

Syllabus for Ph.D. Course Work in Botany

DEPARTMENT OF BOTANY



**COTTON UNIVERSITY,
GUWAHATI-781001, ASSAM**

DISTRIBUTION OF PAPERS/CREDITS (L+T+P FORMAT)

The PhD coursework in Botany will comprise of 14 credits spread in 4(four) papers. One paper on Research ethics with 2(two) credits and while other 3 (three) papers will comprise worth 4(four) credits each which will be in L+T+P , where L, T and P stand for Lecture, Tutorial and Practical respectively. The distribution of papers/credits are detailed below:

<u>Paper Code</u>	<u>Title of the papers</u>	<u>L+T+P</u>	<u>Total Credits</u>
LS 2500RM	Research Methodology	3+0+1	4
BOT2501C	Advanced tools and techniques	3+1+0	4
BOT2502 SP-01	Taxonomy of Angiosperm	3+1+0	4
BOT2502 SP-02	Plant Biochemistry and Stress Physiology	3+1+0	4
BOT2502 SP-03	Mycology and Plant pathology	3+1+0	4
BOT2502 SP-04	Microbiology	3+1+0	4
BOT2502 SP-05	Cytogenetics, Molecular Biology and Plant Breeding	3+1+0	4
BOT2502 SP-06	Plant Ecology	3+1+0	4
BOT2502 SP-07	Advances in Plant Biology	3+1+0	4

*Compulsory for all the departments under the faculty of Life Sciences

#Compulsory for the departments of Botany

Note 1: PhD student have to opt for only one special paper out of the above mentioned papers offered (BOT-PhD-SP-01/02/03/04/05/06/07) by the departments of Botany.

Note 2: In addition PhD student have to opt one paper on Research ethics(Credit:2) at University Level

RESEARCH METHODOLOGY

(Faculty of Life Sciences)

Paper code: LS2500 RM

Credit: (3+0+1)

UNIT 1: RESEARCH METHODOLOGY

14 L

What is science?; philosophy of science from Aristotle through Popper to Feyerabend; Introduction to research and research methodology, scope and research problem; identification, selection, research hypothesis; formulation of research objectives; literature collection, reference management software and researcher network, research design-experimental and field study; sampling design, data collection and types, data processing and analysis, data presentation and interpretation.

UNIT 2: SCIENCE COMMUNICATION

9 L

Principles of science communication; nitty-gritty of writing a good research proposal, effective oral and poster presentation; how to read and write a scientific paper?; how to review a paper? Reference management and managing research; communication and advocacy of science to the public and to policy-makers; art of writing effective academic emails & CV.

UNIT 3: RESEARCH ETHICS

15 L

Intellectual Property Rights (IPR): Types of IP: Patents, Trademarks, Copyright and Related rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; Indian Intellectual Property – Administrative Machinery, International framework for the protection of IP; Trade-Related Aspects of Intellectual Property Rights (TRIPS), World Intellectual Property Organization (WIPO), Intellectual Property Treaties. Roles of Institutional Ethical and Biosafety Committees, Plagiarism.

UNIT 4: BIOSTATISTICS

10 L

Experimental design and scientific method (natural history, descriptive approaches, hypothesis testing, ANOVA, Post hoc test, t-test, regression, correlation, probability test.
Statistical Packages: Basics of Statistical packages like Excel/ R/ SPSS/Origin Pro etc.; introductory features and functions, data entry and interpretation.

Practical

Review of literature, report preparation and presentation through powerpoint mode and communication to suitable journal.

References:

1. Thesis and Assignment Writing, 3rd Edition (1998) – J Anderson, BH Dursten and M Poole, John Wiley & Sons Inc.
 2. A Hand book of Methodology of Research (1976) – P Rajammal and P Devadoss, RMM Vidya Press
 3. The Craft of Scientific Writing (2018) – Michael Alley (Springer)
 4. Research methodology (2005) – R Panneerselvam, PHI, New Delhi
 5. Biological Safety: Principles and Practices, 4th Edition (2006) – DO Fleming and DA Long, ASM Press
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6. Bioethics: Introduction to History, Methods and Practice, 3rd Edition (2011) – NS Jecker, AR Jonsen and RA Pearlman, Jones and Bartlett Learning, Sudbury, Massachusetts
7. BARE ACT, Indian Patent Act 1970 Acts and Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
8. A Step by Step Guide to Data Analysis using SPSS for Windows 3rd Editions, (2013) – Julie Pallant, Open University Press
9. Handbook On Intellectual Property Rights In India, Rajkumar S. Adukia; available online http://www.caaa.in/image/34_hb_on_ipr.pdf
10. The R book (2012) – MJ Crawley, John Wiley & Sons, 2012.
11. Applied statistics in ecology: common pitfalls and simple solutions (2013). SE Ashley, MC Kennedy, PG Cunningham and JS Stanovick. Ecosphere 4(9):1-13
12. BARE ACT, The Wild Life (Protection) Act, 1972 (2011). Universal law publishing Co. Pvt. Ltd. New Delhi, India 2011
13. Biostatistical Analysis (2010) –JH Zar, Prentice Hall
14. A primer of Ecological Statistics, 2nd Edition (2013) – NJ Gotelli and AM Ellison, Sinauer Associates, INC. Publishers, Sunderland, Massachusetts, USA.

ADVANCED TOOLS AND TECHNIQUES

Paper code: BOT2501 C

Credit: (3+1+0)

UNIT 1: ENZYMOLOGY

L-10

Enzyme Isolation and purification techniques. Enzyme assay, enzyme activity and specific activity determination, Protein quantification by different methods. Isozyme analysis and activity staining, Enzyme production and applications. Enzyme Modification, Enzyme as tools in research and diagnostics

UNIT 2: CHROMATOGRAPHIC TECHNIQUES:

L-12

Ion exchange chromatography, Molecular sieve chromatography, affinity chromatography, paper chromatography, Thin Layer Chromatography, Ultracentrifugation,

Gel electrophoresis, Isoelectric focusing and immunoelectrophoresis, Capillary electrophoresis , Pulse field electrophoresis. HPLC and HPTLC: Principle , instrumentation and application

UNIT 3: MICROSCOPIC AND SPECTROSCOPIC TECHNIQUES: L-10

Microscopy and its techniques: Electron Microscopy and Confocal microscopy, SEM/TEM, Emission spectroscopy :- Fluorescence , phosphorescence and chemiluminiscence, GC-MS, FTIR, Principles of Fluorescence , UV, Visible ,NMR, Atomic absorption spectroscopy.

UNIT4: MOLECULAR BIOLOGY AND BIOINFORMATICS – L-15

Principle and techniques of gene cloning, Expression and Cloning Vectors , PCR & Real time PCR (Principles and applications),Primer design-Basics,

DNA Analysis – (Electrophoresis, Blotting, DNA sequencing , Microarray)

Protein microarray and Protein sequencing .

Basics of Bioinformatics, Biological Databases (Nucleic Acid and Protein), Retrieval of data from different databases, Sequence analysis (Protein and DNA), Nomenclature and identification techniques, Phyllogenetic analysis, Introduction to RNA sequencing and analysis.

Reference:

- 1) Wilson ,K & Walker ,J (Eds) (2000) practical Biochemistry : Principls &Techniques, Cambridge University Press.
- 2) Bradshaw ,L.J(1992) Laboratory Microbiology ,Harcourt Brace ,San Diego ,California.
- 3) Edwin ,G.W.(1997) Analytical Instrumentation Handbook,Marcel Dekker.
- 4) Kanika Sarma (2005)- Manual of Microbiology : Tools &Techniques ,Ane Bokks.
- 5) Bioinformatics: Sequence and Genome analysis by D.W. Mount, 2004. Cshl Press
- 6) Bioinformatics: Principles and Application by Dr. Zhumar Ghosh and Dr. Bibekanand Mallick. 2008. OUP, India
- 7) Nelson, D. L. & Cox, M. M. Lehninger... Principles of Biochemistry. Freeman,
- 8) Bob B Buchanan.....Biochemistry & Molecular Biology of Plants
- 9) Watson, J. D. et al. Molecular Biology of the Gene. Benjamin Cummings
- 10) Brown, T. A. Gene Cloning and DNA analysis: an introduction. Blackwell Science,

TAXONOMY OF ANGIOSPERMS

Paper code: BOT2502 SP-01

Credit (3+1+0)

UNIT 1:

L -12

Taxonomy and Systematic –Basic components of taxonomy ,advancement levels of taxonomy and internet revolution.

Classificatory systems-Taxonomic groups, categories and ranks , Utilization of categories (species , intraspecific categories ,genus and family) , conceptual development of post –Darwinian classifications, angiosperm phylogeny groups (APG).

UNIT 2:

L -12

Phenetic Taxonomy –Principles ,OTUs , taxonomic characters and their coding ,measuring resemblance (Simple matching coefficient ,coefficient of association ,Yule coefficient ,taxonomic distance),Cluster analysis(Agglomerative methods ,divisive methods, hierarchical classifications),

Cladistic Taxonomy: Important Cladistic Concepts.

Process of Identification: Field work, Herbarium methods, Identification (taxonomic literature ,taxonomic keys).

UNIT 3:

L -12

International Code Of Botanical Nomenclature(ICBN): Principles , rules and recommendations,typification ,priority of names ,effective and valid publication ,rejection of names ,citation of authority , synonyms and homonyms.

UNIT 4:

L -12

Strategies for conservation: ex-situ conservation; principles and practices ,role of Botanical gardens, field gene bank ,seed bank, general account of BSI,National Bureau of Plant Genetics Resources(NBPGR),Indian Council of Agricultural Resources(ICAR),DBT,CSIR and DST.

References:

- 1) Ahmedullah,M. and M.P.Nayar .1987.Endemic Plants of the India Region (vol.1.)BSI.
 - 2) Cronquist ,A.1981.An Integrated System of Classification Of Flowering Plants.Columbia University Press.New York.
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- 3) Davis, P.H. and V.H. Heywood 1991. Principles of Angiosperm Taxonomy. today and Tomorrow Publications. New Delhi.
- 4) Endress Peter, K. 1994. Diversity and Evolutionary Biology of Tropical Flowers. Cambridge.
- 5) Greuter, W. (Edn.). 1999. International Code of Botanical Nomenclature (Saint Louis Code).
- 6) Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing company. Ltd. New Delhi.

PLANT BIOCHEMISTRY AND STRESS PHYSIOLOGY

Paper code: BOT2502 SP-02

Credit (3+1+0)

UNIT 1: Structural and functional aspects of nucleic acids :

L -12

DNA, RNA and their forms, RNA & DNA electrophoresis and Blotting techniques, Nucleotide synthesis and its regulation, Noncoding RNAs and their role in gene regulation (micro RNA, siRNA, antisense RNA etc). Gene silencing techniques and physiological functions in plants. DNA analysis; Micro Array and Gene Sequencing Techniques

UNIT 2: Enzymes:

L -12

Isolation and purifications of Enzymes. Application of enzymes, Kinetics of Enzymes and its application in research. Enzyme engineering techniques. Mechanism and regulation of enzyme action, RUBISCO, PEP Carboxylase, ATPase. Nitrogenase, Nitrate reductase, Antioxidant enzymes and their function in plants

UNIT 3: Stress Physiology:

L -12

Oxidative stresses – Generation of reactive oxygen species, effect of ROS and RNS on metabolism, ROS detoxification mechanism in plants. Transgenic approaches for abiotic stress tolerance in crop.

Gaseous stresses – Effect of elevated CO₂ concentration on plant metabolism, effect of air pollutant SO₂ and O₃ on plants.

Temperature stress ; High temperature and cold temperature stress responses in plants
Radiation stresses- Influence of high light intensity on Photosynthesis, Photoprotection mechanism.

Stress responsive proteins (Aquaporins, Dehydrins, HSP, Phytochelatin and metallothionins)
stress responsive genes and their functions.

Concept of multiple stress tolerance in plant

UNIT 4: Proteomics and metabolomics

L -12

Proteomics approach for stress tolerance: Basic concepts: Aims, strategies, application and challenges in proteomics. Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry, Protein structure and function analysis, Proteomic databases.

Metabolomics: Introduction to metabolomics: Metabolite, Metabolome and metabolic pathways, Techniques in metabolomics. NMR, LC-MS and GC-MS in plant metabolomics, Metabolic data analysis, Metabolic Databases

References:

- 1) Nelson, D. L. & Cox, M. M. *Lehninger... Principles of Biochemistry*. Freeman,
 - 2) Bob B Buchanan.....*Biochemistry & Molecular Biology of Plants*
 - 3) Watson, J. D. et al. *Molecular Biology of the Gene*. Benjamin Cummings
 - 4) Brown, T. A. *Gene Cloning and DNA analysis: an introduction*. Blackwell Science,
 - 5) Wilson, K. & Walker, J. *Principles and Techniques of Biochemistry and Molecular Biology*.
 - 6) *Plant Physiology*, Salisbury and Ross, CBS Publishers and Distributors. Jain Bhawan Bholanath Nagar, Shahadar Delhi 110032
 - 7) Lincon Taiz, Eduardo Zeiger, *Plant Physiology*.
 - 8) William J Griffiths (Editor), Stephen Neidle, *Metabolomics, Metabonomics and Metabolite Profiling*
 - 9) Wolfram Weckwerth and Guenter Kahl, *The Handbook of Plant Metabolomics*.
 - 10) Sastia Prama Putri and Eiichiro Fukusak, *Mass Spectrometry-Based Metabolomics: A Practical Guide*
 - 11) Richard Twyman, *Principles of Proteomics*
 - 12) *Laboratory Plant Physiology*, Bernard S Meyer, D B Underson, CA Swanson. East west Press Pvt.Ltd. New Delhi.
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MYCOLOGY AND PLANT PATHOLOGY

Paper code: BOT2502 SP-03

Credit (3+1+0)

UNIT 1 : FUNGI ,METHODS OF STUDYING PLANT DISEASES:

General characters, thallus structure, nutrition in fungi. Methods of reproduction and classification of fungi, symptomology and dispersal methods.

Laboratory studies, culturing of pathogenic organisms (Fungi, Bacteria, Mycoplasma etc.) Koch's Postulates.

L -12

UNIT 2: EPIDEMIOLOGY, BIOTECHNOLOGY IN RELATION TO PLANT DISEASES:

Elements of epidemic, Factors affecting epidemic, development of epidemic and forecasting of plant disease epidemic.

Plant pathological tissue culture technique, Genetic engineering in plant pathology.(Recombinant DNA Technology) Molecular biology of plant pathogens.

L -12

UNIT 3: PRINCIPLES OF PLANT DISEASE CONTROL:

Regulatory methods .Physical methods, Cultural methods .Direct protection-Biocontrol agents (Microbial), chemical control.

L-12

UNIT 4: MUSHROOM CULTIVATION, MYCORRHIZAL FUNGI:

Mushroom Production Technology: - Food values of edible mushrooms. Cultivation of white button, Paddy straw and Oyster mushroom – steps involved production of spawn .Diseases of mushrooms.Mycorrhizae –definition and types .Isolation techniques .Methods of inoculum production .Applications of mycorrhizal fungi in agriculture and forestry.

L-12

References:

- 1) Plant pathology .P.D.Sharma.Rastogi Publication. Shivaji Road Meerut-250002.
 - 2) Fundamentals of Plant pathology.V.N.Pathak, N.M.Khatri and M.Pathak.Publ.
 - 3) Agricultural Microbiology .G.Rangaswamy and D.J.Bagyaraj Prentice Hall of India.Pvt.Ltd.New Delhi 110001
 - 4) Mycorrhizal Symbiosis Harley,J.L.and Smith S.E.(1983),Academic press London.
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- 5) Miller R.M.19897 The ecology of Vesicular Arbuscular mycorrhizae in grass and shrub land in.GR Safir (Ed.)CRC Press Boca Raton Finland.
- 6) Smith S E and D J Read 1997 ,Mycorrhizal symbiosis (2nd edition) Academic Press San Diego California ,USA.
- 7) Mycorrhizal Symbiosis Harley J L and Smith S E 1983 Academic Press London.
- 8) G Rangaswamy and A Mahadevan,Disease of crops in India .Prentice Hall of India Pvt Ltd.New Delhi 110001
- 9) I Burdon: Disease and plant population biology,Cambridge University Press.
- 10) S.Nagarjan.Plant disease Epidemiology ,Oxford and IBH Publ.Coy.Ltd.New Delhi (1983):
- 11) R.T.Fox Principles of Plant pathology.Mac Milan Publishers Ltd .London.
- 12) R.T.V.Fox Principles of Diagnostic Techniques in Plant Pathology .CAB International,Wallingford UK.(1993).
- 13) R.S.Singh ,Introduction to principled of plant pathology ,Oxford and IBH Publishers,New Delhi(1984)
- 14) Text Book of Plant Pathology .S.K.Singh and Seema ,Shrivastava,Campus books International, Ansari Road New Delhi.
- 15) Plant Pathology .G.K.Gupta ,Discovery publishing house New Delhi.
- 16) Plant Protection .K.M.Chandniwala,Anmol Pubs.Pvt.Ltd.New Delhi.
- 17) Techniques of Mushroom cultivation ; P.Shrivastav.Discovery Publishing House,New Delhi

MICROBIOLOGY

Paper code: BOT2502 SP-04

Credit (3+1+0)

UNIT 1:

Microbioal interactions in soil,sample collection ,detection of microbial numbers ,detection of nonculturable bacteria,methods to detect and quantify bacteria in soil. Soil enzymes-origin and range of enzymes in soil,methods of measurement and extraction of soil enzymes,interactions between agrochemical and soil enzymes.Recent advances in biological Nitrogen Fixation.

L -12

UNIT 2:

Various methods for isolation of pure culture methods for measurement of microbial growth,manipulation of environment ,nutritional and genetic parameters for over growth,manipulation of environment,nutritional and genetic parameters for over production of metabolites ,maintainence and preservation of microbes(pure

culture).design of production of nutrient media .preparation of inoculums ,alternative carbon and nitrogen sources,pretreatment of carbon ,growth kinetics.

L-12

UNIT 3:

Design of fermenter : material for construction ,aeration ,agitation,sterilization of gases and liquids ,on-line and off-line monitoring of rheological parameters,scale up ,computer application,types of fermenters,solid state (substrate) fermentation,process economics,fermentation economics.

L -12

UNIT 4:

Organic solvents and Acids: Alcohols, acetone-butanol,vinegar and citric acid.

Beverages: Wine, Beer, Rum, whisky

Enzymes: Amylases, proteases..

Antibiotics: Penicillin, streptomycin, rifamycin, semisynthetic antibiotics.

L-12

References:

- 1) Microbial Technology by H.J.Peppler .Academic Press
 - 2) Annual Reviews in Microbiology Volume 48 by L.N.Ornston ,A.Balows and E.P.Greenberg (eds).Academic Press.
 - 3) Enzyme Biotechnology by S.Sridhar
 - 4) Food Microbiology by M.R.Adams and M.O.Moss
 - 5) Dairy Microbiology Volumes 1 and 2 by R.K.Robinson.
 - 6) Fermentation Microbiology and Biotechnology by E.M.T.EI-Mansi and C.F.A.Bryce.
 - 7) Microbiological Aspects of Pollution Control by Dart and Stretton Surabhi Publishers,Jaipur.
 - 8) Annual Reviews in Microbiology Volume 48 by L.N.Ornston ,A.Balows and E.P.Greenberg(eds).Academic Press.
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CYTOGENETICS, MOLECULAR BIOLOGY AND PLANT BREEDING

Paper code: BOT2502 SP-05

Credit (3+1+0)

Unit 1:

Cell Cycle: Phases of cell cycle ,Interphase ,Divisional phase ,Regulation of cell cycle,Mitosis –phase , Meiosis –phase , synaptonemal complex.

Karyotype concept: Techniques for preparation of karyotypes and ideograms,evolutionary significance of karyotypes.

L -12

Unit 2:

Polyploidy in higher plants : Allopolyploidy and genome analysis ,Criteria for distinction between autopolyploids and allopolyploids ;Allopolyploidization of autopolyploids;Genome analysis in allopolyploids,synthesis of new genera and species using allopolyploidy.

Molecular cytogenetics : Genetic, Cytogenetics and Physical maps using molecular markers ;Techniques on Restriction mapping ;Genetic maps using Restriction Fragment Length Polymorphism as markers ;Genetic maps using random Amplified Polymorphic DNA generated through PCR; Genetic maps using mini and microsatellites ; physical maps using molecular markers. Marker assisted selection (MAS)

L -12

Unit 3:

Breeding for resistance to physiological atresses;temperate stress ,drought stress , salt stress, biotechnological approaches; Quantitative Trait (QTL),Importance in plant breeding, Techniques. Mutation breeding, Importance of plant breeding with special reference to biotic and abiotic stress resistance

L-12

Unit 4:

Somaclonal variation, techniques for generation, importance in genetics and breeding, genetically modified crops. Genetic transformation in plants. Somatic hybridization, Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility.

L-12

References:

- 1) Genetics –Monroe W.Strickberger ,PHI learning Pvt.ltd
 - 2) Genetics –Susan Elrod &William Stansfield ,Tata McGraw Hill.
 - 3) Principle of Genetics –Robert H.Tamarin ,Tata McGraw Hill.
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- 4) Molecular Biology –David Freieder ,Narosa Publishing House.
- 5) Microbial Genetics –David Freielder ,Narosa Publishing House.
- 6) Genetics –K .B. Ahluwalia ,Wiley Eastern Limited.
- 7) Genetics-P.K.Gupta ,Rastogi Publication.
- 8) Biotechnology and Genomics –P.K.Gupta ,Rastogi Publications.

PLANT ECOLOGY

Paper code: BOT2502 SP-06
Credit (3+1+0)

L-8

1. Introduction:

Importance and Scope of ecology, levels of organization, spatial and temporal scales, Interaction of ecological factors in the environment; environmental issues in India; Tolerance range and limiting factors, adaptations, ecotypes and ecads.

L-8

- 2. Population ecology :** Concept; characteristics of a population; population growth curves; population regulation - by abiotic factors – nutrients, moisture, food availability ; by biotic factors – competition, predation, density ; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, age structured population.

L-8

- 3. Community organization and development:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones; vegetation characteristics (analytical and synthetic characters), methods of analysis; concept of habitat and niche; niche width and overlap; fundamental and realized niche; ecological succession: concept and changes in ecosystem properties during succession.

L-8

- 4. Ecosystem organization:** Structure and functions; primary production (global pattern and controlling factors); energy dynamics—trophic levels, energy flow pathways and ecological efficiencies; decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P, & S.
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5. **Ecosystem stability and ecological management** : Concept (resistance and resilience); ecological perturbations (Both natural and anthropogenic) and their impacts on plants and ecosystems; ecology of plant invasion; EIA; ecological restoration; sustainable development; sustainability indicators.

6. **Conservation biology**: Principles of conservation; Problems of conservation-causes of extinction; red list categories; hot spots, key stone species, flag ship species; umbrella species; strategies of conservation; insitu and exsitu conservation – gene bank, cryopreservation, protected areas, wild life sanctuaries, national parks and bioserves; role of Botanic Gardens in conservation.

Suggested References:

1. Misra, R. 1968. - *Ecology Work Book*. Oxford & IBH, New Delhi.
 2. Mukherjee, B. 1996. - *Environmental biology*. Tata McGraw Hill Publ., New Delhi.
 3. Nayar, M.P. & Sastry, A.R.K. 1987, 1989, 1990. - *Red Data Book of Indian Plants* (3 vols.).
 4. Odum, E.P. (1983), *Basic Ecology*, Sanders, Philadelphia.
 5. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi.
 6. Smith, R.L. (1996), *Ecology and Field Biology*, Harper Collins, New York.
 7. Walter, K.S. & Gillett, H.J. (1998). - *IUCN Red List of threatened plants*. The World Conservation Union, Cambridge.
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ADVANCES IN PLANT BIOLOGY

Paper code: BOT2502 SP-07

Credit (3+1+0)

UNIT 1: Phytochemistry and Pharmacognosy:

L -16

Phytochemical techniques; Extraction and quantifications of Phytochemicals from medicinal plants. DNA barcoding in plants, Molecular markers in quality control and drugs evaluations,

Secondary plant products: Plant phenolics, Alkaloids- Flavonoids, Terpenoids Isolation, characterization, classification , their therapeutic potential. Plants based anticancer and antidiabetic drugs. Pharmacognosy of curcumins and Green tea catechins, Metabolic Engineering approach in plants. Phytochemicals as nutraceuticals

UNIT 2: Bioenergy and biofuel:

L-8

Plants as a source of biofuel. Biotechnology of biodiesel production with special reference to Algae and higher plants; Engineering for biofuel production in plants

UNIT 3: Advanced Plant Physiology:

L-12

Molecular physiology of seed dormancy and seed germination, Gene regulation during Photosynthesis, Photoperiodism and flower development, Fruit ripening and Senescence. Hormone signaling in plants. Effect of electromagnetic radiation in plants. Detoxification of xenobiotics in plants

L-12

UNIT 4: Nanotechnology in plant biology

Basic concept of nanotechnology: Definition and Scope, Phytosynthesis of nanoparticles, Physiological effect of nanoparticles on plants; Uptake, translocation and phytoxicity; Application of nanoparticles in agriculture. Nanoparticles as fertilizers, disease control in plants, Improvement of plant functions.

References:

- 1) Nelson, D. L. & Cox, M. M. Lehninger... *Principles of Biochemistry*. Freeman,
 - 2) Bob B Buchanan.....*Biochemistry & Molecular Biology of Plants*
 - 3) Plant Physiology ,Salisbury and Ross ,CBS Publishers and Distributors.Jain Bhawan Bholanath Nagar ,Shahadar Delhi 110032
 - 4) Lincon Taiz, Eduardo Zeiger, *Plant Physiology*.
 - 5) William J Griffiths (Editor), Stephen Neidle , *Metabolomics, Metabonomics and Metabolite Profiling*
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- 6) Ashutosh Kar, 2007, 2nd Edition Pharmacognosy and Pharmacobiotechnology
 - 7) Cesar G Fraga, (Eds) 2010, Plant Phenolics and Human Health, Wiley Publication
 - 8) Mohamed H. Al-Whaibi, (Eds), 2015, Nanotechnology and Plant Sciences, Springer
 - 9) Mahendra Rai, Clemens Posten,(Eds) , 2013, Green Biosynthesis of Nanoparticles: Mechanisms and Applications
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