UNIVERSITY OF DELHI

REVISED SYLLABUS

FOR

M. Phil. Program in Botany
(Semester system)

Syllabus applicable for students seeking admission to

M.Phil. Program in Botany

w.e.f. 2017-18 academic session

DEPARTMENT OF BOTANY

FACULTY OF SCIENCE

UNIVERSITY OF DELHI

DELHI – 110007.

University of Delhi
Examination Branch

Date : September 14, 2017

Course : M.Phil. course work - Botany

Check List of New Course Evaluation for AC Consideration

S.No.	Parameters	Status
1	Affiliation	
2	Programme Structure	
3	Codification of Papers	
4	Scheme of Examinations	
5	Pass Percentage	
6	Promotion Criteria	
7	Division Criteria	
8	Qualifying Papers	
9	Span Period	
10	Attendance Requirements	
11	Course content for each paper	
12	List of Readings	

MASTER OF PHILOSOPHY
(BOTANY)

FULL-TIME PROGRAMME

RULES, REGULATIONS AND COURSE CONTENTS

Department of Botany

FACULTY OF SCIENCE

UNIVERSITY OF DELHI

DELHI – 110007

2017

MASTER OF PHILOSOPHY

(BOTANY)

FULL-TIME PROGRAMME

AFFILIATION

The proposed programmes shall be governed by the Department of Botany, Faculty of Science, University of Delhi, Delhi – 110007.

PROGRAMME STRUCTURE

The M.Phil. Programme is divided into two Parts as under. Each part will consist of one Semester as given below.

Part I	Semester – 1
Part II	Semester – 2

Semester I would consist of 12 credit courses. Semesters I (Part I) would have Core Units to be studied compulsorily by all students of the M.Phil. Botany programme, and Elective Units from which each student would have to select **Eight** units of his/her choice. Semester II would consist of 12 credit course which is in the form of Dissertation based on original research conducted by the student and viva-voce examination.

The schedule of papers prescribed for various semesters shall be as follows:

I. SEMESTER I
RM 01 Research Methodology - Introduction to scientific practice
RM 02 Research Methodology - Statistics for Biologists
RM 03 Research Methodology - Science writing
RM 04 Research Methodology - Online Tools and Presentation Skills

ELECTIVE UNITS (SEMESTER I)**

II. SEMESTER I *Eight Units from 1 – 20 are to be selected.*
EL 01 Bryophyte Diversity and Evolution
EL 02 Community and Ecosystem Ecology
EL 03 Comparative Genomics
EL 04 Developmental Biology
EL 05 Functional Plant Structure
EL 06 Genetic Markers and Mapping
EL 07 Integrative Plant Biology
EL 08 Interactions of Plants with Pathogens, Pests and Symbionts
EL 09 Landscape Ecology
EL 10 Lipid Biochemistry and metabolism

EL 11 Photosynthetic responses to abiotic stresses in plants
EL 12 Phylogenetic Biology
EL 13 Plant Growth Regulators
EL 14 Plant Metabolic Engineering
EL 15 Plant Systematics
EL 16 Population Ecology
EL 17 Proteomics
EL 18 Nano-Biotechnology
EL 19 Redox Physiology
EL 20 Regulation of Gene Expression during Plant Growth and Development

III. SEMESTER II
DE 01 Dissertation and Viva-Voce examination

SCHEME OF EXAMINATIONS

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by the University of Delhi.
3. Each unit will be for 25 marks (1 credit). Research Methodology (Units RM 1 to 4) is mandatory for all and candidates can choose any eight units from the available electives (Units EL 1 to 20).

4. The system of evaluation shall be as follows:

4.1 Assessment of the Practical component would include continuous evaluation and an end-semester examination. These criteria are tentatitive and could be modified based on guidelines approved by the Academic Council.

4.2 The scheme of evaluation of the Dissertation shall be as follows:

4.2.1 The dissertation topic would be assigned at the end of Semester I to enable students to initiate work on the same.

4.2.2 The dissertation component would be evaluated for 200 marks.

4.2.3 There shall be a viva-voce examination on the topic of Dissertation and shall be evaluated for 100 marks.

PASS PERCENTAGE

Minimum marks for passing the examination in each module shall be 55%.

A candidate who has not secured the minimum marks to pass in each module may reappear in the relevant paper/s in the next semester. No student would

be allowed to avail of more than 2 chances to pass a paper inclusive of the first attempt.

PROMOTION CRITERIA

Students shall be required to fulfill the Credit score requirement. All students fulfilling the credit requirements will be promoted to semester II. A student who fulfills the credit score of 7 out of 10 CGPA is eligible for switching over to Ph.D. if there are vacancies and need not submit his/her dissertation and his/her registration will be transferred to Ph.D. list from M.Phil. list.

DIVISION CRITERIA

Successful candidates will be classified on the basis of results of examination as follows:

Candidates securing 60.00% and above	:	Ist Division
Candidates securing between 55.00% and 59.99%	:	IInd Division
All others	:	Fail

QUALIFYING PAPERS

None

SPAN PERIOD

Students are required to clear all modules within one year (first two semesters) from the date of admission.

ATTENDANCE REQUIREMENT

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head of the Department of Botany, University of Delhi, to have attended 75% of the total number of lectures and seminars conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions, the Head, Department of Botany, may permit a student to the next Semester who falls short of the required percentage of attendance by not more than 10% of the lectures and seminars conducted during the Semester.

COURSE CONTENT FOR EACH COURSE

Submitted as annexure

LIST OF READINGS

Will be assigned as appropriate

REVISED COURSE STRUCTURE FOR M.Phil – BOTANY, DEPARTMENT OF BOTANY, UNIVERSITY OF DELHI, DELHI - 110007 (20017-18 onwards)

CORE UNITS (SEMESTER I)*

I.	SEMESTER I	Page	Unit Code
1.	Research Methodology - **Introduction to Scientific Practice**	*3*	RM 01
2.	Research Methodology - **Statistics for Biologists**	*3*	RM 02
3.	Research Methodology - **Science Writing**	*3*	RM 03
4.	Research Methodology - **Online Tools and Presentation Skills**	*4*	RM 04

ELECTIVE UNITS (SEMESTER I)**

II.	SEMESTER I *Eight Units from 1 – 20 are to be selected.*		
1.	**Bryophyte Diversity and Evolution**	*4*	EL 01
2.	**Community and Ecosystem Ecology**	*4*	EL 02
3.	**Comparative Genomics**	*5*	EL 03
4.	**Developmental Biology**	*5*	EL 04
5.	**Functional Plant Structure**	*5*	EL 05
6.	**Genetic Markers and Mapping**	*6*	EL 06
7.	**Integrative Plant Biology**	*6*	EL 07
8.	**Interactions of Plants with Pathogens, Pests and Symbionts**	*6*	EL 08
9.	**Landscape Ecology**	**7**	EL 09
10.	**Lipid Biochemistry and Metabolism**	**7**	**EL 10**
11.	**Photosynthetic Responses to Abiotic Stresses in Plants**	7	EL 11
12.	**Phylogenetic Biology**	**8**	**EL 12**
13.	**Plant Growth Regulators**	**8**	**EL 13**
14.	**Plant Metabolic Engineering**	**8**	**EL 14**
15.	**Plant Systematics**	**8**	**EL 15**
16.	**Population Ecology**	**9**	**EL 16**
17.	**Proteomics**	**9**	**EL 17**
18.	**Nano-Biotechnology**	**9**	EL 18
19.	**Redox Physiology**	**10**	**EL 19**
20.	**Regulation of Eukaryotic Gene Expression**	**10**	**EL 20**

* *: Core units are mandatory for all.*

**: *Elective units will be offered as per the availability of faculty and sufficient minimum strength of students. The Ordinance VI of University of Delhi allows the students of the flexibility to choose credit courses offered by other sister departments. Similarly students of other sister departments also can opt for the electives that are available from the Department.*

Each unit is of 1 credit with 7 hrs of Theory and 8 hrs of Tutorials/ Practicals/Seminars/Instrumentation.

DISSERTATION AND VIVA VOCE (SEMESTER II)***

II.	SEMESTER II	
	Dissertation and Viva-Voce examination	**DE 01**

***** Dissertation and viva-voce examination will be for 12 credits of which 8 credits will be for dissertation and 4 credits for viva-voce examination**

M.Phil./Ph.D. Course work contents

Each module (1 credit) will be a stand-alone unit
Each module equals 1 credit = 15 (7+8) hours (7 hours of lectures + 8 hours of tutorials/ instrumentation; practicals, projects and assignments that can be internally evaluated)
PhD and MPhil students will take 12 course credits
Research Methodology (RM1-4) are compulsory for all
Electives A-H will be based on students' options elected from those available from the 20 units (EL 1-20)

Sem I	**credits**	**MPhil**	**PhD**
RM 1	1	X	X
RM 2	1	X	X
RM 3	1	X	X
RM 4	1	X	X
Elective A	1	X	X
Elective B	1	X	X
Elective C	1	X	X
Elective D	1	X	X
Elective E	1	X	X
Elective F	1	X	X
Elective G	1	X	X
Elective H	1	X	X
Total		12	12

Sem II	**credits**	**MPhil**	**PhD**
MPhil Thesis and viva voce examination	12	X	-
PhD Confirmation Seminar (including literature review and thesis proposal)	0	-	X

Module No.	Module Name
RM 1	Introduction to Scientific Practice
RM 2	Statistics for Biologists
RM 3	Science Writing
RM 4	Online Tools and Presentation Skills
EL 1	Bryophyte Diversity and Evolution
EL 2	Community and Ecosystem Ecology
EL 3	Comparative Genomics
EL 4	Developmental Biology
EL 5	Functional Plant Structure
EL 6	Genetic Markers and Mapping
EL 7	Integrative Plant Biology
EL 8	Interactions of Plants with Pathogens, Pests and Symbionts
EL 9	Landscape Ecology
EL 10	Lipid Biochemistry and Metabolism
EL 11	Photosynthetic Responses to Abiotic Stresses in Plants
EL 12	Phylogenetic Biology
EL 13	Plant Growth regulators
EL 14	Plant Metabolic Engineering
EL 15	Plant Systematics
EL 16	Population Ecology
EL 17	Proteomics
EL 18	Nano-Biotechnology
EL 19	Redox Physiology
EL 20	Regulation of Eukaryotic Gene Expression

RM 1. Introduction to Scientific Practice: This module will introduce research scholars to the theory and practice of scientific methods

Theory
Scientific method: Introduction to the philosophy and practise of science. **Research ethics**: Falsification and fabrication of data, Plagiarism, IPR, Biological collections -The Convention on Biological Diversity (1992), Biodiversity Act (2002), National Biodiversity Authority, guidelines for biological collections. **Databases** and their responsible use: NCBI, Biodiversity databases. **Safety in the Laboratory**: Chemical safety, wastes and disposal. Biological waste, transgenics. Radioactive materials, safe use and disposal.

Practicals
Discussion, demonstration, exercises to evaluate familiarity with basic procedures/protocols.

RM 2. Statistics for Biologists: This module will help students to apply biostatistical concepts to design experiments, analyse, interpret and present data.

Theory
Introduction: Distributions, summary statistics, sample and population, measures of central tendency, measures of dispersion and variability. Hypothesis testing: One sample, two sample, paired sample and multiple sample hypothesis. Regression and correlation: Simple linear and multiple regression, significance of p, coefficient of determination and correlation coefficient. Use of t-test, chi-square test and F-statistics, Analysis of Variance (ANOVA). Experimental design: Understanding research question, sampling techniques.

Practicals
Exercises based on theory.

RM 3. Science Writing: This module will introduce students to appropriate practices in writing scientific documents.

Theory
Students would be given basic instructions on the "do's" and "don'ts" of general as well as scientific writing. This would include use of correct grammar, punctuation, sentence structure, use of present/past tense. etc. The students would be taught about précis writing and editing a scientific document for linguistic, grammatical, and punctuation errors.

Practicals
Practicals would include exercises such as (i) description of a general figure and (ii) Description and analysis of scientific data (iii) Writing the précis of a scientific document (iv) Correction of a scientific document for linguistic, grammatical, and punctuation errors.

RM 4: Online Tools and Presentation Skills: This module is designed to familiarize students with diverse writing tools online, and to train them in effective oral scientific communication.

Theory
Online tools meant for citation, correct usage of technical language and scientific peer network, and presentations will be discussed. **Presentation skills**: Effective oral scientific communication to specialized audiences, including peer groups, as well as general audiences such as students, the general population and policy makers.

Practicals
Exercises based on theory, Presentation skills

EL 1. Bryophyte Diversity and Evolution: This module will give students a comprehensive view of bryophytes and their diversity in structure, function and ecology.

Theory
Phylogenetic tree of land plants: Evolutionary relationships of major land plant groups, origin of bryophytes. **Evolution of traits**: Characteristic traits of land plants and bryophytes. Structure, breeding systems and ecological adaptations. **Classification** of bryophytes. **Sampling methods** in collection and ecological studies of bryophytes. Mosses as model organisms. **Monitoring pollution** using bryophytes.

Practicals
Exercises based on theory

EL 2. Community and Ecosystem Ecology: This module will give students an understanding of species interactions at the community levels and their role in shaping of ecological niches, use of diversity indices, and understanding of ecosystem structure and functions.

Theory
Niche and Succession theory: Fundamentals of niche concept, Ecological niche differentiation and modelling, Ecological succession and environmental factors. Coevolution and symbiosis, prey-predator interactions. **Mathematical indices in community study**: Diversity indices & community assessment. **Methodological developments in assessment of structure and function of ecosystems**: framework for assessment and mapping of ecosystem health and services, plant defence mechanism, island biogeography. **Models in ecosystem ecology**: Use of mathematical models in ecosystem function analysis.

Practicals
Exercises in laboratory analysis and theoretical analysis of ecological models

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EL 3. Comparative Genomics: This module will introduce students to broad patterns of genome evolution, analysis of genomes through synteny analyses and introduction to comparative genomics.

Theory
Genome evolution:Trends and patterns, Evolutionary implications of genome size, polyploidy, whole genome duplications and genome rearrangements. Genes and their differentiation through neofunctionalization. Approaches to establish micro- and macro-synteny: Tools and techniques for whole genome comparison, Comparative genomics of selected families, Genome browsers. Applications of comparative genomics: Structural and functional annotation of genes, building ancestral genome karyotype, deciphering plant evolutionary history.

Practicals
Exercises based on theory.

EL 4. Developmental Biology: This module will familiarize scholars with diverse approaches that help understand mechanisms of development during various stages of the life cycle. Introduction to developmental staging and phenotyping will assist research scholars in standardizing and designing systematic investigations of plant systems.

Theory
Developmental staging of plant organs. Pollen-Pistil Interactions. **Agamospermy:** Apomeiosis, Parthenogenesis, Autonomous & pseudogamous endosperm development. **Zygotic embryogenesis** - Maternal to Zygotic Transition, Cell Polarity, Patterning. **Phenomics**: Plant phenotyping technologies, Plant growth analysis, Phenomic tools, Imaging and Image analysis, Applications of modelling to plant phenotyping. **Molecular genetics of plant development**: Approaches to study plant development, generation of Mutants - Random mutagenesis, random Insertional mutagenesis, genome-wide mutagenesis, targeted mutagenesis, T-DNA based, transposon based, RNAi / artificial miRNA based, CRISPR-Cas based genome editing. Analysis of Mutants and case studies: Mutants of leaf development, shoot development, root development, flower and fruit development.

Practicals
Microtomy, Microscopy, Tutorials and assignments based on theory

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EL 5. Functional Plant Structure: This module will examine variation in the plant form (morphological, anatomical, other phenotypic) in relation to function.

Theory
Plant morphology and internal structure, quantitative description (morphometrics). Developmental origin of plant organs, morphospace and constraints on variation. Developmental, biomechanical and comparative evolutionary analysis of structural diversity. Functional traits: physiological and ecological implications of variation in form, adaptations. Significance of plant functional traits in community and ecosystem ecology.

Practicals
Exercises based on theory.

EL 6. Genetic Markers and Mapping: This module will deal with recent advances in molecular markers and their uses in mapping and analysis of association with traits.

Theory
Recent developments in molecular markers: Approaches for developing high throughput marker systems with emphasis on SNPs and microsatellites. Considerations for developing markers. Methods for genotyping. **Maps and their relation to genome**: Establishing relationships between physical maps, genetic maps and genome sequences. **Analyzing marker trait association**: Methods to analyze marker trait association with emphasis on association mapping and genomic selection.

Practicals
Exercises based on theory.

EL 7. Integrative Plant Biology: This module will address a single topic from diverse levels of biological organization and processes--molecular, biochemical, cellular, organismal, community, ecosystem, physiological, developmental, ecological, genetic, phylogenetic, evolutionary--to give students a grasp of issues related to integrating understanding across disciplines.

Theory
Specific topics will vary from year to year and will be decided by the set of teachers who will offer the course that year. This topic will be addressed from diverse levels of biological organization and processes--molecular, biochemical, cellular, organismal, community, ecosystem, physiological, developmental, ecological, genetic, phylogenetic, evolutionary.

Practical
Exercises based on theory.

EL 8. Interactions of Plants with Pathogens, Pests and Symbionts: This module will introduce basic concepts in interactions of plants with their pathogens, pests and symbionts, as well methods of study.

Theory
Plant-pathogen/pest interactions part I: Theories of Plant defense. **Plant-pathogen/pest/symbiont interactions part II**: Biochemical and molecular mechanisms (molecular patterns, innate immunity, induced defense responses). **Management and control of pathogens and pests**: Natural and engineered methods (case studies). Introduction to methods in study of selected plant pathogens and pests.

Practicals
Exercises based on theory.

EL 9. Landscape Ecology: This module will discuss the importance of spatial and temporal patterns in ecological processes and basic ways to measure these patterns.

Theory

Basics of landscape ecology: Spatial and temporal pattern and their relationship to ecological processes and changes, habitat loss and fragmentation, landscape design, habitat corridor, ecosystem management. **Landscape metrics**: landscape pattern, spatial pattern and metrics. Fundamentals of GIS & RS technology applications in Landscape ecology. Ecological models in Landscape ecology.

Practicals

Exercises based on theory.

EL 10. Lipid Biochemistry and Metabolism: This module will deal with biosynthesis of various fatty acids and their incorporation into different forms of lipids such as membrane lipids or storage lipids. It will also deal with techniques applied for analyses of various plant lipids through separation, identification, and characterization.

Theory

Overview: functions of various lipid classes. Lipids act as energy reserve, form membranes and also act as signalling molecule under various stresses. Biosynthesis and function of these classes of lipids will be studied. **Separation and analysis of lipid classes:** Isolation of total lipids, and further separation into various phospholipids and galactolipids through chromatography. **Analyses of oil and fatty acids**, chemical analysis and quantification. **Understanding molecular diversity** of lipid classes and positional distribution of fatty acids.

Practicals

Practicals/ demonstrations based on theory.

EL 11. Photosynthetic Responses to Abiotic Stresses in Plants: This module will examine the effects of abiotic stresses on photosynthetic processes in plants.

Theory

Photosynthetic electron transport chain, photophosphorylation, PSI and PSII, inhibitors of photosynthetic electron transport chain: effective herbicides, chlorophyll fluorescence (Fv/Fm), leaf gas exchanges by stomata and their associated parameters, CO2 assimilation mechanism in plants (C3, C4 and CAM pathway/photosynthesis), energetics of the C3 cycle, photorespiration.

Practicals

Practicals/ demonstrations based on the theory.

EL 12. Phylogenetic Biology: This module will give an overview of comparative biology in a phylogenetic context. This module will equip students with basic theoretical and practical skills (phylogenetic analysis software) to tackle analysis of cross-species data.

Theory
Basics of evolutionary biology: Evolution of populations, Speciation. Estimating Phylogenetic Trees: Trees and tree-thinking, Morphological data and Maximum Parsimony, Molecular data and Maximum Likelihood, Bayesian methods. Using Phylogenetic Trees in Taxonomy, Biogeography, Divergence times, Character evolution, Ecology, Comparative phylogenetic methods.

Practicals
Application of theoretical concepts using software for phylogenetic and comparative analysis.

EL 13. Plant Growth Regulators: This module will discuss plant growth regulators, particularly novel ones, and their roles in tolerance to abiotic stresses.

Theory
Hormonal regulation of abiotic stress tolerance. Novel plant growth regulators: current scenario.

Practicals
Instrumentation and exercises based on theory.

EL 14. Plant Metabolic Engineering: This module will introduce basic concepts of plant metabolic engineering, and technical approaches for achieving this.

Theory
Introduction to plant metabolic engineering and plant secondary metabolites and their biosynthetic pathways. **Tools and techniques** employed during metabolic engineering: (a) **Principles of genetic transformation** (gene isolation, vector construction, transformation, cloning and expression analysis). (b) **Scaling up/elicitation of bioactive compounds** (elicitors, hairy root culture, cell suspension culture, bioreactor, etc.). **Applications**: case studies (Pharmaceutical, Nutraceutical and Bio-fuel industry). **Methods for identification and analysis of plant secondary metabolites** and their bioefficacy study.

Practicals
Practicals, demonstration of instruments based on theory

EL 15. Plant Systematics: This module will introduce basic principles of plant nomenclature, classification, typification, identification and modern methods in plant systematics

Theory
Plant systematics: Definitions. Importance of systematics in society. Plant Classification: Natural to APG IV. Plant nomenclature: Principles of Nomenclature, scientific vs. common names, Typification and Nomenclatural types. Plant identification: Methods of plant identification, Taxonomic keys. Taxonomic Data Sources. Molecular systematics: Molecular markers, Phylogenetic analysis, Molecular systematics of selected taxa: Case studies. DNA Barcoding. Herbaria and Botanic Gardens.

Practicals
Practicals based on theory. Field visit.

EL 16. Population Ecology: This module will appraise the characteristic features of populations and their dynamics in relation to environmental factors influencing them.

Theory
Basics of population ecology: concepts, age structure in plant populations, population dynamics, density dependent and independent population regulations, life history strategies, metapopulation concept. Population metrics: age specific mortality and fecundity matrix models. Population biology of invasive species, population dynamics in conservation biology. Case studies on population dynamics of annuals, biennials and perennial species. Introduction to population genetic theories. Application of molecular tools in differentiation of population and identification of parent offspring relationships.

Practicals
Exercises based on theory.

EL 17. Proteomics: This module will give students a grasp of different methods used for identification of differentially expressed proteins and post-translational modifications.

Theory
Differential proteomics with examples from published work. Advances/modifications in 2D gel electrophoresis to derive useful information. Detecting PTMs using proteomics, Nanoproteomics.

Practicals
Exercises based on theory.

EL 18. Nano-Biotechnology: This module will introduce student to the exciting new area of nanobiotechnology with particular emphasis on green nanotechnology and agriculture nanotechnology.

Theory
Nano biotechnology in plant sciences & agriculture. Green synthesis of nanoparticles –basis/ toxicity, in vitro and in vivo. Applications in medicine /agriculture/biosensors. Nano-bionics, Application of nano bionics to modify plant systems as sensors and better producers.

Practicals
Practicals, seminars and tutorials based on theory. Instrumentation.

EL 19. Redox Physiology: Redox changes and redox modifications are the major physiological regulatory mechanisms during normal growth and development as well as during stress. These mechanisms and their physiological significance would be detailed under this module.

Theory
Abiotic stress signal transduction pathways. Reactive oxygen species- production, anti-oxidative mechanisms, physiological implications. Nitric oxide as a signaling molecule in stress and normal growth and development. PTMs of Nitric oxide. ROS-NO crosstalk.

Practicals
Practicals, Seminars, Tutorials based on theory.

EL 20. Regulation of Eukaryotic Gene Expression: This module will familiarize students with molecular mechanisms of gene expression regulation and tools for analysis of gene expression.

Theory
Overview of tools to study gene expression. Transcriptome analysis using next generation sequencing platforms. Regulation of gene expression by microRNAs with selected case studies from plant biology. Regulation of cell cycle at molecular level with special emphasis on: 1) Cyclin-dependent kinase complexes, 2) Cytoskeleton. Hormonal regulation of gene expression: case study of auxins and strigolactones.

Practicals
Exercises based on theory.
