Mahatma Jyotiba Phule Rohilkhand University, Bareilly

Proposed M.Sc. Botany Syllabus in accordance with New Education Policy 2020

महात्मा ज्योतिबा फुले
रुहेलखण्ड विश्वविद्यालय, बरेली

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20.	Mr. Ragib Husain	Invited Member	Bareilly College, Bareilly
21.	Mr. Vinay Kumar Singh	Invited Member	Bareilly College, Bareilly

Semester wise Titles of the Papers in M.Sc. Botany

Year	Semester	Course Title	Core Compulsory/ Elective/ Value Added	Credits	Teaching Hours
I	First	Algae, Fungi Lichens and Bryophytes	Core Compulsory	04	60
		Pteridophytes, Gymnosperms and Palaeobotany	Core Compulsory	04	60
		Plant Systematics and Reproductive Biology	Core Compulsory	04	60
		Any one of the following: a. Microbiology b. Economic and Ethnobotany	Core Elective	04	60
		Practical Lab 1	Core Compulsory	04	60
		Industrial Training/ Research Project/ Survey	Core Compulsory & Value Added	04	60
		Industrial Microbiology	Minor- Open for other faculty	04	60
	Second	Biomolecules and Cell biology	Core Compulsory	04	60
		Molecular Biology	Core Compulsory	04	60
		Genetics	Core Compulsory	04	60
		Any one of the following: a. Biostatistics b. Plant Anatomy	Core Elective	04	60
		Practical Lab 2	Core Compulsory	04	60
		Industrial Training/ Research Project/ Survey	Core Compulsory & Value Added	04	60
		Biofertilizers	Minor- Open for other faculty	04	60
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II	Third	Plant Physiology	Core Compulsory	04	60
		Growth and Developmental Biology	Core Compulsory	04	60
		Ecology and Evolution	Core Compulsory	04	60
		Any one of the following: a. Plant Breeding and Intellectual Property Rights b. Environmental Issues and Policies	Core Elective	04	60
		Practical Lab 3	Core Compulsory	04	60
		Industrial Training/ Research Project/ Survey	Core Compulsory & Value Added	04	60
		Disaster Management	Minor- Open for other faculty	04	60

	Fourth	Analytical Techniques in Plant Science	Core Compulsory	04	60
		Biotechnology and Plant Tissue Culture	Core Compulsory	04	60
		Biophysical Chemistry and Bioenergetics	Core Compulsory	04	60
		Any one of the following: a. Bioinformatics b. Plant Pathology	Core Elective	04	60
		Practical Lab 4	Core Compulsory	04	60
		Industrial Training/ Research Project/ Survey	Core Compulsory & Value Added	04	60
		Biodiversity and Conservation	Minor- Open for other faculty	04	60

The marks break-up for the credit course examination (Botany) is as follows:

Assessment Type	**Theory Course (Core Compulsory/Core Elective/ Minor):- Marks distribution for the 4 credits**
Internal Assessment	
(a) Examinations	15 Marks
(b) Assignments/ Seminars/ Presentations	10 Marks
External Assessment	
End-Semester Examination	75 Marks
Total	**100 Marks**
Assessment Type	**Lab Course:- Marks distribution for the 4 credits**
Internal Assessment	
(a) Lab Performance/ Demonstration	15 Marks
(b) Lab Record	05 Marks
(c) Viva-voce	05 Marks
External Assessment	
(a) Write-up/ Exercise	20 Marks
(b) Viva/ Record/ Field Work	25 Marks
(c) Lab Execution/Performance/ Demonstration	30 Marks
Total	**100 Marks**
Assessment Type	**Industrial Training/ Research Project/ Survey for the 4 credits**
(a) Active Participation	30 Marks
(b) Records/ Assignments	30 Marks
(c) Presentation/ Viva-Voce	40 Marks
Total	**100 Marks**

SEMESTER: I

SEMESTER: I
Course Code: To be added by University [Core Compulsory]
Course Title: Algae, Fungi, Lichens and Bryophytes

Unit	Syllabus	Teaching Hours
I	Introduction and general features of algae: Cell structure, thallus organization and reproduction of Cyanophyta, Xanthophyta, Bacillariophyta, Dinophyta, Chlorophyta, Phaeophyta, Cryptophyta and Rhodophyta. Classification as proposed by R. E. Lee (2008). Algal research in India. Algal culturing techniques in the laboratory. Algal biofuels: algal biodiesel, bio-ethanol and biohydrogen production. Algae in global warming: carbon capture by algae. Algal blooms and Algal Biofertilizers. Algal bioremediation. Bioactive compounds of algae.	20
II	Introduction and general features of fungi: Myxomycota, Oomycota, Chytidriomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota. Recent trends in the classification of Fungi. Fungal research in India. Fungal culturing techniques in the laboratory. Heterothallism and Parasexuality. Economic importance of Fungi.	18
III	Lichen: Thallus structure, classification and reproduction. Collection and identification techniques. Lichen research in India. Economic importance of lichens.	06
IV	Introduction and general features of Bryophytes. Affinities with Algae and Pteridophytes. Recent classification of Bryophytes. Bryophyte research in India. Comparative structural organization of gametophyte and sporophyte among major groups: Marchantiophyta (Liverworts) Anthocerotophyta (Hornworts), Bryophyta (Mosses). Bryophytes in relation to embryophyte evolution.	16

Suggested Readings:

1. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.
2. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.
3. Chapman, V.J. and Chapman D.J. (1975). The algae. 2nd Edition, Mac. Millan Publ. Inc. New York.
4. Chopra, R. N., and Kumar, P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York (NY).
5. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.
6. Hoek, C. van den, Mann, D. G. and Jahns, H. M. (1995). Algae: An introduction to Phycology. Cambridge University Press, UK.
7. Kashyap, S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part1, Chronica Botanica, New Delhi.
8. Kashyap, S. R. (1932). Liverworts of the western Himalayas and the panjab plain (illustrated). Part 2, The Chronica Botanica, New Delhi.
9. Puri, P. (1981). Bryophytes: Morphology, Growth and Differentiation. Atmaram and Sons, New Delhi.
10. Prescott, G. W. (1969). The algae: A review. Nelson, London.
11. Round, F.E. (1981). The Ecology of Algae. Cambridge University Press, Cambridge.

SEMESTER: I
Course Code: To be added by University [Core Compulsory]
Course Title: Pteridophytes, Gymnosperms and Palaeobotany

Unit	Syllabus	Teaching Hours
I	Introduction and general features of Pteridophytes. Affinities with Bryophytes and Gymnosperms. Classification of Pteridophytes as proposed by Smith *et al.* 2006. Pteridophyte research in India. Comparative account of morphology, anatomy and reproduction among important members of Psilotopsida, Equisetopsida, Marattiopsida and Polypodiopsida. Development of leaf and vascular system in Pteridophytes. Steps in seed evolution. Apogamy, Apospory and Parthenogenesis in Pteridophytes.	18
II	Introduction and general features of Gymnosperms. Affinities with Pteridophytes and Angiosperms. Classification as proposed by Sporne (1965). Comparative account of Pteridospermales, Bennettitales, Pentoxylales, Cycadales, Cordaitales, Coniferales, Taxales, Ginkgoales and Gnetales. Ovule and seed development in Gymnosperms. Advance features and position of Gnetales among Seed Plants. Economic importance of Gymnosperms.	18
III	Introduction to fossils, types of fossilization and methods in study of fossils. Fossil record of Algae, Bryophyte, Pteridophytes, Gymnosperms and Angiosperms. Palaeobotany researches in India. Recent trends in the study of fossils. Geological Time Scale. Importance of fossils in studying evolution of plants. Speciation in the fossil record, a case study on diatom *Rhizosolenia*.	18
IV	Important and useful databases of Algae, Fungi, Bryophytes and Gymnosperms. Features and use of nuclear, mitochondrial and chloroplast regions in classifying non-flowering plants. Origin of angiosperms.	06

Suggested Readings:

1. Agashe, S. N. (1995). Paleobotany. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
2. Arnold, A. C. (2005). An Introduction to Paleobotany. Agrobios (India), Jodhpur.
3. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
4. Biswas, C. and Johri, B. M. (1997). Gymnosperms. 4 Narosa Publishers, NewDelhi.
5. Parihar, N.S. (1976). Biology and morphology of the Pteidophytes. Central Book Depot.
6. Rashid, A. (1999). An Introduction to Pteridophyta.Vikas Publishing House Pvt. Ltd., New Delhi.
7. Ramanujan, C.K.G. (1970). Indian Gymnosperms in time and space. Today &Tomorrow 's Printers & Publishers.
8. Sporne, K.R. (1965). Morphology of Gymnosperms. Hutchinson University Library.
9. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.

SEMESTER: I
Course Code: To be added by University [Core Compulsory]
Course Title: Plant Systematics and Reproductive Biology

Unit	Syllabus	Teaching Hours
I	Need for scientific names, development of botanical code, contents of botanical code, Ranks and endings provided by the ICN, Typification (Holotype, Isotype, Paratype, Syntype, Lectotype, Neotype), Author citation, Publication of Names, Principle of Priority, PhyloCode. Outline of classification of Angiosperms as proposed by Bentham and Hooker. APG classification system: Basal living angiosperm, Monocots and Eudicots. Phylogenetic relationships of major angiosperm clades.	20
II	Special features of important families: Monocots (Cyperaceae, Poaceae, Orchidaceae), Eudicots (Magnoliaceae, Ranunculaceae, Papaveraceae, Brassicaceae, Malvaceae, Rutaceae, Fabaceae, Rosaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Convolvulaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae).	15
III	Herbarium preparation and use, Virtual Herbarium, Roles of a Botanical Garden, Floras, Journals, Taxonomic Keys, DNA Barcoding. Chemotaxonomy, Embryology and Palynology Sieve-tube plastids in relation to taxonomy. Possible ancestors of Angiosperms.	10
IV	Stamen and Carpel evolution. Microsporogenesis and Megasporogensis. Embryo sac and its types. Pollination and Fertilization. Embryo and Endosperm development. Placentation and its types. Types of fruits. Seed germination. Dormancy.	15

Suggested Readings:

1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition. 29
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi. 5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.

6. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
7. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
8. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

SEMESTER: I
Course Code: To be added by University [Core Elective]
Course Title: Microbiology

Unit	Syllabus	Teaching Hours
I	Introduction and general characteristics of Viruses, Classification of plant viruses. Isolation, purification and characterization of viruses. Replication, transmission of viruses, economic importance, symptomatology of plant viruses. Virus-induced cell transformation, virus-induced cancer. Cyanobacteria, Viroids, Prions. Archaebacteria and Eubacteria: General account, ultrastructure, nutrition and reproduction, economic importance. Plasmids and their characteristics. 16s r-DNA sequencing.	20
II	Agricultural Microbiology: Agriculturally important microorganisms, Biological nitrogen fixation, Mycorrhizae, Plant diseases and their biocontrol. Plant growth promoting rhizobacteria (PGPR). Weed and Pest Biocontrol.	10
III	Environmental Microbiology: Microbes and quality of environment. Microbial degradation of pesticides and hydrocarbons. Biodegradation of the agricultural residues. Bioremediation of contaminated soils and water. Microbes in nanotechnology. Biosensors, Biogas Production.	15
IV	Food and Industrial Microbiology: Fermentation, fermenter design and growth processes. Food spoilage. Microbes in recovery of metal (bioleaching) and oil. Cell and enzyme immobilization. Microbial enzymes of industrial interest. Single Cell Protein. Vaccines.	15

Suggested readings:

1. Pelezar, M.I. and Reid, R.D. (1993) Microbiology McGraw Hill Book Company, New York, 5th Edition.
2. Atlas, M. Ronald (1995) Principles of Microbiology, 1st Edition, Mosby-Year Book, Inc, Missouri, U.S.A.
3. Block, J.G. (1999) Microbiology Principles and Explorations, 4th Edition John Wiley and Sons Inc.
4. Frazier, W.C. (1988) Food Microbiology, McGraw Hill Inc. 4th Edition.
5. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition

SEMESTER: I
Course Code: To be added by University [Core Elective]
Course Title: Economic and Ethnobotany

Unit	Syllabus	Teaching Hours
I	Cereals: Wheat Rice and millets. Legumes: General account, importance to man and ecosystem. Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses. Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel,	20

	saffron, clove and black pepper.	
II	Beverages: Tea, Coffee (morphology, processing & uses). Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and Brassica and Coconut (Botanical name, family & uses) Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	10
III	Natural Rubber: Para-rubber: tapping, processing and uses. Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis. Timber plants: General account with special reference to teak and pine. Fibres: Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).	10
IV	Ethnobotany: Plants used by the tribals (Food plants, intoxicants and beverages, Resins and oils and miscellaneous uses. Significance of the following plants in ethno botanical practices: Azadiractha indica, Ocimum sanctum, Vitex negundo, Gloriosa superba, Tribulus terrestris, Pongamia pinnata, Cassia auriculata, Indigofera tinctoria. Role of ethnobotany in modern medicine with special example: Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.	20

Suggested readings:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
5. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
6. Lone et al,. Palaeoethnobotany
7. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
8. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.
9. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons.

SEMESTER: I
Course Code: To be added by University [Core Compulsory]
Course Title: Practical Lab 1

Practical will be based on all the courses of Semester I.

SEMESTER: I
Course Code: To be added by University [Minor- Open for other faculty]
Course Title: Industrial Microbiology

Unit	Syllabus	Teaching Hours
I	Exploitation of microorganisms and their products, screening, strain development strategies, immobilization methods, fermentation media, raw material used in media production, antifoaming agents, buffers, downstream processing.	15
II	Fermentation equipment and its uses, fermentor design, Types of fermentors and fermentations- single, batch, continuous, multiple, surface, submerged	15

	and solid state.	
III	Industrial products from microorganisms- antibiotics: production of penicillin, streptomycin. Interferons, vaccines, hormones, vitamins.	15
IV	Enzymes from microbes: amylase, protease. Organic acids: citric acid, acetic acid, amino acids: glutamic acid, lysine. Production of alcoholic beverages: bear and wine, biofuels: ethanol, methane, biogas.	15

Suggested Readings:

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Frazier, W.C. (1988) Food Microbiology, McGraw Hill Inc. 4th Edition.
4. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition

SEMESTER: II

SEMESTER: II
Course Code: To be added by University [Core Compulsory]
Course Title: Biomolecules and Cell Biology

Unit	Syllabus	Teaching Hours
I	Carbohydrate, Lipids and Amino acid: Classification, Structure and properties of some important carbohydrates, lipids and amino acid and their significance to plants.	15
II	Protein structure and Enzymes: Hierarchical structure of proteins; folding; degradation; Application of principles of thermodynamics in biology; Enzyme classification, Physiochemical nature, enzyme kinetics and regulation of enzymatic activity. Brief overview of various signal transduction pathways.	15
III	Structure and function of Plant Cell Wall and Cell Membrane; Nucleosome and Chromosomal Packaging Structure of nuclear Envelope, Nuclear pore complex. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.	15
IV	Protein sorting: Organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretary pathway, protein sorting in the Golgi, traffic in the endocytic pathway, exocytosis. Trafficking between nucleus and cytoplasm: Protein and RNA transport.	15

Suggested Readings:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman

4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

SEMESTER: II
Course Code: To be added by University [Core Compulsory]
Course Title: Molecular Biology

Unit	Syllabus	Teaching Hours
I	DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).	15
II	RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).	15
III	Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).	15
IV	Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).	15

Suggested Readings:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

SEMESTER: II
Course Code: To be added by University [Core Compulsory]
Course Title: Genetics

Unit	Syllabus	Teaching Hours
I	Mendelian genetics and its extensions: Codominance, incomplete dominance, gene interactions, pleiotropy, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Quantitative inheritance: Concept of gene effects (additive, dominance, over–dominance and epistasis); polygenes and quantitative trait loci (QTL).	15
II	Mutations and mutagenic agents: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Practical application of mutation in crop improvement.	15
III	Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes.	15
IV	Extrachromosomal inheritance: Criteria for extra chromosomal inheritance; plastid inheritance in *Mirabilis*, iojap in corn, Kappa particles in *Paramecium*, coiling in snails, brief idea of mitochondrial (male sterility in plants) and chloroplast genetics, paternal inheritance.	15

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

SEMESTER: II
Course Code: To be added by University [Core Elective]
Course Title: Biostatistics

Unit	Syllabus	Teaching Hours
I	Introduction of Biostatistics. Collection and Classification of data: Sampling and types of sampling methods. Presentation of Data: Tabular, Graphical, Line Diagrams, Frequency Polygon, Frequency Curve, Scatter or Dot Diagram, Bar Diagrams, Pie Chart. Measures of central tendency - Mean, median, mode. Measures of dispersion: Range, standard error, standard deviation, co-efficient of variations.	15
II	Probability: Sum rule, Product rule and Binomial expansion. Probability distribution: Normal, Binomial and Poisson. Kurtosis. Correlation and Regression: Types of correlation (linear, non-linear, positive and negative),	15

	difference between correlation and regression.	
III	Analysis of variance (ANOVA): Summary of steps involved in ANOVA. Test of hypothesis and tests of significance: Student's t-Test, Chi-square test, F-test. Introduction to life table. Parametric and Non-parametric test.	15
IV	Experimental Designs: Introduction, Observational Investigation, Steps in Methodology and Designing, Guidelines on Methodology, Experimental Investigation, Use of Computers.	15

Suggested Readings:

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

SEMESTER: II
Course Code: To be added by University [Core Elective]
Course Title: Plant Anatomy

Unit	Syllabus	Teaching Hours
I	Plant Tissues: Classification; Simple and complex tissues; cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfe cells, adcrustation and incrustation, Ergastic substances.	10
II	Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Leaf: Structure of dicot and monocot leaf, Kranz anatomy. Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.	20
III	Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; dendrochronology. Periderm: Development and composition of periderm, rhytidome and lenticels.	20
IV	Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes. Secretory System: Hydathodes, cavities, lithocysts and laticifers.	10

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

SEMESTER: II
Course Code: To be added by University [Core Compulsory]
Course Title: Practical Lab 2

Practical will be based on all the courses of Semester II.

SEMESTER: II
Course Code: To be added by University [Minor- Open for other faculty]
Course Title: Biofertilizer

Unit	Syllabus	Teaching Hours
I	General account about the microbes and plants used as biofertilizer: *Rhizobium* (isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis).	18
II	*Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.	18
III	Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.	18
IV	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	06

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay -Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

SEMESTER: III

SEMESTER: III
Course Code: To be added by University [Core Compulsory]
Course Title: Plant Physiology

Unit	Syllabus	Teaching Hours
I	**Photosynthesis** - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways. **Respiration and photorespiration** – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. **Nitrogen metabolism** - Nitrate and ammonium assimilation; amino acid biosynthesis.	20
II	**Sensory photobiology** - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.	10
III	**Water, solute transport and photoassimilate translocation** – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.	15
IV	**Secondary metabolites** - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.	15

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U. S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. 33 Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

SEMESTER: III
Course Code: To be added by University [Core Compulsory]
Course Title: Growth and Developmental Biology

Unit	Syllabus	Teaching Hours
I	**Plant hormones** – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development.	20
II	Development of flower: Transition to flowering - vegetative to reproductive evocation, floral homeotic mutations in Arabidopsis, Antirrhinum and Petunia, axis development in flower, gender expression in monoecious and dioecious plants. Control of floral identity (ABC Model).	12
III	Developmental biology of male and female gametophytes: Regulation of anther	18

	and ovule development, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, male sterility- mechanisms and applications, pollen embryogenesis. Pollen-pistil interaction: In vivo and in vitro pollen germination, pollen tube growth and guidance, double fertilization, self-compatibility mechanisms.	
IV	Embryogenesis, seed and fruit development: Polarity during embryogenesis, pattern mutants, in vitro fertilization, endosperm development, apomixis, polyembryony, somatic embryogenesis. Developmental mechanisms and applications.	10

Suggested Readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U. S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition
3. Bob B. Buchanan (2015). Biochemistry and Molecular Biology of Plants

SEMESTER: III
Course Code: To be added by University [Core Compulsory]
Course Title: Ecology and Evolution

Unit	Syllabus	Teaching Hours
I	**The Environment:** Abiotic and biotic environment **Habitat and Niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. **Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection)	15
II	**Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. **Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. **Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax.	15
III	**Ecosystem Ecology:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). **Biogeography:** Major terrestrial biomes; concept of endemism, botanical zones of India.	15
IV	**Population Genetics**: Gene and Allele frequency, hardy Weinberg law, Forces of evolution: Genetic drift – Sampling error; Mutation. Migration/Gene Flow. **Speciation:** Reproductive isolation. Species concepts and processes of speciation. Drivers of speciation. allopatry and sympatry, Adaptive Radiation. Geological time scale.	15

Suggested Readings:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
6. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition

SEMESTER: III
Course Code: To be added by University [Core Elective] Course
Title: Plant Breeding and Intellectual Property Right

Unit	Syllabus	Teaching Hours
I	**Plant breeding and crop improvement:** Objectives and scope of plant breeding, hybridization in self- and cross-pollinated crops, genetic basis of inbreeding depression and heterosis, breeding for disease and insect resistance, transgenes and transgenic plants.	15
II	Alien gene transfer through chromosome: Transfer of gene through individual chromosome characterization and utility of alien addition and substitution lines. Physical and genetic mapping using molecular markers. **Crop varieties:** Identification, release and notification of crop varieties, institutions involved in release of varieties.	15
III	IPR in India and world (WTO (TRIPS, WIPO). **Patents:** Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Infringement. **Copyrights:** Introduction, Works protected under copyright law, Rights, Infringement. **Trademarks:** Objectives, Types, Rights, Protection of goodwill, Infringement.	15
IV	**Geographical Indications:** Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position. **Protection of Plant Varieties:** Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers.National gene bank, Benefit sharing.Protection of Plant Varieties and Farmers' Rights Act, 2001. Biotechnology and Intellectual Property Rights.	15

Suggested Readings:

1. Allard, R.W. (1960). Principles of Plant Breeding. John Wiley, New York
2. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
3. Frey, K. J. (1966). Plant Breeding. The Iowa State University Press, Ames.
4. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
5. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
6. Singh B. D. (2007). Plant Breeding. Kalyani Publishers. Ludhiana
7. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
8. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
9. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

SEMESTER: III
Course Code: To be added by University [Core Elective]
Course Title: Environmental Issues and Policies

Unit	Syllabus	Teaching Hours
I	Environmental Pollution: Causes and effects of air, water, soil, noise, radioactive pollution; Basic pollution abatement practices and technologiesGlobal Change: Global land cover and land use change; Multiple impacts of land use change; Causes, effects and mitigation strategies for global climate change and stratospheric ozone loss.	15
II	Biotic Invasions: Extent and mechanisms of biological invasions; Ecological and economic impacts; Management strategies. Loss of Biodiversity: Threats and pattern of biodiversity loss; Natural and anthropogenic causes; IUCN threat categories, Red data books; Conservation and restoration of biodiversity, Biodiversity act.	15
III	Global Water Crisis: Distribution, withdrawal and consumption patterns; Causes and effects of water crisis; Water conservation approaches. Global Energy Crisis: Sources of energy supply; Current potential and future prospects of energy sources; Energy crisis; Energy conservation strategies.	15
IV	Challenges of Urbanization: Trends of urbanization; Environmental impact of urbanization; Concept of green cities. National Policies on Environment: National Forest Policy; National Water Policy; National Energy Policy; National Action Plan on Climate Change; National Biodiversity Action Plan.	15

Suggested Readings:

1. Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
2. Environmental Chemistry, AK. De, Wiley Eastern Ltd, New Delhi.
3. Introduction to Biodeterioration, D.Allsopp and K.J. Seal, ELBS / Edward Arnold.
4. Bioremidation, Baaker, KH and Herson D.S., 1994. Mc.GrawHill Inc, NewYork.
5. Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, _2006. Horizon Press.
6. Environmental Molecular Biology, Paul. A, Rochelle, 2001.Horizon Press.
7. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ. House

SEMESTER: III
Course Code: To be added by University [Core Compulsory]
Course Title: Practical Lab 3

Practical will be based on all the courses of Semester III.

SEMESTER: III
Course Code: To be added by University [Minor- Open for other faculty]
Course Title: Disaster Management

Unit	Syllabus	Teaching Hours
I	Introduction to Disasters Concepts, and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks. Disasters: Classification, natural hazards and Man-made disasters, Causes, Impacts (including social, economic, political, environmental, health, psychosocial, etc) Global trends in disasters, urban disasters and climatic change.	15
II	Approaches to Disaster Risk reduction Disaster management cycle-Phases, Culture of safety prevention, mitigation and preparedness community based DRR, Role of NDMA, NDRE, NIDM, STATE DM in disaster Management.	15
III	Disasters and Development: Impact of Development projects such as doms, embankments changes in Land-use etc, Climate Change Relevance of indigenous knowledge and local resources.	15
IV	Disaster Risk Management in India Hazard and Vulnerability profile of India, Components of Disaster Relief Water, Food. Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy).	15

Suggested Reading:

1. David, A. (2000). Introduction in Confronting Catastrophe. Oxford University Press.
2. Andharia, J. (2008). Vulnerability in Disaster Discourse. JTCDM, Tata Institute of Social Sciences, Working Paper no. 8.
3. Blaikie, P., Cannon, T., Davis, I., Wisner, B. (1997). At Risk Natural Hazards, Peoples Vulnerability and Disasters, Routledge.
4. Damon, C. P. (2007). Introduction to International Disaster Management.
5. Nick, C. (1991). Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines

SEMESTER: IV

SEMESTER: IV
Course Code: To be added by University [Core Compulsory]
Course Title: Analytical Techniques in Plant Science

Unit	Syllabus	Teaching Hours
I	Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.	15
II	Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical	15

	centrifugation, ultracentrifugation, marker enzymes. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.	
III	Spectrophotometry: Principle and its application in biological research. Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography. PCR and its Types.	15
IV	Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE. RNA Interference, Antisense RNA Technology, miRNA and Gene silencing.	15

Suggested Readings:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition

SEMESTER: IV
Course Code: To be added by University [Core Compulsory]
Course Title: Biotechnology and Plant Tissue Culture

Unit	Syllabus	Teaching Hours
I	Recombinant DNA technology, basic concept in genetic engineering, tool and techniques of recombinant DNA technology. Enzymes in genetic engineering. Restriction enzymes, DNA ligase, Polymerase, exonucleases, endonucleases, restriction endonucleases, S I nucleases, DNA ligases, reverse transcriptase and alkaline phosphatase. etc. Cloning vehicles: Plasmids, Cosmids, Lambda phage, Charon phage, shuttle vectors, 2μ DNA plasmids, yeast plasmids, M13 vector. Transposons, Primary vectors and plasmids - expression vectors.	15
II	Selection of genes, Gene libraries, Genomic and cDNA library - Gene transfer methods, Genetic organization of Ti plasmids, Ti plasmid mediated transfer - *Agrobacterium tumifaciens*, DNA mediated transfer. Calcium phosphate, PEG, DEAE, via liposomes - Microinjection - Macroinjection, microprojectile, and electroporation, - Selection of clones, marker and reporter genes in screening methods. Hybridizations - colony, Southern, Northern, Western Blotting. Elementary Knowledge of next generation sequencing.	15
III	Introduction to Plant Tissue culture, Terms and definitions, Tools and techniques of plant tissue culture. Culture media, culture media preparation and sterilization, callus and suspension cultures. Organ Culture and Protoplast culture. Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion- chemical. Techniques and applications of somatic embryogenesis and regeneration of plants, anther, pollen, ovule, endosperm, hairy root cultures.	15
IV	Cell/callus line selection for resistance to herbicide, stress and diseases. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and synthetic seeds. Plant transformation: Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer	15

	using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposme mediated DNA delivery. Transgenic plants for crop improvement: Maize, Rice, Wheat, Cotton, Brinjal and Tomato.	

Suggested Readings:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science
Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

SEMESTER: IV
Course Code: To be added by University [Core Compulsory]
Course Title: Biophysical Chemistry and Bioenergetics

Unit	Syllabus	Teaching Hours
I	**Solution:** Normality, molarity and molality of the solution, ppm and percent solutions, colligative properties of electrolyte solution: the Donnan effect.	10
II	**Acid and Bases:** Definition of acid and base, acid-base properties of water, concept of pH and pK_a, acid (amino acids) and base titration, diprotic and polyprotic acids, preparing a buffer solution with specific pH, dissociation of amino acid, isoelectric point, titration of protein.	10
III	**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, Gibbs energy of biological membrane transport. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change. High energy phosphate compounds: introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG.	20
IV	**Kinetics of biochemical reaction**: Biochemical equilibrium and protein ligand binding mechanism. Kinetics of zero & first order reactions. Classification of multi substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms, denaturation and renaturation kinetics of DNA and protein, Cot curve.	20

Suggested Readings:

1.L. Stryer, Biochemistry, 5th Edition, (2002) Freeman &Co. New York

2. D.L. Nelson and M.M. Cox, Lehninger Principles of Biochemistry 3rd Edition ((2002) McMillan North Publication
3. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.

SEMESTER: IV
Course Code: To be added by University [Core Elective]
Course Title: Bioinformatics

Unit	Syllabus	Teaching Hours
I	Introduction to Bioinformatics: Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Databases in Bioinformatics: Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.	10
II	Biological Sequence Databases: National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.	20
III	Alignment of sequences: Introduction to sequence analysis, models for sequence analysis (local, global, end free space alignment and gap penalty), Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM). Molecular Phylogeny: Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.	15
IV	Databases used in agricultural biotechnology. Applications of Bioinformatics: Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.	15

Suggested Readings:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. _II Edition. Benjamin Cummings

SEMESTER: IV
Course Code: To be added by University [Core Elective]
Course Title: Plant Pathology

Unit	Syllabus	Teaching Hours
I	Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds. Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine,integrated pest management. Post-harvest pathology: Fungal deterioration of food commodities, mycotoxins and health hazards, control measures.	15
II	**Physiological and Molecular Plant Pathology:** Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanismsof pathogenesis: recognition phenomenon, penetration, invasion, primary disease determinant. Enzymes and toxins in relation to plant disease. Mechanisms of resistance. Phytoalexins. PR proteins. Antiviral proteins. SAR. HR and active oxygen radicals. Tissue culture. Somoclonal variation and somatic hybridization. Elementary genetic cngineering. Management of pathogens through satellite, antisense - RNA. Ribozymes, coat protein, hypovirulence cross protection/useful genes and promoter technology biosafety and bioethics.	20
III	Study of plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Wart disease of potato, blight of colocasia, downy mildew of cucurbits, stem gall of coriander, peach leaf curl, ergot of bajra, smut of sugarcane, Karnal bunt of wheat, linseed rust, Tikka disease of groundnut, red rot of sugarcane, Panama disease (Fusarium wilt) of banana, bacterial blight of rice, leaf curl of tomato, yellow vein mosaic of bhindi, mosaic of sugarcane, potato spindle tuber mosaic, ear cockles of wheat, grassy shoot of sugarcane, phylloidy of sesamum, Citrus greening	15
IV	**Management of Plant diseases:** General principles of plant quarantine. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics: their bioassy and compatibility with other agricultural chemicals; resistance to fungicides/ antibiotics; effect on environment.	10

Suggested Readings:

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India

SEMESTER: IV
Course Code: To be added by University [Core Compulsory]
Course Title: Practical Lab 4

Practical will be based on all the courses of Semester IV.

SEMESTER: IV
Course Code: To be added by University [Minor- Open for other faculty]
Course Title: Biodiversity and Conservation

Unit	Syllabus	Teaching Hours
I	**Introduction to biodiversity:** Levels of biodiversity: Genetic, species, community and ecosystem	15
II	**Magnitude and distribution:** Diversity gradients and related hypotheses, methods for biodiversity monitoring, megadiversity zones and hot spots Biodiversity and ecosystem functions: Concepts and models.	20
III	**Biodiversity and ecosystem services:** Provisioning, regulating, supporting and cultural. **Threats to biodiversity:** Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book.	15
IV	**Strategies for biodiversity conservation:** Principles of biodiversity conservation, in-situ and ex-situ conservation strategies; Biodiversity act	10

Suggested Readings:

1. Essentials of Conservation Biology, 6th ed. (Primack. 2014. Sinauer)
2. Principles of Conservation Biology, 3rd ed. (Groom. 2005. Sinauer)
3. Conservation Biology, 2nd ed. (van Dyke. 2008. Springer)
4. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.