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UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC2(S)/55/2024-25 Dated: 20.07.2024

Notification

Sub:- Modification of Syllabus and Scheme of Examinations of Botany (PG) programme from the Academic year 2024-25.

Ref:-1. Decision of Board of Studies in Botany (CB) meeting held on 07-06-2024.
2. Decision of the Faculty of Science & Technology meeting held on 19-06-2024.
3. Decision of the Academic Council meeting held on 28-06-2024.

*****

The Board of Studies in Botany (CB) which met on 07-06-2024 has resolved to recommend & approved the modified Syllabus and Scheme of examinations of Botany (PG) programme from the Academic year 2024-25.

The Faculty of Science & Technology and Academic Council at their meetings held on 19-06-2024 and 28-06-2024 respectively has also approved the above said modified Syllabus and Scheme of examinations hence it is hereby notified.

The Syllabus and Scheme of Examinations content may be downloaded from the University Website i.e., www.uni-mysore.ac.in.

Registrar

Registrar
University of Mysore
Mysore

To;

1. The Registrar (Evaluation), University of Mysore, Mysuru.
2. The Chairman, BOS/DOS in Botany, Manasagangothri, Mysore.
3. The Dean, Faculty of Science & Technology, DOS in Mathematics, MGM.
4. The Director, Distance Education Programme, Moulya Bhavan, Manasagangothri, Mysore.
5. The Director, PMEB, Manasagangothri, Mysore.
6. Director, College Development Council , Manasagangothri, Mysore.
7. The Deputy Registrar/Assistant Registrar/Superintendent, Administrative Branch and Examination Branch, University of Mysore, Mysuru.
8. The PA to Vice-Chancellor/ Registrar/ Registrar (Evaluation), University of Mysore, Mysuru.
9. Office Copy.

University of Mysore

M.Sc., Botany Choice - Based Credit System (CBCS) Syllabus
(CBCS-CGP) (2024-25)
CORE SUBJECT: BOTANY – [POST GRADUATE] M Sc. BOTANY DEGREE

Programme Details

Name of the Department	**:**	**Department of Studies in Botany**
Subject	**:**	**Botany**
Faculty	**:**	**Science and Technology**
Name of the Course	**:**	**Master of Botany (M.Sc.)**
Duration of the Course	**:**	**2 years – divided into 4 semesters**

Programme Outcome

- The Post-Graduate Program has been designed to benefit all students who love plant science. It allows them to study the theory and practical aspects of plant biology, including its applications in different areas of science. The program also prepares them for broader areas of research and extension in basic and applied areas of plant biology.

- Emphasis is given to students for understanding theoretical and practical knowledge through a number of hard/soft core courses. These are delivered through lectures, interactive tutorials, and lab/field-oriented practical sessions. Upon completion of the program, students will be able to undertake independent teaching, research, and extension activities in institutes of higher learning. The program aims to provide guidance and, where appropriate, the facilities to allow students to develop a number of skills in plant science.

- Students are trained/groomed to either take up an academic career in undergraduate colleges or universities or to pursue research work in universities or research institutes. They can also take up scientific careers in various organizations as plant taxonomists, medicinal botanists, plant pathologists, weed biologists, conservation specialists, scientists, plant geneticists, biotechnologists, agriculturists/horticulturists, curators, etc.

- Furthermore, the program curriculum is also designed and regularly updated to cater to the needs of aspiring students who wish to write national level administrative exams viz., CSIR/UGC- NET, K-SET, ICAR, GATE, ICMR, IAS, IFS, KAS, etc.

- The program has also been designed to establish links with industry, agriculture (crop science, plant breeding, plant pathology, crop physiology, and Ayurvedic research organizations). Placements are also provided depending on the availability of supervisors and a research project.

Programme Specific Outcome:

After successful completion of two year degree program in Botany, a student will be able to;

1. Identify and classify all plant groups from algae to angiosperms, also understand the evolutionary relationship and their taxonomic aspects.
2. Know the concept, process, physiology, and molecular basis of plant development.
3. Know the methods of cultivation & economic importance of various species, millets, leguminous plants, fruits, essential oils, vegetables, etc.
4. Understand economically important algae, their cultivation, and applications. Also, understand the methods of preparation and application of algal products.
5. Understand the application of biopesticides; know about sources, methods, and production of biofuel.
6. Acquire knowledge of fermentation technology and production of fermented products.
7. Gain knowledge about seed structure development, chemical composition, seed production, processing, seed testing, quality control, seed certification, and new hybrid variety.
8. Learn the basic biostatistics, experimental statistics, and bioinformatics.
9. Understand plant - organism interaction.
10. Inculcate the scientific temperament in the students and outside the scientific community.

Scheme of Examination and Details of Course Patterns for M.Sc. Degree Course (CBCS)

FIRST SEMESTER					**Credits: 20**
Sl. No.	**Course/ Paper Code**	**Title of the Course/ Paper**	**Hrs/Week L:T:P**	**Credits**	**Total Credits**
1	H C 1.1	Virology, Bacteriology, Mycology and Plant Pathology	2:2:0	2:1:0	3
2	H C 1.2	Phycology, Bryophytes, Pteridophytes and Gymnosperms	2:2:0	2:1:0	3
3	H C 1.3	Systematics of Angiosperms	2:2:0	2:1:0	3
4	H C 1.4	Practical – I (Based on HC 1.1, 1.2, 1.3 Courses)	0:0:6	0:0:3	3
5	S C 1.1**	Fungal Biology and Biotechnology	2:2:0	2:1:0	3
6	S C 1.2**	Algal Biology and Biotechnology	2:2:0	2:1:0	3
7	S C 1.3**	Lichenology and Mycorrhizal Technology	2:2:0	2:1:0	3
8	S C 1.4**	Phytopathology	2:2:0	2:1:0	3
9	S C 1.5	Practical – II (Based on 2 Soft Core Courses)	0:0:4	0:0:2	2
*Field Study/Tour: The student shall undertake a field trip for a minimum of 2-3 days and shallsubmit the herbaria and tour report for evaluation. **Any two soft core courses shall be studied. H C = Hard Core; SC = Soft Core, OE = Open Elective					

SECOND SEMESTER					**Credits: 20**
Sl. No.	Course/ Paper Code	Title of the Course / Paper	Hrs/Week L:T:P	Credits	Total Credits
1	H C 2.1	Reproductive Biology of Angiosperms and Plant Morphogenesis	2:2:0	2:1:0	3
2	H C 2.2	Cell Biology and Genetics	2:2:0	2:1:0	3
3	H C 2.3	Plant Breeding and Evolutionary Biology	2:2:0	2:1:0	3
4	H C 2.4	Practical – III (Based on H C 2.1, 2.2, and 2.3 Courses)	0:0:6	0:0:3	3
5	S C 2.1*	Plant Anatomy and Histochemistry	2:2:0	2:1:0	3
6	S C 2.2*	Ethno-Botany and Intellectual Property Rights (IPR)	2:2:0	2:1:0	3
7	S C 2.3*	Economic Botany	2:2:0	2:1:0	3
8	S C 2.4	Practical IV – (Based on any 2 Soft Core Courses)	0:0:4	0:0:2	2
9	O E 2.1	Medicinal Plants	2:2:0	2:2:0	4
	** Any two soft core courses shall be studied. HC = Hard Core; S C = Soft Core, O E = Open Elective				

THIRD SEMESTER					Credits: 16
Sl. No.	Course/PaperCode	Title of the Course /Paper	Hrs/Week L:T:P	Credits	Total Credits
1	H C 3.1	Biochemistry and Plant Physiology	2:2:0	2:1:0	3
2	H C 3.2	Molecular Biology	2:2:0	2:1:0	3
3	H C 3.3	Plant Biotechnology	2:2:0	2:1:0	3
4	H C 3.4	Practical – V (Based on H C 3.1, 3.2, 3.3 and 1 Soft Core Courses)	0:0:8	0:0:4	4
5	S C 3.1*	Molecular Genetics of Plants	2:2:0	2:1:0	3
6	S C 3.2*	Molecular Plant Pathology	2:2:0	2:1:0	3
7	S C 3.3*	Plant Propagation and Plant Breeding	2:2:0	2:1:0	3
8	S C 3.4*	Phyto - chemistry Herbal Drug Technology	2:2:0	2:1:0	3
9	O E 3.1	Plant Propagation Techniques	2:2:0	2:2:0	4
	* Any one soft core course/paper shall be studied. H C = Hard Core; S C = Soft Core, O E = Open Elective				

FOURTH SEMESTER					Credits: 16
Sl. No.	Course Course/Paper Code	Title of the Course /Paper	Hrs/Week L:T:P	Credits	Total Credits
1	H C 4.1	Ecology, Conservation Biology and Phytogeography	2:2:0	2:1:0	3
	H C 4.2	Seed Technology	2:2:0	2:1:0	3
2	H C 4.3	Practical – VI (Based on H C 4.1 and 4.2 Courses)	0:0:4	0:0:2	2
3	S C 4.1*	Seed Pathology	2:2:0	2:1:0	3
4	S C 4.2*	Bio -Analytical Techniques	2:2:0	2:1:0	3
5	S C 4.3*	Plant Genetic Engineering	2:2:0	2:1:0	3
6	S C 4.4	Practical – VII (Based on 2 Soft Core Courses)	0:0:4	0:0:2	2
7	H C 4.2*	Project Work	0:0:16	0:0:8	8
8	O E 4.1	Plant Diversity and Human Welfare	2:2:0	2:2:0	4
	*The student shall study two soft core courses or in lieu of two soft core courses a project work shall be undertaken in the Department or in any other University or Institute under the guidance of a Research Supervisor and shall submit a Project Report duly signed by Student, Research Supervisor and Chairperson for Evaluation. The candidate is also required to present her/ his research findings by PPT before the Assessment Committee and shall attend the Viva- Voce Examination. H C = Hard Core; S C = Soft Core; O E = Open Elective				

Semester- Wise Credit Pattern

I Semester = 20 (HC- 12 + SC-08)
II Semester = 20 (HC- 12 + SC-08)
III Semester = 16 (HC- 13 + SC-03)
IV Semester = 16 (HC- 08 + SC-08)

Total Hard Core credits to be earned by the students = 45 (Max. 56)
Total Soft Core credits to be earned by the students =27 (Mini. 16) Student has to earn
minimum 4 credits from open Electives = 04
Total number of credits required for qualifying M.Sc. Botany = 76

UNIVERSITY OF MYSORE

SCHEME OF EXAMINATION/ASSESSMENT MODEL QUESTION PAPER (THEORY)

M.Sc., Degree------ Semester Examination May/June-20--

BOTANY

Course/Paper: ……

Course/Paper Code……..

Time: 3 Hrs **Max Marks: 70**

Instructions: 1) Answer all questions.
2) Draw neat and labelled diagrams wherever necessary.

I. Answer the following; (10MCQs of 1 Mark each) **10 X 1 = 10**

2 from Unit I; 3 from Unit II; 2 from Unit III; 3 from Unit IV

II. Answer the following; **4 X 5 = 20**

2 from Unit I with internal choice 2 from Unit II with internal choice 2 from Unit III with internal choice2 from Unit IV with internal choice

III. Answer the following; **4 X10 = 40**

2 from Unit I with internal choice 2 from Unit II with internal choice 2 from Unit III with internal choice2 from Unit IV with internal choice

UNIVERSITY OF MYSORE

SCHEME OF PRACTICAL EXAMINATION/ASSESSMENT

MODEL QUESTION PAPER (FOR HARD CORE PRACTICALS)

M.Sc., Degree I Semester Examination

BOTANY

Course/Paper: ……
Course/Paper Code…….

Time: 3 Hrs **Max Marks: 70**

Q I. Conducting Experiments/ Micro-preparation/ Plant identification (A, B and C)	15
Q II. Minor experiment/ Demonstrations/ Procedure Writing (D, E and F)	15
Q III. Critically comment on (3x5 Marks) (G, H and I)	15
Q IV. Identification (6 x 2.5 Marks) (J, K and L)	15
Q V. Viva-voce examination	05
Q VI. Class Records/ Submissions/ Tour Report	05

UNIVERSITY OF MYSORE

SCHEME OF PRACTICAL EXAMINATION/ASSESSMENT

MODEL QUESTION PAPER (FOR SOFT CORE PRACTICALS)

M.Sc., Degree I Semester Examination

BOTANY

Course/Paper: ……

Course/Paper Code…….

Time: 3 Hrs **Max Marks: 70**

Q I. Conducting Experiments/ Micro-preparation/ Plant identification (A and B)	15
Q II. Minor experiment/ Demonstrations/ Procedure Writing (C and D)	15
Q III. Critical comment (2x6 Marks) (E and F)	12
Q IV. Identification (6 x 3 Marks) (G, H, I, J, K and L)	18
Q V. Viva-voce examination	05
Q VI. Class Records/ Submissions/ Tour Report	05

BOTANY: I SEMESTER- HARD CORE 1.1

VIROLOGY, BACTERIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Theory-64 Hrs

Learning Objectives:

- To understand the world of microbes and important types: Virus, Fungi, and Bacteria.
- Study of form, habitat, biology, and impact of living organisms on humans and the ecosystem.
- Scheme of classification, developments in the field, and modern-day classification systems.
- Developments in virology, bacteriology, and mycology with reference to basic and applied research.
- Application and effects of living organisms in health, industry, and environmental fields.
- In-vitro and In-vivo growth and its effect on a variety of fields and the impact of organisms on society.
- Major discoveries and applications of living microorganisms to the field of agriculture and Health.
- To understand the economic and pathological importance of bacteria, virus, and fungi and the respective diseases they cause in crop plants.

Course Outcome:

On successful completion of this course, each student will be able to:

- Understand the world of microbes and their economic importance.
- Appreciate the adaptive strategies of the microbes and their reproduction.
- Understand the economic and pathological importance of microbes.
- Understand the ecological significance of microbes and their classification.
- Able to identify common plant diseases and try their management.

Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Virology: Origin and evolution of viruses; Classification of viruses-ICTV and Baltimore Systems; Genome diversity in viruses; Methods of cultivation of viruses; Purification and detection of viruses; Transmission of viruses; Mechanism of replication of DNA and RNA viruses; Viroids - Structure and multiplication; Prions - structure and multiplication; Prion diseases.

Unit-2: Bacteriology: Introduction and classification of Bacteria by Bergey's Manual of Determinative and Sytematic Bacteriology; C. R. Woese- Three domain classification of Bacteria; Archaebacteria and Eubacteria - diversity and evolution; Nutritional types of bacteria; Bacterial growth; Recombination in bacteria (conjugation transformation, and transduction); Brief account on actinomycetes; Structure and multiplication of Mycoplasma and Phytoplasmas; Economic importance of bacteria.

Unit -3: Mycology: Present status of fungi; Outline classification of fungi (Ainsworth-1973). Vegetative organization in fungi; Nutrition in fungi (saprotrophs, biotrophs, necrotrophs; symbiotrophs); Methods of reproduction in fungi - Asexual and sexual methods; Spore liberation in fungi; Evolution of sex in fungi; Heterothallism and parasexuality; Life cycle pattern and phylogeny of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Fungi and their economic importance.

Unit-4: Plant Pathology: Concepts and scope of plant pathology; Plant diseases and crop losses; Classification of plant diseases; Parasitism and disease development; Effect on physiology of host; Host range of pathogens; Defence Mechanisms in Plants; Plant Disease epidemics and plant disease forecasting; Methods of plant disease management; Study of plant diseases- Sandal Spike, Citrus Canker, Bacterial Blight of Paddy, Late Blight of Potato, Downy Mildew of Bajra, Tikka Disease of Ground nut, Grain Smut of Sorghum, Phloem Necrosis of Coffee, Root Knot Disease of Mulberry.

References

1) Madigan, M .T. 2012. Brock Biology of Microorgasms, 13t edn. Benjamin Cummings.
2) Willey, J, Sherwood, L. and Woolverton, C.J. 2013. Prescott`s Microbilogy 9th edn. Mc Graw-Hill Educations.
3) Wagner, E.K, and Hewlett, M.J. 2009. Basic Virology. Blackwell Science Ltd. 2nd edn. USA.
4) Kodo, C.I. and Agarwal, H.O. 1972. Principles and Techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
5) Conrat, F.H., Kimball, P.C. and Jay, L. 1988.V irology. Prentice Hall, Englewood Chiff, NewJercy.
6) Jawaid, A. Khan and Jeanne Dijkstra. 2002. Plant Viruses as Molecular Pathogens. Food Products Press, NY
7) Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 2013. Introductory Mycology 4th edn.Wiley.
8) Singh, R. S. 2009. Plant Disease. 9th edn. Oxford and IBH Pub.Co., New Delhi.
9) Agrios, G. N. 2005. Plant Pathology 5th edn. Academic Press, San Diego.
10) Rangaswamy, G. and Mahadevan, A. 2002. Diseases of crop plants in India, Prentice Hall of India Pvt.Ltd. New Delhi.
11) Mehrotra, R. S. 2003. Plant Pathology. 2nd edn. Tata Mc Graw-Hill Pub. Co. Ltd., NewDelhi.
12) Cann, A.J. 2012. Principles of Molecular Virology 5th edn. Elsevier Ltd, USA.
13) Flint, S.J. Enaquist, L.W., Rancnicllo, V. R. and Skalka, A.M. 2009. Principles of Virology pathogenesis and control. 3rd edn. APS Press, USA.
14) Hall, R. 2014. Plant Virology, 5th edn. Elsevier, USA.
15) Aneja, K.R. 2003. Experiments in Microbiology plant Pathology and Biotechnology, 4th edn. New Age International Publishers, New Delhi.
16) Holt, J.G., Krige, N.R., Sneath., P.H.A. Stuley, J.T. and Williams, S.T. 2010. Bergey`sManual of Determinative Bacteriology, 9th edn. Williams and Wilkins, USA.

BOTANY: I SEMESTER - HARD CORE 1.2

PHYCOLOGY, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Theory-64 Hrs

Learning Objectives:

- To study the algal diversity, distribution, and pigmentation.
- Study of algal phylogeny, various life cycles, and the economic importance of algae.
- Study of lower plants Bryophytes - Diversity; External and internal morphology; and Phylogeny.
- The study of comparative accounts of gametophytes of Bryophytes.
- The Study of Pteridophytes - Diversity; External and internal morphology, and Phylogeny.
- Study of stelar evolution, evolution of sporangium, and Heterospory and seed habit in Pteridophytes.
- The study of naked seed plants Gymnosperms - Diversity and distribution; External and internal morphology; Phylogeny; reproduction, and economic botany.

Course Outcome:

On Successful completion of this course, each student will be able to:

- Explore methodically the lower and higher forms of the Plant kingdom.
- Study the Habit, forms, and characteristic reproductive strategies from Algae to Gymnosperms.
- Know the abundance and distribution of these lower forms from an ecological context.
- Scientifically study the classification strategies in practice of these groups of organisms.
- Know the evolutionary trends and geography of lower plants.
- Study the economic importance of these life forms and their conservation.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Phycology: General characteristics, Diversity and distribution of algae; classification and phylogeny of algae; Pigmentation in algal groups; Role of photosynthetic and accessory pigments; Reproduction in algae; Origin and evolution of sex in algae; Life cycles in algae - Haplontic, Diplontic, Isomorphic, Heteromorphic; Fossil algae; Ecology of algae; Economic importance of algae.

Unit -2: Bryophytes: Origin and evolution of Bryophyta; General characteristics, Classification and phylogeny of Bryophytes; Distribution and Habitat; External and internal morphology; Reproduction and life cycle; Comparative account on gametophytes; Evolution of Sporophytes; Physiology of Bryophytes; Economic and Ecological importance; As bioindicator of pollution- Air and water; Fossil Bryophytes; Threats to and conservation of Bryophytes.

Unit -3: Pteridophytes: Origin and evolution of Pteridophyta; classification and phylogeny; Morphology, anatomy reproductive biology and phylogeny; Psilophytes, Lycophytes, Sphenophytes, Filicophyta; Evolution of sorus; evolution of sporangium; Gemetophyte development - homosporous and heterosporous ferns; Heterospory and seed habit; Stelar evolution in Pteridophytes; Ecology of Pteridophytes; Economic importance. Study of Fossil Pteridophytes- Equisetales, Sphenophylllales, Lycopdiales.

Unit- 4: Gymnosperms: Evolution of Gymnosperms; Distribution, General characteristics, classification and phylogeny of Gymnosperms; Range in morphology, anatomy, reproduction and interrelationships of -

Cycadales, Ginkgoales, Coniferales, Gnetales; Pteridosperms; Economic importance; Ecology of Gymnosperms; Fossils of Gymnosperms

References:

1. Bower, F.O. 1935. Primitive land plants, Macmillan, London.
2. Campbell, D. H. 1972. Evolution of land plants (Embryophytes), Central Book Department Allahabad.
3. Watson, E.V. 1971. The structure and life of Bryophytes Hutchinson and Co. Ltd. London.
4. Parihar, N.S. 1970 An Introduction to Embryophyta Vol. 1. Bryophyta. Central Book Department, Allahabad.
5. Prempuri, 1981. Bryophytes, Morphology, Growth and Differentiation. Atmaram and sons, New Delhi.
6. Nayar, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2005. Bryophytes of Wyanad.
7. Murthy, A.V.S.S. 2005. A text book of algae. IK International Pvt., Ltd., New Delhi.
8. Bold, H. C. and Wynne, M.J. 1978. Introduction to the algae. Structure and reproduction. Prentice Hall.
9. Chapman and Chapman. 1973. The Algae. Macmillan Co., New York.
10. Fritsch, F. E. 1935. Structure and Reproduction of Algae Vol. I & II. Cambridge Univ. Press, London.
11. Odum, E.P. Fundamentals of Ecology. 3rd edn. Toppan Co., Ltd., Japan.
12. Round, F. E. 1973. Biology of the algae. Edward Arnold Ltd., London.
13. Smith, G.M. 1951. Manual of Phycology. Pub. Co. Waltham., Mass.
14. Venkataraman, G.S. 1974. Algae form and function. Today & Tomorrow's Pub., New Delhi.
15. South, G. R. And Whittick, A. 1987. Introduction to Phycology. Blackwell Scientific Publication, UK.
16. Hoek, V., Mann, D. G. And Jahns, H. M. 1995. An introduction to Phycology. Cambridge University Press, UK.
17. Biswas, C. and Johri, B. M. 1997. The Gymnosperms. New Age Publishers, New Delhi.
18. Rashid A. 1986. An Introduction to Pteridophytes. Vikas, New Delhi.
19. Sporne K. R. 1969. Morphology of Gymnosperms. Hutchinson University Library, London.
20. Sporne, K. R. 1969. Morphology of Pteridophytes. Hutchinson University Library, London.
21. Chase, M.W. and Reveal, J.L. 2009. A Phylogenetic classification of the land plants to accompany APG III. Botanical Journal of the Linnean Society, 161: 122-127.
22. Sundararajan, S. 2007. Introduction to Pteridophyta. New Age International Publishers, New Delhi.
23. Vashishta, P.C. (2008). Botany for Degree Students: Pteridophyta. S. Chand & Co. Ltd., New Delhi.
24. Afroz Alam (2015)Text book of Bryophyta. I.K. International publishing house Pvt. Ltd., New Delhi
25. Laura Barsanti and Paolo Gaultieri (2014) Algae- Anatomy, Biochemistry And Biotechnology.CRC press, Taylor and Francis Group, New York.

BOTANY: I SEMESTER - HARD CORE 1.3

SYSTEMATICS OF ANGIOSPERMS

Theory-64 Hrs

Learning Objectives:

- To understand the basic knowledge of the plant's diversity- habit, morphology and reproductive characters.
- To know the present and past systems of plant classifications.
- To understand various Angiospermic plant families and emphasize their morphology by identifying distinctive features.
- To ensure the students in understanding plant characterization, identification, classification, and nomenclature.
- To identify thrust areas of modern taxonomy without shifting focus from the traditional ones.
- To train students for their careers in plant exploration and identification.

Course outcome:

On Successful completion of this course, each student will be able to:

- Explore methodically the higher forms of the Plant kingdom.
- Demonstrate a comprehensive understanding of plant Systematics concepts and methods.
- Apply knowledge of classification systems and molecular techniques in plant taxonomy.
- Accurately identify plants using taxonomic keys and understand nomenclature principles.
- Appreciate the importance of herbaria and botanic gardens in taxonomic research

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.
- Field trip study/ botanical exploration shall be undertaken for plant identification

Unit-1: Introduction to plant systematics; Plant classification systems-artificial, natural and phylogenetic systems; Contributions of Carolus Linnaeus, Michel Adanson, de Jussieu, de Candolle to plant classification; Concepts of taxonomic hierarchy; Taxonomic Categories- Genus concept; Species concept; Intraspecific categories; subspecies; varieties and forms; History of botanical nomenclature; ICBN and ICN aims and principles; Rules and recommendations; Rule of priority; Typification; Author citation, Legitimate and illegitimate names; Name changes and synonyms; Effective and valid publication; Herbarium and its significance; Botanical gardens.

Unit-2: **Taxonomic Literature:** General taxonomic indices, world floras and manuals; Monographs and revisions; Bibliographies, catalogues and reviews; Periodicals, glossaries and dictionaries; Hortus Malabaricus; Taxonomic websites-IPNI, Plant List, Tropicos, Botanico-Periodicum-Huntianum (BPH); Biodiversity Heritage Library (BHL); Botanicus, Index Herbariorum; Taxonomic Keys- bracketed keys, indented keys, numbered keys, edge punched and body punched keys.

Unit-3: Study of plant classification Systems; Broad outlines of Bentham and Hooker's system, Engler and Prantl's system, Hutchinson's system, Takhtajan's system, and Cronquist's system; Numerical Taxonomy-principles, selection of characters, merits and demerits; Angiosperm Phylogeny Group (APG) III & IV clasiification; Study of angiosperm families-Magnoliaceae, Nympheaceae, Urticaceae, Droseraceae,

Podostemaceae,Balanophoraceae, Loranthaceae, Alismataceae, Cyperaceae, Commelinaceae, Dioscoreaceae and Orchidaceae.

Unit-4: Molecular Systematics: Nuclear, mitochondrial and chloroplast genes. Gene sequencing, analysis of molecular data, alignment of sequences; Phylogenetic tree construction-Maximum Likelihood and Neighbour Joining Methods; Phylogenetic analysis- rooted and unrooted trees; Data analysis- alignment, substitution, model building; Phylogentic softwares-CLUSTAL W, MEGA, Mesquite, PAUP, PHYLIP, Treefinder, TreeBase.

References:

1) Cronquist, A. 1981. An Integrated system of classification of flowering plants.Columbia University Press, New York.
2) Simpson, M.G. 2006. Plant Systematics. Elsevier, Amsterdam.
3) Swafford, D.L. 2001. PUAP. Phylogenetic Analysis Using Parsimony, version 4.Sinauer Associates, Sunderland.
4) Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.A. and Donoghue, M.J. 2002.Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
5) Gurucharan Singh. 2004. Plant Systematics: Theory and Practice, Oxford and IBHPublishing Co. Pvt. Ltd., New Delhi.
6) Jeffrey, C. 1982. An introduction to Plant Taxonomy. II Edn., Cambridge Uni. Press.
7) Mondal, A.K. 2009. Advanced Plant Taxonomy. New Central Book Agency Pvt. Ltd.,Kolkata, WB.
8) Pullaiah, T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi.
9) Johri, B.M. and Bhatacharjee, S.P. 1994. Taxonomy of Angiosperms. NarosaPublishers, New Delhi.
10) Lawrence, G.H.M. 191. Taxonomy of Vascular Plants. MacMillan, London.
11) Chase, M.W. and Reveal, J.L. 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of Linnaean Society, 161: 122-127.
12) Nei, M. and Kumar, S. 2000. Molecular Evolution and Phylogenetics. Oxford Univ. Press, New York
13) APG-IV. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants APG-IV. Botanical Journal of Linnaean Society, 181: 1-20.

BOTANY I SEMESTER- HARD CORE 1.4 (PRACTICALS – I: Based on HC 1.1, 1.2 and 1.3)

HARD CORE 1.1

VIROLOGY, BACTERIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Practicals- 32 Hrs

1) Laboratory guidelines, design, tools, equipments and other requirements for studyingmicroorganisms.
2) Measuring the dimensions of microorganisms using Micrometry.
3) Determining total count of microbes using Haemocytometer.
4) Gram and special staining of bacteria.
5) Preparation of NA, PDA, sterilization, pouring, inoculation and culturing ofbacteria/fungi.
6) Staining of fungi including VAM fungi.
7) Identification of fungi.
8) Measurement of bacterial growth by Spectrophotometer.
9) Recording environmental factors (Temperature, RH, and Rainfall and windvelocity).
10) Splash liberation of spores from diseased tissue.
11) Estimation of total phenols in diseased and healthy plant tissues.
12) Study of the following diseases: Sandal Spike, Citrus canker, Bacterial Blight of paddy, Late Blight of Potato. Downy Mildew of Bajra, Tikka disease of ground nut, Grain smut of Sorghum, Phloem Necrosis of Coffee, Root Knot disease of Mulberry.

HARD CORE 1.2

PHYCOLOGY, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Practicals-32 Hrs

1-4) Algae: Study of Cyanophyceae: *Anabaena, Oscillatoria*; Study of Chlorophyceae: *Oedogonium*, *Pediastrum;* Study of Phaeophyceae: *Turbinaria, Ectocarpus*; Study of Rhodophyceae: *Gracilaria, Batrachospermum*; Economic products of algae.

5-7) **Bryophytes:** Study of morphology, anatomy and reproductive morphology – Hepaticopsida *Marchantia, Dumortiera*; Anthocerotopsida- *Anthoceros, Notothylas*; Bryopsida- *Bryum* and *Polytrichum*. Study of IUCN red list of Bryophytes.

8-10) **Pteridophytes:** Study of vegetative habit, anatomy and reproductive morphology of *Psilotum, Lycopodium, Isoetes, Ophioglossum, Botrychium, Angiopteris, Pteris, Hymenophyllum, Marselia, Salvinia, Azolla;* **Paleobotany**- Study of fossils Lepidodendrales- lepidedendron, Lepidostrobus. Equisetales- Calamites, Sphenophylllum and Coenopteridales. *Sigillaria, Stigmaria*

Gymnosperms: Study of morphology, anatomy and reproductive morphology of *Zamia, Pinus* and *Ephedra, Ginkgo, Araucaria, Podocarpus, Gnetum, Agathis, Cupressus, Thuja*; Economic importance of Gymnosperms.

HARD CORE 1.3
SYSTEMATICS OF ANGIOSPERMS

Practicals-32 Hrs

1 Methods of preparation and maintenance of Herbaria.
2-4) A field trip of three days to a floristically rich area to study plants belonging to different families (Every student shall submit a tour report and herbarium as part of practical examination).
5-10) Identification of the flowering plants in and around Mysore using keys, floras and monographs.
11-12) Construction of phylogenetic tree based on molecular data of plant species retrieved fromGene Bank.

BOTANY: I SEMESTER - SOFT CORE 1.1
FUNGAL BIOLOGY AND BIOTECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- To study the relevance of fungi in agriculture, industry, medicine, and environment, their relevance in basic and applied research fields including molecular biology and biotechnology.
- To understand the diversity of fungi, systematics, estimation, and significance in ecosystem biology.
- To study the different ecological groups of fungi, their biology, and applications.
- To study the beneficial and harmful groups of fungi in different ecological niches, parasitic, saprophytic, and symbiotic fungi and their interactions and commercial exploitation in the fermentation industry.
- The course is of national and international relevance as the fungal organisms are very important in biotechnology and academic research.

Course Outcome:

On successful completion of this course, the students will be able to:

- Understand the diversity of fungi, systematics, and significance in ecosystem biology.
- Know the relevance of fungi in agriculture, industry, medicine, and environment, their relevance in basic and applied research fields including molecular biology and biotechnology.
- Study the different ecological groups of fungi, their biology, and applications.
- Differentiate beneficial and harmful groups of fungi in different ecological niches, parasitic, saprophytic, and symbiotic fungi and their interactions and commercial exploitation in the fermentation industry.
- The course is of national and international relevance as the fungal organisms are very important in biotechnology and academic research.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Introduction and historical overview of mycology; General characteristics and importance of fungi in human life; Fungi –Taxonomy and Systematics; Fungi in genetic and applied research; Estimation of Fungal diversity; Quantitative Indices- species richness, species evenness and species abundance; Molecular

methods used for fungal diversity estimation-nuclear genome, messenger RNA transcripts, Ribosomal/DNA sequence comparisons and mitochondrial genome.

Unit-2: Macro fungi and micro fungi living on plant substrata; Lignicolous macrofungi; Lichenized fungi; Sequestrate fungi; Endophytic fungi; Saprobic soil fungi; Fungi in stressful environment; Mutualistic, arbuscular, and endomycorrhizal fungi; Yeasts; Fungicolous fungi; Fungi in fresh and marine water habitats; Fungi associated with aquatic animals; Fungi as parasites of humans and plants; Fungi associated with animals, insect, arthropod and nematodes; Coprophilous fungi.

Unit-3: Fungal Fermentation and Food Products: Food and Beverages; Single cell proteins-Myco-proteins; Food processing by fungi-bread, soybean products, cheese and fermented milk; Fungal secondary metabolites-antibiotics, immunosuppressive agents, anti-tumour agents, fungal toxins as medicines; Fungal pigments; Steroid transformation; Fungal enzymes; Bio-control agents; Application of molecular biology in fungal biotechnology.

Unit-4: Mushrooms and fungi in medicine; Toxic macromycetes; Mushroom cultivation; Model organisms- *Saccharomyces cerevisiae*/*Neurospora crassa*; Bio-deteriorationof food grains and mycotoxins; Fungal communities of herbivore dung; The fungal communities of composts; Fungal interactions and practical exploitation; Heavy metals in fungi-accumulation and sorption; Biotechnology of wood rotting fungi.

References:

1) Alexopoulos, C. J., Mims, C. W. and Blakwell, M. 2007. Introductory Mycology 4th edn.Wiley India, New Delhi.
2) Deacon, J. W. 1997. Modern Mycology 3rd edn. Blackwell Science publishers, London.
3) Mehrotra, R.S. and Aneja, K.R. 1990. An Introduction to Mycology, New Age International
4) (P) Limited, New Delhi.
5) Mueller, G M; Bills, GF and Foster, M.S. 2004. Biodiversity of Fungi, Elsevier AcademicPress, New York.
6) Rai, M. and Bridge, P.D. 2009. Applied Mycology, CABI International, UK.
7) Carlile, M.J. Watkinson,S.C. and Gooday, G.W. 2001.The Fungi, 2nd edn. Academic Press,USA.
8) Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi. 3rd edn. Cambridge UniversityPress, Cambridge.

BOTANY: I SEMESTER - SOFT CORE 1.2

ALGAL BIOLOGY AND BIOTECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- This course offers insights into the basic and applied aspects of one of the most cosmopolitan groups of photosynthesizing organisms possessing unicellular or multicellular organization in their body plan.
- The first unit comprising of algal biology elucidates the range of thallus organization in various algal classes followed by their classification, phylogeny, and cellular ultra-structural details and algal physiological processes.
- The second unit focuses on the topics related to the harmful toxins produced by groups of algae and their health hazards on the environment, which is of national as well as global relevance. Besides, the unit also contains topics on algae of extreme environments and their distribution as fresh and marine water communities. Freshwater planktonic, epiphytic, and colonial forms can be documented from lake samples which in turn, indicate the quality of water bodies and is of chief concern.
- The algal biotechnology comprises techniques and methods involved in the mass cultivation of both microalgae and macroalgae. The mass cultivation is necessary in order to meet the global demand for the benefits derived from the algal products as sources of nutraceuticals.
- Both micro and macroalgae offer immense health benefits and their consumption necessitates the mass production on a global scale.
- Both, algae and their products have several therapeutic and industrial applications in the production of renewable source of energy as biofuel, pigments as food colorants, pollution indicators. The metabolic pathways play a significant role in the production of clean energy fuel to meet the global demand for biofuel production.

Course Outcome:

- On successful completion of this course, each student will be able to:
- Study the basic and applied aspects of the cosmopolitan group of photosynthesizing organisms.
- Elucidate the range of thallus organization in various algal classes, classification, phylogeny, and cellular ultrastructural details and algal physiological processes.
- Study the harmful toxins producing algae and algae of extreme environments and their distribution, freshwater planktonic, epiphytic, and colonial forms to indicate the quality of water bodies.
- Acquaint with algal biotechnology techniques and methods involved in the mass cultivation of microalgae and macroalgae. Understand the health benefits of algae and their consumption, benefits of algal products as sources of nutraceuticals.
- Know the importance of algae and their products in therapeutic and industrial applications in the production of renewable source of energy as biofuel, pigments as food colorants, and pollution indicators.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1:Algal Biology: Historical development of Phycology and contributions of Phycologists; Thallus organization in algae-Cyanophyceae, Chlorophyceae, Charophyceae, Euglenophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae; General characteristics, algal classification, affinities and phylogeny- polyphasic approach; Molecular markers for phylogenetic study; Algal physiology- ultra-structure of cells; Photosynthesis and respiration.

Unit-2: Algal blooms and Toxins: Blooms produced by algal groups; Toxins produced by cyanobacteria, diatoms, dinoflagellates, prymnesiophytes and eugleoids; bioaccumulation and biomagnification; effects of toxins on aquatic life and humans; Scenario in coastal waters of India- monitoring and safety measures; Algal communities of extreme environments- Thermal hot springs, cold springs, snow and ice; **Fresh water algae**-Ecological classification of fresh water organisms; Lentic communities of algae (pond, lake, bog, swamp); Lotic communities (streams, rivers, rapids; **Marine algae**- Marine biota; zonation; quantitative study of phytoplanktons, marine communities of algae.

Unit-3: Algal Biotechnology: Algal culture techniques; general principles; physical parameters; culture media; strain improvement; **Algal cultivation methods**-conventional, advanced; **Cultivation of microalgae-*Spirulina*** and ***Dunaliella***; Media, seeding, cultivation systems, harvesting; processing, drying methods, packaging, marketing; Algal cultivation and production in India; **Cultivation of macroalgae-*Porphyra;*** Nutritional value; importance of life cycle; methods of cultivation in advanced countries; Pillar, semi raft floating and open sea cultivation.

Unit-4: Applications of algae/products: Pollution indicators, treatment of waste water plants, heavy metal toxicity and phyco-remediation; Bio-fouling and biofuel production; Algal products as sources of nutraceuticals; Food colorants; Aquaculture feed; Therapeutics and cosmetics; Medicines; Dietary fibres from algae and uses; Biotechnological applications of algal silica and oils.

References

1) Bold, H. C. and Wynne, M. J. 1978. Introduction to the algae. Structure and reproduction.Prentice Hall, New York.
2) Chapman and Chapman, V.J. 1973. The Algae. Macmillan Co., New York.
3) Fritsch, F. E. 1935. Structure and reproduction of Algae Vol. I and II. CambridgeUniversity Press, London.
4) Hoek, V., Mann, D. G. and Jahns, H. M. 1995. An introduction to Phycology, CambridgeUniversity Press, UK.
5) Murthy, A.V.S.S. 2005. A text book of algae. I.K. International Pvt., Ltd., New Delhi.
6) Odum, E. P. Fundamentals of Ecology. 3rd edn. Toppan Co., Ltd., Japan.
7) Round , F. E. 1973. Biology of the algae. Edward Arnold Ltd., London.
8) Southcott, G. R. and Whittick, A. 1987. Introduction to Phycology. Blackwell ScientificPublication, UK.
9) Venkataraman, G.S.1974. Algae form and function. Today and Tomorrow's Pub., NewDelhi.
10) Bux *et al.* (eds.). 2016. Algae Biotechnology: Products and Processes, Springer, ISBN9783319123332 (P), 9783319123349 (Online).
11) Chu, W. 2012. Biotechnological Applications of Microalgae. IeJSME 6(1): S24-S37.

BOTANY: I SEMESTER - SOFT CORE 1.3

LICHENOLOGY AND MYCORRHIZAL TECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- To understand the development and Biology of Lichens.
- To study the diversity of Lichens.
- To study the secondary metabolites of lichens and their applications in medicines and Pharmacology.
- To understand the role and impact of lichens on the Environment.
- To understand the Mycorrhiza, their types, and importance.
- The study of the role of Mycorrhiza in Agriculture, Horticulture, and Forestry.

Course Outcome:

On successful completion of this course, each student will be able to:

- Study the science, Biology, and diversity of Lichens.
- Study the importance of Secondary metabolites of lichens and their applications in medicines and Pharmacology.
- Study the role of lichens as indicators of air pollution.
- Understand the types and importance of Mycorrhiza.
- Understand the role of Mycorrhiza in Agriculture, Horticulture, and Forestry.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Introduction: Photobionts- identification, reproduction, and taxonomy of photobionts; Occurrence within lichens; Mycobionts- Lichenized versus nonlichenized fungi; Bryophilous and folicolous lichens; Thallus morphology and anatomy; Growth forms - crustose lichens, foliose lichens, fruticose lichens; Vegetative structures- Homoiomerous thallus, stratified thallus, cortex, epicortex, and epinecral layer, photobiont layer and medulla, lower cortex, Attachment organs and appendages; Cyphellae and pseudocyphellae; Cephalodia (Photosymbiodemes); Reproductive structures- sexual reproduction in lichen-forming ascomycetes; Mating systems, dikaryon formation, Ascomal ontogeny, Ascosporogenesis; Ascus structure and function; Generative reproduction: ascoma, perithecia, apothecia, Thallinocarpia, Pycnoascocarpia, Hysterothecia, Asci, Basidioma; Vegetative reproduction- aposymbiotic propagules, symbiotic propagules; Systematics of lichenized fungi- History, classification and phylogeny.

Unit-2: Morphogenesis- Acquisition of a compatible photobiont; Recognition and specificity; Structural and functional aspects of the mycobiont–photobiont interface; Genotypes and phenotypes, growth patterns; Biochemistry and secondary metabolites- intracellular and extracellular products; The fungal origin of the secondary metabolites; Major categories of lichen products; Application to pharmacology and medicine; Harmful properties of lichen substances, lichens in perfume, lichens in dyeing; Stress physiology and the symbiosis- stress tolerance, limits to stress tolerance; harmful effects of stress, constitutive and inducible stress tolerance, evolution of stress tolerance in lichens; Modes of water uptake, light, temperature, carbon dioxide; The carbon economy of lichens.

Unit-3: Nitrogen, its metabolism and potential contribution to ecosystems, Methods of determination of

nitrogen fixation; Nutrients- chemical and physical properties of nutrients and metals; Nutrient requirements, sources of nutrients, accumulation mechanisms, compartmentalization of elements within lichens; Metal toxicity, metal tolerance; Environmental role of lichens- dispersal, establishment, pedogenesis and biodeterioration; Community structure, succession, ecosystem dynamics; Animal and lichen interactions; Forest management, conservation, environmental monitoring; Lichen sensitivity to air pollution- lichens in relation to sulfur dioxide, oxidants and lichens, hydrogen fluoride and organopollutants.

Unit-4: Mycorrhizal fungi: Introduction and classification; Types of mycorrhizas- Arbutoid mycorrhizas, ectomycorrhizas, vesicular arbuscular mycorrhizas or arbuscular mycorrhizas, ectendomycorrhizas, ericoid mycorrhizas, monotropoid mycorrhizas and orchid mycorrhizas; Phosphate solubilisation; Ecological significance of AM fungi; Importance of mycorrhiza in evolution of land plants; Role of mycorrhiza in agriculture, horticulture and forestry.

References:

1) Thomas H. Nash , 2008. Lichen Biology, 3rd edn. Cambridge University Press, TheEdinburgh Building, Cambridge CB2 8RU, UK
2) Awasthi D.D. 2000. Lichenology in Indian subcontinent: A supplement to "A handbook of lichens". Publisher: M/s Bishen Singh Mahendra Pal Singh, Dehra Dun.
3) Awasthi D. D. 2013). A hand book of lichens , Publisher: M/s Bishen SinghMahendra Pal Singh, Dehra Dun.
4) Sally E. Smith and David J. Read (2008). Mycorrhizal Symbiosis. 3rd edn. AcademicPress, New York.
5) Larry Peterson R., Hugues B. Massicotte, Lewis H. Melville, 2004. Mycorrhizas:Anatomy and Cell Biology, CAB International, UK.

BOTANY: I- SEMESTER - SOFT CORE 1.4

PHYTOPATHOLOGY

Theory- 64 Hrs

Learning Objectives:

- Learn the concepts and types of diseases in plants.
- Identify major principles of plant pathology and factors causing diseases.
- Recognize the etiological agents/microbes responsible for plant disease and disease cycle and lifecycle of various important diseases.
- Study and employ methods to diagnose and manage a wide range of plant diseases.
- Describe aspects of integrated pest management.
- Explain the impact of plant disease on humans.

Course Outcome:
On successful completion of this course, each student will be able to:

- Understand the economic importance of crop diseases and abiotic and biotic agents responsible for plant diseases, their biology, life cycles, and dissemination.
- Understand the science of development of Plant Pathology in India and the World and the role of Plant Clinics and Plant Doctors for alleviating crop losses.
- Know the mechanism of disease development and genetics of host-pathogen interactions.
- Study the plant diseases caused by different etiological agents, symptoms, epidemiology, and their management.
- Understand the disease management practices such as regulatory, cultural, physical, biological, chemical, and biotechnological approaches including IDM.
- Know the national and international relevance as it is dealing with the protection of food from pests and diseases for sustained food security.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Concept of plant disease, Economic aspects of plant diseases; Types of plant diseases- Infectious diseases and non-infectious diseases; Causative agents of plant diseases; Angiospermic parasites; Development of plant pathology; Plant pathology in practice- Plant Clinic and Plant Doctor Concept; Parasitism and pathogenicity; Disease triangle; Infections and colonization; Weapons of plant pathogens; Effect of pathogen on physiology of host plant (photosynthesis, translocation and transpiration, respiration, permeability, transcription and translation).

Unit-2: Defence mechanisms in Plants- Pre-existing structural and chemical defences, induced structural and biochemical defences; Plant disease epidemiology- Elements of an epidemic and development of epidemics; Plant Disease forecasting; Genes and Diseases, Gene for gene concept, non-host resistance; Types of plant resistance to pathogens (Horizontal and Vertical Resistance); 'R' Genes and 'avr' genes; Genetics of virulence in pathogens and resistance in host plants; Breeding for disease resistance.

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Unit-3: Management of Plant Diseases: Exclusion, eradication, cross protection, direct protection, integrated disease management, chemical methods of plant disease control; Biotechnological approaches to plant disease management; Gene silencing and disease control; Mechanism of gene silencing and control of viral diseases; Engineered resistance to viral, bacterial, fungal and insect diseases of crop plants.

Unit-4:Study of diseases of crop plants: Potato Spindle Tuber Disease, Tobacco Mosaic Disease, Sandal Spike Disease, Bacterial blight of Paddy, Citrus Canker, Late Blight of Potato, Downy Mildew of Maize, Blight of Paddy, Angular leaf spot of Cotton, Tikka disease of ground nut, Rust of coffee, Grain and Head smut of Sorghum. Leaf blight of Paddy, Blast of Paddy, Powdery mildew of cucurbits, Wilt of Tomato, Phloem Necrosis of Coffee, Root Knot of Disease of Mulberry and Vegetables; Non-parasitic diseases of plants; Seed-borne diseases.

References:

1) Agrios, G. N. 2005. Plant Pathology 5th edn. Academic Press, San Diego.
2) Dickinson, M. 2003. Molecular Plant Pathology, Garland Publishing Inc, CT.
3) Ingram,D.S. and Robertson, N.F. 1999. Plant Diseases, Collins Publishers, London.
4) Johnston, A and Both, C. 1983. Plant Pathologists Pocket-book. 2nd edn. CommonwealthMycological Institute, Oxford and IBH Pub. Co. Calcutta.
5) Lane, C.R., Beales P.A. and Hughes, K.J.D. 2012. Fungal Plant Pathogens, CABI Publishing, Wallingford.
6) Mehrotra, R. S., 2003. Plant Pathology, 2nd edn. Tata Mc. Graw Hill Pub. Co. Ltd., NewDelhi.
7) Rangaswamy, G. and Mahadevan, A. 2002. Diseases of crop plants in India, Prentice Hall ofIndia Pvt.Ltd. New Delhi.
8) Schumann, G. L. and D'Arcy, C. J. 2012. Hungry Planet: Stories of Plant Diseases, APS Press,USA.
9) Singh, R. S., 2009. Plant Diseases. 9th edn. Oxford and IBH Pub.Co. New Delhi.
10) Vidhyasekaran, P. 2004. Encylopedia of Plant Pathology.Viva Books Pvt. Ltd. New Delhi.

BOTANY I SEMESTER- SOFT CORE 1.5 (PRACTICALS – II: Based on 2 Soft Core Courses offered)

SOFT CORE 1.1

FUNGAL BIOLOGY AND BIOTECHNOLOGY

Practicals-32 Hrs

1) Study of Myxomycetes and Chytridiomycetes
2) Study of Plasmodiophoromycetes and Oomycetes
3) Study of Zygomycetes
4) Study of Ascomycetes
5) Study of Basidiomycetes
6) Study of Deuteromycetes
7) Study of Lichens
8) Study of VAM fungi
9) Detection of aflatoxin B1
10) Cultivation of Oyster mushroom.
11) Alcoholic fermentation of grape juice by *Saccharomyces*.
12) Cultivation of *Penicillium* and testing antibiotic principle.
13) Study of edible and poisonous mushrooms.
14) Study of fungal model organisms - *Saccharomyces cerevisiae*/*Neurospora crassa*

SOFT CORE 1.2

ALGAL BIOLOGY AND BIOTECHNOLOGY

Practicals-32 Hrs

1) Study of fresh water planktonic forms in the lake samples.
2) Study of fresh water diatoms.
3) Chlorophyceae: *Ulva, Caulerpa, Halimeda, Acetabularia.*
4) Xanthophyceae: Mounting of *Botrydium* from soils.
5) Phaeophyceae: *Dictyota, Sargassum, Cystophyllum.*
6) Rhodophyceae: *Gracilaria, Gelidium.*
7) Cyanophyceae: *Microcystis, Nostoc, Spirulina.*
8) Estimation of carotene content in algal cells .
9) Culturing of microalgae: *Spirulina/ Chlorella/Scenedesmus/Dunaliella.*
10) Applications of algal products: Agar, spirulina tablets/powder, beta-carotene, phycobiliproteins, triglycerides, Mycosporine like amino acids (MAA), diatom silica as nanoparticles.
11) Visit to National Institute of Oceanography, Goa.
12) Study of algal herbaria.

SOFT CORE 1.3
LICHENOLOGY AND MYCORRHIZAL TECHNOLOGY

Practicals-32 Hrs

1-3) Survey of lichen vegetation in the study area: Frequency, density and abundance.
4) Determination of species richness and species diversity.
5) Isolation and maintenance of cyanobionts and phycobionts
6) Isolation and maintenance of mycobionts
7) Analysis of secondary metabolites of lichens.
8) Biological activity of secondary metabolites of the lichens.
9) Culture methods for lichens and lichen symbionts.

10) Root clearing and staining technique to study arbuscular mycorrhizal fungi.
11) Assessment of % root colonization of arbuscular mycorrhizal fungi.
12) Isolation and identification of arbuscular mycorrhizal fungi.

SOFT CORE 1.4
PHYTOPATHOLOGY

Practicals-32 Hrs

1) Isolation of bacterial, fungal, and nematode plant pathogens of crop plants.
2) Study of mineral deficiency diseases of Tomato and French bean.
3) Estimation of foliar infection by Stover's method.
4) Study of spore germination.
5) Estimation of total phenols in diseased and healthy plant tissues.
6) Mycoflora analysis by Standard Blotter Method SBM/agar plating method.
7-9) Study of Tobacco mosaic, Bacterial blight; Downy mildew of Maize; Powdery mildew of cucurbits; Grain smut of sorghum; Leaf rust of Coffee; Root Knot of Mulberry. Bunchy top of banana, Grassy shoot of sugar cane, Little leaf of Brinjal; Potao Spindle Tuber Disease (PSTVd)
10) Study of effect of pathogens on seed germination and vigour index.
11) Study of effect of fungicide on seed-borne pathogens.
12) Study of fungal bio-control agents.

BOTANY: II- SEMESTER- HARDCORE 2.1

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS AND PLANT MORPHOGENESIS

Theory-64 Hrs

Learning Objectives:

- This course imparts fundamental as well as the advanced aspects of plant development.
- The first two units focus on the reproductive biology aspects in plants, comprising of the stages in the production of male and female gametes, their deviations from the normal course of development, and unusual features. A small unit on the significance of experimental embryology as a technique to overcome the shortcomings of normal embryological steps is of relevance to applied aspects comprising of tissue culture techniques.
- The third unit on plant morphogenesis provides the basic differences involved in the plant developmental pathways with relevance to model organisms ranging from unicellular to multicellular from algae, mosses, and angiosperms. One of the most outstanding features of this unit is in understanding the concepts of plant development involving a range of aspects such as polarity, symmetry, differentiation, and regeneration. The seminal part of the development revolves around the stem cell concept in plants and their significance in the development.
- The last unit is based on the fundamental aspects of plant development comprising of meristems (shoot/root), cell as a basis of growth with special reference to abnormal growth in plants, and the role of red and blue light in the growth responses of plants with emphasis on the photoreceptors.
- The course also highlights the patterning of vasculature and leaf developments with special reference to Arabidopsis. The interaction of insects with plants to form an organized structure called galls with high specificity and endemicity are of global significance in order to study the process of tissue differentiation and gall formation.

Course Outcome:

On successful completion of this course, each student will be able to:

- Study the fundamental as well as the advanced aspects of plant development.
- Focus on the reproductive biology aspects in plants, the stages in the production of male and female gametes, their deviations from the normal course of development, and unusual features. Understand the significance of experimental embryology as a technique to overcome the shortcomings of normal embryological steps and tissue culture techniques.
- Study the basic differences involved in the plant developmental pathways using model organisms ranging from unicells to multicellular algae, mosses, and angiosperms.
- Understand the concepts of plant development involving polarity, symmetry, differentiation, and regeneration, and the significance of the stem cell concept in plant development.
- Understand the fundamental aspects of plant development comprising of meristems (shoot/root), cell, abnormal growth in plants, and the role of red and blue light in the growth responses of plants with emphasis on the photoreceptors called phytochromes.
- Know the patterning of vasculature and leaf developments with special reference to Arabidopsis. Understand the interaction of insects with plants to form galls, and study the process of tissue differentiation and gall formation.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Reproductive Biology of Angiosperms: Historical overview; Contributions of P. Maheshwari; BM Johri; BGL Swamy to the development of embryology in India; Microsporogenesis and Microgametogenesis- wall layers and functions; Tapetum- types, concept of male germ unit and its significance; Pollen morphological features; Unusual features-pollen development in Cyperaceae, pollen embryosac; Concept and scope of palynology.

Unit-2: Megasporogenesis and Megagametogenesis; Ovular structure and types; Development of monosporic, bisporic, tetrasporic and special types of embryo sacs; Ultra structure and nutrition of female gametophyte, concept of female germ unit and its significance; Fertilization- a general account, double fertilization, single fertilization, heterofertilization and polyspermy; Pollen recognition and rejection reactions - types, structures, methods to overcome incompatibility reactions; Endosperm- types, haustorial variations, ruminate and composite endosperm; Embryo- structure, development of monocot, dicot and grass embryo; Significance of embryonal suspensor; Experimental Embryology- scope and applications.

Unit-3: Plant Morphogenesis: Models of morphogenesis- comparison of plant v/s animal morphogenetic pathways: Embryo, *Arabidopsis thaliana*; Concepts- cell fate/ fate maps, gradients, stem cells in plants and their significance in development, polarity, symmetry, totipotency of cell types, pleuripotency, plasticity, differentiation, redifferentiation, dedifferentiation and regeneration in *Acetabularia* and *Arabidopsis thaliana.*

Unit-4: Plant Growth and Development: Types, shoot apical meristems, root meristems; control of cell division in meristems; Quiescent center and meresteme de attente; *Arabidopsis*- vascular patterning and leaf development, abnormal growth; Cellular basis of growth- maintenance of cell shape; Cytoskeletal elements; Photomorphogenesis- definition, history, Hartmann's technique; Photoreceptors and photo morphogenesis, localization and properties; Effect of blue light-mediated photomorphogenesis with suitable examples.

References:

1) Johri, B. M. 1984. The embryology of Angiosperms. Springer Verlag.
2) Johri, B. M. 1982. The experimental embryology of vascular plants. Springer Verlag, NewYork.
3) Swamy, B.G.L. & Krishnamurthy, K. V. 1982. From flower to fruit: The embryology of angiosperms. Tata McGraw Hill Co. New Delhi.
4) Eames, 1961. Morphology of Angiosperms. McGraw Hill book Co., Inc., New York.
5) Maheshwari, P. 1950. An introduction to the embryology of Angiosperms. McGraw Hill bookCo., Inc., New York.
6) Maheshwari, P. 1963. Recent advances in the embryology of angiosperms. ed. New Delhi
7) Bhojwani, S. S.and Bhatnagar, S. P. 1978. The embryology of Angiosperms. Vikas PublishingHouse, New Delhi.
8) Turing, A. M. 1952. The chemical basis of morphogenesis. Phil. Trans. R. Soc. Lond. B. 237:37- 72.
9) Sinnot, E. W. 1960. Plant Morphogenesis. Mc Graw- Hill Book Co. Inc. New York, USA.
10) Steeves, T.A. and Sussex, I. M. 1989. Patterns in Plant development. 2nd edn. CambridgeUniversity Press. UK.
11) Chasan, R. 1994. Tracing tracheary element development. The Plant Cell 6:917-919.
12) Lyndon, R. F. 1990. Plant Development : The Cellular basis. Unwin Hyman, London.
13) Aloni, R. 1987. Differentiation of vascular tissues. Annu. Rev. Plant Physiol. 38:179- 219.
14) Raman, A. 2007. Insect induced plant galls of India; unresolved questions. Curr. Sci. 92 (6):748-757.
15) Smith, H. 1975. Phytochrome and Photomorphogenesis- an introduction to the photocontrolof plant development. Mc Graw- Hill Book Co. (UK), Ltd.
16) Mohr, H. 1972. Lectures in photomorphogenesis. Springler- Vohrleg, Berlin, Germany.

BOTANY: II- SEMESTER - HARD CORE 2.2

CELL BIOLOGY AND GENETICS

Theory-64 Hrs

Learning Objectives:

- Understand cell biology from all aspects - Morphology, Anatomy, Physiology, and Biochemistry.
- Gain comprehensive knowledge about cell components, their functions, and mechanisms.
- Understand cell cycle regulation, cell signalling, signal transduction pathway, and programmed cell death in plants.
- Recognize the basic similarities between all living Eukaryotic cells.
- Explore diverse inheritance patterns of Mendelian principles, changing concepts of gene, and expertise in gene mapping techniques.

Course Outcome:

On successful completion of this course, each student will be able to:

- Understand the molecular basis of cell and its internal physiological aspects.
- Study the morphology, micro-anatomy, physiology, and biochemistry of cells.
- Understand membrane structure and function, Chromatin, chromosome, and cell nucleus.
- Acquire in-depth knowledge of cell cycle regulation, cell signalling, signal transduction pathway, and programmed cell death.
- Understand the variation patterns to Mendelian inheritance and the changing concepts of the gene.
- Acquire knowledge on gene mapping techniques in prokaryotes and eukaryotes.
- Understand the mechanism of sex determination and dosage compensation in various model organisms.
- Study the structure, types, and mechanisms of transposition and significance of transposable elements in prokaryotes and eukaryotes.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Bio Molecules and Membranes: Structure, composition of bio-molecules and their stabilizing interactions (carbohydrates, lipids, proteins and nucleic acids); Unit membrane structure and functions; Membrane proteins, membrane transport and the electrical properties; Intra-cellular compartments and protein sorting; Intracellular membrane traffic; Cytoskeletons.

Unit-2: Functions of Organelles: Cell wall, membranes, nucleus, mitochondria, Golgi bodies, lysosomes, spherosomes, peroxisomes, ribosomes, endoplasmic reticulum, Plastids, chloroplast, vacuoles and cytoskeleton; Cell cycle and mechanism of cell cycle regulations; A brief account of cell signalling, receptors, second messengers; General mechanism of signal transduction pathway; Programmed cell death in life cycles of plants.

Unit-3: Extensions of Mendelian Principles co-dominance, incomplete dominance, gene interactions, multiple alleles, lethal alleles, pleiotropy, penetrance and expressivity, polygenic inheritance, linkage and crossing over, sex linked inheritance, sex limited and influenced traits, genome imprinting, extra nuclear

inheritance; C**oncept of the gene**- classical-alleles, multiple alleles, pseudo-alleles, complementation test, experiments on rII locus and lozenge locus, modern- jumping genes, overlapping and genes within genes, split genes, nested genes, fusion genes; **Gene mapping methods**- linkage maps, tetrad analysis; Recombination in bacteria mapping genes in bacteria by interrupted mating technique, fine structure mapping, transduction and transformation mapping, mapping genes in Bacteriophages**,**

Unit-4: Sex Determination and Dosage Compensation: Chromosomal and genetic basis of sex determination; Mechanism of sex determination in *Melandrium, C. elegans*, Drosophila and humans, dosage compensation mechanisms in humans, Drosophila and *C. elegans*. **Transposable elements**- discovery in maize and bacteria, transposal elements in bacteria and bacteriophage, types and functions; Transposable elements in eukaryotes- Plants, *Drosophila* and Humans, mechanisms of transpositions;Transposable elements in research.

References:

1) Atherly, A.G. Girton, J.R. Donald, J.R. 1999. The Science of Genetics. SaundersCollege Publishers. Fortworth .
2) Griffith, A.J.F. Gelbart, W.M. Muller, J.H. and Lewintin, R.C. 1999. Modern GeneticAnalysis. W.H. Freeman and Co. New York.
3) Hartl. D. 1991. Basic Genetics. 2edn., Jones and Barlett Publishers Inc. Boston.
4) Fairbanks, D.J. and Anderson, W.R. 1999. Genetics the continuity of Life.Brooks's/Cole publishing Company, California.
5) Brooker. R.J. 1999. Genetics –analysis and principles. Addison Wesley LongmanInc.California.
6) Snustad, D.P., Simmons, M.J. and Jenkins, J.R. 1997. Principles of Genetics. Hohn Wiley& son's inc. New York.
7) Brown, T.A. 1989. Genetics a molecular approach. Van Nostrand Reinhold (intn) Co.,Ltd. London.
8) Winchester, A.M. 1969. Genetics. 3rd edn. Oxford and IBH, New Delhi.
9) Strickberger, Monroe W. 2000. Evolution. 3rd Edn. Jones & Bartlett Publishers, Inc. 40Tall PineDrive Sudbury, MA 01776, USA.
10) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and PeterWalter. 2008. Molecular biology of the cell, 5th ed., Garland science, Taylor & Francis Group, LLC, 270 Madison Avenue, NewYork NY f 0016, USA.
11) Alberts, B., Bray, D., Lewis, J , Raff, M., Roberts, K and Watson, J.D. 1999 . Molecularbiology of the cell. Garland Publishing, Inc., New York.
12) Kleinsmith, L.J. and Kish, V.M. 1995 .Principles of Cell and Molecular Biology 2nd edn. Harper Collins College Publishers, New York, USA.
13) Lodish, H. Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000.Molecular Cell Biology, 4th edn.W.H. Freeman and Co. New York, USA.
14) Buchanan, B.B. W.Gruissem and Jones, R.L. (2000). Biochemistry and MolecularBiology of Plants. ed. ASPP Press.USA.

BOTANY: II SEMESTER HARD CORE 2.3

PLANT BREEDING AND EVOLUTIONARY BIOLOGY

Theory-64 Hrs

Learning Objectives:

- To study the centers of origin of crop plants, Vavilov's concept, and the domestication of crop plants.
- To study the breeding methods involved in self and cross-pollinated crops.
- To study the techniques involved in plant breeding and crop improvements.
- To study the methods involved in developing resistance to various aspects.
- To study the contributions of scientists and research institutes in plant breeding.
- To study the evolution of the universe, earth, and the origin of life on earth.
- To study life in different eras.
- To study the evolutionary thoughts - Post Darwinism, Darwinism, and Neo-Darwinism.
- To study the various evidences of life - Fossils, geological timescale, anatomy, embryology, and others.
- To study the various types of selection, speciation, and molecular evolution.

Course Outcome:

On successful completion of this course, each student will be able to:

- Study the breeding methods such as plant introduction and acclimatization, pure line, clonal, mass and progeny selections, recurrent selection, pedigree, bulk and backcross methods, and heterosis breeding.
- Understand breeding techniques such as mutation breeding, polyploidy, hybridization, tissue culture techniques in crop improvement, protoplast fusion, electroporation, electro-fusion, biolistics, somatic hybridization, transgenic plants (GMO's).
- Study techniques of breeding for disease and insect resistance, drought and salinity, quality trait, multiple cropping systems, ideotype breeding, breeding for adaptation.
- Understand the basic concepts of origin, theories of evolution of life, earth and the universe, and pre-Darwin, Darwinism, Darwin's evolutionary theory, Neo-Darwinism, modern synthesis, and molecular evolution.
- Understand the concept of natural selection, speciation, variation, and the Hardy-Weinberg law.

- **Course Pedagogy:**
- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Evolution of plant breeding; Objectives and Role of plant breeding; scope of plant breeding; sciences related to plant breeding; Recent trends in plant breeding; Vavilov's concept of origin of centers of origin of crop plants; Plant introduction and Acclimatization; Domestication and Agriculture; Breeding Methods for self pollinated crop plants-Mass, Pure line, Pedigree and Bulk selections and back cross methods. Breeding Methods for cross pollinated crop plants-Progeny selection, Recurrent selection; Heterosis breeding and breeding for synthetic and composite varieties; Breeding Techniques for crop improvement -Mutation breeding, Polyploidy, Hybridization, Tissue culture, Somatic hybridization, Protoplast fusion, Electroporation, Electro-fusion.

Unit-2: Breeding for Specific Purposes: Breeding for disease resistance, insect resistance, drought and salinity; quality trait, multiple cropping systems, Ideotype breeding; Crop breeding and seed production- **S**eed production techniques, Release of new varieties, intellectual property rights, computer application in plant breeding; Crop improvement Institutions/Centers-ICAR, IARI, NBPGR, ICRISAT, IRRI, CIMMYT; Plant genetic resources and Germplasm conservation; Green revolution; The role of Gene technology in plant breeding; Transgenic plants (GMO's);The elite crop (Golden rice); Contributions of **Dr.** M.S. Swaminathan, Dr. Norman E. Borlaug and N.I. Vavilov.

Unit-3: The origin of the universe, the earth and evolution of life. Emergence of the first living cell, origin of prokaryotic and eukaryotic cells; Geological time scale- Palaeozoic, Mesozoic and Coenozoic era, fossilization, and fossil records. Study of phylogeny. Development of Evolutionary thoughts; Pre Darwin, Darwinism, Neo – Darwinism. Evidences from- comparative morphology, physiology, biochemistry, taxonomy, anatomy and embryology, evidence from plant and animal breeding;

Unit-4: Natural Selection : Types of natural selection, selective forces, selection models, sexual selection, Artificial selection, Adaptive radiation, Variations in gene flow, Genetic drift, gene mutation - Mendelian concept, chromosomal mutation, architectural changes in chromosomes; The Hardy – Weinberg law, Polyploidy in plant evolution**;** Speciation and types of speciation, Models of speciation, Pattern of speciation, isolation mechanism and species formation, signification of speciation, Extinctions; Molecular evolution; Evolutionary ecology.

References

1) Atherly, A.G. Girton, J.R. Donald, J.R. 1999. The Science of Genetics. Saunders College
2) Publishers. Fortworth.
3) Griffith, A.J.F., Gelbart, W.M. Muller, J.H. and Lewintin, R.C. 1999. Modern Geneticanalysis. W.H. Freeman and co. New York.
4) Hartl. D. 1991. Basic Genetics. II edn. Jones and Barlett Publishers Inc. Boston.
5) Fairbanks, D.J. and W.R. Anderson. 1999. Genetics the continuity of life. Brooks's/Colepublishing company. California.
6) Brooker, R.J. 1999. Genetics –analysis and principles. Addison Wesley Longman Inc.California.
7) Snustad, D.P., Simmons, M.J. and Jenkins, J.R. 1997. Principles of Genetics. Hohn Wiley &son's inc. New York.
8) Brown, T.A.1989. Genetics a molecular approach. Van Nostrand Reinhold (intn) Co., Ltd.London.
9) Winchester, A.M. 1969. Genetics. III edn. Oxford and IBH, New Delhi.
10) Strickberger, Monroe W. 2000. Evolution. 3rd Ed., Jones & Bartlett Publishers, Inc. 40 TallPineDrive Sudbury, MA 01776, United States of America
11) Futuyma, Douglas J. 2005. Evolution. Sinauer Associates, Inc., 23 Plumtree Road,Sunderland, MA 01375, United States of America
12) Dodson E. O. and Dodson P. 1976. Evolution: Process and Product. 2nd Ed., D. VanNostrand Company, 450 West 33rd Street, New York, N.Y. 10001
13) Chopra, V.L. 2000. Plant Breeding- theory and practices. Oxford and IBH Publishing Co.Pvt. Ltd., Oxford.
14) Chahal, G.S. and Gosal, S.S. 2002. Principles and procedures of Plant Breeding. NarosaPublishing House, New Delhi.

BOTANY II SEMESTER- HARD CORE 2.4
(PRACTICALS – III: BASED ON HC 2.1, 2.2 AND 2.3)

HARD CORE 2.1
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS AND PLANT MORPHOGENESIS

Practicals-32 Hrs

Reproductive Biology of Angiosperms:

1) Study of microsporangium- slides: wall layers, tapetal types, two-celled and three-celled pollen; pollen tetrads.
2) Study of pollen germination: Balsam, Delonix, Hibiscus and Peltaphorum.
3) Study of megasporangium-slides: female gametophyte development in *Penstemon, Xyrispauciflora*, 2, 4, 8-nucleate stages, mature embryo sac.
4) Endosperm mounting- *Cucumis sativus, Grevellia robusta* and *Croton sparsiflorus*
5) Embryo: Slides-monocot, dicot and grass embryo.
6) Embryo mounting: *Crotalaria*.

Plant Morphogenesis:

1) Study of stem cells in plants: SAM, RM.
2) Regeneration abilities of shoot apical meristems of dicots on media with combinations of growth regulators.
3) Study of totipotency in cell types: stomata, epidermal cells, stem and leaf explants on a tissue culture media.
4) Polarity in stem cuttings: *Pothos* spp.
5) Study of regeneration in succulents *Kalanchoe, Byrophyllum.*
6) Study of leaf galls of plants: *Pongamia pinnata and Achyranthes aspera*: Morphological observations and histology.
7) Study of *Arabidopsis thaliana* as a model plant.

HARD CORE 2.2
CELL BIOLOGY AND GENETICS

Practicals-32 Hrs

1) Determination of reducing sugars by Nelson-Somogyi's method.
2) Estimation of total soluble sugars by volumetric method.
3) Quantitative determination of free Amino acid content in germinating seeds.
4) Estimation of ascorbic acid in plant tissues.
5) Estimation of Phospholipids by TLC.
6) Slides/Charts/photos NP (Cytology and Genetics).
7) Study of mitosis in normal and induced root tips cells of Onion.
8) Study of meiosis in onion flower buds, translocation in Rhoeo.
9) Study of special chromosomes- B chromosomes, and sex chromosomes.
10) Determination of chiasma frequency in onion.

11-12) To solve genetic problems on linkage, ordered and unordered tetrads.

HARD CORE 2.3
PLANT BREEDING AND EVOLUTIONARY BIOLOGY

Practicals-32 Hrs

1) Study of floral biology of crops - typical examples of self and cross pollinated plants.
2) Selfing and hybridization techniques - Bagging and emasculation.
3) Pollen viability: germination test and TTC test.
4) Studying of centre's of origin of cultivated crops - N.I. Vavilov Concept.
5) Identification of crop breeding institutes/ centers and logos; contributors of plant breeding - M.S. Swaminathan, N.I. Vavilov, Norman . E. Borlaug.
6) Study of contributions of Philosophers and scientists to evolutionary biology
7) Study of origin of Universe, Sun, Earth, life on earth, prokaryotes and Eukaryotes
8) Lamarkism, Darwinism. Neo-Darwinism, Neo-Lamarkism
9) Study of Geological time scale- Palaeozoic, Mesozoic and Coenozoic era; Continental drift.

10 -12) Study of Photographs/ Models of Evolutionary biology

BOTANY: II- SEMESTER - SOFT CORE 2.1

PLANT ANATOMY AND HISTO-CHEMISTRY

Theory-64 Hrs

Learning Objectives:

- Study plant anatomy to conceptually integrate organismal structure and function.
- Learn more about how organisms are structured and how they function.
- Reveal the relationships between structure, function, taxonomy, ecology, and developmental genetics.
- Distinguish between monocots, dicots, and gymnosperms, linking the study to plant physiology for the improvement of food crops.
- Understand the structural adaptations of plants with respect to diverse environmental conditions.
- Study wood structure and its anomalous growth.
- Address plant diseases and stressful conditions.
- Understand plant protection against pests.

Course Outcome:

On successful completion of this course, each student will be able to:

- Understand the primary vegetative body of the plant, anatomical features of leaf, stem, and root, ultra-structure, and chemistry of the cell wall formation and its uses.
- Know the ultra-structure and differentiation of xylem and phloem tissues; apical meristems - shoot and root apex in Pteridophytes, Gymnosperms, and Angiosperms, theories of apical meristems.
- Study the structure of Vascular cambium, secondary xylem and phloem of gymnosperms and dicots, and Periderm and bark; Anomalous secondary growth in monocots and climbers.
- Know the ontogeny of simple and compound leaf of dicot and Monocot, floral anatomy, floral meristem, vascular system.
- Know the techniques of Histochemistry to test minerals, carbohydrates, lignin, polyphenols, proteins, lipids, and nucleic acids.
- Acquire proficiency to handle and use Microtome, Camera lucida, and Micrometry.
- Know the techniques to kill, fix, preserve, and stain the plant tissues; double staining methods and preparation of histochemical stains.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Plant Anatomy: Primary vegetative body of the plant; Anatomical features of leaf, stem and root (dicot and monocot); leaf of fern and gymnosperm; Structure of modified leaves- Kranz anatomy and C4 photosynthesis; Ultra-structure and chemistry of the cell wall; formation of the cell wall and its uses.

Unit-2: Anatomy of Vascular Tissue: Ultra structure and differentiation of xylem and phloem tissues; Apical meristems- shoot apex in Pteridophytes, Gymnosperms and Angiosperms, theories, root apical meristems.

Unit -3: Secondary Growth: Vascular cambium, secondary xylem of gymnosperms and dicots and secondary phloem of Gymnosperms and dicots; Periderm and bark; Anomalous secondary growth in monocots and climbers; Leaf ontogeny - Dicot- simple, compound, Monocot; Floral anatomy-flower parts, floral meristem, vascular system.

Unit-4: Plant Histochemistry: Tests for minerals, carbohydrates, lignins, polyphenols, proteins, lipids and nucleic acids; Study of instruments: (a) Camera lucida (b) Micrometry (c) Microtome. Principles of histo-chemical stains; Killing, fixing and staining of plant tissues; Double staining- TBA method.

References:

1) Abraham, F. 1982. Plant Anatomy. 3rd edn. Pergaon Press. Oxford.
2) Cariquist, S. 1967. Comparative Plant Anatomy- Holt Reinert and Winston, New York.
3) Cutter, D. G. 1971. Plant Anatomy- Part 1, Cell and Tissues Edward Arnold London.
4) Cutter, D. G, 1971. Plant Anatomy- Part 1, Cell and Tissues Edward Arnold London. Part- II.
5) Eames and McDaniel, 1947. Plant Anatomy. 2nd edn., McGraw Hill, New York.
6) Esau, K. 1965, Plant Anatomy, Joh Wiley and Sons, New York.
7) James, D. Mauseth, 1998. Plant anatomy The Benzamin/ Cummins Publishing Co.Inc.
8) Esau, K. 1979, Anatomy of seed plants- first Wiley eastern reprint. New Delhi.
9) Krishnamurthy, K. V. 1988. Methods in Plant Histochemistry. S. Viswanathan (Printers and Publishers) Pvt. Ltd. Madras.

BOTANY: II- SEMESTER - SOFT CORE 2.2

ETHNO-BOTANY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

Theory - 64 Hrs

Learning Objectives:

- To study the use of plants by different ethnic cultural groups and traditional knowledge practices and their uses.
- To understand, document, and validate the systematic uses of traditional knowledge.
- To know the bio-prospecting, screening, and validation of herbal medicines from medicinal plants used by tribal people.
- To know the types, application, and managing of Intellectual Property Rights (IPRs) related to traditional knowledge.
- To understand the national and international pacts, regulation, laws, and treaties related to IPRs and people.

Course Outcome:

- On successful completion of this course, each student will be able to:
- Study the use of plants by different ethnic cultural groups and traditional knowledge practices and their uses.
- Know the bio-prospecting, screening, and validation of herbal medicines from medicinal plants used by tribal people.
- Know the types, applications, and management of IPRs related to traditional knowledge.
- Understand the national and international pacts, regulation, laws, and treaties related to IPRs and people.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Ethno-botany: Introduction, concept, scope and objectives; Ethno-botany as an interdisciplinary science; The relevance of ethno-botany in the present context; Ethnic groups; Ethno-botany- Major and minor ethnic groups of India and their life styles; Forest Vs. ethnic groups; Plants in tribal life with reference to Magico-religious rituals and social customs; Sacred groves.

Unit-2: Methodology used in the study of Ethnobotany and Ethno pharmacology: Field work, Herbarium, Ancient Literature, Archaeological findings, temples and sacred places, protocols. Preliminary phyto-chemical analysis of ethno-botanical important medicinal plants.

Unit-3: Role of ethno-botany in modern Medicine with special examples; Medico-ethno- botanical Sources in India with special reference to Karnataka; Tribals Vs. Agriculture: Shifting, Podu and Jhum cultivation; Role of ethnic groups on surrounding environment; Crop genetic sources; Endangered taxa and forest management (participatory forest management); Ethno- botany as a tool to protect interests of ethnic groups; Sharing of wealth concept with few examples from India.

Unit-4: Study of Intellectual Property Rights – patents, trademark, geographical indication, copyright; IPR and Traditional Knowledge; Bio-piracy of traditional knowledge; Ethno botany and legal aspects; National and international organizations and treaty related to traditional knowledge – WIPO, TKDL, TRIPS, CBD, Nagoya protocol etc., Ethno botany as a source (recent) of already known drugs: a) *Withania* as an antioxidant and relaxant b) *Sarpagandha* in brain ailments c) *Becopa* and *Centella* in epilepsy and memory development in children d) *Phyllanthus fraternus* in diabetic and viral jaundice e) *Artemisia* as a powerful cerebral anti malarial agent and its possible use in tuberculosis.

References:

1) Jain, S.K. 1995. Manual of Ethno-botany, Scientific Publishers, Jodhpur.
2) Jain, S.K. 1981. Glimpses of Indian. Ethno-botany, Oxford and I B H, New Delhi
3) S.K. Jain 1989. Methods and approaches in ethno-botany. (ed.) Society of ethnobotanists, Lucknow, India.
4) Jain, S.K. 1990. Contributions of Indian ethno-botany. Scientific Publishers, Jodhpur.
5) Colton C.M. 1997. Ethno botany – Principles and applications. John Wiley and sons –
6) Rama Ro, N and A.N. Henry (1996). The Ethno-botany of Eastern Ghats in AndhraPradesh, India. Botanical Survey of India. Howrah.
7) Rajiv K. Sinha – Ethno-botany The Renaissance of Traditional Herbal Medicine –INA – SHREE Publishers, Jaipur-1996
8) Faulks, P.J. 1958. An introduction to Ethno-botany, Moredale pub. Ltd. London

BOTANY: II- SEMESTER - SOFT CORE 2.3

ECONOMIC BOTANY

Theory -64 Hrs

Learning Objectives:

- Introduction to the origin of crop plants and development of cultivation of major staple crops like cereals, pulses, etc.
- To know the major groups of plant and plant products of domestic, national, and international trade.
- Cultivation practices, improvement in Agronomy, and trade of important economic plants, plantation crops, and the impact of science and technology.
- Annual production, trade share, and import and export statistics of essential and economically important various crop products.
- Distribution of economic crops and their trade-related centers of trade.

Course Outcome:

- On successful completion of this course, each student will be able to:
- Learn the basics of ongoing trends in economic aspects of different groups of wild and cultivated plant species since the dawn of civilization.
- Introduction to the origin of crop plants and development of cultivation of major staple crops like cereals, pulses, etc.
- Know the major groups of plant and plant products of domestic, national, and international trade.
- Know the cultivation practices, improvement in Agronomy, and trade of important economic plants, plantation crops, and the impact of science and technology.
- Understand the annual production, trade share, and import and export statistics of essential and economically important various crop products.

- Study the distribution of economic crops and their trade-related centers of trade.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit- 1: Economic Botany: The origin of cultivated plants and Agriculture; The future role of plants in relation to mankind; Introduction to Green revolution; Study of origin, distribution, cultivation and utility of the useful parts of the following- - rice, wheat, maize, barley, sorghum and millets; Red gram, green gram, black gram, horse gram, pea, cow pea, bengal gram; Oil Yielding plants- sunflower, safflower, groundnut, linseed, rape seed; A briefaccount of economically important horticultural and floricultural plants.

Unit- 2: Economic Botany: Study and utility of the useful parts of the following- Sugar yielding plants- sugar cane and sweet potato, sugar beet and *Stevia*; Spices and condiments - ginger, turmeric, cardamom, cinnamon, clove, saffron, all spice, black pepper, nutmeg, red pepper, coriander, cumin, fennel and *Vanilla.*

Unit -3: Economic Botany Study and utility of the useful parts of the following- fibre- cotton, jute, flax, hemp, Sunn hemp, China grass, coconut and Kapok; Timber yielding plants- *Tectona* and *Dalbergia*; Dyes- indigo, henna; Masticatories and fumitories-areca nut, betel leaf, tobacco; rubber- Para rubber and other substitutes; Gums- Gum Arabic, Karaya gum.

Unit-4: Medicinal Botany: Scope and importance of medicinal plants; Indigenous medicinal Sciences; Important medicinal plants and their uses; Major exporters and importers of traditional medicinal plants and plant products; Application of natural products to certain diseases- jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases; Poisonous plants.

References:

1) Hill, A.F. 1952. Economic Botany, TataMcGraw Hill, New Delhi.
2) Kochhar, S.L. 1998. Economic Botany of Tropics, Macmillan India Publishers, New Delhi.
4) Pandey, B.P. 2000. Economic Botany. S. Chand & Company, New Delhi.
5) Pandey, S.N. and Chandha, A. 1999. Economic Botany. Vikas Publishing House Pvt. Ltd.New Delhi.

BOTANY II SEMESTER- SOFT CORE 2.4 (PRACTICALS – IV: Based on 2 Soft Core Courses offered)

SOFT CORE 2.1
PLANT ANATOMY AND HISTO-CHEMISTRY

Practicals-32 Hrs

1) Staining of xylem and phloem elements.
2) Study of anatomy of roots in: *Ficus, Musa, Dieffenbachia, Vanda.*
3) Study of anamalous secondary growth in the following examples: Stem of *Aristolochia, Nyctanthes,, Pyrostegia, Peperomia, Tinospora, Achyranthes*.
4) Study of Ecological anatomy.
5) Study of Vasculature in floral organs.
6) Studying double staining technique.
7-11) Embedding: TBA method, embedding for electron microscope, Sectioning**,** Microtomes, whole mounts maceration.
12) Histochemical- PAS Test**,** Sudan black- lipids**,** Feulgen reaction – Nucleic acids.

SOFT CORE 2.2
ETHNO-BOTANY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

Practicals-32 Hrs

1) Survey and collection important ethno botanical plants by using questionnaire and interview.
2) Preliminary phyto- chemical analysis of medicinal plants.
3) Study of biological functional properties of crude drugs – Anti microbial activity.
4) Study of methods of *in-situ* or *ex-situ* conservation of important medicinal plants.
5) Study of techniques used in Pharmacognosy – organoleptic, anatomy and chemicalmethods.
6) A visit to a Tribal area to conduct field work and collect ethno botanical information /data.
7) Listing of Crude drugs in Pansari shops (local crude drugs shops) and their identification (little known drugs only).
8-12) Visit to nearby Western Ghats and Sacred Groves.

SOFT CORE 2.3
ECONOMIC BOTANY

Practicals-32 Hrs

1) Utility, uses and economic importance of cereals and millets.
2) Utility, uses and economic importance of horticultural and floricultural plants
3) Utility, uses and economic importance of pulses and oil yielding crops.
4) Utility, uses and economic importance of sugar yielding crops.
5) Utility, uses and economic importance of spice and condiments.
6) Utility, uses and economic importance of fiber and timber yielding plants.
7) Utility, uses and economic importance of dye, rubber and gum yielding plants
8) Utility, uses and economic importance of masticatories and fumitories
9) -12) Study of medicinal and poisonous plants.

BOTANY: II SEMESTER- OPEN ELECTIVE 2.1

MEDICINAL PLANTS

Theory-96 Hrs

Learning Objectives:

- To know the use of major classes of medicinal plants used by healers from antiquity.
- To study the historical use of medicinal plants, practices, and uses of medicinal plants in Unani, Ayurveda, Siddha, etc. disciplines of medicine and documentation.
- To learn about bioprospecting for medicinal plants from various tribal cultures and evaluation of medicinal properties of well-known plants and uses.
- To understand the screening, evaluation, and analysis of medicinal plants, activity-guided assay in determining medicinal values.
- To analyze case studies of major proven medicinal plants and medicinal properties of given plants.

Course Outcome:

On successful completion of this course, each student will be able to:

- Know the use of major classes of medicinal plants by the associated historical sketch of humans from antiquity.
- Understand the historical use of medicinal plants, practices, and documentation and uses in Unani, Ayurveda, Siddha, etc. disciplines of medicine.
- Conduct bioprospecting for medicinal plants from various tribal cultures and evaluate the medicinal properties of well-known plants and uses.
- Carry out screening, evaluation, and analysis of medicinal plants, activity-guided assay in determining medicinal values.
- Analyze case studies of major proven medicinal plants and medicinal properties of given plants.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Medicinal Plants: History, scope and importance of medicinal plants; Indigenous medicinal sciences; History, origin, panchamahabhutas, saptadhatu and tridosha concept, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit-2: Medicinal Plants Conservation: Conservation of endangered and endemic medicinal plants; Endemic and endangered medicinal plants; Red list criteria; *In-situ* conservation- biosphere reserves, sacred groves, national parks; *Ex situ* conservation- botanic gardens, ethno medicinal plant gardens; Propagation of medicinal plants - objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit - 3: Funding for Cultivation of Medicinal Plants: Sources of financial aids for medicinal plant

cultivation: Aims and objectives, Functions and activities of the board, Schemes and Projects for Financial assistance, Funding of projects; Procedure for processing project proposal for approval, Implementation and monitoring.

Unit- 4: Ethno botany and Folk medicines: Definition; Ethno botany in India: Methods to study ethno botany; Applications of Ethno botany: National interacts. Ethno medicine. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. Brief introduction to poisonous plants.

References:

1) Trivedi, P. C. 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2) Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn.
3) Agrobios, India.
4) Yoganarasimhan, S.N. Medicinal Plants of India- Vol 1- Karnataka, Interline PublishingPvt. Ltd.

BOTANY: III- SEMESTER - HARD CORE 3.1

BIOCHEMISTRY AND PLANT PHYSIOLOGY

Theory -64 Hrs

Learning Objectives:

- This course emphasizes the physiological and biochemical functions of plants. Despite the spectacular diversity of plants, all plants carry out fundamentally similar physiological functions, like photosynthesis, respiration, metabolic pathways, and programmed cell death.

- The goal of this course is for students to learn about the framework of how the plant system functions by understanding biochemical synthesis pathways, their enzymes, growth regulators, and the acquisition of mineral nutrients, as well as details of stress physiology. This will help for future establishment of research in the field of plant biotechnology.

Course Outcome:

On successful completion of this course, each student will be able to:

- Understand the subtle processes that regulate energy metabolism in green plants.
- Distinguish key physiological processes underlying the formation of seedlings from seed embryos.
- Understand plant system functions by understanding biochemical synthesis pathways, their enzymes, growth regulators, and the acquisition of mineral nutrients.
- Recognize the significance of assimilate translocation and patterns of its partitioning in determining yield in green plants.
- Understand the basics of the physiological and molecular processes that occur during plant growth and development, and during environmental adaptations.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.

- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Biochemistry- Brief account of plant structural and functional molecules- carbohydrates, proteins, lipids and nucleic acids**;** classification, structural and functional properties of bio molecules; Biochemistry of cell membranes; **Lipids-**building and storage molecules, classification and significance; **Proteins-** classification, structure- primary, secondary, tertiary and quaternary structure; properties of proteins; **Enzymes**-Nomenclature, nature and properties of enzymes, active sites, co-enzymes, kinetics of enzyme action, catalysis, specificity and inhibition, allosteric enzymes, ribozyme and abzyme.

Unit-2:Solute transport: Transport of solutes across the membranes Transmembrane proteins, Transport of ions, solutes and macro-molecules, Mechanism of translocations in phloem; Role played in signal transduction pathway stomatal physiology; **Phytosynthesis in higher plants** (i) Photophosphorylation - Calvin cycle; **Photorespiration** - C4 – Pathway, CAM in plants; Oxidative Phosphorylations; Glycolysis - TCA – Cycle and terminal oxidation.

Unit-3: Plant Hormones- plant hormones-discovery, biosynthesis, metabolism, transport and physiological effects of plant hormones and their applications; **Nitrogen metabolism** -(i) Molecular mechanism of N2 fixation (ii) Biosynthesis of amino acids (iii) Assimilation of nitrate and ammonium; **Lipid metabolism-** fats and oils biosynthesis and oxidation of lipids; Physiology of seed germination and flowering.

Unit -4: Stress Physiology: Water deficit and its physiological consequences; Drought tolerance mechanisms, Salinity stress and plant responses. Heat stress and heat shock proteins; Metal toxicity in plants. Biotic stress, HR and SAR mechanisms; Mineral nutrition- in plants and deficiency diseases; Plant development- physiology of flowering; Phytochrome- photochemical and biochemical properties of phytochrome; Concept of photoperiodism and vernalization and its influence on flowering;

References:

1) Barkla, B.J., and Pantajo, O. 1996. Physiology of ion transport across the tonoplast of higherplants. Ann. Rev. Plant Physiol. 47: 159-184.
2) Clayton, R.K. 1980. Photosynthesis: Physical mechanisms and chemical patterns. CambridgeUni. Press, Cambridge.
3) Cohn, E.E., and Stumf, P.K. 1992. Outlines of Biochemistry. Wiley Eastern Pvt. Ltd.
4) Kozaki, A., and Takeba, G. 1996. Photorespiration protects C3 plants from photooxidation.Nature 384: 557- 560.
5) Taiz, L., and Zeiger, E. 1998. Plant Physiology. Sinaur Associates Inc. Publishers, Sunderland Massachusetts.
6) Mukherji, S., and GHosh, A.K. 1996. Plant Physiology. New Central Book Agency Pvt. Ltd.Kolkatta, India.
7) Rabinowithc, E., and Jee, G. 1969. Photosynthesis. Willey Press, New York.
8) Rudier, W., and Thummlar, K. 1994. The Phytochrome, Chromophore I. Photomorphogenesisin Plants, II Edition, Netherlands, 51-69.
9) Spanswick, R.M. 1981. Electrogenic ion pumps. Ann. Rev. Plant Physiol. 32: 267-289.
10) Mc Elroy, W.D. 1995. Cell Physiology and Biochemistry. Prantice Hall of India.
11) Walsh, C.T. 1979. Enzymatic reaction mechanisms. Editors: W.H. Freeman, New York.
12) Webb, E. 1984. Enzyme nomenclature. Academic Press, Orlando Fla.
13) Zimmermann, M.H., and Milburn, J.A. Transport in Plants. 1. Phloem transport(Encyclopedia of Plant Physiology. New Series Vol. 1), Springer, New York.
14) Devline and Witham, 1986. Plant Physiology. CBS Publs. and Distributors, New Delhi.

15) Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., NewYork,USA.
16) Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, NewYork, USA.
17) Singhal *et al*. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphognesis,Narosa Pub. House, New Delhi.

BOTANY: III- SEMESTER - HARD CORE 3.2

MOLECULAR BIOLOGY

Theory-64 Hrs

Learning Objectives:

- Understand the origin of DNA science and related major discoveries that paved the way for molecular biology.
- Learn the basic principle of the Central Dogma of molecular biology and the important structure and function of bio-polymers.
- Study DNA replication, transcription, and translation processes in prokaryotic and eukaryotic organisms and how life processes operate at the cellular level.
- Understand the regulation of the cell cycle and molecular processes such as DNA replication, transcription, and translation, and their implications on life and health.
- Apply principles of molecular biology in various life science approaches.
- Understand genome science and the impact of genomics, proteomics, and metabolomics.

Course Outcome:
On successful completion of this course, each student will be able to:

- Understand the basic principle of the Central Dogma of molecular biology and the important structure and function of bio-polymers.
- Acquaint themselves with molecular processes like DNA replication, transcription, and translation.
- Understand the molecular mechanism of physical and chemical mutations and the various repair mechanisms that rectify the damage, and study the types and mechanisms of recombination.
- Understand the concept of operon and regulation at the cellular level in prokaryotes and various regulatory mechanisms in eukaryotic organisms such as RNA interference.
- Apply principles of molecular biology in various life science approaches.
- Develop proficiency in the isolation, estimation, and determination of biomolecules.
- Conduct classical molecular biology experiments and elucidate the Central Dogma of molecular biology and experimental proof for related cellular molecular events. Understand major discoveries and achievements in molecular biology.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Organization of chromosomes and genes in prokaryotes and eukaryotes - Operon, interrupted genes, gene families, unique and repetitive DNA, heterochromatin, euchromatin, transposons, mitochondrial and chloroplast genome organization, Transposable elements in prokaryotes and eukaryotes, genetic and

evolutionary significance, **DNA replication**- patterns, Messelson and Stahl's and Taylor's experiment, enzymes of replication, mechanism of DNA replication in prokaryotes and Eukaryotes, proof reading and error correction mechanisms.

Unit-2: Molecular mechanism of mutation, repair and recombination:- Mutation-DNA damage by spontaneous mutations, physical and chemical mutagens and their molecular mechanisms, **Repair mechanisms**- direct reversal of damage, base and excision repair, recombinational repair, SOS repair, translation repair synthesis, transcription coupled repair, **Recombination**- homologous recombination, models of recombination, mechanisms, protein machinery of homologous recombination, genetic consequence of homologous recombination, gene conversion, site specific recombination, mechanism and biological significance, non homologous recombination- transposition, molecular mechanisms of transposition- conservative, replicative and retro-transposition.

Unit-3: RNA synthesis, processing and translation: transcription activators and repressors, promoters, RNA polymerases and transcription factors, mechanism of transcription in prokaryotes and eukaryotes, **RNA processing**- capping, polyadenylation, splicing, alternative splicing, RNA editing, exon shuffling and RNA transport, **Translation and processing**- ribosomes, tRNA aminoacylation, aminoacyl tRNA synthetase, genetic code, wobble hypothesis, deciphering of the code, translation mechanism , translation proof reading, translation inhibitors and post translational modifications.

Unit-4: Regulation of gene expression in Prokaryotes: Operon concept, regulation at transcription initiation- lac and trp operon control, regulation of lytic and lysogenic cycles in lambda phage, regulation beyond transcription initiation-premature termination- trp operon, ribosomal proteins as translational repressors, riboswitches, **Regulation of gene expression in eukaryotes**-transcription activators and repressors, regulation after transcription initiation- alternative splicing, translational control in ferretin and tranferrin mRNA, RNA interference, role of chromatin in regulation of gene expression and gene silencing.

References:

1) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 2008. Molecular biology of the cell, 5th edn., Garland science, Taylor &Francis Group, LLC, 270 Madison Avenue, NewYork ,USA.
2) Alberts, B., Bray, D., Lewis, J , Raff, M., Roberts, K and Watson, J.D. 1999 .Molecular biology of the cell. Garland Publishing, Inc., New York
3) Kleinsmith, L.J. and Kish, V.M. 1995 .Principles of Cell and Molecular Biology 2ndEdition Harper Collins College Publishers, New York, USA.
4) Lodish, H. Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology 4th Edition. W.H. Freeman and Co. New York, USA
5) Malaciniski, G.M. and Freidfelder, D. 1998. Essentials of Molecular Biology 3rdEdition. Jones and Bartlet Publishers, Inc., London.
6) Gunning.B.E.S. and Steer, M.W.1996. Plant Cell Biology; Structure and Function.Jones and Bartlett Publishers, Boston, Massachusetts.
7) Harris,Nand Oparka, K.J. 1994. Plant Cell Biology A Practical Approach. IRL Press,Oxford University Press, U.K.
8) F.M. Ausubel, R.Brent, R.E. Kingston, D.D. Moore, J.G. Seidman, J.A. Smith, K.Struhl, (Current Edition) (2005). Current Protocols in Molecular Biology.
9) B.B. Buchanan, W.Gruissem and R.L. Jones . USA (2000) .Biochemistry andMolecular Biology of Plants. Ed. ASPP Press.
10) T.A. Brown, 2000. Essential of Molecular Biology, Vol-I & 2 Oxford UniversityPress.
11) James D. Watson, Tania,. A. Baker, Stephen, P. Bell, Alexander ,Gannm, Michael Levine.2004. Molecular Biology of the gene. 5th Edition, Pearson Education.Philip MGilmartin and Chris.
12) Bowle.2002. Molecular Biology of Plants. Vol 1 & 2 Oxford University Press.

BOTANY: III-SEMESTER - HARD CORE 3.3

PLANT BIOTECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- The aim of this course is to familiarize the students with the concept of tissue culture, genetic engineering and their applications.
- This paper mainly focuses on recombinant DNA technology and its prospects in modern life.
- It involves breeding to improve plants for increasing yield and quality, heat and drought resistance, resistance to phytopathogens, herbicide and insect resistance, increasing biomass for biofuel production, and enhancing the nutritional quality of the crops.
- It helps to get the idea on different techniques of tissue culture and cell harvesting methods.
- The student will also be introduce to gene cloning and its applications.
- Moreover, this paper also gives the information on cryopreservation through which a cell can be preserved under freezing condition for a longer duration.

Course Outcome:

- On successful completion of this course each student will be able to:
- Develop and manage plant tissue culture techniques for crop improvement and to utilize in-vitro techniques for commercial production of crop plants.
- Understand the methods for obtaining and application of genetically modified plants.
- Know regulatory issues for genetically modified plant production.
- Know the application of plants as bioreactors for production of vaccines, therapeutic proteins and production of secondary metabolites.
- Know latest scientific achievements in the field of plant biotechnology.
- Explore entrepreneurial avenues in this field.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Plant Tissue Culture: Scope and importance of plant tissue culture - Media composition and types, hormones and growth regulators, explants for organogenesis; Micro propagation, embryo and endosperm culture, somatic embryogenesis, variation and cell line selection, adrogenesis and microspore culture, significance of haploids, diploidization and bulbosum technique; Cryopreservation, germplasm collection; Somatic Hybrids- Isolation and protoplast culture and somatic hybridization and its significance, Synthetic seed production and somaclonal variations.

Unit-2: Genetic Engineering: Milestones in plant recombinant DNA technology; Importance of gene manipulation in future perspectives; **Tools in Genetic Engineering-** Enzymes in genetic engineering - restriction endonucleases, types and their actions, other DNA modifying enzymes; Cloning vectors- plasmids isolation and purification - Ti Plasmid, pBR322, pUC-series. Phage vectors-M13 phage vectors, Cosmids - types, phasmids or phagemids, shuttle vectors-types; YAC and BAC vectors, Lambda phage vectors, Lamda

phage DNA as a vectors; Cloning vectors and expression vectors; Vectors for plant cells; Vectors for animal cells, baculovirus vectors- adenoviruses, retroviruses, transposons as vectors, Synthetic construction of vectors.

Unit 3: The genetic manipulation of herbicide resistance: The use of herbicide in modern agriculture, strategies for engineering herbicide resistance, the environmental impact of herbicide-resistant crops, **The genetic manipulation of pest resistance-**GM strategies for insect resistance, *Bacillus thuringiensis* approach to insect resistance, insect resistant crops and food safety. **The genetic resistance to plant disease resistance- p**lant pathogen interaction, natural disease resistance pathways, Overlap between pests and diseases, biotechnological resistance to disease resistance, Transgenic approaches to viral and bacterial disease resistance.

Unit 4: Engineering for stress tolerance: The nature of abiotic stress, the nature of water deficit stress, targeted approaches towards the manipulation of tolerance to specific water deficit stresses, **Metabolic Engineering of Plants-** plant cell culture for the production of useful chemicals and secondary metabolites (hairy root culture, biotransformation, elicitation), pigments, flavanoids, alkaloids; mechanism and manipulation of Shikimate pathway, therapeutic proteins. **Future prospects for GM crops- t**he current state of transgenic crops, concerns about GM crops, the regulations of GM crops and products.

References:

1) Slater, N. Scott and M. Fowler. Plant Biotechnology 2003: The genetic manipulation of plants.Oxford University Press, Oxford.
2) Plant Biotechnology. 2000. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds). SpringerVerlag, Heidelberg.
3) Text Book of Biotechnology. 2004. H.K. Das (ed). Wiley India Pvt. Ltd., New Delhi.
4) Plant Biotechnology -The Genetic Manipulation of Plants, Adrian Slater, Nigel Scott andMark Flower, Oxford University Press, (2000).
5) Plant Genetic Transformation and Gene Expression by (eds) J.Draper *et.al*. BlackwellScientific Publications, Oxford (1988).
6) Reinert, J. 1982. Plant Cell and Tissue Culture: A Laboratory Manual. Narosa Publishing
7) House, New Delhi.
8) Chawla H.S., 2009, Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. 8)Bhojwani, S.S. and Razdan, M.K. 2004. Plant Tissue Culture: Theory and practice. Elsevier Science Publishers, New York, USA.
9) PUROHIT S. D., 2012. Introduction To Plant Cell Tissue And Organ Culture PHI LearningPvt. Ltd., New Delhi
10) Roberta, H. Smith, 2012. Plant Tissue Culture: Techniques and Experiments 3 edition.Academic Press; US.

BOTANY III SEMESTER- HARD CORE 3.4
(PRACTICALS – V: Based on HC 3.1, 3.2, 3.3 and 1 Soft Core Courses offered)

HARD CORE 3.1
BIOCHEMISTRY AND PLANT PHYSIOLOGY

Practicals-32 Hrs

1) Estimation of protein by Lowry's method
2) Determination of water potential of tissue by plasmolytic method
3) Determination of water potential by Gravimetric method
4) Quantitative estimation of chlorophyll a, chlorophyll b and total chlorophyll in plant tissue
5) Determination of diurnal fluctuation of acid content of CAM plants (TAN)
6) Determination of temperature quotient (Q10) of water uptake
7) Separation of chlorophyll pigments/Anthocyanin by TLC
8) Protein analysis by SDS- PAGE method.
9) Estimation of Alpha-amylase activity in germinating seedling.
10) Silver staining of proteins
11) -12) Visit to Molecular Biology Laboratories.

HARD CORE 3.2
MOLECULAR BIOLOGY

Practicals-32 Hrs

1) Isolation of DNA from CTAB method.
2) Isolation of DNA from Onion.
3) Isolation of DNA from mulberry leaves.
4) Estimation of DNA by DPA method.
5) Extraction of RNA by trizol/ phenol-chloroform methods.
6) Estimation of proteins by Biuret method.
7) Estimation of protein by Bradford method.
8) Determination of Tm value of DNA.

9-12) Photo graphs/ charts related to molecular biology/Molecular Biologists.

HARD CORE 3.3
PLANT BIOTECHNOLOGY

Practicals-32 Hrs

1) Preparation of plant tissue culture media and types.
2) Organ culture (Shoot tip, nodal and leaf culture) for callus Initiation and regeneration.
3) Anther culture for the production of haploids.
4) Suspension culture and production, separation and estimation of secondarymetabolites.
5) Encapsulation of somatic embryos and production of Synthetic seed.
6) Extraction of secondary metabolites using Soxhlet extractor and Identification of Invitro secondary metabolites-alkaloids, steroids and flavonoids.
7) Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
8) Isolation of genomic DNA from bacteria/plants and purification by agarose gelelectrophoresis.
9) Restriction analysis of plasmids, gel purification of DNA, small and large scale purification of plasmids.

10) Preparation of competent *E. coli* cells. Bacterial transformation and recovery ofplasmid clones.
11) Gene cloning in plasmids, analysis of recombinant plasmids.
12) DNA amplification by PCR, RT-PCR, Real Time PCR.
13) Analysis of DNA and RNA and Protein by Southern, Northern and Western blotting.
14) Primer design for PCR.

SOFT CORE 3.1
MOLECULAR GENETICS OF PLANTS

Practicals-32 Hrs

1) *Arabidopsis thaliana*- study of plant system and its biology.
2) *Arabidopsis* RNA extraction (total and polysomal) for Northern blotting.
3) Expression of foreign genes in plant cells through *Agrobacterium tumefaciens* (Chart)
4) Production of tobacco transgenic plants and assay for the introduced transgenic (Chart)
5) Co-cultivation of tobacco *Agrobacterium tumefaciens*
6) -12) Learning gene bank formats- EMBL format, FASTA format, Swiss- PROT, Ex PASy

SOFT CORE 3.2
MOLECULAR PLANT PATHOLOGY

Practicals-32 Hrs

1) Testing hypersensitivity reaction in *Nicotiana*
2) Testing hypersensitivity reaction in *Bajra.*
3) Estimation of Lypoxygenease in diseased and healthy plants.
4) Estimation of polyphenols in diseased and healthy plants.
5) Studying systemic acquired resistance in crop plants.
6) Genetic testing of disease resistance in plants.
7) Molecular detection of viruses, Mycoplasma, fungi and bacteria from infected plants.
8) *In-vitro* testing of pathogen virulence.
9) Visit to agricultural research station to study diseases on different crop plants.

SOFT CORE 3.3
PLANT PROPAGATION AND PLANT BREEDING

Practicals-32 Hrs

1) Study of types of vegetative propagation: Cutting, Grafting, budding, layering.
2) Study of propagation by modified stems and modified roots.
3) Preparation of media, explants, culture, initiation of shoot multiplication.
4) Pot and green house implants (demonstration) (5) Studying of floral biology.
6) Hybridization techniques - bagging and emasculation.
7) Pollen viability test : Seed germination test, TTC test.
8) Mode of pollination study in different crops.
9) Visit to crop breeding stations/institutes / centres.
10) Estimation of protein quality, Amino acid Analysis and determination of oil and fatty acids.
11) Observation of colour and conditions of mature anthers in different crops.
12) Identification of and studying of important plant breeders.

SOFT CORE 3.4
PHYTOCHEMISTRY AND HERBAL DRUG TECHNOLOGY

Practicals-32 Hrs

1) Survey and collection of medicinal plants for analysis.
2) Selection of plant part, processing and storage of samples for further analysis.
3) Extraction methods - aqueous and sequential solvent extraction of compounds.
4) Preliminary phytochemical analysis of active principles from the extracts.
5) Antibacterial/antifungal activity of crude /active principles
6) Identification of secondary metabolites using TLC- phenolics, flavonoids, alkaloids, terpenes,saponins etc.
7) Column chromatographic separation of active principles.
8) Characterisation of active principle using spectroscopy, HPLC, GCMS, LCMS, FTIR, andMALDI TOF.
9) -12) Submission of report on TEN important curative principles of Indian medicinal plants.

BOTANY: III- SEMESTER- SOFT CORE 3.1 MOLECULAR GENETICS OF PLANTS

Theory-64 Hrs

Learning Objectives:

- Exposure to plant model organisms and study of various developmental aspects of model organisms through understanding their gene expression.
- To understand the genes and their expression in the organization of Chromatin, in Histone modifications.
- To understand the genetic mechanism of gene transfer.
- To understand the basic concepts of Genomics, Proteomics and study of tools of Genomics, Proteomics.
- Exposure to Bioinformatics - Applications and significance.
- Study of types of databases of Bioinformatics and their applications.
- Hands-on experience of online tools of bioinformatics to access and to interpret the nucleotide and amino acid sequences.

Course Outcome:
On successful completion of this course each student will be able to:

- Study the genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
- Emphasis on the molecular mechanisms directing plant gene expression under diverse environmental and developmental stimuli.
- Understand the genetic basis of photosynthesis, nitrogen fixation, leaf, flower and seed development.
- Study the biology and genetics of Agrobacterium and mechanism of gene transfer and integration and development of vectors for plant transformation.
- Understanding the basic concepts of Genomics, Proteomics and bioinformatics study of tools of Genomics, Proteomics, bioinformatics in drug design and discovery.
- Develop computational tools and appreciate their relevance for investigating specific contemporary biological questions.
- Know the new algorithms and analysis method, existing software to effectively extract information from large databases and to use this information in computer modeling.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Plants as genetic tools in Biology: *Arabidopsis, Rice, Maize, Saccharomyces;* Genome organization in plants; *Arabidopsis thaliana*- an experimental model for understanding plant development and functions; Plant genes and regulation; nucleus and chromatin organization; Histones and histone modifications; DNA packaging, organization and types of DNA sequences; functional and non- functional sequences, organization of plant nuclear genes, plastid genes and mitochondrial genes.

Unit-2: Genes responding to hormones, phytochrome, responses to abiotic stresses; Genes induced by water stress and freezing stress; Genes involved in photosynthesis and nitrogen fixation and their regulation; Molecular development of leaf and flower - ABC and revised model of flower development; Genes involved in fertilization, seed development, embryo development.

Unit-3: Genetics of *Agrobacterium:* Biology and genetics of *Agrobacterium tumefaciens;* The Ti- plasmid, *Vir* genes and expression, Mechanism of T-DNA transfer and integration; Basic features of vectors for plant transformation; Proteomics, genomics and bioinformatics; Structural and functional genomics, comparative genomics - biochemical, evolutionary, physiological and phylogenomics; Tools to study functional genomics.

Unit-4: Proteomics- functional and comparative proteomics; Protein distribution, characterization and identification, differential display proteomics, detection of functional linkages; Pharmacogenomics; Bioinformatics- tools of bioinformatics, data bases and data base management, bioinformatics in taxonomy, biodiversity, agriculture; Bioinformatics in drug design and drug discovery.

References:

1) Buchmann, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. ASPP Press, USA.
2) Ausubel, F.M., Brent, R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith, J.A., and Struhl, K. 2005. Current protocols in molecular biology. Current Edition.
3) Brown, T.A. 2000. Essentials of Molecular Biology. Vol. I & II, Oxford University Press.
4) Potrykus, I., and Spangenberg, G. 1995. Gene transfer to plants. Springer, Berlin, Heidelberg.
5) Watson, J.D., and Baker, T.A., Bell, S.P. Gannm, A. and Levine, M. 2004. MolecularBiology of Genes. 5th edn., Pearson Education.
6) Gilmartin, P.M., and Bowler, C. 2002. Molecular Biology of Plants. Vol. I & II, OxfordUniversity Press.
7) Karchar, S.J. 1995. Molecular Biology- A Project Approach, Academic Press, New York.
8) Sambrock, J., Fritch, E.F., and Maniatis, T. 1989. Molecular cloning- a laboratory manual.
9) Slater, A., Scott, N., and Flower, M. 2000. Plant Biotechnology- the Genetic Manipulation of Plants, Oxford University Press, Oxford.
10) Lea, P.J., and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology. JohnWilley and Sons Press, New York.
11) Draper, J. 1988. Plant Genetic Transformation and Gene Expression. Blackwell ScientificPublications, Oxford.
12) Old, R.W., and Primrose, S.B. 2004. Principles of Gene Manipulation. An introduction toGenetic Engineering. 5th Edition, Blackwell Science Publications.

BOTANY: IV- SEMESTER- SOFT CORE 3.2

MOLECULAR PLANT PATHOLOGY

Theory-64 Hrs

Learning Objectives:

- To involve in learning and track the novel approaches in plant pathology concept, plant protection and application.
- Learn major technical advances in the process of pathogenicity and pathogen adaptation in agricultural systems.
- To acquire knowledge necessary to understand, plan, and carry out molecular plant pathology schemes to identify pathogen using molecular techniques.
- To study the process of host pathogen interaction and factors affecting the growth and spread of serious pathogens and possible remedial approaches to check or manage infection in real time.
- To focus on novel research approaches and the related technologies required for addressing challenges in plant pathology and on major worldwide fungal and bacterial plant pathogens as well biocontrol agents used in agriculture.

Course Outcome:

On successful completion of this course each student will be able to:

- To understand the mechanism of disease development and genetics of host pathogen interactions.
- Understand the molecular basis of interactions between plants and viruses, micro-organisms, nematodes, insects, parasitic plants, symbiotic bacteria and fungi.
- Understand the complexity of the repertoire of defence mechanisms that plants utilize to (directly or indirectly) counteract attackers.
- Explain the fundamental molecular knowledge on these biological processes can be exploited to improve control measures, by novel non-toxic chemicals or genetic modification.
- Understand the economic importance of crop diseases and abiotic and biotic agents responsible for plant diseases, their biology, life cycles and dissemination.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Concepts and scope of physiological and molecular plant pathology; Molecular approaches to plant disease diagnosis; Nucleic acid based probes for detection of plant pathogens including non-culturable organisms; **Pathogenicity and Disease Development**-factors; induced resistance, virulence and pathogenecity factors; Plant-pathogen interactions with emphasis on incompatible interactions and induced resistance.

Unit -2: Pathogenesis: Necrogenic plant pathogenic bacteria with emphasis on hrp and avr genes and

virulence factors; Fungal plant pathogens with emphasis on virulence and pathogenicity factors; Plant viruses with emphasis on virus replication, virus transport in plants and control of plant viruses with transgenic plants; **Signal Transuduction-** recognition of the pathogen by the host, transmission of the alarm signal to the host defense providers; Necrotic defense reaction, defense through hypersensitive response; Molecular basis of induced biochemical reaction; Local and systemic acquired resistance (SAR).

Unit-3:Genetics of Plant Diseases and Resistance: Genes and diseases; physiological specialization among plant pathogens; Variability in viruses, bacteria and fungi; Levels of variability in pathogens and loss of virulence in plant pathogens; Genetics of virulence in pathogens and of resistance in host plants; Molecular plant breeding for disease resistance.

Unit-4: Genetics and molecular basis of host-pathogen interaction: Evolution of parasitism; genetics oh host-pathogen interaction; Gene for gene relationship; Criteria for gene for gene type relationship; Molecular basis of host pathogen interaction; Host-parasite-interaction. **Biotechnological methods of plant disease management;** Genetic engineering and crop protection; Cross protection; Gene silencing and disease control- mechanism of gene silencing and control of viral diseases; Engineered resistance to viral, bacterial, fungal and insect diseases of crop plants.

References:

1) Singh, R. S. (1973). Plant Disease. Oxford and IBH Pub.Co. New Delhi.
2) Agrios, G. N. (1994). Plant Pathology 2nd Edn. Academic Press NY.
3) Johnston A and Both, C. 1983-Plant Pathologists Pocket-book. 2nd Edn. CommonwealthMycological Institute, Oxford and IBH Pub. Co. Calcutta.
5) Rangaswamy G and Mahadevan A 2002. Diseases of crop plants in India, Prentice Hall ofIndia Pvt. Ltd. New Delhi.
6) Mehrotra, R. S.1983-Plant Pathology Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi.
7) Vidhyasekaran, P. 2004. Encylopedia of Plant Pathology.Viva Books Pvt.Ltd. New Delhi.

BOTANY: III SEMESTER- SOFTCORE 3.3

PLANT PROPAGATION AND PLANT BREEDING

Theory-64 Hrs

Learning Objectives:

- To learn the importance of plant propagation and modes, merits and demerits of plant propagation.
- Familiarize with the basic life cycles of plants that is sexual (seed) and asexual (vegetative) propagation.
- Technical know-how of development of new cultivars and its characteristics.
- Explain how genes and gene expression impact plant growth and development.
- Study the influence of plant hormones and their role in plant development.

Course Outcome:

On successful completion of this course each student will be able to:

- Identify characteristics of self- and cross-pollinated plants.
- Identify sources of genetic variation to conduct a breeding program.
- Determine breeding methodology appropriate for plants with different mating systems.
- Conduct basic statistical analyses related to plant breeding.
- Aptitude in seed propagation methods, including control of environmental factors, seed selection preparation for germination and seedling management.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: **Plant Propagation:** History, scope and importance of plant propagation; Propagation structures with reference to green house equipment and media; Seed propagation and vegetative propagation; Propagation by cuttings; Biology and techniques of grafting; Techniques of budding; Layering and its natural modifications; Propagation by specialized stems and roots; Micro propagation – techniques and applications in forestry and horticulture; Limitations and applications of vegetative propagation; Propagation methods of some selected plants – Citrus, Grape, Mango, Mulberry, Hibiscus, Rose, Croton, Eucalyptus.

Unit-2: Plant Breeding: History of plant breeding, objectives of plant breeding, salient achievements of plant breeding; Centres of origin of crop plants, Exploration and collection of plant genetic resources, evaluation of germplasm collection, documentation, conservation of plant genetic resources, utilization of genetic resources; The theory of pure line selection – Genetic basis, sources of genetic variation in pure lines, the land variety (races); Mendelian consequences of planned hybridization in self – pollinated crops - Early experiments on hybridization in plants, planned hybridization; Quantitative Inheritance; Applications of biometrical genetics in plant breeding.

Unit-3: Plant Breeding: Types of plant breeding; Fertility regulating mechanisms - manual or mechanical control, genetic control, incompatibility, male sterility, genetic engineering for male sterility, chemical control, genetic basis of heterosis; Synthetic and composite varieties -genetic basis, procedure for developing synthetic and composite varieties - genetic basis, procedure for developing synthetic varieties; Breeding for resistance to disease and insect pests.

Unit - 4 :Mutation Breeding: Significance of induced mutations in plant breeding; Polyploidy in plant breeding- **t**ypes of polyploids, induction of polyploidy, phenotypic effects of polyploidy, significance of polyploids; Tissue culture in crop improvement; Molecular approaches to crop improvement- probes, gel electrophoration, electrofusion, biolistics, gene cloning, transgenic plants (GMO's), molecular markers, construction of genetic maps, application of DNA makers in plant breeding, the role of gene technology in plant breeding; Crop breeding Institutes/Centers, Molecular biology in relation to intellectual property rights.

References:

1) Abbottt, A.J. and Atkin, R.K. eds. 1987. Improving vegetatively propagated crops. Academicpress, New York.
2) Bose, T.K., Sadhu, M.K., & Das, P., 1986. Propagation of Tropical and SubtropicalHorticultural crops, Nowya Prakash, Calcutta.
3) Hartmann, H.T., Kester E.D., Davis, F.T., and Geneve, R.L. 1997. Plant propagation.Principles and practices. Prentice Hall of India Private Limited, New Delhi.
4) Krishnamurthy. H.M. 1981. Plant Growth substances including application in Agriculture.
5) Pierik, L.M. 1987. In vitro culture of Higher plants Murtinus Nijhoff pub. Dordrecht.
6) Razdan, M.K. 1994. An Introduction to Plant tissue culture, Oxford and IBH Pub. Co., PVT.Ltd., Bombay and Calcutta.
7) Mac Donald, B. 1987. Practical woody plant propagation for nursery growers. Portland, OR:
8) Timber press.
9) Sadhu, M.K. 1989. Plant propagation Wiley eastern Ltd. N. Delhi.

BOTANY: III SEMESTER SOFT CORE 3.4
PHYTOCHEMISTRY AND HERBAL DRUG TECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- To learn the principles of various medicinal plants and phytochemical contents of these plants.
- Explore the interrelation between phytochemistry and traditional medicine.
- Bioprospecting approaches to screening novel molecules for medicinal purposes from different sources like ethnobotany.
- New strategies, including principal component analysis to provide an evidence base for the quality, safety and efficacy of traditional medicines, as a route to improved healthcare.

Course Outcome:

- On successful completion of this course each student will be able to:
- Explain the modern extraction, isolation and purification techniques of phytoconstituents.
- Describe the rules and regulations for assessment of herbal drugs, patenting of natural products and manufacture of herbal formulations based on traditional medicines.
- Understand many chemical reactions and structures of biological molecules essential for life on earth.
- Explain present status and prospects of herbal drug based industry and components for Good Manufacturing Practice for Indian systems of medicine.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: **Phytochemisrty:** Scope of phytochemistry, plants as source of chemical compounds, primary and secondary metabolites and its applications; Definition, source of herbal raw materials, identification, authentication, standardization of medicinal plants as per WHO guidelines and different herbal pharmacopoeias; Natural pigments, natural products as markers for new drug discovery.

Unit-2: Extraction, isolation and purification of phytochemicals: Selection of plant samples, processing and storage of samples for extraction; Factors influencing the choice of extraction, principles of extraction methods, infusion, decoction, digestion, maceration, percolation, solvent extraction, fluid extraction, ultrasound, microwave assisted extraction, advantage and disadvantage involved in each method; Isolation of selected primary and secondary metabolites – amino acids, proteins and carbohydrate; Phenolics, flavonoids, alkaloids, lipids, oils, terpenes and saponins; Purification techniques for primary and secondary metabolites – solvent-solvent fractionation and chromatography techniques.

Unit-3: Characterisation of Phytochemicals: Preliminary, qualitative and quantitative techniques – paper chromatography, thin layer chromatography, column chromatography- HPLC, GC (qualitative and quantitative), colour reactions for amino acids, sugars, phenolics, flavonoids, alkaloids, terpenes, saponins, oils, lipids; Spectroscopic estimations/gravimetric determination of total sugars, amino acids, proteins, phenolics, flavonoids, alkaloids, terpenes, saponins, oils, lipids; Characterisation using spectroscopic techniques - UV/VIS, FTIR, DSC (differential scanning calorimeter), NMR, MS, MALDI. XRD – single crystal and powder.

Unit-4: Standardisation and Validation of Phytochemical: Quality determination of herbaldrugs; Role of processing methods and storage conditions on quality of drugs; Standardisation parameters- impurity limit, ash content, extractable matter, moisture content, other phytochemicals, microbial contaminants, pesticides; Validation of drug – guidelines, limit of detection and quantification of impurities, organoleptic properties, physical, chemical, biological characteristics, stability testing, storage conditions and packing system/unit.

References:

- Braithwaite, A. and Smith, F.J. 1996. Chromatographic Methods. 5th edn., Blackie Academic & Professional, London.
- Bourne, U.K. Kokate, Purohit, C.K. and Gokhale S.B. 1983. Pharmacognosy. Nivali Prakashan Publication.
- Braithwaite, A. and Smith, F. J. 1996. Chromatographic Methods. 5th edn. Blackie Academic & Professional, London.
- Sadasivam. S. and A. Manickam, 0000. Bio Chemical methods 2nd edn. New Age International Pvt Ltd. New Delhi.
- Harborne, J.B. 1984. Phytochemical Methods, 2nd edn. Chapman and Hall, London. Harborne J.B., 1973. Phytochemical methods a guide to modern techniques of plants analysis. Chapman and Hall Ltd. London.

BOTANY: III SEMESTER- OPEN ELECTIVE 3.1

PLANT PROPAGATION TECHNIQUES

Theory-96 Hrs

Learning Objectives:

- To learn the concept and application of different techniques of propagation.
- To familiarize with different methods of propagation like cutting, layering, grafting and budding and their commercial exploitation.
- Identification, standardization and implementation of successful or highly effective techniques for production of rare, medicinal and commercially important plants.
- To acquire knowledge, skill and techniques of development and management of nursery.

Course Outcome:
On successful completion of this course each student will be able to:
- Identify characteristics of self- and cross-pollinated plants.
- Identify sources of genetic variation to conduct a breeding program.
- Determine breeding methodology appropriate for plants with different mating systems.
- Conduct basic statistical analyses related to plant breeding.
- Aptitude in seed propagation methods, including control of environmental factors, seed selection preparation for germination and seedling management.

Course Pedagogy:
- The course involves rigorous two hours of lectures, two hours of tutorial, activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: History, scope and importance of plant propagation; Propagation structures with reference to green house equipment and media; Seed propagation – the development of seeds, techniques of seed production and handling principles and media.

Unit-2: Vegetative propagation: Techniques of propagation by cuttings; stem cuttings – hard wood, semi hard wood, soft wood and herbaceous, leaf cuttings, leaf bud cuttings, root cuttings; Biology and techniques of grafting: Whip and tongue, wedge and cleft, bark, side grafting, approach.

Unit-3: Techniques of budding: T- budding patch budding, chip budding, ring budding; Layering and its natural modifications- simple layering, tip layering, mound or stool layering, air layering, compound or serpentine layering and trench layering; Propagation by specialized stems and roots.

Unit- 4: Micro propagation – techniques and applications in forestry and horticulture; Advantage, limitations and applications of vegetative propagation, clones, genetic variation in asexually propagated plants, different methods; Propagation methods of some selected plants – Citrus, gape, mango, mulberry, hibiscus, rose, Croton, Eucalyptus.

References:

1) Abbott, A.J. and Atkin, R.K. (eds.) 1987. Improving vegetatively propagated crops. Academicpress, New York.
2) Bose, T.K., Sadhu, M.K., and Das, P., 1986. Propagation of Tropical and SubtropicalHorticultural crops, Nowya Prakash, Calcutta.
3) Hartmann and Kester, 1983. Plant propagation
4) Hartmann, H.T., Kester E.D., Davis, F.T. and Geneve, R.L. 1997. Plant propagation. Principlesand practices. Prentice Hall of India Private Limited, New Delhi.
5) Krishnamurthy. H.M. 1981. Plant Growth substances including application in Agriculture.
6) L.M. Pierik 1987. In vitro culture of Higher plants Murtinus Nijhoff pub. Dordrecht.
7) M.K. Razdan 1994. An Introduction to Plant tissue culture, Oxford and IBH Pub. Co., PVT.Ltd., Bombay and Calcutta.
8) Mac Donald, B. 1987. Practical woody plant propagation for nursery growers. Portland, OR:Timber press.
9) Sadhu, M.K. 1989. Plant propagation Wiley eastern Ltd. N. Delhi.

BOTANY: IV- SEMESTER- HARD CORE 4.1

ECOLOGY, CONSERVATION BIOLOGY AND PHYTOGEOGRAPHY

Theory-64 Hrs

Learning Objectives:

- This course is designed to systematically learn the ecosystem and ecosystem functioning.
- Components of world biodiversity, importance, values and distribution of biodiversity on earth.
- Characteristics and dynamics of various biotic and abiotic components to operate at individuals, population, community levels for successful ecosystem functioning.
- Important aspects of environment, deterioration of environments and conservation of biodiversity at its basic level.
- Phytogeography and major vegetational types of the world and biodiversity hot spots and threats to biodiversity.
- Functioning of ecosystem and natural resources and its state and deterioration.
- Conservation concept, world conservation efforts and status of conservation movements at national and international level by different organizations.

Course Outcome:

On successful completion of this course each student will be able to:

- Enhance the knowledge about the basic concept and structure of ecosystem, concept of community, animal habitat interaction, many behavioural aspects, dependency and biodiversity values.
- Understand and appreciate major living and non-living components of regional and global environment, and how they interact; identify threats to them; and know how these threats can be mitigated; manage and protect the diversity.
- Enhance the understanding about the national and International treaties, international biodiversity conventions and action plans.
- Identify the pros and cons of various approaches to monitoring environment.
- Identify and articulate scope, interconnections, and multiple roles of environmental policy across different scales and sectors (local, state, national, international policy).
- Understand Phytogeography and elements of floristic studies, endemism, effect of climate distribution of vegetation types.
- Know the application of remote sensing and geographical information system (GIS) technology in wildlife conservation and management.
- Adapting sustainability as a practice in life and in society.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Introduction and scope of Ecology: Plants and the environment- plant adaptation, ecotypes, habitat ecology- fresh water and marine water ecology (ecosystems), wetlands and their characteristics; Ecosystem function; The distribution of biomes; Major Terrestrial Biomes; Forests-Tropical Forests-Temperate Forests, Taiga, Grasslands, Savanna, TemperateGrasslands/Prairies, Tundra, Desert and Chaparral.

Unit-2: Environmental Biology: Global warming: Greenhouse gases - causes and consequences; Ozone depletion- causes and consequences; Air, water and soil pollution - major pollutants, their source, permissible limits - and control methods; Radioactive pollution- Ionising radiation, disposal of radioactive waste, nuclear accidents; Environmental Education Programmes - WWF, UNEP, MAB; Role of plants in solving energy crisis and ameliorating global warming.

Unit-3: Biodiversity and Conservation Biology: Science in the service of Biodiversity, biodiversity and its value, biodiversity issues, concerns, management; Biodiversity hot spots; Biodiversity- threats and current status of biodiversity; IUCN categories, Red Data book and Red lists, invasive alien species as threat to biodiversity; Conservation strategies- past, present, and future; Attitudes about conservation; conservation movements; CITES (Convention on international trade in endangered species), WCU (World Conservation Union); Endangered species Act. 2002 (GOI); Protected areas, Network of India- history, size, scale and management; Heritage trees.

Unit-4: Phytogeography: Biogeography of the world, India and Karnataka; Climatic zones, tectonics, continental movements; Types of plant distribution – discontinuous distribution - land bridge theory, continental drift; continuous distribution-cosmopolitan, circumpolar, circumboreal, circumaustral, pantropical; Distribution of plants - islands; Phytochorea of the world, India; Plant dispersal, migrations and isolation; Eendemic plants of Western Ghats andEastern Himalayas; Origin, distribution and acclimatization

of coffee, cardamom, sugarcane, cashew, ragi, maize, wheat, rice and cotton; Remote sensing and GPS, study of vegetation by GIS (Geographical Information system).

References:

1) Polunin, N. 1961. Introduction to plant geography.
2) Good R.D. 1974. Geography of the flowering plants.
3) James H. B. 1998. Biogeography.
4) Cain, S.A. 1944. Foundations of plant Geography.
5) Croiat, 1952. Manual of Phytogeography.
6) Edgar A. 1972. Plants, Man and Life.
7) Valentine, D. H. 1972. Taxonomy, Phytogeography & Evolution.
8) Phil Gibson J. and Gibson Terri, R. 2006. Plant ecology.
9) Primack, R. B. 2006. Essentials of conservation biology.
10) Ricklefs, R. E. 2001. The Economy of Nature.
11) Narasaiah M. L., 2005. Biodiversity and Sustainable Development. 12)Tondon P, Abrol Y. P, Kumaria S., 2007. Biodiversity and its significance.
14) Krishnamurthy K. V. 2007. An Advanced Textbook on Biodiversity: Principles and Practice.
15) Christian Leveque and Jean-Claude Mounolou (2003). Biodiversity.
16) Jeffries Michael J. 2006. Biodiversity and conservation.

BOTANY: IV- SEMESTER- HARD CORE 4.2

SEED TECHNOLOGY

Theory-64 Hrs

Learning Objectives:

- To introduce the principles of seed science and technology, its development in India and world.
- To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance. Importance of seed in Agriculture, seed structure, types and development and seed economy.
- Study the development of superior crop plant varieties, their evaluation and release.
- To study seed production, processing, seed storage, seed testing, seed quality control, seed certification, seed marketing.
- To study various conventional and non-conventional Hybrid Seed Production technologies.
- To know distribution and research on seed these aspects. Seed production, seed handling based on modern botanical and agricultural sciences. National and international seed quality control organizations, regulatory bodies and seed certification agencies.
- Management practices of timely supply of new varieties and distribution.
- Assured high quality of seeds, good vigour and viability in produced seeds.

Course Outcome:

On successful completion of this course each student will be able to:

- Have a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.
- Know the various conventional and non-conventional Hybrid Seed Production technologies.
- Explain the concepts and significance of seed certification and seed legislation. Knowledge of national and international seed quality control organizations and seed certification agencies.

- Promote the possibility of self-employment and build-up a progressive and successful career in industries with a biotechnological perspective.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Seed Technology: Introduction to seed science and technology and its goals; Development of seed technology industry in India; Seed as basic input in agriculture; Seed Biology - Seed development, morphology and anatomy of dicot and monocot seeds; Seed structure and functions; Seed programmes and organizations; Seed village concept, seed production agencies, seed industry and custom seed production in India; International Seed Science and Technology Organizations.

Unit-2:Seed Production: General principles of seed production in self and cross pollinated and vegetatively propagated crops; Hybrid seed production; Maintenance of inbred lines and breeders seeds; Synthetic and composite seeds; Improved seed and their identification; Germplasm banks; **Seed Processing**-Harvesting, seed drying, seed cleaning and grading; Equipments; Seed Storage- types of storage structure; seed factors affecting storage life, effect of storage on relative humidity, temperature and moisture; Seed deterioration; Seed treatment.

Unit-3: Seed Quality Testing: Devices and tools used in seed testing; ISTA and its role in seed testing; Seed sampling- physical purity and heterogeneity test; Seed moisture content-importance and determination and methods; Viability and vigour testing; Genetic purity testing -objectiveand criteria for genetic purity testing, seed health testing, field and seed standards, designated diseases, objectionable weeds; Significance of seed borne diseases, seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes; Preparation and dispatch of seed testing reports, storage of guard samples, application and use of seed standards and tolerances.

Unit- 4: Seed Certification: Principles and philosophy of seed certification, purpose and procedures, national seed programme; National Seed Corporation (NSC) - agencies responsible for achieving self-reliance in seed production and supply of quality of seeds (State Seeds Corporation; National Seed Development Council (NSDC); Central Seed Committee(CSC) ; Seed market surveys, seed industry in relation to global market; Concept of WTO, GATT, IPR, Plant Variety Protection and its significance seed technology; UPOV and its role.

References:

1) ACAR.2009. Handbook of Agriculture. Indian Council of Agricultural Research, NewDelhi.
2) ACAR.2013. Handbook of Horticulture. Indian Council of Agricultural Research, NewDelhi.
3) Agarawal, P. K. 2005. Principles of Seed Technology.2nd edn. Oxford and IBH PublishingCo. Pvt. Ltd. New Delhi.
4) Basra, A. S. 2006. Handbook of Seed Science and Technology, The Haworth Press, USA.
5) Copeland, L. O. and McDonald, M. B. 2001. Principles of Seed Science and Technology.4th edn. Chapman & Hall.
6) Copeland, L.A. 1995. Principles of Seed Science and Technology- Kluwer AcademicPublishers, The Netherlands.
7) Michael, B. and Bewley, D. 2000. Seed technology and its biological basis. Wiley- Blackwell.
8) Neergaard, P. 2005. Seed Pathology, Palgrave, Macmillan, Denmark. Science, Technology andUses. CABI, UK.
9) Vanangamudi, K., Natarajan, K., Saravanan, T., Natarajan, N., Umarani, R., Bharathi, A. and Srimathi, P. 2006. Advances in Seed Science and Technology: Vol: III: Forest Tree Seed Technology and Management, Agrobios, New Delhi.

BOTANY IV SEMESTER- HARD CORE 4.3
(PRACTICALS – VI: Based on HC 4.1 and 4.2) Courses

HARD CORE 4.1
ECOLOGY, CONSERVATION BIOLOGY AND PHYTOGEOGRAPHY

Practicals-32 Hrs

1) Study of local vegetation by quadrate method.
2) Water analysis for pollution studies.(Bio-monitoring: TDS, Hardness, Chlorides, CO_2 COD,DO, BOD)
3) Rapid detection of bacteriological quality of water with special reference to feacal coliforms.
4) Morphology and anatomy of plants in relation to habitats - Xerophytes, Mesophytes,Hydrophytes.
5) *In situ* and *Ex situ* method of conservation.
6) Eminent phytogeographers of the world (photos).
7) Continental drift (charts).
8) Application of Remote Sensing, GIS and GPS in Forestry and Wild life management.
9) Biogeography of the world – Oceans, deserts, islands, mountains.
10) Biogeography of India –rivers, mountains, islands.
11) Floristic regions of world – India and Karnataka.
12) Study of endemic plants of India.
13) Origin, acclimatization and distribution of Coffee, Cardamom, Sugarcane, Cashew, Ragi,Maize, Wheat, Rice and Cotton.

HARD CORE 4.2
SEED TECHNOLOGY

Practicals-32 Hrs

1) Determination of physical purity of seed samples.
2) Determination of density or weight per thousand seeds.
3) Determination of seed Heterogeneity.
4) Visual examination of dry seeds for disease symptoms.
5) Determination of moisture content by hot air oven method.
6) Seed viability test- TTC method.
7) Determination of seed germination by TP/BP/Sand method.
8) Evaluation of seedlings vigour by BP/Sand methods.
9) Seed vigour evaluation by (a) conductivity test (b) Hiltner's test (c) Performance test (d)Accelerated ageing test (e) Cold test.
10) Examination of suspensions obtained from washings of seed.
11) Infection sites studied by planting seed components.
12) Detection of seed-borne fungi and their characters of five seed borne pathogens.
13) Vist: Visit to seed industries/seed companies/ seed research stations.

BOTANY: IV- SEMESTER- SOFT CORE 4.1

SEED PATHOLOGY

Theory - 64 Hrs

Learning Objectives:

- To learn the basic and applied principles of different kinds of crop seed and seed pathology.
- To impart competence in planning to grow a seed crop, managing the crop and inspecting it for varietal purity and seed borne diseases.
- To provide knowledge about seed quality attributes and how the attributes apply to seed usage by the farmer and long-time storage.
- To learn the various methods without adversely affecting physiological and genetic quality; managing seeds in storage to ensure protracted longevity.
- To know the strategies of evaluation and, pre-and post-control tests of certified seeds, in the field plots as part of seed quality control activities.
- Explains the need for proper seed marketing and distribution for the benefit of the seed enterprise and the farmer/end user of the produced seed.

Course Outcome:
On successful completion of this course each student will be able to:

- Develop competence in planning to grow a seed crop, managing the crop and inspecting it for varietal purity and seed borne diseases.
- Disseminate knowledge about seed quality attributes and how the attributes apply to seed usage by the farmer.
- Explain the various methods without adversely affecting physiological and genetic quality; managing seeds in storage to ensure protracted longevity.
- Explain the evaluation and pre-and post-control tests of certified seeds, in the field plots as part of seed quality control activities.
- Know the need for proper seed marketing and distribution for the benefit of the seed enterprise and the farmer/end user of the produced seed.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit-1: Seed Pathology: Introduction, historical development, development of seed health testing; Reduction in crop yields loss in due to seed-borne diseases; Seed-borne pathogens **(**Fungi, Bacteria, Mycoplasma-like Organisms, fastidious Vascular Bacteria, Spiroplasmas, Viruses, Viroids, Nematodes); Location of seed-borne inoculums, histopathology of some seed-borne pathogens; Seed infection, mechanism of seed infection, seed infestation or contamination; Factors affecting seed infection; Longevity of seed-borne pathogens.

Unit-2: Seed transmission and inoculation, factors affecting seed transmission; Cultural practices, epidemiology and inoculum thresholds of seed-borne pathogens; Classification of seed-borne; Role of Seed-borne inoculum in disease development; Economic loss due to seedborne pathogens; Certification program; Seed health tests, Nonparasitic seed disorders; Deterioration of grains; Storage fungi, field and storage fungi; Invasion by storage fungi; effects of seed deterioration.

Unit-3: Detection of Seed-borne Diseases: Examination of dry seeds; Isolation of fungi, Bright-field microscopic examination, observation under UV light, measurement of gases, Determination of FAV, Moldy smell, collection of seed exudates; Immunoassays, ergosterol estimation; Avoiding damage to seeds during harvesting; Processing, threshing, storage conditions, reducing seed moisture to safe limits, seed treatment, resistance.

Unit-4: Mycotoxins - Fungi known to produce mycotoxins, Factors affecting mycotoxin production the effects and control of mycotoxins, storage conditions, sorting of grains, cultural operations, chemical treatment, biological control, detoxification, regulatory measures, use of resistant cultivars; Control of seed-borne pathogens; Selection of seed production areas; Crop management, crop rotation, isolation distances, rouging, biological control, chemical method, mechanical method, physical methods; Certification-certification standards, plant quarantine, national and international regulations.

References

1) Agarwal, V. K. and Sinclair, J. B. 1996. Principles of Seed Pathology, 2nd edn. CRC Press,Tayler and Francis, USA.
2) Neergaard, P. 1977. Seed Pathology. Vol. I..Macmillan Press, Cornell University, USA.
3) Agrios, G. N. 1994 -Plant Pathology 2nd edn. Academic Press, New York.
4) Mehrotra, R. S. 1983-Plant Pathology Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi.
5) Rangaswamy, G. and Mahadevan, K. 2002. Diseases of Crop plants in India. Prentice Hall of India Private Limited New Delhi.
6) Agarawal, P. K. 2005. Principles of Seed Technology.2 o. Pvt. Ltd. New Delhi. edn. Oxford and IBH Publishing
7) Basra, A. S. 2006. Handbook of Seed Science and Technology, The Haworth Press, USA.
8) Copeland, L.A. 1995. Principles of Seed Science and Technology- Kluwer Academic Publishers, The Netherlands.
9) Vanangamudi, K., Natarajan, K., Saravanan, T., Natarajan, N., Umarani, R., Bharathi, A and Srimathi, P. 2006. Advances in Seed Science and Technology: Vol: III: Forest Tree Seed Technology and Management, Agrobios, New Delhi.

BOTANY: IV- SEMESTER- SOFT CORE 4.2

BIO- ANALYTICAL TECHNIQUES

Theory-64 Hrs

Learning Objectives:

- To familiarise various basic and improved bio-analytical techniques used in biology.
- Especially the spectroscopic, Electrophoretic and molecular biology techniques which play crucial role in basic and applied research and academic learning.
- Methods, instrumentation and concepts related to study biological problems and effectively solve them.
- Application of these techniques in various fields like R&D labs, industry, Acadia and medicine.

Course Outcome:

On successful completion of this course each student will be able to:

- Bridge the gap between academics, research and industry.
- Explain the bioanalytical techniques along with their theory, working principal, common instrumentation and possible applications.
- Develop the skills to understand the theory and practice of bioanalytical techniques.
- Provide scientific understanding of analytical techniques and detailed interpretation of results.
- Understand the strengths, limitations and creative use of techniques for problem-solving.
- Discuss the principles involved in undertaking standard sample preparation procedure and recognise the critical importance of rigorous instrumental calibration procedures and the use of standards and reference materials.

- Work in various scientific areas including, life science, chemical science, material science and environmental science.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit- 1: Spectroscopy: Principles of UV-Visible spectroscopy, chromophores and theirinteraction with UV-visible radiation and their utilization in structural, qualitative and quantitative analysis of drug molecules; Infrared Spectroscopy, Infrared radiation and its interaction with organic molecules, vibrational mode of bonds, instrumentation and applications, interpretation of IR spectra; FTIR and ATR, X-ray diffraction methods.

Unit-2: Nuclear Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, field and precession, instrumentation and applications of NMR; Chromatographic techniques- Principles and applications- types- column, paper, thin layer and gas chromatography, HPLC, HPTLC, size exclusion chromatography, Affinity chromatography, Mass spectrometry, MALDI-TOF.

Unit-3: Electrophoresis: Principle and application of PAGE, SDS PAGE, immunostaining, immuno-electrophoresis, Iso-electric focusing, 2D electrophoresis Centrifugation- Principles, techniques of preparative and analytical centrifugation. Ultracentrifuges, molecular weight determination, sedimentation analysis, RCF. Microscopy- principles and applications of electron microscope (SEM and TEM), CryoEM, Preparations of specimen for electron microscopy- freeze drying, freeze etching, fixing, staining; confocal, fluorescent, flow cytometry - principles and applications.

Unit-4: Molecular Biology Techniques: Primer designing; Principles and applications of PCR; Blotting techniques; Hybridization techniques; Micro-array; Next Generation Sequencing- Nucleic acid sequencing.

References

1) Braithwaite, A. and Smith, F.J. 1996. Chromatographic Methods. 5th edn. BlackieAcademic & Professional London.
2) Budzikiewicz, H., Djerassi, C. and Williams, D.H. 1968. Mass Spectrometry ofOrganic Compounds. Holden-Day, San Francisco, CA
3) Harborne, J.B. 1984. Phytochemical Methods. 2nd edn. Chapman and Hall, London.
4) Harborne J.B. (1973) Phytochemical methods a guide to modern techniques of plantsanalysis. Chapman and Hall, London Ltd.

BOTANY: IV- SEMESTER- SOFT CORE 4.3

PLANT GENETIC ENGINEERING

Theory-64 Hrs

Learning Objectives:

- To understand the concepts, scope, and tools of genetic engineering, and appreciate its future perspectives.
- To learn about different cloning vectors and their applications in plant and animal cells.
- To comprehend the process of plant transformation using binary vectors and techniques integrating plant tissue culture.
- To study the genetic manipulation of herbicide resistance, pest resistance, and disease resistance in crops.
- To understand the nature of abiotic stress and strategies for engineering tolerance to specific water deficit stresses.
- To explore the genetic manipulation of crop yield and quality, including fruit ripening and protein composition.
- To learn about molecular farming, including metabolic engineering of plants and the economic considerations involved.
- To understand the current state of transgenic crops, concerns about GM crops, and the regulations of GM crops and products.

Course Outcomes:
On successful completion of this course each student will be able to:

- Ability to apply the principles and tools of genetic engineering in practical scenarios.
- Competence in using different cloning vectors for plant and animal cell transformations.
- Understanding of how to engineer crops for herbicide resistance, pest resistance, and disease resistance.
- Ability to engineer plants for tolerance to specific abiotic stresses, such as water deficit.
- Skills to manipulate the genetic factors influencing crop yield and quality.
- Understanding of the principles and applications of molecular farming.
- Awareness of the economic considerations, benefits, and challenges associated with transgenic crops.
- Knowledge of the regulatory landscape for GM crops and products, and the ability to navigate it effectively.

Course Pedagogy:
- The course involves rigorous two hours of lectures, two hours of tutorial, and two hours of practical/skill-based activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit 1: Introduction to Genetic Engineering: Concepts and scope of genetic engineering. Milestones in Plant Recombinant DNA Technology. Importance of gene manipulation in future perspectives. Tools in Genetic Engineering: Enzymes in genetic engineering - Restriction endonucleases- types and action, All DNA modifying enzymes. Cloning vectors: Plasmids isolation and purification- Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids, Shuttle vectors-types. YAC and BAC vectors, Lambda phage vectors, Lamda phage DNA as a vectors. Cloning vectors and expression vectors. Vectors for Plant cells, Vectors for animal cells, Baculovirus vectors- adenoviruses, Retroviruses, Transposons as vectors. Synthetic construction of vectors.

Unit 2:Binary vectors for plant transformation: Introduction, Desirable features of any plasmid vector, Development of plant transformation vector, Basic features of vectors for plant transformation, Optimization, Clean gene technology. Techniques for plant Transformation: Integration of plant tissue culture in to plant transformation protocols. Introduction, *Agrobacterium* mediated gene transfer, The Ti-plasmid, The process of T-DNA transfer and integration, Practical applications of Agrobacterium-mediated plant transformation, Transformation in Planta, Direct gene transfer methods

Unit 3:The genetic manipulation of herbicide resistance: The use of herbicide in modern agriculture, Strategies for engineering herbicide resistance, The environmental impact of herbicide-resistant crops. The genetic manipulation of pest resistance: GM strategies for insect resistance The *Bacillus thuringiensis* approach to insect resistance, The Copy Nature Strategy, Insect resistant crops and food safety. The genetic resistance to plant disease resistance**:** Plant pathogen interaction, Natural disease resistance pathways-Overlap between pests and diseases, Biotechnological resistance to disease resistance. Transgenic approaches to viral disease resistance.

Unit 4: Engineering stress tolerance: The nature of Abiotic Stress, The nature of Water deficit stress, Targeted approaches towards the manipulation of tolerance to specific water deficit stresses. The Improvement of crop yield and quality: The genetic manipulation of fruit ripening, engineering plant protein composition for improved nutrition, The genetic manipulation of crop yield by enhancement of photosynthesis. Molecular Farming/Pharming: Metabolic engineering of plants. Carbohydates and lipids, Molecular farming of proteins, Economic consideration of molecular farming. Future prospects for GM crops: The current state of transgenic crops, Concerns about GM crops, the regulations of GM crops and products.

References:

1) A. Slater, N. Scott and M. Fowler. 2003. Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, Oxford.
2) B.B. Buchanan, W. Gruissen and R.L. Jones (eds). 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Biology, Rockville, USA.
3) J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds). 2000 Plant Biotechnology. Springer Verlag, Heidelberg.
4) H.K. Das (ed.) 2004. Textbook of Biotechnology. Wiley India Pvt. Ltd., New Delhi.
5) I.Potrykus and G.Spangenberg, 1995 Gene Transfer to plants Springer, Berlin. Heidelberg.
6) J. Sambrook, E.F.Fritsch and T.Maniatis 1989. Molecular Cloning - A Laboratory Manual
7) Adrian Slater, Nigel Scott and Mark Flower, 2000 Plant Biotechnology -The Genetic Manipulation of Plants,Oxford University Press,).
8) J.Draper 1988. Plant Genetic Transformation and Gene Expression Blackwell Scientific Publications, Oxford.
9) R.W. Old, S.B.Primrose. 2004. Principles of Gene Manipulation. An Introduction to Genetic Engineering. Fifth Edition, Black well Science Publications.

BOTANY IV SEMESTER- SOFT CORE 4.4 (PRACTICALS – VII: Based on 2 Soft Core Courses offered)

SOFT CORE 4.1
SEED PATHOLOGY

Practicals-32 Hrs

1-5) Detection of seed-borne fungi and their identification.
6) Detection of Seed-borne bacteria.
6) Detection of seed-borne viruses.
7) Detection of seed-borne insects by egg-plug staining.
8) Detection seed-borne nematodes.
9) Effect of deterioration of grains by Storage Fungi.
10) Detection of seed-borne fungi by PCR.
11) Estimation of ergosterol by UV-visible Spectrophotometer.
12) Detection of mycotoxins by thin Layer chromatography.

SOFT CORE 4.2
BIO- ANALYTICAL TECHNIQUES

Practicals-32 Hrs

1) Calibration of bio-analytical instruments.
2) Principles and instrumentation and applications of imaging techniques:
3) Separation of fatty acids/lipids by TLC/HPTLC.
4) Separation of proteins by PAGE, SDS- PAGE.
5) Agarose gel electrophoresis of DNA/RNA.
6) Immunoelectrophoresis
7) Agar gel diffusion, counter immuno electrophoresis.
8) Verification of Beer Lambert law with the U.V. spectrophotometer.
9) Demonstration of blotting techniques.
10) Performing PCR for amplification of ITS regions of fungi/ bacteria.

SOFT CORE 4.3
PLANT GENETIC ENGINEERING

Practicals-32 Hrs

1) Isolation of genomic DNA from bacteria/plants and purification by agarose gel electrophoresis.
2) Restriction analysis of plasmids, gel purification of DNA, small and large scale purification of plasmids.
3) Preparation of competent *E. coli* cells. Bacterial transformation and recovery of plasmid clones.
4) Gene cloning in plasmids, analysis of recombinant plasmids.
5) DNA amplification by PCR, RT-PCR, Real Time PCR.
6) Analysis of DNA and RNA and Protein by Southern and Northern and Western blotting.
7) Demonstration: Plant tissue culture-preparation of Murashige and Skoog medium, shoot differentiation in tobacco. Transformation of *Agrobacterium* by triparental mating and by electroporation, *Agrobacterium*-mediated transformation of tobacco, detection of GUS and GFP in transgenic plants. Acclimatization of transgenic plants and maintenance in greenhouse.

BOTANY: IV- SEMESTER- SOFT CORE 4.4

PROJECT WORK OF 256 Hours

Learning objectives:

- Students will demonstrate a proficiency in knowledge of essential concepts in given science dissertation topic
- To learn essential concepts, techniques and individually perform thesis work under guidance and demonstrate outcomes of the work.
- Will be able to describe these principles and concepts and prepare thesis/dissertation at departmental level.
- Prepares challenging careers as budding researcher and organize required skills of writing debating and defending science problems.

COURSE OUTCOME

- The student shall submit and defend his/her science project work satisfactorily to qualify/complete the course.

BOTANY: IV SEMESTER - OPEN ELECTIVE 4.1

PLANT DIVERSITY AND HUMAN WELFARE

Theory-96 Hrs

Learning Objectives:

- Familiarize with local plant diversity to Understand different plant species.
- Raise awareness about biodiversity loss to recognize the impact of human activities on biodiversity.
- Appreciate the significance of plants for human welfare to explore the use of plants in medicine, forestry, and other aspects of human life.
- Understand conservation strategies to learn about in situ and ex situ conservation methods
- Recognize the importance of heritage trees to appreciate the cultural and ecological value of specific tree species.
- Explore plant resources sustainably to know how plants contribute to human well-being while maintaining ecological balance.

Course Outcome:

After successful completion of the course the student shall be able to;

- Students will be able to recognize and classify different plant species in their environment.
- Understand the causes of biodiversity loss and its consequences for ecosystems.
- Explore the role of plants in medicine, food, and other aspects of daily life.
- Learn about in situ and ex situ conservation methods to protect plant diversity.
- Appreciate the significance of heritage trees and their preservation.
- Understand how to balance human needs with ecological conservation.

Course Pedagogy:

- The course involves rigorous two hours of lectures, two hours of tutorial activities per week.
- Classroom teaching involves the conventional method of teaching using a blackboard and by PowerPoint presentation.
- Each student shall present one seminar/Assignment per course during the tutorial hour.
- Each student will be evaluated in the practical class on a daily basis.

Unit -1: Plant Diversity and Significance: Role of plant diversity in ameliorating energy crisis and global warming; Types of biodiversity-genetic diversity, species diversity, plant diversity at the ecosystem level; Agro-biodiversity and cultivated plant taxa, wild taxa; **Values and uses of Biodiversity-** Ethical and aesthetic values, precautionary principle, methodologies for valuation, uses of plants and microbes.

Unit -2: Loss of Biodiversity: Major causes of for biodiversity loss; Loss of genetic diversity, Loss of species diversity; Loss of ecosystem diversity; Loss of agro-biodiversity; Projected scenario for biodiversity loss; Management of Plant Biodiversity- Organizations associated with biodiversity management; Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations; Biodiversity information management and communication.

Unit -3: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Conservation of Heritage Trees.

Unit-4: Role of plants in relation to Human Welfare: Importance of forestry their utilization and commercial aspects, Avenue trees, Ornamental plants of India, Alcoholic beverages through ages, Fruits and nuts- Fruit crops of Karnataka and their commercial importance; Wood and its uses.

References:

1) Krishnamurthy K. V. 2007. An Advanced Textbook on Biodiversity: Principles and Practice.Oxford & IHB Publishing Co. Pvt. Ltd. New Delhi.
2) Christian Leveque and Jean-Claude Mounolou, 2003. Biodiversity. John Wiley & Sons Ltd,The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
3) Jeffries Michael J. 2006. Biodiversity and conservation, 2nd edn. Taylor and Francis Group,New York.

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