DAVUNIVERSITY JALANDHAR

Course Scheme & Syllabus
For
Ph.D. CourseWork BOTANY
(Program ID-252)

1st and 2ndSEMESTER
Examinations:2018-2019

Syllabi Applicable For Admissions in 2018

Total minimum credits required for Pre Ph.D. course work Botany is 14

Scheme of Courses
Ph.D. Course Work BOTANY

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BCH801	Core	Research Methodology	4	0	0	4
2	BOT801	Core	Advanced Techniques in Plant Sciences	4	0	0	4
3	BOT802	Core	Seminar	0	0	0	2
4		Elective	Departmental Elective-I	4	0	0	4
	Total						14
Departmental Elective-I (4Cr) Choose any one theory course							
	BOT803	Elective	Phytoremediation	4	0	0	4
	BOT804	Elective	Perspectives in Plant Systematics	4	0	0	4
	BOT805	Elective	Plant Ecology & Remote Sensing	4	0	0	4
	BOT806	Elective	Fundamentals of Abiotic Stress Management in Plants	4	0	0	4
	BOT807	Elective	Resource Acquisition and Partitioning	4	0	0	4

L: Lecture T: Tutorial P: Practical Cr: Credits

Ph.D. Course Work BOTANY

Paper: Research Methodology
Code: Theory: BCH801

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:
To make the students learn how to design an experiment and what are the various research strategies.

Teaching Methodology:
Class room Lectures, practicals, models, charts, power point presentations.

Learning outcomes
This course will impart the comprehensive knowledge of designing a research experiment, how to write a research paper, the relevant ethics, copy right, impact factor etc.

UNIT-I

Biostatistics: Definition and relevance in biological research; Measures of Central Tendency: Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis.

Inferential Statistics: Hypothesis testing, Errors in Hypothesis Testing-Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance.One tailed and Two-tailed tests.

Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression. **(12 lectures)**

UNIT-II

Parametric and Non-Parametric Statistics: Definition, Advantages, Disadvantages, Assumptions; Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-Parametric Tests: Analysis of Variance, Chi square and Kendall Rank Correlation

Experimental Set-up: Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design. **(12 lectures)**

UNIT-III

Data collection, organization and interpretation.

Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings.

How to write a research paper, reference styles, process of submission of a paper; process of proof reading of a research manuscript; process of reviewing.

Important journals in life-sciences.

An introduction to Science citation index; H-index,i10 index, Impact factor calculation, Impact factor of a journal; Eigen factor, Major journal search engines.

Copyright act; Academic frauds; Plagiarism; Softwares to check plagiarism.**(12 lectures)**

UNIT-IV

Biosafety and Bioethics in Research: Guidelines for Biosafety and Bioethics; Safety practices and Bio-waste in the laboratory; Radioactivityand Safety; Fire hazards and safety; Institutional Biosafety, Ethics and Animal Ethics compliance and concerns; Genetically modified organisms; Patents and Intellectual property rights; Reproduction of published material, Citation and acknowledgement; Guidelines for Ph.D. thesis. **(12 lectures)**

References:

1. Kothari, C.R. *Research Methodology–Methodsand Techniques*. 2nd revised ed. New Delhi: New Age International (P) Ltd. Publishers, 2007. Print.
2. McKillup, S.*Statistics Explained: An Introductory Guide for Life Scientists*. Cambridge, UK: Cambridge University Press, 2006. Print.
3. Selvin, S.*Biostatistics–How it Works: First Impression*. New Delhi: Pearson EducationInc., 2007.Print.
4. Agarwal, B.L.*Basic Statistics*. New Delhi: New Age International, 2006. Print.

Ph.D. Course Work BOTANY

Paper: Advanced Techniques in Plant Sciences
Code: Theory: BOT801

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:

To acquaint the students about the various techniques used to analyze a biological system.

Teaching Methodology:

Class room lectures, practicals, models, charts, power point presentations.

Learning outcomes

This course will make the students learn the principles, procedures and uses of various bioanalytical techniques used for plant/animal analysis.

UNIT I

Chromatographic techniques: principles and applications of HPLC, Low pressure columnchromatography, Adsorption chromatography, Partition chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Affinity chromatography, Gas-liquid
chromatography. **(12 lectures)**

UNIT II

Principles and applications of molecular markers: randomly amplified polymorphic DNA, restriction fragment length polymorphism, Amplified fragment length polymorphism, Simple sequence repeats, Inverted Simple Sequence Repeats, Single Nucleotide Polymorphism, DNA Barcoding.Microarrays. **(11 lectures)**

UNIT III

Nucleic acid sequencing methods: DNA sequencing: Sanger's chain termination method, Maxam-Gilbert, Advanced methods; Shot gun sequencing; Highthroughput methods: Polony sequencing, Pyro sequencing, SOLiD sequencing, Nanoball sequencing; Sequencing by hybridization: Next gen sequencing. RNA sequencing: Non coding RNA sequencing, Direct RNA sequencing.Introduction to nucleic acid sequence databases. **(12 lectures)**

UNIT IV

Protein based techniques: Protein sequencing: Edman degradation, Protein purification: fractionation, dialysis, chromatographic techniques, SDS-PAGE, Isolectric focusing, 2-D electrophoresis, Mass spectroscopy, MALDI-TOF. Introduction to protein databases.Advanced techniques: Gene silencing: RNAi, CRISPER-Cas; Spectroscopy: Inductively coupled plasma spectroscopy; Infra red mass spectroscopy; Carbon isotope discrimination.

(14 lectures)

References:

1. Plummer, D.T. *An Introduction to Practical Biochemistry*. New Delhi: Tata McGraw Hill Publishing Ltd., 1994. Print.
2. Potter, G.W.H. *Analysis of Biomolecules: An introduction to Principles, Instrumentation and Techniques*. London: Chapman and Hall, 1995. Print.
3. Primrose, S.B.,Twyman, R.M., and Old R.W. *Principles of Gene Manipulation.* UK: Blackwell Publishers, 2001. Print.
4. Sawhney, S.K. and Singh, R. *Introductory Practical Biochemistry*. New Delhi: Narosa Publishing House, 2002.
5. Wilson, K. and Walker, J. *Principles and Techniques of Practical Biochemistry*. Cambridge: Cambridge University Press. 2000. Print.
6. Brown, T. Molecular Biology LabFax. Academic Press. 1998. Print.

Ph.D. Course Work BOTANY

Paper: Seminar
Code: BOT802

L	T	P	Credits	Max. Marks	Minimum marks
0	0	2	2	50	20

During the course students will come to know about the general understanding of the common problems and recent advances in research. Each student shall be allotted a topic by the instructor. The students shall submit a synopsis on the allotted topic, which shall be evaluated by the concerned internal faculty. Student will have to understand the topic and collect literature and present a seminar on the topic. Through this, the students will develop habit of reading newer topics, will become inquisitive and develop research aptitude.

Ph.D. Course Work BOTANY

Paper: Phytoremediation
Code: Theory: BOT803

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objectives:
The students in this course will get a good understanding of the processes involved in phytoremediation, i.e. the use of plants and their associated microbes to remediate environmental pollution.

Teaching Methodology:
Class room lectures, practicals, models, charts, power point presentations.

Learning outcomes
Students will know in some detail about the biological mechanisms involved in pollutant uptake, accumulation and transformation. The students will obtain some basic insight into plant-microbe interactions involved in phytoremediation, the effects of soil properties and environmental conditions, and risk assessment. The students will have learned to do a literature search, to design a proposal, and to make a Powerpoint presentation.

UNIT-I

Basic Physiological Processes: Basic Plant anatomy and physiology, Microbial processes, bio-catalysis, symbiosis with plant roots, plant processes, inorganic nutrition, water uptake and transpiration, photosynthetic production of phytochemicals, root exudation and root turnover, biometabolism. (9 lectures)

UNIT-II

Pollutants in environment and ecotoxicology: sources of organic and inorganic pollutants in environment, plant ecotoxicology (6 lectures)

Mechanism of Phytoremediation: Phytosequestration, Rhizodegradation, hytoextraction, Phytodegradation, Phytovolatilization, Evapotranspiration (6 lectures)

UNIT-III

Phytoremediation of inorganics: types of inorganic pollutants (heavy metals, metalloids, etc), plant uptake, translocationmechanisms for inorganics, plant accumulation, biotransformation, tolerance mechanisms for inorganics construction of a wetland for metal cleanup, genetic engineering of plant trace element metabolism. (9 lectures)

Phytoremediation of organics: types of organic pollutants, mechanisms involved in plant uptake, translocation, degradation of organics, role of plant and microbial enzymes (6 lectures)

UNIT-IV

Soil Plant Microbe Interaction:rhizoremediation, Rhizosphere Ecology, root exudates and their role in rhizosphere, quorum sensing, metal transformation, metal immobilization, degradation of organics (6 lectures)

Mycorrhizal Fungi as helping agents in "phytoremediation of degraded and contaminated soils" (5 lectures)

References:

1. Tsao, D.T. *Phytoremediation: Advances in Biochemical Engineering Biotechnology*. 151 edition, Springer. 2003

2. Todd, A.A.*Bioremediation through Rhizosphere Technology*. 15th edition, An American Chemical Society Publication. 1994.

3. Mackova, Martina,Dowling, David,Macek, Tomas. *Phytoremediation and Rhizoremediation*. Springer. 2006

Ph.D. Course Work BOTANY

Paper: Perspectives in Plant Systematics
Code: BOT804

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:
To familiarize the students about the origin, evolution and taxonomy of angiosperms.
Teaching Methodology:
Class room lectures, practicals, models, charts, power point presentations.
Learning outcomes
The students will acquire the knowledge of evolution, their systematic position, nomenclature of an organism/species.

UNIT-I

Plant Molecular Systematics: Basic concepts of Systematics, identification, description, nomenclature, classification; Taxonomic category versus taxon.Acquisition of molecular data; DNA Sequence data: Polymerase chain reaction, DNA sequence reaction, types of DNA sequence data, analysis of DNA sequence data; Restriction site analysis; Allozymes; Microsatellite DNA; Random amplified polymorphic DNA, Amplified fragment length polymorphism. (13 lectures)

UNIT-II

Methods and Principles of Biological Systematics: Phylogenetics: How are phylogeny constructed; Character, Character states and Networks; Evolutionary trees & rooting; Choosing trees, Parallelism, reversal, Maximum likelyhood method; Assessing homoplasy, consistency index and retention index; Constructing a classification, Grouping, naming and ranking of taxa. (12 lectures)

UNIT-III

Phylogenetic trees: Rooted and Unrooted trees; Gene tree, species tree, Expected and realized trees; Topological distance; Tree Building methods; Distance matrix methods: UPGMA, Least square method, Minimum evolution method, Neighbor joining method; Phylogenetic reconstruction. (11 lectures)

UNIT-IV

Sequence database and database searching: Sequence databases: Nucleic acid and protein databases, specialized sequence databases, reference database and genome databases; Search tools: Entrez, Sequence retrieval system; Database searching by sequence similarity: BLAST, FastA. (12 lectures)

References:

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., and Donoghue, M.J. *Plant Systematics: A Phylogenetic Approach*. Massachusetts: Sinauer Associates, Inc., 2002. Print.
2. Nei, M., and Kumar, S. *Molecular evolution and phylogenetics*. Oxford university press, 2000. Print.
3. Lemey, P., Salemi, M., and Vandamme, A.M. *The Phylogenetic handbook: A practical approach to phylogenetic analysis and hypothesis testing*. Cambridge University Press, 2009.
4. Simpson, M.G. *Plant Systematics*. Amsterdam: Elsevier, 2006. Print.
5. Singh, G. *Plant Systematics: Theory and Practice*. 3rded. New Delhi: Oxford & IBH Pvt. Ltd., 2012. Print.

Ph.D. Course Work BOTANY

Paper: Plant Ecology and Remote Sensing
Code: BOT805

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:
To familiarize the students about the origin, evolution and taxonomy of angiosperms.
Teaching Methodology:
Class room lectures, practicals, models, charts, power point presentations.
Learning outcomes
The students will acquire the knowledge of evolution, their systematic position, nomenclature of an organism/species.

Unit I

Concept of biosphere and biodiversity, Levels of organization, Diversity as effective number of species, Whittaker's multiplicative law of diversities, equitability and evenness of distribution of species, SHE analysis, SAR curves, species accumulation curve, directional (turnover) diversity through gradients of time (diachronic) and space (synchronic)

(11 lectures)

Unit II

Phytosociology, sampling techniques (line transect, belt transect and bisect transect, quadrat method and point methods), density, relative density, frequency, relative frequency, Raunkiaer frequency law, abundance, relative abundance, evenness, basal area, importance value index, association index and index of similarity, qualitative characteristics, life forms, biological spectrum, continuum concept of vegetation, application of ANN modeling in ecology (13 lectures)

Unit III

Remote sensing and GIS, overview of NAVIC,sensors, image characteristics, satellite characteristics, different types of resolution (spectral, radiometric, temporal and spatial), multispectral scanning, geometric distortion in imagery, image classification, false color composite, reflectance indices (NDVI, DVI, AFRI, SR, GCI, NLI etc.), correlation of different bands of Landsat data with reflectance indices and phytosociological parameters, use of remote sensing in ecology, GPS (10 lectures)

Unit IV

Diversity indices: Simpson's index, Reciprocal Simpson's index, Shannon's index, Brillouin's index, Chao's index, Menhinick's index, Pilou's index, Mclntosh diversity index, Margalef's index, Odum's index, Berger-Parker dominance index, Fisher's alpha index, Renyi index, Hill index, Whittaker's beta index, Cody beta index, Routledge's beta index, Wilson and Schmida's index, Similarity coefficients (Jaccard's, Sorensen's and Mountford's coefficients) (14 lectures)

References

1. Dombois, D.M. and Ellenberg, H. *Aims and methods of vegetation ecology*. John Wiley and Sons Inc, New York.1974.
2. Gaston, K.J. and Spicer J.I. (2004). Biodiversity: *An Introduction.* 2nd Edition. Blackwell Science Limited, U.S.A.
3. Ludwig, J.A. and Reynolds J.F. (1988). *Statistical Ecology*: *A Primer on Methods andComputing*.John Wiley & Sons, New York.
4. Thukral, A. K., Chawla, A. and Samson, M.O. (2006). *Measurement of Biodiversity*. Central Statistical Organization, Ministry of Statistics and Programme Implementation, Government of India, pp. 244-256.

Ph.D. Course Work BOTANY

Paper: Fundamentals of Abiotic Stress Management in Plants
Code: BOT806

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:
To make students conversant with the responses of plants to various abiotic stresses and role of plant growth regulators in the management of abiotic stress.

Teaching Methodology:
Class room lectures, practicals, models, charts, power point presentations.

Learning outcomes:
The students will understand the mechanisms of the responses of plants to abiotic stress factors and how plant growth regulators help in mitigating thenegative effects of these factors.

Unit I

Oxidative stress tolerance in plants: Production of ROS in plants, Enzymatic components of the ROS-scavenging pathways of plants, Cellular localization and coordination of the ROSscavenging pathways of plants, Gene annotation and expression of the ROS network in *Arabidopsis*, Key components of the reactive oxygen gene network identified by reverse genetics, ROS signal transduction pathway of plants. (15 lectures)

Unit II

Metabolomics for plant stress response: Metabolomics technology, Metabolomics data analysis and the 'plant metabolome' challenge, Combination of the omics platforms and systems biology approach, Metabolomics studies of stress in plants. (9 lectures)

Unit III

Role of plant growth regulators in abiotic stress tolerance: Role of auxins,brassinosteroids, ethylene, gibberellins,jasmonates and salicylic acid in abiotic stress tolerance.**(**Significance in general plant growth and development, brassinosteroids-mediated modulation of plant antioxidant defense system under metal/metalloid stress, temperature regimes, drought stress, salinity stress,pesticide stress).

(13 lectures)

Unit IV

Interactions/crosstalk of plant growth regulators under abiotic stress: Interaction of auxins with other hormones, interactionofcytokininswithother hormones, interaction of gibberellins withother hormones, interaction of abscisic acid withother hormones, interaction of ethylene withother hormones, interaction of jasmonic acid withother hormones, interaction

of salicylic acid withother hormones, interaction of brassinosteroidswithother hormones, interaction of polyamines withother hormones.

(11 lectures)

References:

1. Shulaev, V., Cortes, D., Miller, G. and Mittler, R. (2008). Metabolomics for plant stress response. *PhysiologiaPlantarum*, 132**(2):**199-208.
2. Mittler, R., Vanderauwera, S., Gollery, M. and Van Breusegem, F.(2004). Reactive oxygen gene network of plants. *Trends In Plant Science*, 9**(10):**490-498.
3. Choudhary, S.P., Yu, J.Q., Yamaguchi-Shinozaki, K., Shinozaki, K. and Tran, L.S.P.(2012). Benefits of brassinosteroid crosstalk. *Trends in Plant Science*, 17(10) :594-605.
4. Colebrook, E.H., Thomas, S.G., Phillips, A.L. and Hedden, P., 2014. The role of gibberellin signalling in plant responses to abiotic stress. *Journal Of Experimental Biology*, 217**(1):**67-75.
5. Kazan, K., (2015). Diverse roles of jasmonates and ethylene in abiotic stress tolerance. *Trends In Plant Science*, 20**(4):**219-229.
6. Khan, M.I.R., Fatma, M., Per, T.S., Anjum, N.A. and Khan, N.A., 2015. Salicylic acid-induced abiotic stress tolerance and underlying mechanisms in plants. *Frontiers in Plant Science, 6*:462.doi: 10.3389/fpls.2015.00462.
7. Sharma, E., Sharma, R., Borah, P., Jain, M. and Khurana, J.P. (2015). Emerging roles of auxin in abiotic stress responses. In *Elucidation of Abiotic Stress Signaling in Plants.* 299-328. Springer New York.
8. Bali, S., Poonam, Gautam, V., Kholi, S.K., Sharma, A., Kumar, V., Saini, P., Thukral, A.K. Arora, S., Ohri, P. and Bhardwaj, R. (2017). Interactions of plant hormones under abiotic stress.*Mechanisms BehindPhytohormonalSignalling and Crop Abiotic Stress Tolerance*. NOVA Science Publishers, New York,89-115.

Ph.D. Course Work BOTANY

Paper: Resource Acquisition and Partitioning
Code: BOT807

L	T	P	Credits	Max. Marks	Minimum marks
4	0	0	4	100	40

Objective:
To acquaint the students about molecular regulation of resource partitioning at cytological and molecular levels in plants.

Teaching Methodology:
Class room lectures, practical, models, charts, power point presentations.

Learning outcomes
The students will have a comprehensive knowledge about the Physiological and biochemical regulation of the processes that are necessary for sustenance of life on earth.

UNIT I

Photosynthesis: photosynthetic pigments – their biosynthesis and regulation, absorption of sunlight and transfer of excitation energy of the photons to the reaction centers, van Niel's equation, Hill equation, electron transport in photosynthetic reaction center of purple bacterium, bioenergetics of red drop and Emerson enhancement effect, photosynthetic electron transport, inhibitors of photosynthetic electron flow, regulation of energy distribution between PS I and PS II, chloroplast ATP synthesis and transport of light generated ATP from chloroplast into the cytosol. (14 lectures)

UNIT II

Biochemistry of pathways of CO_2 assimilation and its regulation in C3, C4 and CAM plants. Bioenergetics of photorespiration, chemical modulations of the toxic species produced during photorespiration. Sucrose and starch – biosynthesis; regulation of starch and sugar biosynthesis, role of fructose-2,6-bis phosphate in carbon partitioning between sucrose and starch. Storage kinetics of starch in different plant tissues. (11 lectures)

UNIT III

Transport in the phloem: directionality in phloem; cytoplasmic connections in phloem transport; phloem loading kinetics; Munch hypothesis and tall trees; speed of phloem transport; phloem unloading and distribution; concept of sink strength; introduction to PIN proteins. (12 lectures)

UNIT IV

Nutrient uptake and different proteins involved in uptake; different strategies for nutrient uptake in plants; role of protons and phytosiderophores in nutrient uptake; nutrient movement in xylem; basis of nutrient partitioning in plants. (11 lectures)

References:

1. Bonner, B., and Varner, J.E. *Plant Biochemistry*. London: Academic Press, 1976. Print.
2. Srivastava, L.M. *Plant Growth and Development*. NewYork: Associated Press, 2002. Print.
3. Stryer, L. *Biochemistry*. 5th ed. New York: W.H. Freeman and Co., 1995. Print.
4. Taiz, L., and Zeiger, E. *Plant Physiology*. California: The Benjamin/Cumming Publishing Company, 1998. Print.
5. Voet, D. and Voet, J.G. *Biochemistry*. New York: John Wiley and Sons Inc., 1995. Print.
6. Wilkins, M.B. *Advanced Plant Physiology*. New York: Pitman, 1984. Print.
7. Buchanan, B.B., Gruissem, W. and Jones, R.L. *Biochemistry and Molecular Biology of Plants*. India: I K Internationals, 2005. Print.
8. Heldt, H.W. *Plant Biochemistry*. California: Elsevier, 2005. Print.