

LABORATORY COURSE – II

(Pteridophytes, Gymnosperms, Palaeobotany, Anatomy, Embryology and Morphogenesis)

Semester I **Hours/week: 4**
16PBO1105 **Credits: 3**

Pteridophytes

Psilotum, Lycopodium, Selaginella, Equisetum, Alsophila and *Marsilea.*

Gymnosperms

Cycas, *Cupressus, Gnetum.*

Palaeobotany

Rhynia, Lepidodendron, Calamites, Lyginopteris, Williamsonia, Cordaites.

Plant Anatomy and Embryology

Study of cambia - non storied and storied.

Study the anomalous primary and secondary features in *Aristolochia and Bignonia.*

Micrometry of xylem elements.

Study of leaf anatomy – structure, stomata, trichomes, types of stomata.

Study of pollen morphotypes (Malvaceae and Asteraceae)

Isolation of different stages of embryo and polyembryony in citrus, jamun (*Syzygium cumini*)

Tests for pollen viability using stains and in vitro germination. Pollen germination using hanging drop technique.

ECOLOGY AND PHYTOGEOGRAPHY

(Core Elective -1: Online Study)

Semester – I **Hours/Week: 4**
16PBO1201A **Credits: 4**

Assurance of Learning:

1. To understand the basic concepts of ecosystem and biodiversity.
2. To study the principle of sustainable utilization and management of bioresources.

Unit – I:

Introduction to ecology: ecosystem structure; and dynamics - food chain and food webs, energy flow, mineral cycling (C, N, P) and succession. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, natality and mortality and age structure, population growth and population interactions.

Unit – II:

Greenhouse effect, global warming, global climatic changes and the consequences. Climate change conferences – role of UNFCCC and IPCC. Paris 2015 COP21: legality, common but differentiated responsibilities and respective capabilities, long-term goal, mitigation, carbon markets, transparency, compliance, adaptation, loss and damage and next steps. Carbon economy and carbon credits.

Unit – III:

Phytogeography: Geological time scale, geographical history, continental drift, land bridges, and shifting of poles. Phytogeography of the Western Ghats. *Concepts of phytogeography:* Endemism, hotspots and hottest hotspots, plant introductions and explorations, invasions and exotic species.

Unit – IV:

Biodiversity: types – species, genetic, ecosystem and habitat. Importance of genetic diversity with reference to crops and farm animals. Preserving the crop genetic resources – germplasm collections and the Svalbard Global Seed Vault. Centres of origin of diversity – Vavilov's and FAO's.

Unit – V:

Conservation: approaches – *in* situ and *ex situ* and their evaluation. Biodiversity, its importance, assessment, loss and conservation and World organisation for conservation of biodiversity, biodiversity act (2002), Red List categories of IUCN, means and ways for conservation.

Book

1. Sharma P.D, (2009). Ecology and Environement, Rastogi Publications, Meerut

Reference

1. Odum, E.P., (1970). Fundamentals of Ecology, 3rd edn, W.B. Saunders Ltd., UK
2. Melchias Gabriel 2001 Biodiversity and Conservation, Science Publ., NH USA
3. Krishnamurthy K.V. 2003. An advanced text book on Biodiversity Principle and Practice. Oxford and IBH Publishing Co. New Delhi.

FORESTRY AND WOOD SCIENCE

(Core Elective – 1: Online Study)

Semester –I **Hours/week: 4**
16PBO1201 B **Credits: 4**

Assurance of Learning:

1. To prepare students for careers in the forest services and wood products industry.
2. To educate students to provide technical expertise to the wood industries.

Unit – I:
World and Indian forest scenario; Forest types of India; Factors that influences forest and forest protection; Rare and endangered species; Conservation strategies; Exotics and its significance; Silviculture- principles and practices; Genetic Engineering and its application in forestry; Remote sensing and GIS in forestry.

Unit – II:
Forest Resources and utilization; Forest products; Forest laws and policies, people and Forest; Social and community forestry; Forest industries; Role of social forestry in cottage industry; Role of forestry in Indian economy. Biomass conversion strategies – energy plantations.

Unit – III:
Nature and properties of wood: physical, chemical, mechanical and anatomy of wood. Durability of wood. Wood seasoning and preservation; Defects and abnormalities of wood; types of commercial wood species of India.

Unit – IV:
Wood deterioration- fungi, insects and other agents; Wood protection- Practical methods for preserving and protection, Chemical processing of wood.

Unit – V:
Composite wood: adhesives-manufacture, properties, uses, manufacture and uses of plywood, fiber boards and particle boards. Present status of composite wood, paper and rayon industries. Present position of supply of raw material to industries and wood substitution.

Activity: Raising nursery for social forestry

Books

1. De Vere Burton L., 2000, Introduction to Forestry Science, Delmar publishers, N Y
2. J.L. Bowyer, R. Shmulsky and J.G. 2007. Haygreen. Forest Products and Wood Science: An Introduction, Blackwell Publishing Professional.
3. Franz F. P. Kollmann, Wilfred A. Jr. Cote. 2012. Principles of Wood Science and Technology: I Solid Wood, Springer.

Reference

1. Negi, S.S., 1994, India's Forests, Forestry and Wildlife, Indus publishing Com., New Delhi.
2. Jha, L.K., 1996. Forestry for rural development, APH Publishing Corporation, New Delhi.

PLANT PHYSIOLOGY

Semester II **Hours/week: 5**
16PBO2106 **Credits: 5**

Assurance of Learning:

1. To study the recent aspects of various physiological processes in plants.
2. To understand the application of physiology in agriculture.

Unit – I:

Water relations of plants: Water potential, osmotic potential and pressure potential. Stomatal physiology, mechanism of transpiration and antitranspirants. Mineral nutrition of plants. Organization of cell membranes and functions: membrane protein diffusion, ion channels, membrane pump. Different method of Mineral ion uptake in plants. Various mechanism of solutes translocation- phloem, Munch hypothesis and electro-osmotic theory.

Unit – II:

Photosynthesis: Organization of photosynthetic apparatus and light absorbing antenna systems. Absorption and transformation of radiant energy. Photosynthetic Electron transport and phosphorylation. Photo-oxidation of water, C_3, C_4, CAM pathways and their efficiencies, Photorespiration and its regulation. Inorganic carbon concentrating mechanisms, RuBisCO and PEPC.

Unit – III:

Respiration: Glycolysis, gluconeogenesis and their regulation. Oxidation of pyruvate and the Citric Acid cycle. Pasteur effect, anaplerotic reactions, amphibolic nature of the Citric Acid cycle. Respiratory chain complexes and oxidative phosphorylation, unique electron transport enzymes of plant mitochondria, alternate electron pathways in plants and their significance. The Glyoxylate cycle. Pentose phosphate pathway and its importance.

Unit – IV:

Biological nitrogen fixation, nif gene, assimilation of nitrate and ammonium. Applications of auxins, gibberellins, cytokinins in agriculture and horticulture. Physiology of growth retardants - ethylene and abscisic acid. Biological rhythm - circadian rhythm, photoperiodism - phytochrome mediated processes.

Unit – V:

Physiology of flowering and fruit ripening. Dormancy of seeds - causes and methods of breaking dormancy. Physiology of seed germination. Ageing and senescence – types and physiological/biochemical changes. *Stress Physiology:* Response of plants to abiotic stresses; mechanism of tolerance to abiotic stress (drought and salinity).

Books:

1. Frank B. Salisbury & Cleon W. Ross, 1992, Plant Physiology 4th Edition, Wadsworth Publishing Co., Belmont.
2. Pandey, S.N. & Sinha, 2010, Plant Physiology, Vikas Publishing, New Delhi.

Reference:

1. Noggle, G.R. and Fritz, G.J. 2001, Introductory Plant Physiology, Prentaice - Hall, India.
2. Devlin, R.M., 2000, Plant Physiology, Affiliated East West Press Pvt. Ltd.
3. Epstein, E., 2000, Mineral Nutrition in Plants-Principles and Perspectives, Wiley.
4. Lincoln, T and Zeiger, Plant Physiology.2010 www.plantphys.net

LABORATORY COURSE – III

(Plant Physiology)

Semester – II **Hours/week: 3**

16PBO2107 **Credits: 3**

1. Determination of water potential (Shardakov's method).
2. Determination of solute potential.
3. Hill reaction.
4. Estimation of total acidity in CAM plants.
5. Apparent photosynthesis.
6. Effect of CO_2 concentration on photosynthesis
7. Effect of quality of light on photosynthesis
8. Estimation of total free aminoacids and proline.
9. *In vivo* assay of NR and NiR.
10. Estimation of IAA.
11. Estimation of starch by perchloric method.
12. Estimation of nitrogen (Nessler's method).
13. Determination of activity of peroxidase and lipase

GENETICS

Semester II **Hours/week: 5**
16PBO2108 **Credits: 4**

Assurance of Learning:

1. To understand the principle and the hereditary mechanisms.
2. To study the structure and functions of genetic materials.

Unit – I:
Mendel and his work: Laws of inheritance. Gene interaction and Modified Mendelian ratios - lethal genes: non-epistatic inter allelic, kinds of epistatic interactions. Quantitative inheritance and Multiple alleles. Problem solving in genetics.

Unit – II:]
Linkage and crossing over, Sex linked inheritance, Sex determination in plants, theories of sex determination and chromosome basis of heredity. DNA is the genetic material: proof: Griffith's, Avery *et al*., and Hershy and Chase. RNA as genetic material.

Unit – III:
Organization of eukaryotic chromosome and bacterial genome. Special chromosome types – polytene & lamp brush. Chloroplast and Mitochondrial genomes. Watson and Crick model of DNA. Replication of DNA: types and mechanism. DNA repair mechanisms - mismatch and proof reading, photoreactivation, excision, recombination and SOS mechanisms in *E. coli.*

Unit – IV:
Gene mutation: Types, physical and chemical mutagens and their mode of action. Application of mutation. Mobile genetic elements- IS elements and transposons in maize and bacteria. Transposition, phenotypic and genotypic effects – evolutionary significance.

Unit – V:
Population genetics: gene frequency, gene pool, Hardy–Weinberg equilibrium. Gene frequencies – conservation and changes. Decline of human gene pool and eugenics. Genomics: *Arabidopsis* genome and rice genome. Human genome project and the controversies.

Books:

Verma, P.S. & V.K. Agarwal, 2003, Genetics. S. Chand, New Delhi-55.

Reference:

1. Gardner E J, Simmons M J, Snustad D P (1991). *Principles of Genetics* (III Edn). John Wiley and Sons Inc. 8th Edn., New York.
2. Snustad D P, Simmons M J (2000). *Principles of Genetics* (III Edn). John Wiley and Sons.
3. Strickberger (2005). *Genetics* (III Edn). Prentice Hall of India Pvt. Ltd.
4. William S Klug, Michael R Cummings (1994). *Concepts of Genetics*. Prentice Hall.
5. Robert J Brooker (2009). *Genetics: Analysis and principles* (III Edn). McGraw Hill.
6. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
7. D Peter Snustad and Michael J Simmons (2010). *Principles of genetics*. John Wiley & Sons.

RESEARCH METHODOLOGY

Semester II **Hours/week: 5**
16PBO2109 **Credits: 5**

Assurance of Learning:

1. To identify the influencing factors of research parameters
2. To test the significance, validity and reliability of the research

Unit – I:
Research - types, objectives and approaches. Census method, Sample - types; Sampling Techniques. Hypothesis: definition, characteristics, types, significance. Methods of collecting data: primary and Secondary- merits and demerits, Code of research ethics.

Unit – II:
Literature collection: web browsing. Review: Introduction, components and purpose. Structure of thesis and journal article. Manuscript for publication and proof correction. Structure and components of research proposal, National and International funding sources.

Unit – III:
Bibliometrics: definition and relevance; Lotka's and Bradford's Laws. Bibliometrics databases, h-index, Page Rank, Impact Factor and evaluation. The use of bibliometrics in research: Citation Research, Science Citation Index. The Institute for Scientific Information (ISI) and Thomson Reuter's Webmetric and ORCID. Plagiarism, tailored research and retraction.

Unit – IV:
Biostatistics: Introduction, Classification of data; Frequency Distribution: Discrete, Continuous and Cumulative Frequency Distributions – Tabulation of data- Diagramatic and graphic representation of data; Histogram, Frequency polygon, Frequency curve, Ogive curve, Bar Charts: Simple, Multiple, Subdivided, Pie diagram.– Measures of Central values: Mean, Median and Mode- Measures of Dispersions, : Range, Mean Deviation, Standard Deviation.

Unit – V:
Coefficient of Variation – Skewness and Kurtosis. Probability: binomial, poisson and normal distributions. Correlation: types, methods, Regression analysis, Large sample (Z), small sample testing: t-test, chi-square and F test. ANOVA - one and two way, Duncan Multiple Range Test. Principles of experimental design - randomization, replication, local control, size and shape of the plot, CRD, RBD.

Books

1. Kothari, C.R. 2000. Research Methodology – Methods & Techniques. Wishwa Prakashan
2. Misra, R.P, 2000 Research Methodology - a handbook, Concept Publg Company, New Delhi.
3. Gupta, S.P., 1990 Statistical Methods, Sultan Chand & Sons, New Delhi.
4. Pillai and Bagavathi, 2008 Statistics, S.Chand & Company Ltd, New Delhi
5. Nageswara Rao, G. 1983. Statistics for Agricultural Science Oxford & IBH, New Delhi
6. Gupta, S.C, 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.

Reference:

1. Hawkins, C and Sorgi, M. 2000 Research, Narosa Publishing House, New Delhi.
2. Daniel, W.W., 1983, Biostatistics; A Foundation for Analysis in the Health Science, John Wiley and Sons Inc., New York.

Reference for Bibliometrics:

1. Ball, Philip. 2005. Index aims for fair ranking of scientists. *Nature* 436 (7053):900. http://dx.doi.org/10.1038/436900a
2. Bornmann, Lutz, and Hans-Dieter Daniel. 2007. What do we know about the h index? *Journal of the American Society for Information Science and Technology* 58 (9):1381-1385. http://dx.doi.org/10.1002/asi.20609
3. Bornmann, Lutz, Rüdiger Mutz, and Hans-Dieter Daniel. 2008. Are there better indices for evaluation purposes than the h index? A comparison of nine different variants of the h index using data from biomedicine. *Journal of the American Society for Information Science and Technology* (5):830-837. http://www3.interscience.wiley.com/cgi-bin/fulltext/117908948/HTMLSTART
4. Costas, Rodrigo, and María Bordons. 2007. The h-index: Advantages, limitations and its relation with other bibliometric indicators at the micro level. *Journal of Informetrics* 1 (3):193-203. http://www.sciencedirect.com/science/article/B83WV-4NCK2JT-1/1/ddf6c25f8810c462fb8c22ae3d5b5d28
5. Craig, Iain D., Andrew M. Plume, Marie E. McVeigh, James Pringle, and Mayur Amin. 2007. Do open access articles have greater citation impact?: A critical review of the literature. *Journal of Informetrics* 1 (3):239-248. http://www.sciencedirect.com/science/article/B83WV-4P18BNV-1/1/0d60463e068ba604e67030229ce6d33b
6. Eysenbach, G. 2006. Citation advantage of open access articles. *PLoS Biol* 4 (5):e157. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=16683865
7. Thomson Reuters. 2008. Using bibliometrics: a guide to evaluating research performance with citation data. http://scientific.thomsonreuters.com/news/newsletter/2008-07/8465001/
8. Garfield, E 2006. The history and meaning of the journal impact factor. *JAMA* 295 (1):90-93. http://jama.ama-assn.org/cgi/content/full/295/1/90

LABORATORY COURSE – IV

(Genetics & Research Methodology)

Semester II **Hours/week: 4**

16PBO2110 **Credits: 3**

Problems in Genetics:

A. Problem solving in Mendelian Ratios
B. Problem solving in Gene Interactions
C. Problem solving in Quantitative Genetics
D. Problem solving Statistical Testing in Experimental Results (Chi square)
E. Estimation of Probability among Natural Populations
F. Estimation of Inheritance
G. Problem solving in Linkage Mapping
H. Problem solving Molecular genetics: DNA Replication, Transcription & Translation

Research Methodology:

1. Sampling by Random Number Table
2. Data Collection
3. Classification of Data: Discrete, continuous and cumulative.
4. Statistical diagrams: Histogram, Frequency curve, Bar chart and Ogive curve
5. Measures of Central Values: Mean, Median and Mode
6. Measures of Dispersion: Range, Mean deviation and standard Deviation.
7. Exercises with Tests of Significance
8. Exercises in the calculation of Citation Index.
9. Determination of Impact Factor of Author, Article and Journal

BIOPHYSICS AND INSTRUMENTATION

(Core Elective - 2)

Semester II **Hours/Week: 4**
16PBO2202A **Credits: 4**

Assurance of Learning:

1. To understand the mechanism of cell communication.
2. To understand how cells are programmed and the mechanism of cancer and apoptosis.

Unit – I:

Introduction to biophysics, its importance in modern biology. *Bioenergetics:* First and second law of thermodynamic, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, ATP and high energy phosphate compounds.

Unit – II:

Biophotonics: Redox potential, Oxidation and reduction, redox potential and its calculation by Nernst equation, examples of redox potential in biological system. Osmosis and osmotic pressure, role of osmosis in cell volume regulation. Iso, hypo, and hypertonic solutions, their influence on the cell. Ionic diffusion. Active and passive bioelectric properties of membranes.

Unit – III:

Microscopy: Bright field microscopy – magnification, resolving power, contrast. Dark field microscopy, phase-contrast microscopy, fluorescent microscopy, electron microscopy (SEM and TEM).

Unit – IV:

Centrifugation: Principle, procedure and application. Types of centrifugation- density gradient centrifugation, ultracentrifugation and differential centrifugation. *Chromatography:* Principles, instrumentation, and applications of Paper, thin layer, column chromatography, gas chromatography, HPLC and HPTLC.

Unit – V:

Spectrophotometry: principles and instrumentation of UV/Vis, Atomic absorption spectrophotometer (AAS), NMR, ESR. *Tracer techniques:* Important stable radioisotopes and their uses in research. Radiation hazards and precautions taken while handling radioisotopes. Measurement of radioactivity – autoradiography, GM counter and scintillation counter.

Books

Pranab Kumar Banerjee (2008) Introduction to Biophysics S. Chand, New Delhi.

Reference:

1. R.N. Roy A text book of Biophysics. New Central Book Agency Pvt. Ltd, Calcutta.
2. Upadhyay, Upadhyay &Nath Biophysical Chemistry. Himalaya Publ. House, Bangalore.
3. Mohan Arora Biophysics. Himalaya Publishing House, Bangalore.
4. R.p Budhiraja Separation chemistry. New age international (P) Ltd, New Delhi.

PLANT PATHOLOGY

(Core elective- -2)

Semester II **Hours/week: 4**
16PBO2202B **Credits: 4**

Assurance of Learning:

1. To study the process of plant pathogenesis and disease establishment
2. To understand the basis of defence mechanism against pathogens and disease control

Unit – I:

Introduction - scope, significance and terminology of plant pathology. Diseases- concepts, components and causes. Classification of diseases: necrosis, hypertrophy, hyperplasia and hypoplasia.

Unit – II:

Pathogenesis- pathogens and their mode of dissemination, pre-penetration, penetration and post penetration, entry through natural openings, wounds and intact plant surfaces, role of enzymes and toxins in disease development.

Unit – III:

Effect of infection on physiology of host viz. photosynthesis, respiration, carbohydrate metabolism, nitrogen metabolism, phenols, shikimic acid pathway, importance of phenol oxidation in plant diseases.

Unit – IV:

Defense mechanisms in plants, morphological and structural defense mechanisms, defense structures, existing before infection, biochemical defense mechanisms, pre-existing defense mechanisms. Phytoalexins, defense through induced synthesis of proteins and enzymes.

Unit – V:

Control of plant diseases: biological, cultural and chemical methods, fungicidal, chemotherapy. Plant diseases: causal organisms, symptoms, disease cycle and control measures for the following diseases rots, damping off, rusts, wilt, root rot, leaf spot and leaf blight (one example for each type). Agricultural terrorism.

Books:

Mehrotra R.S., 1994, Plant pathology, Tata Mc Grew publishing company Ltd.

Reference:

1. Rangasamy G. 1998. Diseases of crop plants in India. Prentice- Hall of India, New Delhi
2. Sharma P.D., 2001, Microbiology and plant physiology Rastogi publications.
3. Harsfall JG & Cowling E B. 1979. Plant Disease, an advanced Treatise. Academic Press, NY.
4. Mukherjee KG and Jayanti Bhasin, 1986. Plant diseases of India. Tata MacGraw-Hill publishing company Ltd. New Delhi.

IDC–I : SOFT SKILLS

Semester II **Hours/week: 4**

16PBO2401 **Credits: 4**

PLANT SYSTEMATICS

Semester III **Hours/week: 6**
16PBO3111 **Credits: 5**

Assurance of Learning:

1. To understand the relevance of molecular techniques in plant systematics.
2. To study the classical taxonomy with reference to different parameters.

Unit – I:
Taxonomic History: Natural systems to Cladistics; Phenetics; Cladistics. *Concepts of Taxonomic hierarchy:* Species, Genus, Family and other categories; species concept and intraspecific categories - subspecies, varieties and forms. *Botanical nomenclature:* History of ICBN, Priority, Typification, Author citation, Retention, Rejection and changing of names, naming a new species, synonyms, effective and valid publication.

Unit – II:
Construction of taxonomic keys: indented and bracketed – their utilization. *Taxonomic tools:* Herbarium, Floras and Botanical gardens. *Systematic Evidence:* Morphology, anatomy, palynology, embryology, cytology, phytochemistry.

Unit – III:
Molecular systematics – plant genomes: nuclear, chloroplast and mitochondria. Molecular markers, generating molecular data, restriction site mapping, gene sequencing, analysis of molecular data, alignment of sequences, methods of phylogeny reconstruction.

Unit – IV:
Study of the following families (Bentham & Hooker) in detail with special reference to their salient features, interrelationships, evolutionary trends and economic significance: Menispermaceae, Nymphaeaceae, Capparaceae, Caryophyllaceae, Meliaceae, Aizoaceae, Rubiaceae, Asteraceae, Convolvulaceae, Solanaceae.

Unit – V:
Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae, Loranthaceae, Euphorbiaceae, Hydrocharitaceae, Commelinaceae, Araceae and Cyperaceae.

Books:

1. Davis, P.H. & Heywood,V.M 1963, Principles of Angiosperm Taxonomy, Oliver & Boyd.
2. Crawford, D.J. 2003. Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
3. Heywood,V.K & Moore, D.M., 1984, Current Concepts in Plant Taxonomy, AP, London.
4. Lawrence, G.H.M., 1955, The Taxonomy of Vascular Plants, Central Book Depot, MacMillan, NY.

Reference:

1. Burkill, I.H., 1965, Chapters of the history of Botany in India, Government of India Press, Nasik, The Manager of Publications.
2. Grant, W.F., 1984, Plant Biosystematics, Acad Press Inc., Canada.
3. Harborne, J.B. & Turner,B.L, 1984, Plant Chemosystematics, Acad. Press, London.
4. Heywood, V.H., 1967, Plant Taxonomy. English Language Book Society, London.
5. Hillis, DM., Moritz, C & Mable, BK (eds) 1996, Molecular Systematics, Sinaver Associates, Sunderland, USA
6. Jeffrey, C., 1982, Introduction of Plant Taxonomy, Cambridge Uni. Press, Cambridge.
7. Jain,S.K., 1981, Glimpses of Indian Ethnobotany, Oxford & IBH Publ. Co., New Delhi.

LABORATORY COURSE – V

(Plant Systematics)

Semester III **Hours/week: 4**

16PBO3112 **Credits: 3**

I. Binomial identification using flora.

II Study of the following families with reference to their South Indian representatives and a minimum of one member each to be taxonomically described, dissected and sketched (to scale):

Menispermaceae, Nymphaeaceae, Capparaceae, Caryophyllaceae, Meliaceae, Aizoaceae, Rubiaceae, Asteraceae, Convolvulaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae, Loranthaceae, Euphorbiaceae, Hydrocharitaceae, Commelinaceae, Araceae, Cyperaceae

III. Exercises in key-making.

IV. Exercises in the important Articles of the Code.

V. Submission of 5 herbarium sheets and digital description of any 5 plant species.

VI. Field Trip Report

BIOCHEMISTRY

Semester III **Hours/week: 5**
16PBO3113 **Credits: 5**

Assurance of Learning:

1. To fathom the chemical environment and the dynamics of the biological system.
2. To elucidate the interrelationships of the various pathways.

Unit – I:
Carbohydrates: Homoglycans: chemical structure and properties of starch, glycogen, cellulose, dextrin and inulin. Heteroglycan: chemical structure and properties of agar, alginic acid (sea weed polysaccharide), glycosaminoglycans and pectins. Glycocalyx oligosaccharide.

Unit – II:
Lipids and Biomembranes: Triglycerides, phosphoglycerols, derived lipids - steroids, prostaglandins and leukotrienes. Structure of membrane model, lipid bilayer. Structure of membrane proteins and membrane receptors: adrenalin receptors, acetylcholine receptors and insulin receptors.

Unit – III:
Amino acids and peptides: Amino acids: general structure and classification. Glutathione: structure, metabolism and function. Biology of cyclosporin. Metabolism of phenylalanine and tyrosine; glycine, cysteine and methionine. Over view of metabolisum: carbohydrate,protein lipid and vitamins.

Unit – IV:
Proteins: The peptide bond and primary structure. Protein sequencing strategies : Ramachandran plot - chemical and enzymic. Secondary structure, domain, motif and backbone folding. Tertiary structure and stabilizing forces in collagen. Quaternary structure of haemoglobin and its regulatory features.

Unit – V:
Enzymes: Principles of catalysis, activation barrier and energy changes in reaction profile, initial velocity and principles of enzyme kinetics: Michaelis-Menten Equation, K_M and V_{Max} measurements - LB blot; active site organization; and role of cofactors/vitamins. Enzyme regulation: pH, temperature and substrate concentration. Inhibitions and regulation of glutamine synthetase.

Books:

Stryer Lubert, 2005, Biochemistry, W.H. Freeman & Co., NY.

Reference:

1. Apps *et al*., 1992, Biochemistry, ELBS
2. Caret *et al*., 1993, Inorganic, Organic and Biological Chemistry, WMC Brown, USA
3. Rawn, David, 1989, Biochemistry, Neil Patterson USA

LABORATORY COURSE 6

(Biochemistry)

Semester III **Hours/week: 3**

16PBO3114 **Credits: 3**

1. Estimation of glycogen / total polysaccharides
2. Estimation of hexosamine
3. Determination of total proteins [Bradford's / Lowry's]
4. Study of Enzyme Kinetics (experiments with acid phosphatase)
5. Effect of temperature on enzyme activity.
6. Effect of pH on enzyme activity.
7. Effect of [E] on enzyme activity.
8. Effect of [S] on enzyme activity; measurement of Vmax and Km.
9. Estimation of Ascorbic acid [Calorimetric / volumetric]
10. Estimation of Riboflavin
11. Estimation of Phenolics [Folin – Ciocalteau]
12. Estimation of Tannins [Folin – Denis / Vanillin hydrochloride]
13. Estimation of total lipids and cholesterol

CELL AND MOLECULAR BIOLOGY

(Core Elective – 3: Online Study)

Semester III **Hours/week: 4**
16PBO3203A **Credits: 4**

Assurance of Learning:

1. To understand the structural organization and function of different cell organelles.
2. To study the basic principles of the central dogma of life.

Unit – I:

Phases and control system of Cell cycle, Cell cycle checkpoints – DNA damage, centrosome duplication, spindle assembly. Cyclins and Cyclin-dependent kinases. Cytoskeleton structure and functions: actin filaments (microfilaments), microtubules, and intermediate filaments.

Unit – II:

Cell communication: general principles. Signaling molecules and their receptors. *Receptors:* Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK). Plant two-component signaling systems.

Unit – III:

Genetic code: Cracking the genetic code. Important features of the genetic code, proof for the triplet code, Exceptions to the standard code. RNA polymerases. *Transcription in prokaryotes:* Initiation, elongation and termination.

Unit – IV:

Transcription in eukaryotes: General transcription factors and formation of pre-initiation complex. Elongation and termination. *Post-transcriptional events:* Split genes, splicing signals, splicing mechanisms. Alternative splicing, exon shuffling, *cis* and *trans* splicing. Organization of mRNA, RNA editing, mRNA export.

Unit – V:

Translation: Important features of mRNA – Open Reading Frame (ORF), ribosomal binding site (RBS) *Stages in translation:* Initiation – initiation factors in prokaryotes and eukaryotes, Kozak sequence. Elongation – process of polypeptide synthesis, active centers in ribosome - Elongation factors. Termination – process of termination, release factors, ribosome recycling. *Protein sorting and translocation:* Post-translational modification of proteins. Protein folding – self assembly and role of chaperones. *Principles of gene regulation: lac* operon and *trp* operon.

Text Book:

Gardner *et al*. 2004, Principles of genetics. John Wiley &Sons Inc. Singapore.

Reference:

1. De Robertis and De Robertis, 1990, Cell and Molecular Biology, Saunders College, Philadelphia, USA
2. Freifelder D. 1987, Molecular Biology. Jones and Bartlett, Boston, USA
3. Weaver, R.F. and Hedrick,P.W., 1989, Genetics. Wm, C. Brown Pub, Dubuque
4. Watson J.D. *et. al*., 2004, Molecular biology of the gene, Pearson education, Singapore.
5. Lodish *et. al*., 2004, Molecular cell biology, COH freeman & Co. New York.

PHARMACOGNOSY

(Core Elective – 3: Online Study)

Semester III **Hours/Week: 4**
16PBO3203B **Credits: 4**

Assurance of Learning:

1. To study the different systems of Indian medicines and the bioactive principles
2. To know the ethnopharmacological importance of medicinal plants

Unit – I:

Traditional and alternative system of medicine – Principle, practice, short history and merits of herbal medicine- naturopathy, traditional chinese, folk medicine, Ayurveda, Siddha, Unani, Homeopathy, Aromatherapy and acupuncture. Global trend in herbal market. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants. WHO regulation of herbal medicine.

Unit – II:

Classification of crude drugs - alphabetical, taxonomical, morphological, chemical, pharmacological (therapeutical). Cultivation-sexual and asexual method of propagation, fertilizer and manure, pest and its control, collection, processing of herbal drugs – harvesting, drying, dressing, packing and storage. Conservation of medicinal plants.

Unit – III:

Medicinally useful plant parts – Root: *Hemidesmus indicus, Withania somnifera*, *Rauvolfia serpentina*; Rhizome: *Zingifera officinalae, Acorus calamus*, *Curcuma longa*; Stem- *Tinospora cordifolia, Santalum album*, *Cinchona officinalis;* Bark: *Terminalia arjuna, Cinnamomum verum, Saraca asoca*; Leaf: *Adhatoda vasica, Ocimum sanctum, Cynodon dactylon*; Flowers: *Crocus sativus*, *Syzygium aromaticum, Leucus aspera*; Fruits: *Phyllanthus emblica, Piper longum, Terminalia chebula;* Seeds: *Azadirachta indica, Vernonia anthelmintica, Ricinus communis*.

Unit – IV:

Herbal preparation methods – bolus, capsules, compresses, creams, decoctions, extracts, infusions, herbal tea, ointments, massage oils, medicinal vinegar, poultice & plasters, powders, salves, syrups, tinctures, tonic, maceration and baths and bathing remedies teas and dry extract (pills or capsules).

Unit – V:

Pharmaceutical plant products- alkaloids, glycosides, terpenoids, tannins, flavonoids, lipids, proteins. Nutracueticals, cosmecuticals, pharmaceuticals – fibre, sutures, surgical dressings, adaptogens, rasayana. Drug adulteration and methods of evaluation – physical, chemical and microscopic.

Books

1. James Green, 2000 Herbal Medicine-Maker's Handbook, Crossing Press, U.S.
2. Weiss, Rudolf Fritz 2000 Herbal Medicine, 2nd Edition Thieme Medical Publishers
3. S. Somasundaram 1997. Maruthuva Thavaraiyal, Ilangovan Padhippagam, Palayamkottai
4. Kokate CK, Purokit AP and Gokahale, 2006. Pharmacognosy, Nirali Prakashan.

Online Resources

http://www.gallowglass.org/jadwiga/herbs/preparations.html
http://shawnacohen.tripod.com/thetribaltraditions/id51.html
http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf
http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf

BIOPROCESS TECHNOLOGY

(Interdisciplinary Course 2)

Semester III **Hours/week: 4**
16PBO3402 **Credits: 4**

Assurance of Learning:

1. To study the avenues of exploiting microbes in bioconversion technology.
2. To study the downstream processing for product recovery in fermentation.

Unit – I:

Principles of fermentation process, Bioprocess vs Chemical process, Media formulation – Growth factors, Buffers, O_2, Antifoams and Media Optimization. Cell growth and quantitation – density, cell mass, growth pattern, yield factors and environmental conditions. Batch, Continuous and Fed batch culture.

Unit – II:

Bioreactor design, parts and functions, sterilization, impellers, baffles and sparger. Types of reactor – submerged reactor, mechanically stirred draught-tube reactor, continuous flow stir type reactor, airlift reactor, jet loop reactor, surface reactor and packed bed reactor.

Unit – III:

Bioprocess control and monitoring variables: O_2 requirement and uptake-factors affecting K_La-aeration, agitation, pressure and pH, medium rheology. Computers in bioprocess. Flow measurement and control, control system – manual and automatic PID control.

Unit – IV:

Bioconversion and biocatalysts: Immobilization of cells and enzymes – methods and advantages. Selection of industrially important microorganisms. Strain improvement preservation and properties of industrial strains. Production strategies for insulin, lactic acid and vinegar.

Unit – V:

Downstream processing: recovery of microbial cells and products – Precipitation. Filtration and Centrifugation. Cell disruption – physical and chemical methods. Chromatography. Membrane processes, drying and crystallization.

Books:

1. Stanbury, P F & Whitaker, A, 1995, *Principles of Fermentation Technology*, Pergamon
2. Schuler ML & Fikret Kargi, 2002, *Bioprocess Engg: Basic Concepts*, PrenticeHall, NJ.
3. Wulf Crueger & Anneliese Cruger, 2004, *Biotechnology: A Textbook of Industrial Microbiology*, 2nd Edn., Panima Publishing Co.
4. E.MT. El-Mansi & C F A Bryce, 2002, *Fermentation Microbiology and Biotechnology*, Taylor & Francis Co., USA.
5. Bailley & Ollis, 1986, *Biochemical Engg Fundamentals*, McGraw Hill, New York.
6. Coulson, J M & Richardson, S F, 1984, *Chemical Engg*, Pergamon Press.
7. Mooyoung (ed.), 1985, *Comprehensive Biotechnology*, Vol. I, II, III & IV, Pergamon Press.

HORTICULTURE AND LANDSCAPING

(Interdisciplinary Course 3)

Semester III **Hours/week: 4**
16PBO3403 **Credits: 4**

Assurance of Learning:

1. To understand the methods of plant propagation
2. To know the state of art in landscape designing and its aesthetic values.

Unit – I:

Importance and scope of horticulture; divisions of horticulture; climate, soil and nutritional needs. Water irrigation; plant propagation methods – cutting, layering, grafting, and budding. Stock –scion relationship, micropropagation by root induction.

Unit – II:

Indoor gardening – foliage plants, flowering plants and hanging basket. Bonsai plants – training and pruning. Floriculture –cultivation of commercial flower crops; rose, jasmine and chrysanthemum. Flower decoration – dry and wet. Applications of cut flower technologies.

Unit – III:

Fruit crops – induction of flowering, flower thinning, fruit setting, fruit development. Cultivation of important fruit crops – mango, grapes and guava.

Unit – IV:

Landscaping principles – planning designs for house gardens, institutional and industrial gardens – bioaesthetic planning for rural gardens, recreational grounds, avenue planting, highway planting, railway planting – trees, shrubs, climbers, herbs and ground covers suited for different situations their culture, training and pruning – tree transplantation.

Unit – V:

Lawns: different grasses, maintenance of lawns and turf in play grounds, gardens and golf courses; special types of gardens: traffic islands, vertical garden, roof /terrace garden, bog garden, water garden, planning parks and public garden; beautification of urban areas.

Books:

1. Arora JS. 1992. Introductory ornamental horticulture, Kalyani Publishers, New Delhi.
2. George Acquaah. 2002. Horticulture principles and practices, 2nd Edn. Pearson Edn, Delhi.
3. Manibushan Rao K. 1991. Text book of horticulture. MacMillan Publishing Co., New York.
4. Edmond JB et al., 1977. Fundamentals of horticulture. Tata McGraw Hill Ltd., New Delhi.
5. Rao KM. 2000. Text Book of Horticulture, MacMillan India Ltd., New Delhi.
6. Gopalswamy Iyyangar, 1970. Complete gardening in India, Kalyan Printers, Bangalore.

MICROBIOLOGY AND IMMUNOLOGY

Semester IV **Hours/week: 6**
16PBO4115 **Credits: 5**

Assurance of Learning:

1. To study the microorganisms and their activities.
2. To understand and exploit their potentialities in agriculture, industry and other environmental aspects and to know the basic concepts of the immune system

Unit – I:
General microbiology; scope, branches and history. Structure and organization of Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Viruses - Viroids and prions. Culture of microorganisms, synchronous, batch and continuous culture. chemostat and turbidostat, preservation of microbes.

Unit – II:
Food, dairy and environmental microbiology. Microbial contamination of food; food poisoning, food-borne infections and food preservation. Microbial contamination of milk, milk-borne diseases - preservation of milk and dairy products. Aquatic microbiology - fresh water and marine microbes. Treatment and disposal of contaminated waters and sewage. Soil microbes and their role in biogeochemical cycling.

Unit – III:
Industrial microbiology: selection of industrially useful microbes, fermentation processes, recovery of end products; production of alcohol, insulin, lactic acid, vinegar, hydrocarbons, single cell oil and single cell protein. Common immunizations, antibiotics and other chemotherapeutic agents and their mode of action. Drug resistance in microbes.

Unit – IV:
Immunology – Immune system: structure and functions of primary and secondary lymphoid organs - immune cells - haemetopoiesis -detailed study of T and B cells. General structure of antibodies - classes – Generation of antibody diversity.

Unit – V:
Antigens – types, properties, antigen-antibody interaction. Types of immunity - innate and adaptive - emphasis on cell mediated and humoral immune responses. Vaccines - Immunization schedule.

Books:

1. Prescott *et al*., 2009 7e, Microbiology. Wm. C. Brown Publishers.
2. Kuby J, 2000, Immunology, 4th edition, W H Freeman

Reference:

1. Pelczar *et al.* 1998, Microbiology - Concepts & Applications. Tata McGraw Hill New Delhi.
2. Adams MR and Moss MO, 2008, Food Microbiology. Royal Soc. Chem., Cambridge, UK.
3. Dickinson M. 2003. Molecular Plant Pathology. BIOS Scientific Publishers, London.
4. Janeway and Travers, Immunobiology, 3rd edition Gerland Pub. Inc. NY.
5. Nandini Shetty 1996, lmmunology - An introductory Text Book, New Age Intl (P) Ltd.
6. Roitt *et al*., 1998, Immunology 5th edition, Mosby International Ltd. London. UK.

GENETIC ENGINEERING AND BIOTECHNOLOGY

Semester IV **Hours/week: 6**
16PBO4116 **Credits: 5**

Assurance of Learning:

1. To know the art of recombining genes and traits.
2. Understanding the revolutions that unfold in biotechnology

Unit – I:
Crown gall and *Agrobacterium*; generation of bacterial genes (restriction enzymes) and eukaryotic (cDNA). Joining DNA molecules and the strategies - *E. coli* and T_4 DNA ligases, linkers and homopolymers.

Unit – II:
Cloning vectors: ideal cloning vehicles: Natural vectors (*E. coli* and *Agrobacterium* based), *in vitro* vectors (pBR), sstrDNA vectors (M13) and shuttle vectors. Expression of cloned genes - problems and solution. Cloning strategies - cDNA libraries and genomic libraries.

Unit – III:
Engineered microbes - bioremediation of oil spills: oil-eating super bugs (*B.megatarium*, *P. putida,* & *A.borkumensis*); Bt crops, golden rice technology, plantibodies and edible vaccines. Strategies for crop improvement: engineering for resistance against herbicides and diseases. Antisense RNA technology.

Unit – IV:
Technology protection systems (GURT) - the terminator. Biosafety aspects of GMOs and GM foods. Principles of biosafety; potential risks; environmental impacts; safety of food and animal feed derived from GM crops; and patterns of gene flow. Issues concerning release of Bt brinjal. Essentials of IPRs and patents.

Unit – V:
Synthetic biology – scope and importance. Artificial DNA and synthetic genome. Contribution of JC Venter. Minimal genome, expanded gene pool. Creation of synthetic organisms: top-down and bottom-up approaches. Potentials and applications; ethical issues of synthetic organisms.

Books:
1. Old RN and Primrose S B. 2004, Principles of gene manipulation - Blackwell Sci., USA.
2. Watson JD *et al*., 2005. Recombinant DNA. Blackwell Science Publ. USA.

Reference:
1. Adrian Slater *et. al*., 2003, Plant Biotechnology, Oxford University press, U.K.
2. Glick BJ & Pasternack JJ. 2004. Molecular biotechnology. Panima Publ. Bangalore.
3. European Commission Report of a NEST High-Level Expert Group, 2005. Synthetic Biology: Applying Engineering to Biology.
4. Presidential Commission for the Study of Bioethical Issues, 2010. (www.bioethics.gov)
5. ETC Group, Canada, 2010. Extreme Genetic Engg - an introduction to synthetic biology.
6. Young, E and Alper, H, 2010. Synthetic Biology: A Review. *J Biomedicine and Biotechnology.*
7. Benner SA. & Sismour AM, 2005. Synthetic Biology, *Nature* Reviews, Genetics, **6**: 533

LABORATORY COURSE VII

(Microbiology, immunology, Genetic Engineering & Biotechnology)

Semester IV **Hours/week: 4**

16PBO4117 **Credits: 3**

1. Isolation and enumeration (CFU) of microorganisms in soil by serial dilution.
2. Bacterial staining - Simple, Gram's staining.
3. Isolation of bacteria from skin, mouth and urine.
4. Potability test of water - presumptive, confirmative and completed tests.
5. Quantitative estimation of bacteria in milk.
6. Testing quality of milk by methylene blue reductase (MBRT) and phosphatase test.
7. Morphological and biochemical identification of bacteria - indole test, methyl red test, Voges-Proskaur test, Citrate utilization test, TSI agar test.
8. Blood grouping
9. WIDAL- test for typhoid
10. RPR- test for syphilis
11. RF- test for rheumatoid arthritis
12. Immunoelectrophoresis
13. ELISA – Demo
14. Identification of local crop diseases (sugar cane, paddy, banana, brinjal and citrus).
15. Callus induction and regeneration.
16. Clonal propagation.
17. Embryo culture
18. Electrophoretic separation of DNA, protein and restriction digestion.
19. Preparation of synthetic seeds.

COMPREHENSIVE EXAMINATION

Semester IV
16PBO4118 **Credits: 2**

Assurance of Learning:

The Course has been designed such that
1) the students will have read almost all the topics relating to UGC-CSIR NET contents, and
2) they will have revisited all the most relevant areas of the modern science of Botany.

Unit – I:
Structure and function of biomolecules; metabolism; principles of enzyme catalysis; protein & nucleic acids; bioenergetics; membrane structure and function; intracellular organelles; cell division and cell cycle; genes and chromosomes.

Unit – II:
Mendelian inheritance; quantitative genetics; mutation; DNA replication, repair and recombination; DNA damage and repair mechanisms; gene expression – transcription & translation; RNA synthesis and processing; protein synthesis and processing.

Unit – III:
Recombinant DNA methods; transgenic organisms; and Bioremediation. Gametogenesis and fertilization; embryogenesis; seed formation and germination; meristem and morphogenesis; organogenesis in plants.

Unit – IV:
Photosynthesis; Respiration; nitrogen metabolism; plant hormones; sensory photobiology; solute transport and photo-assimilate translocation; secondary metabolites; stress physiology; principles and methods of taxonomy; concepts of species and hierarchical taxa.

Unit – V:
Major habitat types of the subcontinent, geographic origins and migrations of species; Environment; Species interactions; Ecological succession; Ecosystem structure and function; Biogeography; Climate change; Conservation Biology; Evolutionary thoughts.

SELF-PACED LEARNING: PLANT BREEDING AND EVOLUTION

16PBO4119 Credits: 2

Assurance of Learning:

1. To study the progress made in the field of plant breeding.
2. To understand the principles, techniques and applications of plant breeding.

Unit – I:

Plant Breeding: Historical aspect of plant breeding and genetic basis. Objectives of plant breeding – Modes of reproduction in relation to breeding methods, sexual, asexual and apomitic reproduction – Floral Biology in relation to selfing and crossing techniques. Breeding Methods: Plant introduction – Types and procedures – Centres of diversity and origin of cultivated plants.

Unit – II:

Hybridization: Objectives – Choice of parents – problems and causes of failure of hybridization – incompatibility and sterility. Methods of handling genetic consequence of hybridization – method of handling segregation material for isolation of superior strains – Bulk method and pedigree method of selection – Role of interspecific and intergeneric hybridization in plant improvement.

Unit – III:

In breeding depression and heterosis: Genetic basis and application in plant breeding. Steps in the production of single cross, double cross, three way cross and synthetics – induced polyploidy in plant breeding; role of auto and allopolyploidy – Heteroploids – Mutagen and crop improvement. Population genetics: Hardy-Weinberg principle; gene frequencies; and the factors that change it.

Unit – IV:

Back Crossing: Theory and procedure for transferring various types of character. Preservation and utilization of germplasm. Breeding of rice, sugarcane, groundnut and maize. Breeding for disease resistance and drought tolerance.

Unit – V:

Evolution: Origin of life, theories of evolution of life forms: Lamarkism, Darwinism and Speciation. Variations – Definition, causes and types, Mutations (Principles of Hugo de'veries), Role of mutations in speciation. Evidences for evolution, adaptive radiation, biological evolution.

Books:

1. Chaudhari, H.K., (1995) Revised Ed., Elementary Principles of Plant Breeding.

Reference:

1. Chandrasekaran & Parthasarathy, (1990). Cytogenetics and Plant Breeding.
2. Sinha,U. and Sinha, S., (1992).Cytogenetics, Plant Breeding and Evolution.
3. J. R. Sharma (1996) Principles and Practice of Plant Breeding.

PROJECT DISSERTATION AND *VIVA VOCE*

Semester IV **Hours/week: 14**
16PBO4120 **Credits: 07**
