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University of Mysore

(Estd.1916)

M.Sc. BOTANY

Choice Based Credit System (CBCS)

UNIVERSITY OF MYSORE

Department of Studies in Botany
Manasagangotri, Mysuru-570006

Regulations and Syllabus
Master of Science in Botany
(Two-year semester scheme)

Under
Choice Based Credit System (CBCS)

Chairman
Board of Studies in Botany
University of Mysore
Manasagangotri
MYSORE-570 006

UNIVERSITY OF MYSORE
GUIDELINES AND REGULATIONS
LEADING TO
MASTER OF SCIENCE IN BOTANY
(TWO-YEAR SEMESTER SCHEME UNDER CBCS)

Programme Details

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

PROGRAMME OUTCOMES

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

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

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

- Further, the program curriculum is also designed and updated regularly 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 a 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 and economic importance of various species, millets, leguminous plants, fruits, essential oils, vegetables etc.
4. Understand economically important algae and fungi, their cultivation, uses and 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 interactions,
10. Inculcate the scientific temperament among students and outside the scientific community.

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

FIRST SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	30801	Virology, Bacteriology, Mycology and Plant Pathology	HC	2	2	2	4
2	30802	Phycology, Bryophytes, Pteridophytes and Gymnosperms	HC	2	2	2	4
3	30803	Systematics of Angiosperms	HC	2	2	2	4+2 = 6
4	30804	Fungal Biology and Biotechnology	SC	2	2	2	4
5	30805	Algal Biology and Biotechnology	SC	2	2	2	4
6	30806	Lichenology and Mycorrhizal Technology	SC	2	2	2	4
7	30807	Phytopathology	SC	2	2	2	4

*Field Study/Tour: The student shall undertake a field trip for a minimum of 2-3 days and shall submit the herbaria and tour report for evaluation-2 credits.**Any two soft core papers shall be studied.

SECOND SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	30811	Reproductive Biology of Angiosperms and Plant Morphogenesis	HC	2	2	2	4
2	30812	Cell Biology and Genetics	HC	2	2	2	4
3	30813	Plant Breeding and Evolutionary Biology	HC	2	2	2	4
4	30814	Plant Anatomy and Histochemistry	SC	2	0	2	3
5	30815	Ethno-Botany and Intellectual Property Rights (IPR)	SC	2	0	2	3
6	30816	Economic Botany	SC	2	0	2	3
7	30817	Medicinal Plants	OE	2	2	0	3

** Any two soft core papers shall be studied.

THIRD SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	30821	Biochemistry and Plant Physiology	HC	2	2	2	4
2	30822	Molecular Biology	HC	2	2	2	4
3	30823	Plant Biotechnology	HC	2	2	2	4
4	30824	Molecular Genetics of Plants	SC	2	2	2	4
5	30825	Molecular Plant Pathology	SC	2	2	2	4
6	30826	Plant Propagation and Plant Breeding	SC	2	2	2	4
7	30827	Photo-chemistry and Herbal Technology	SC	2	2	0	3
8	30828	Plant Propagation Techniques	OE				

* Any one soft core courses/papers shall be studied.

FOURTH SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	17031	Ecology, Conservation Biology and Phytogeography	HC	2	2	2	4
2		Project Work*	HC				8
3	17035	Seed Technology	SC	2	2	2	4
4		Seed Pathology	SC	2	2	2	4
5		Bio -Analytical Techniques	SC	2	2	2	4
6	17067	Plant Diversity and Human Welfare	OE	2	2	0	3

*Project Work: The student shall undertake a Project Work 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 and Research Supervisor for Evaluation.

FIRST SEMESTER
HARD CORE

COURSE-I: VIROLOGY, BACTERIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

LEARNING OBJECTIVES

- To understand the world of microbes and important types: Viruses, Fungi and Bacteria
- Study of form, habitat, biology and impact of living organisms on humans and 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 organism in health, industry and environmental fields
- *In-vitro* and *In-vivo* growth and its effect on variety of fields and impact of organisms to Society.
- Major discoveries and applications of living microorganisms to field of Agriculture, Health
- To understand the economic and pathological importance of bacteria, virus and fungi and the respective disease 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 their management.

PEDAGOGY

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

COURSE CONTENT

UNIT-I : 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-II: Bacteriology: Introduction and classification of Bacteria by Bergey's Manual of Determinative and Systematic 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-III: 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-IV: 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; Defense 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.

PRACTICALS

1. Laboratory guidelines, design, tools, equipments and other requirements for studying microorganisms.
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 of bacteria/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 wind velocity).
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.

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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`s Manual of Determinative Bacteriology, 9th edn. Williams and Wilkins, USA.

COURSE-II: PHYCOLOGY, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

LEARNING OBJECTIVE

- To study the algal diversity, distribution and pigmentation.
- Study of algal phylogeny and various life cycles and 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 Plant kingdom
- Study the Habit, forms and characteristic reproductive strategies from Algae to Gymnosperms
- Know the abundance and distribution of these lower forms from ecological context
- Scientifically study the classification strategies in practice of these group of organisms
- Know the evolutionary trends and geography of lower plants
- Study the economic importance of these life forms and their conservation

COURSE PEDAGOGY:

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

COURSE CONTENTS

UNIT-I: Phycology: Diversity and distribution of algae; Unicellular, colonial, filamentous, heterotrichous, parenchymatous, pseudoparenchymatous, siphonous forms; General characteristics, classification and phylogeny of algae; Pigmentation in algal groups; Role of photosynthetic and accessory pigments; Life cycles in algae - haplontic, diplontic, isomorphic and heteromorphic; Economic importance of algae.

UNIT-II: Bryophytes: Introduction, general characteristics, classification and phylogeny of Bryophytes; Distribution, habitat, external and internal morphology and reproduction; Comparative account on gametophytes and sporophytes of bryophytes; Economic and ecological importance.

UNIT-III: Pteridophytes: Introduction, 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.

UNIT-IV: Gymnosperms: Distribution, general characteristics, classification and phylogeny of Gymnosperms; Range in morphology, anatomy, reproduction and interrelationships of

- Cycadales, Ginkgoales, Coniferales, Gnetales; Pteridosperms; Economic importance of Gymnosperms.

PRACTICALS

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.

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 Lepidodendrales, Calamitales, Sphenophyllales and Coenopteridales (Fossil Pteriodophytes).

11-12) **Gymnosperms:** Study of morphology, anatomy and reproductive morphology of Zamia, Pinus and Ephedra, Ginkgo, Auracaria, Podocarpus, Gnetum, Agathis, Cupressus, Thuja; Economic importance of Gymnosperms.

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COURSE-III: SYSTEMATICS OF ANGIOSPERMS

LEARNING OBJECTIVE

- Understanding of plant morphology terminologies and identifying morphological peculiarities of plant and plant families.
- Understand the core systems of classification of angiosperms, nomenclature and interdisciplinary approaches and development of various classification systems
- Provide practical training in writing short species descriptions and illustration with specific examples
- Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance.
- Evaluate the medicinal importance of selected angiosperms.

COURSE OUTCOME:

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

- Understand the plant morphological terminologies and learn morphological diversity of plants.
- Learn the system and scheme of classification of angiosperms, nomenclature and identification of plants
- To gain proficiency in the use of taxonomic keys and identification manuals for identifying any unknown plants to species level.
- Provide lab-based training in writing short species descriptions and illustration with floral diagram.
- Recognize members of the major angiosperm families by identifying their diagnostic features and study their ecological distribution and their economic importance.
- Learn the techniques of herbarium preparation and maintenance

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical class on a daily basis
- A 3-day Botanical field trip/Semester to floristically rich regions of Western ghats, in addition to field trips to local region per week shall be undertaken to familiarize the students to the diversity of flora
- The students have to submit the tour report and herbaria for evaluation for 2 credits

COURSE CONTENTS

UNIT-I: 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-II: **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-III: 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-IV: 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.

PRACTICALS

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 report for evaluation for two credits).

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 from GenBank.

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SOFT CORE

COURSE-IV: FUNGAL BIOLOGY AND IOTECHNOLOGY

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, systematic, 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 and parasitic, saprophytic and symbiotic fungi and their interactions and commercial exploitation in including 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 Fermentation industry.
- The course is of national and international relevance as the fungal organisms are very important in biotechnology and academic research.

COURSE PEDAGOGY:

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

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV: Mushrooms and fungi in medicine; Toxic macromycetes; Mushroom cultivation; Model organisms- *Saccharomyces cerevisiae/Neurospora crassa*; Bio-deterioration of 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.

PRACTICALS

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*

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COURSE-V: ALGAL BIOLOGY AND BIOTECHNOLOGY

LEARNING OBJECTIVES:

- This course offers insights into the basic and applied aspects of one of the most cosmopolitan group 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 ultrastructural 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. Fresh water 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 macro algae. 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 necessitate 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, fresh water 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. 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:

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

COURSE CONTENTS: **Theory-32 hrs.**

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.

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.

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COURSE-VI: LICHENOLOGY AND MYCORRHIZAL TECHNOLOGY

LEARNING OBJECTIVE:

- To understand the development and Biology of Lichens
- To Study the diversity and biology 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 Environment.
- To understand the Mycorrhiza their types and importance
- The study of role of Mycorrhiza in Agriculture, Horticulture and Forestry.

COURSE OUTCOME:

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

- Understand the method of collection, identification and diversity of lichens
- Understand the importance of secondary metabolites of lichens and their applications in medicines and Pharmacology.
- Learn role of lichens as indicators of air pollution
- Understand the types and importance of Mycorrhiza, methods of collection and isolation of AM fungi
- Understand role of Mycorrhiza in Agriculture, Horticulture and Forestry.

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.

- Class room teaching involves conventional method of teaching using black board, power point presentation and online resourses.
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENT:

UNIT-I: 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-II: 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-III: 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-IV: 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; Phoshate solubilisation; Ecological significance of AM fungi; Importance of mycorrhiza in evolution of land plants; Role of mycorrhiza in agriculture, horticulture and forestry.

PRACTICALS

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.

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COURSE-VII: PHYTOPATHOLOGY

LEARNING OBJECTIVES:

- Learn the concepts and types disease in plants.
- Identify major principles of plant pathology and factors causes diseases.
- Recognize the etiological agents/ microbes responsible for plant disease and disease cycle and life cycle 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 ethological 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 protection of food from pests and diseases for sustained food security.

COURSE PEDAGOGY:

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

COURSE CONTENT

UNIT-I: 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-II: 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.

UNIT-III: 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-IV: 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.

PRACTICALS

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.

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SECOND SEMESTER

HARDCORE

COURSE-I: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS AND PLANT MORPHOGENESIS

LEARNING OBJECTIVE:

- 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 the 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 called phytochromes.
- 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 the female gametes, their deviations from the normal course of development and

- unusual features. 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 significance of 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.* The interaction of insects with plants to form galls,to study the process of tissue differentiation and gall formation.

COURSE PEDAGOGY:

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

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV : 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.

PRACTICALS

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, Xyris pauciflora, 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

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

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COURSE-II: CELL BIOLOGY AND GENETICS

LEARNING OBJECTIVE:

- Cell biology is a multidisciplinary field of Science, to be complete, it is necessary to envision the cell from all its facets - its Morphology, its Anatomy, its Physiology and its Biochemistry.

- The cell is the basic unit of life forms, knowledge about it with what it is made up of like each component of molecules, how do they work, their functionality as well as mechanisms are as fundamental as needed to get the holistic ability of life with its environment – Biosphere, the nature of life and its unity. In-depth knowledge of cell cycle regulation, cell signalling, signal transduction pathway and programmed cell death in plants. The conditions and laws governing under which organisms exists and flourishes - the phenomena of Life.

- Recognizing the basic similarities between all living Eukaryotic cells gives a better understanding, the present situation as we are using a few model organisms and " OMICS" techniques, there might many organism in the treasure house of nature, one can find out a few more organisms by identifying and establishing via extensive research as experimental tool/ sample, with a background of this Hard Core paper in their Masters.

- Study the diverse inheritance pattern of Mendelian principles, changing concepts of gene, expertise in mapping techniques of gene in prokaryotes and eukaryotes including solving genetic problems in practical classes. Understanding the mechanism of sex determination and dosage compensation in various organisms. Detail study and significance of transposable elements.

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 of plants, microbial model organisms including, different prokaryotic and eukaryotic cells and cell organelles.

- Study the morphology, micro-anatomy, physiology and biochemistry of cells and its nature.
- Understand membrane structure and function, membrane pump, membrane carrier, membrane channels, membrane physiology, Chromatin, chromosome and cell nucleus, Chemical and physical structure of chromosome.
- Acquire in-depth knowledge of cell cycle regulation, cell signalling, signal transduction pathway and programmed cell death, Physiological, biochemical and molecular aspects of cellular organelles and membrane trafficking, post translational targeting of protein etc.
- Understand the variation patterns to Mendelian inheritance and the changing concepts of the gene
- Acquire knowledge on gene mapping techniques in prokaryotes and eukaryotes and solving problems related to linkage and tetrad analysis.
- Understand the mechanism of sex determination and dosage compensation in various model organisms and studying the structure, types and mechanisms of transposition and significance of transposable elements in prokaryotes and eukaryotes

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical classes for each course

COURSE CONTENT

UNIT-I: 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-II: 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-III: 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; **Concept 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-IV: 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.

PRACTICALS

1) Determination of reducing sugars by Nelson-Somogyim'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 Genetics and Embryology).

8) Study of mitosis in normal and induced root tips cells of Onion.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.

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COURSE-III: PLANT BREEDING AND EVOLUTIONARY BIOLOGY

LEARNING OBJECTIVE:

- To study the Centres of origin of crop plants- Vavilov concept and 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 in crop improvements
- To study the methods involved in developing resistance to various aspects.
- To study the study of contribution 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 the life in the different eras. To study the evolutionary thoughts- Post Darwinism, Darwinism and Neo Darwinism.
- To Study the Various evidences of life- Fossils, geological time scale, 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 back cross 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 and variation and The Hardy – Weinberg law

COURSE PEDAGOGY:

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

COURSE CONTENTS

UNIT-I : Introduction: Objective and role of plant breeding; Evolution of plant breeding, scope of plant breeding, sciences related to plant breeding, Vavilov's concept of origin of centers of origin of crop plants; Recent trends in plant breeding; **Breeding Methods-**plant introduction and acclimatization, domestication and agriculture, pure line, clonal, mass and progeny selections, recurrent selection, pedigree, bulk and back cross methods; Heterosis breeding synthetic and composite varieties; **Breeding Techniques-**Mutation breeding, polyploidy, hybridization, tissue culture techniques in crop improvement, protoplast fusion, electrophoration, electro-fusion, biolistics, somatic hybridization, transgenic plants (GMO's); The role of Gene technology in plant breeding.

UNIT-II: Breeding for Specific Purposes: Breeding for disease resistance, insect resistance, drought and salinity, quality trait, multiple cropping systems, ideotype breeding, breeding for Adaptation; **Crop breeding and seed production-** Breeding field crops, seed production techniques, release of new varieties, intellectual property rights, computer application in plant breeding, crop breeding Institutes/Centers; Genetic resources and germplasm conservation; Scientific Plant breeding;
Green revolution; The elite crop (Golden rice); Contributions of **Dr.** M.S. Swaminathan, Dr. Norman E. Borlaug and N.I. Vavilov.

UNIT-III: Nature of Evolution : The origin, theories of evolution of life, earth and the universe,; Conditions of the early earth, emergence of the first living cell, origin of prokaryotic and eukaryotic cells, life in the Palaeozoic, Mesozoic and Coenozoic era. **Development of Evolutionary thoughts;** Ecological context, before Darwin, Darwinism, Darwin's evolutionary theory, Neo – Darwinism, modern synthesis: **Fossil evidence of Ancient life,** fossilization,; Interpreting geological time scale and fossil records; Evidences from comparative, morphology, patterns of development, comparative physiology and biochemistry, biogeography, palaeontology, taxonomy, anatomy and embryology, plant and animal breeding; Evidence from changing earth and sea; Extinctions; Evolutionary ecology.

UNIT-IV: Natural Selection : Types of natural selection, selective forces, selection models, sexual selection, selection and non adaptive characters, Adaptive radiation, artificial selection, **Variation- g**ene flow, genetic drift, gene mutation - Mendelian concept, chromosomal mutation, architectural changes in chromosomes; The Hardy – Weinberg law,

polyploidy in plant evolution; Speciation and origin of higher categories -Types of speciation, models of speciation, pattern of speciation, isolating mechanism and species formation, signification of speciation; Molecular evolution.

PRACTICALS

(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) Mode of pollination study in different crops.

(6) Identification of crop breeding institutes/ centers and logos.

(7) Studying and identification of contributors of plant breeding - M.S. Swaminathan, N.I. Vavilov, Norman . E. Borlaug .

(8) Study of contributions of scientists to evolutionary biology.

(9) -12) Study of models and photographs related to evolution.

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3) Griffith, A.J.F., Gelbart, W.M. Muller, J.H. and Lewintin, R.C. 1999. Modern Genetic analysis. W.H. Freeman and co. New York.
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15) Chahal, G.S. and Gosal, S.S. 2002. Principles and procedures of Plant Breeding. Narosa Publishing House, New Delhi.

COURSE: IV: PLANT ANATOMY AND HISTO-CHEMISTRY LEARNING OBJECTIVE :

- Studying plant anatomy allows a student to conceptually integrate organismal structure and function.
- To learn more about how organisms are put together and how they work
- It helps to reveal the relationships between structure, function, taxonomy, ecology, and developmental genetics.
- It also helps us to distinguish between monocots, Dicots, and gymnosperms. Such, a study is linked to plant physiology. Hence, it helps in the improvement of food crops
- The study of plant anatomy helps us to understand the structural adaptations of plants with respect to diverse environmental conditions.
- Wood structure and industrial activity
- How to address plant diseases and stressful condition
- Plant protection against pests
- Discovering new plant species and to obtain a deeper knowledge of how to care for plants

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 and preserve and stain the plant tissues; Double staining methods and preparation of histochemical stains

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENTS

UNIT-I: 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-II: 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 -III: 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-IV: 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.

PRACTICALS

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.

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2) Cariquist, S. 1967. Comparative Plant Anatomy- Holt Reinert and Winston, New York.

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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.

COURSE-V: ETHNO-BOTANY AND INTELLECTUAL PROPERTY RIGHTS (IPR)

LEARNING OBJECTIVES:

- To study the use of plants by different ethnic groups and traditional knowledge, practices and their uses.
- To document and validate the systematic uses of traditional knowledge.
- To bio prospect, screen, validate herbal medicines from medicinal plants used by tribal people.
- To know the types, application and managing of 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:

- Understand the different ethnic groups and traditional knowledge practice and their uses.
- Learn the bioprospecting, screening and validation of herbal medicines from medicinal plants used by tribal people.
- Understand the nature and management of IPRs, issues related with Traditional knowledge.
- Understand the national and international pacts, regulation, laws and treaties related to IPRs and people.

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board, power point presentation and online resources / demonstration
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV: Study of Intellectual Property Rights – patents, trademark, geographical indication, copyright; IPR and Traditional Knowledge; Bio-piracy of traditional knowledge; Ethnobotany 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.

PRACTICALS

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 chemical methods.
6) A visit to a Tribal area to conduct field work and collect ethno botanical information / data.

7) Listing of Crude drugs in Pansali shops (local crude drugs shops) and their identification (little known drugs only).
8) -12) Visit to nearby Western Ghats and Sacred Groves.

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 ethno botanists, Lucknow, India.
4) Jain, S.K. 1990. Contributions of Indian ethno-botany. Scientific Publishers, Jodhpur.
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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.

COURSE-VI: ECONOMIC BOTANY

LEARNING OBJECTIVES:

- Introduction to 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 impact of science and technology
- Annual production, trade share and import and export statistics of essential and economic importance of 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 basics of ongoing trends in economic aspects of different groups of wild and cultivated plant species since the dawn of civilization
- Introduction to 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 impact of science and technology

- Understand the annual production, trade share and import and export statistics of essential and economic importance of various crop products.
- Study the distribution of economic crops and their trade related centres of trade

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student will be evaluated in the practical classes for each course

COURSE CONTENTS

UNIT-I: 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 brief account of economically important horticultural and floricultural plants.

UNIT-II: 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-III: 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-IV: 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.

PRACTICALS

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.
5) Utility, uses and economic importance of sugar yielding crops.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.

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.
3) Pandey, S.N. and Chandha, A. 1999. Economic Botany. Vikas Publishing House Pvt. Ltd. New Delhi.

OPEN ELECTIVE

COURSE-VII: MEDICINAL PLANTS

LEARNING OBJECTIVES:

- To know the use of major classes of medicinal plants used by healers from antiquity
- Historical use of medicinal plants, practices and uses of medicinal plants in Unani, Ayurveda, Siddha etc discipline of medicine and documentation.
- Bioprospecting for medicinal plants from various tribal cultures and evaluation of medicinal properties of well-known plants and uses
- Screening, evaluation and analysis of medicinal plants, activity guided assay in determining medicinal values.
- 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
- Know the historical use of medicinal plants, practices and documentation and uses in Unani, Ayurveda, Siddha etc discipline of medicine.
- Bioprospecting for medicinal plants from various tribal cultures and evaluation of medicinal properties of well-known plants and uses
- 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:

- Course involves rigorous two hours of lectures, two hours of tutorial /skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation

- Each student shall present one seminar/Assignment per course during tutorial hour

COURSE CONTENTS

UNIT-I: 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-II: 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 - III: 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- IV: 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.

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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 Publishing Pvt. Ltd.

THIRD SEMESTER

HARD CORE

COURSE-I: BIOCHEMISTRY AND PLANT PHYSIOLOGY

LEARNING OBJECTIVE:

- This course emphasizes on physiological and biochemical functions of plants. The spectacular diversity of plants is familiar to everyone, regardless of their distribution, all plants carryout fundamentally similar physiological functions, like photosynthesis, respiration, metabolic pathways and programmed cell death.

- The goal of this course is students learn about the framework of how the plant system functions by understanding biochemical synthesis pathways, their enzymes , growth regulators and acquisition of mineral nutrients and details of stress physiology. Which 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.
- Know the Plant system functions by understanding biochemical synthesis pathways, their enzymes, growth regulators and 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:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical classes for each course

COURSE CONTENTS

UNIT-I : 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-II: 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-III: 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 -IV: 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;

PRACTICALS

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.

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COURSE-II: MOLECULAR BIOLOGY

LEARNING OBJECTIVES

- To know the origin of DNA science and related major discoveries which paved the beginning of molecular biology
- Acquire basic in-depth knowledge of biological cellular processes through the study of the underlying molecular mechanism - the principle of Central dogma of molecular biology.
- Learn the detailed molecular processes of DNA replication, Transcription and translation processes in prokaryotes and eukaryote organisms
- Familiarize with regulation of cell cycle and molecular processes of DNA Replication, Transcription and Translation and its implication on cellular function
- Application of molecular biology principle in every life science approaches
- Appreciate the latest achievements of Genome science and impact of genomics, proteomics and metabolomics in life and health

COURSE OUTCOME:

On successful completion of this course the student will be able to;

- Gains detailed know how of chemical and molecular processes that occur in and between living cells.
- Provide insight into the most significant molecular and cell-based experimental methods used in molecular biology to expand our understanding of functioning of biology.
- Develop precise knowledge and understanding of physical and chemical mutations and the various repair mechanisms that rectify the damage in cellular processes.
- Develop proficiency in isolation, estimation and determination of biomolecules to understand cellular mechanism of operon and RNA interference.
- Develop capacity to plan conduct and report independent experiments of molecular biology appreciating the recent developments.

COURSE PEDAGOGY:

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

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV : 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.

PRACTICALS

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 RNA by Orcinol method
7) Estimation of proteins by Biuret method.
8) Estimation of protein by Bradford method.
9) Determination of Tm value of DNA.9-12)Photo graphs/ charts related to molecular biology/Molecular Biologists.

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COURSE-III: PLANT BIOTECHNOLOGY

LEARNING OBJECTIVES

- The aim of this paper is to familiarize the students with the concept of genetic engineering and their enzymology.
- This paper mainly focuses on recombinant DNA technology and its prospects in modern life.
- Involves breeding to improve plants for various reasons such as 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 get the idea of cloning and its related field.
- 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 productionKnow 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
- Class room teaching involves conventional method of teaching using black board and by power point presentation

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

COURSE CONTENTS

UNIT-I: 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-II: 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 III: 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 IV: 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.

PRACTICALS

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 secondary metabolites.
5) Encapsulation of somatic embryos and production of Synthetic seed.
6) Extraction of secondary metabolites using Soxhlet extractor and Identification of In vitro 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 gel electrophoresis.
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 of plasmid 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.

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10. Roberta, H. Smith, 2012. Plant Tissue Culture: Techniques and Experiments 3 edition. Academic Press; US.

COURSE-IV: MOLECULAR GENETICS OF PLANTS

LEARNING OBJECTIVES

- To understand the various developmental aspects operating at molecular level of plants and model organisms.
- To understand the genes and their expression in model organisms.
- To understand the genetic mechanism of gene transfer
- To understand the basic concepts of Genomics and Proteomics.
- Types of databases of Bioinformatics and their applications
- Bioinformatics and its applications in crop improvement

COURSE OUTCOME:

On successful completion of this course each student will be able to understand the ;

- Molecular mechanisms directing plant gene expression under diverse environmental and developmental stimuli.
- The genetic basis of photosynthesis, nitrogen fixation, leaf , flower and seed development
- The biology and genetics of Agrobacterium and mechanism of gene transfer and integration and development of vectors for plant transformation
- The basic concepts of Genomics, Proteomics and bioinformatics,
- Know the new algorithms and analysis method, existing software to effectively extract information from large databases and to use this information in computer modeling.
- The application of bioinformatics in drug discovery and development.

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board, power point presentation and online demonstration.
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV: 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.

PRACTICALS

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

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COURSE-V: MOLECULAR PLANT PATHOLOGY

LEARNING OBJECTIVE

- 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:

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

COURSE CONTENTS

UNIT-I: 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 -II: 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-III: 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-IV: 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.

PRACTICALS

1-2) Testing hypersensitivity reaction on *Nicotiana and Bajra.*
3) Estimation of lypoxygenease in diseased and healthy plants.
4) Estimation of polyphenols in diseased and healthy plants.
5-7) Studying systemic acquired resistance in crop plants.
8) Genetic testing of disease resistance in plants.
9-11) Molecular detection of viruses, Mycoplasma, fungi and bacteria from infected plants.
12) In-vitro testing of pathogen virulence.
Visit to agricultural research station to study diseases on different crop plants.

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COURSE-VI: PLANT PROPAGATION AND PLANT BREEDING

LEARNING OBJECTIVE

- To learn 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 knowhow 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;

- 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:

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

COURSE CONTENTS

UNIT-I: **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-II: 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-III: 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 - IV :Mutation Breeding: Significance of induced mutations in plant breeding; Polyploidy in plant breeding- types 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.

PRACTICALS

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.

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1) Abbottt, A.J. and Atkin, R.K. eds. 1987. Improving vegetatively propagated crops. Academic press, New York.
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COURSE-VII: PHYTOCHEMISTRY AND HERBAL TECHNOLOGY

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 health care.

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:

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

COURSE CONTENTS

UNIT-I: **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-II: 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-III: 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-IV: Standardisation and Validation of Photochemical: Quality determination of herbal drugs; 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.

PRACTICALS

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, and MALDI TOF.
9) -12) Submission of report on TEN important curative principles of Indian medicinal plants.

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3) Braithwaite, A. and Smith, F. J. 1996. Chromatographic Methods. 5th edn. Blackie AcademicProfessional, London.
4) Sadasivam. S. and A. Manickam, 0000. Bio Chemical methods 2nd edn. New Age International Pvt Ltd. New Delhi.

5) Harborne, J.B. 1984. Phytochemical Methods, 2nd edn. Chapman and Hall, London.
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OPEN ELECTIVE

COURSE-VIII: PLANT PROPAGATION TECHNIQUES

LEARNING OBJECTIVE

- 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:

- Course involves rigorous two hours of lectures and two hours of tutorial per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student shall present one seminar/Assignment per course during tutorial hour

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV: 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. Academic press, New York.
2) Bose, T.K., Sadhu, M.K., and Das, P., 1986. Propagation of Tropical and Subtropical Horticultural 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. Principles and 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.

FOURTH SEMESTER

HARD CORE

COURSE-I: ECOLOGY, CONSERVATION BIOLOGY AND PHYTOGEOGRAPHY

LEARNING OBJECTIVE

This course is designed to systematically learn the ecosystem and ecosystem functioning.

- 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.
- Phytogeogrpahy and major vegetational types of the world and biodiversity hot spots and threats to biodiversity.
- Biodiversity, importance, values and distribution of biodiversity on earth.
- 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 behavioral 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.
- Identify and articulate scope, interconnections, and multiple roles of environmental policy across different scales and sectors (local, state, national, international policy).
- Understand Phytogeogrpahy 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:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board, power point presentation and online demonstration
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENTS

UNIT-I: 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, Temperate Grasslands/Prairies, Tundra, Deser and Chaparral.

UNIT-II: 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-III: 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-IV: Phytogeogrpahy: 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 and Eastern 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).

PRACTICALS

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.

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.

COURSE-II: PROJECT WORK

LEARNING OBJECTIVE

- 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

COURSE PEDAGOGY:

- Course involves rigorous two hours discussion sessions, and eight hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation
- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical class on a daily basis

COURSE CONTENTS: Defined once the project topic is decided by respective supervisor

SOFT CORE

COURSE-III: SEED TECHNOLOGY

LEARNING OBJECTIVE

- 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:

- Course involves rigorous two hours of lectures, two hours of tutorial and two hours of practical/skill-based activities per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation

- Each student shall present one seminar/Assignment per course during tutorial hour
- Each student will be evaluated in the practical classes for each course
- Visit to seed industries/seed companies/seed research stations to familiarize with seed production, processing ,testing and marketing aspects of commercial seed organizations.

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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 - objective and 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- IV: 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.

PRACTICALS

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. Vist: Visit to seed industries/seed companies/ seed research stations.

REFERENCES

1) ACAR.2009. Handbook of Agriculture. Indian Council of Agricultural Research, New Delhi.
2) ACAR.2013. Handbook of Horticulture. Indian Council of Agricultural Research, New Delhi.
3) Agarawal, P. K. 2005. Principles of Seed Technology.2nd edn. Oxford and IBH Publishing Co. 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 Academic Publishers, 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 and Uses. 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.

COURSE-IV: SEED PATHOLOGY

LEARNING OBJECTIVE

- To learn the basic and applied principles of different kinds of crop seed and seed pathology.
- To impact 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 longevityTo 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:

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

COURSE CONTENTS

UNIT-I: 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-II: 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 seed borne 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-III: 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-IV: 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.

PRACTICALS

1-5) Detection of seed-borne fungi and their identification.

6) Detection of Seed-borne bacteria.

7) Detection of seed-borne viruses.

8) Detection of seed-borne insects by egg-plug staining.

9) Detection seed-borne nematodes.

10) Effect of deterioration of grains by Storage Fungi.

11) Detection of seed-borne fungi by PCR.

12) Estimation of ergosterol by UV-visible Spectrophotometer.

13) Detection of mycotoxins by thin Layer chromatography.

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 Co. Pvt. Ltd. New Delhi.
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10) Vanangamudi, K., Natarajan, K., Saravanan, T., Natarajan, N., Umarani, R., Bharathi,
11) A. and Srimathi, P. 2006. Advances in Seed Science and Technology: Vol: III: Forest Tree Seed Technology and Management, Agrobios, New Delhi.

COURSE-V: BIO- ANALYTICAL TECHNIQUES

LEARNING OBJECTIVE:

- To familiarize 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 bio analytical techniques along with their theory, working principal, common instrumentation and possible applications.
- Develop the skills to understand the theory and practice of bio analytical techniques. Provide scientific understanding of analytical techniques and detail 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:

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

COURSE CONTENTS

UNIT- I: Spectroscopy: Principles of UV-Visible spectroscopy, chromophores and their interaction 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-II: 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-III: 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-IV: Molecular Biology Techniques: Primer designing; Principles and applications of PCR; Blotting techniques; Hybridization techniques; Micro-array; Next Generation Sequencing- Nucleic acid sequencing.

PRACTICALS

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.

REFERENCES

1) Braithwaite, A. and Smith, F.J. 1996. Chromatographic Methods. 5th edn. Blackie Academic & Professional London.
2) Budzikiewicz, H., Djerassi, C. and Williams, D.H. 1968. Mass Spectrometry of Organic Compounds. Holden-Day, San Francisco, CA
3) Harborne, J.B. 1984. Phytochemical Methods. 2nd edn. Chapman and Hall, London.
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OPEN ELECTIVE

COURSE-VI: PLANT DIVERSITY AND HUMAN WELFARE

LEARNING OBJECTIVE

- This course is intended to learn about plants and their impact on humans.
- Which include plant as food, medicine and many other basic needs of humans
- How plants are distributed and influence the human population as natural resourse
- How we are all depend on plant diversity and humans are deteriorating it
- Conservation of these precious diversity and maintain sustainable utilization of plants
- Explore and learn using plants and plant products to cater human need without harming world plant community

COURSE OUTCOME:

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

- Understand the ecological perspectives of the environmental challenges, opportunities, and ecological management of the natural environment.
- Obtain insight into the management of interaction of human with the environment.
- Obtain insight into how biotechnology can be utilized for protection of environment.

- Enhance the knowledge about the basic concept and structure of ecosystem, concept of community, animal habitat interaction, many behavioral aspects, dependency and biodiversity values.
- Adapt the sustainability as a practice in life and in society.

COURSE PEDAGOGY:

- Course involves rigorous two hours of lectures and two hours of tutorial per week.
- Class room teaching involves conventional method of teaching using black board and by power point presentation and online resourses
- Each student shall present one seminar/Assignment per course during tutorial hour

COURSE CONTENTS

UNIT-I: 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-II: 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-III: 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-IV: 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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