



DEPARTMENT OF BOTANY

MINUTES OF THE MEETING OF THE BOARD OF STUDIES (BOS), OF BOTANY DEPARTMENT, SSU, PALAMPUR HELD ON 05.02.2019 AT 2:30 PM AT SSU PALAMPUR.

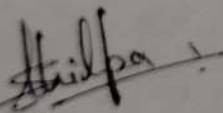
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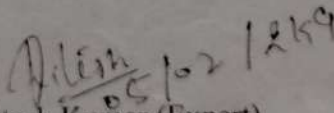
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|------------------------------------|----------|
| 1. Dr. Babina Rana, HoD            | Chairman |
| 2. Dr. Hitesh Kumar (Expert)       | Member   |
| 3. Ms. Shilpa, Assistant Professor | Member   |

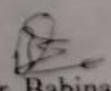
**The following agenda items were discussed:**

- The proposed syllabi for M.Sc Botany was discussed in detail and same were approved.
- The subject codes of units and all the papers were standardised as per the norms of Sri Sai University.
- The committee further recommended that the proposed syllabi be implemented w. e. f. the session 2019 -20 after the approval of the Academic Council.

The meeting ended with a vote of Thanks to the chair.

  
Ms. Shilpa  
Member

  
Dr. Hitesh Kumar (Expert)  
Member

  
Dr. Babina Rana  
Chairman

*Submitted to Hon'ble Vice Chancellor for approval of minutes*

*Crump*  
*5-2-19*

*VC*

*Approved*

*5/2/19*

## SEMESTER - I

### BOT 101 (BIOLOGY AND DIVERSITY OF ALGAE AND FUNGI)

L	T	P	Credit
4	0	0	4

#### Unit I

- Algae in diversified habitats (terrestrial, freshwater, marine).
- Thallus organization.
- Cell ultrastructure.
- Reproduction (vegetative, asexual, sexual) and patterns of life cycle.
- Criteria for classification of algae: (pigments, reserved food, flagella).

#### Unit II

- Fine structure of Algal plastids.
- Algal blooms.
- Algal biofertilizers.
- Economic importance of algae.
- General account of Lichens and their economic importance.

#### Unit III

- Introduction to Mycology: General characteristics of fungi, their significance to humans, organization of fungal cell, thallus, ultrastructure, reproduction (vegetative, asexual and sexual).
- Recent trends in classification.
- Comparative study of habits, habitats, somatic organization, anamorphs, teleomorphs and evolutionary trends in the life cycles of the members of the following:  
Ascomycota (ascocarp development, ascocarp types, centrum types and their bearing on classification, with emphasis on Yeast, Penicillium, Aspergillus, chaetomium, Neurospora, Claviceps and Venturia; *pleosporales*)

#### Unit IV

- General account of Powdery mildews and Discomycetes, Basidiomycota (basidiocarps types, development, general account of Hymenomycetes, Ustilaginomycetes and Urediniomycetes).
- General account of Deuteromycetes (sprouting structures), predaceous fungi, Dermatophytes, Alternaria, Helminthosporium, Cercospora, Colletotrichum, Pyricularia, Fusarium.

#### Unit V

- Sex hormones in fungi, Heterothallism and parasexual cycle
- Nutrition in fungi ( saprophytes, parasites, predators, symbionts)
- Importance of fungi in different microbial and biotechnological processes: Fungi in food and food industry, as agents of biodeterioration and biodegradation, in agriculture, in medical biotechnology

#### Books Recommended:

1. Fritsch, F.E. (1971). The structure and function of Algae. Vol I and II, London, Cambridge Univ Press.
2. Gupta, R. and Mukerji, K.G. (2001). Microbial Technology. APH Publishing Corp. New Delhi.
3. Kamat, N.D.(1982). Topics in Algae, Sai Kirpa Prakashan, Aurangabad
4. Kumar, H.D.(1985). Algal Cell Biology. Affiliated East-west Press Limited, New Delhi
5. Kumar, H.D.(1988). Introductory Phycology. Affiliated East-west Press Limited, New Delhi
6. Moore-Landecker, E.J. (1972). Fundamentals of the Fungi. Prentice Hall, Englewood cliff.

## BOT 102 (BIOLOGY AND DIVERSITY OF MICROBES AND PLANT PATHOLOGY)

L	T	P	Credit
4	0	0	4

### Unit I

- History and scope of microbiology, landmarks in microbiology, major groups of microorganisms, characterization, identification and classification of microorganisms.
- Structure of Bacteria: Structure and fine structure of cell wall and of internal and external structures to cell wall, spores and cysts. Nutrition of Bacteria: modes of nutrition, nutritional types, growth characteristics.
- Reproduction and genetic recombination in Bacteria: Binary fission, resting structure, conjugation, transformation and transduction, mechanisms of antibacterial action.
- General account of Rickettsia, Chlamydiae, Mollicutes and diseases caused by them.

### Unit II

- Viruses: History structure and classification, plant and animal viruses, nature and transmission, genome organization (TMV, CMV, CAMV and Gemini viruses).
- Isolation and Purification, detection, identification and economic importance, Bacteriophages, viroids and prions- nature and importance.
- Viruses in cancer; Principles of Immunology: general account of immunity, allergy, antigen-antibody, serology and types of vaccines.
- Applications of microbes in agriculture (Biofertilizers, biopesticides), industry (Alcoholic beverages, citric acid, penicillin production), environment (pollution indicator and control), and genetic engineering.

### Unit III

- History of plant pathogens, concepts, diagnosis, classification, importance and identification of unknown diseases, symptomatology and disease development.
- Host- pathogen interaction at population level: Transmission and spread of plant pathogens, disease epidemics, modelling and disease forecasting to control crop losses.

### Unit IV

- Management of plant diseases: Chemical, biological.
- IPM system development of transgenics, biopesticides, plant diseases clinics, quarantine.

### Unit V

- Specific plant diseases caused by diverse pathogens: Black wart of potato, Club root of Crucifers, Damping of seedlings, Late blight of potato, Downy mildew of grapes and bajra, Stem gall of coriander, Powdery mildew of wheat and apple, Apple scab.

### **Books Recommended:**

1. Barnett, J.H. (1968). Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
2. Bilgrami, K.S. and Dube, H.C. (1980). A text Book of Modern Plant Pathology. Vikas Publication House, New Delhi.
3. Butler, E.J. and Jones, S.G. (1986). Plant Pathology. Periodical Expert Book Agency, New Delhi.
4. Dube, R.C. and Maheshwari, D.K. (1999). A Text Book of microbiology, S.Chand and Co. Ltd. New Delhi.
5. Gupta, R. and Mukerji, K.G. (2001). Microbial Technology. APH Publishing Corp., New Delhi.

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**BOT 103 ( BIOLOGY AND DIVERSITY OF BRYOPHYTES AND PTERIDOPHYTES)**

L	T	P	Credit
4	0	0	4

**Unit I**

- General Introduction, Classification and salient features of Bryophytes.
- Comparison among Cryptogamous plants.
- A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales

**Unit II**

- Morphogenesis in Bryophytes.
- Distribution and ecology of Bryophytes in India with particular reference to Himachal Pradesh.
- Ecological and Economic importance of Bryophytes.

**Unit III**

- General introduction, Classification and Salient features of Pteridophytes; Comparison among ARCHIGONIATE.
- Introduction to Palaeobotany: Basic principles and techniques.
- A general account of the following fossil pteridophytes: Rhynia, Horneophyton, Asteroxylon, Lepidodendron, Sphenophyllum, Calamites

**Unit IV**

- Salient features of PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA and PTEROPSIDA (Emphasis is not to be placed on orders, families or type studies).
- Structure and Evolution of Stellar system in Pteridophytes.
- TELOME THEORY or the Evolution of Sporophyte in Pteridophytes.

**Unit V**

- Alternation of generations; Natural & Induced Implications of Apogamy and Apospory in Pteridophytes.
- Heterospory and Seed habit in Pteridophytes.
- Distribution and Ecology of the Ferns of the Himalaya with particular reference to Himachal Pradesh.
- Cytological Evolution and Economic Importance of Pteridophytes.

**Books Recommended:**

1. Bierhorst D.W. (1971). Morphology of vascular plants. Mac Millan Publishers. New York.
2. Cavers, F. (1911). The interrelationship of Bryophytes. New Phytology. Reprint No. 4: 1-203.
3. Chopra, R.S. (1976). The interrelationships of Indian Bryophytes. The Chronica Botanica. New Delhi.
4. Chopra, R.S. and Kumar, S.S. (1976). Musci of the western Himalayas and the Punjab Plains. The Chronica Botanica. New Delhi.
5. Sharma, O.P (1990). Textbook of pteridophyta. Mac Millan India Ltd. New Delhi.
6. Smith, G.M. (1971). Cryptogamic Botany. Vol. II: Bryophytes and Pteridophytes. Tata McGraw Hill. New Delhi.
7. Sporne, K.R. (1982). The morphology of Pteridophytes. Hutchinson University Press. London.
8. Stewart, W.N. and Rothwell, G.W. (1993). Paleobotany and the evolution of plants. Cambridge University Press. London.
9. Udar, R. (1976). Bryology in India. The Chronica Botanica. New Delhi.

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Department of Botany  
University of Delhi

**BOT 104 (BIOLOGY AND DIVERSITY OF GYMNOSPERMS)**

L	T	P	Credit
4	0	0	4

**Unit I**

- General Introduction and Salient features of Gymnosperms.
- Comparison among TRACHEOPHYTES.
- Classification of Gymnosperms.
- Introduction to Paleobotany, some basic principles and techniques.
- A general account of the following Fossil Cycadopsida: Archaeopteris, Lyginopteris, Crossotheca, Medullosa, Whittleseya, Aulotheca, Dolerotheca, Glossopteris, Wielandiella, Cycadeoidea, Pentoxylon And Cycas

**Unit II**

- A general account of the following Fossil Coniferopsida: Mesoxylon, Cordaites.
- Salient features of Living CYCADALES, CONIFERALES (Including Taxus) and GINKGOALES (Emphasis not to be placed on Families and Type studies).
- A general account of EPHEDRALES, WELWITSCHIALES and GENETALES.

**Unit III**

- Distribution of Conifers in India (with particular reference to Himachal Pradesh) and their economic importance.
- Structure, Identification and Evolution of wood and bark in Conifers.
- Structure, properties and uses of the following commercial timbers: Blue Pine, Chir pine, Deodar, Cypress and Yew.

**Unit IV**

- Comparative account of the Leaf Anatomy of the living Gymnosperms.
- Comparative study of male and female cones of Living Gymnosperms.
- Pollination mechanisms in Gymnosperms.

**Unit V**

- Comparative study of male and female gametophytes of the living Gymnosperms.
- Structure & evolution of Archaeogonium in Gymnosperms.
- Cytological evolution in Gymnosperms.

**Books Recommended:**

1. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms, New Age International Pvt. Ltd. New Delhi.
2. Bierhorst D.W. (1971). Morphology of vascular plants. McMillan Publishers. New York.
3. Biswas, C and Johri, B.N. (1997). The Gymnosperms. Narosa Publishing House. New Delhi.
4. Chamberlain, C.J. (1986). Gymnosperms: structure and evolution. CBS publishers. New Delhi.
5. Kubitzki, K. (1990). The families of vascular plants: Pteridophytes and Gymnosperms. SpringerVerlag. New York.
6. Sahni, K.C. (1990). Gymnosperms of India. Bishen Singh and Mahendrapal Singh and Co. Dehradun.
7. Sharma, O.P. (2002). Gymnosperms. Pragati Prakashan. Meerut.
8. Siddiqui, K.A. (2002). Elements of Palaeobotany. Kitab Mahal. Allahabad.
9. Singh, H. (1978). Embryology of Gymnosperms. In Encyclopedia of Plant Anatomy X. Gebryder, Bortragear, Berlin.
10. Sprone, K.R. (1965). The Morphology of Gymnosperms. Hutchinson and Co. London.



**BOT 105 (PRACTICAL I: MICROBES, ALGAE, FUNGI AND PLANT PATHOLOGY)**

L	T	P	Credit
0	0	1	1.5

**ALGAE**

Study of Morphological and reproductive parts of following Algal genera:

- Cyanophyta: *Anabaena*, *Synechocystis*, *Microcystis*, *Oscillatoria*.
- Chlorophyta: *Acetabularia*, *Chlorella*, *Cladophora*, *Hydrodictyon*, *Halimeda*, *Oedogonium*, *Pithophora*, *Spirogyra*, *Volvox*, *Nostoc*, *Ulothrix*.
- Xanthophyta: *Vaucheria*
- Phaeophyta: *Dictyota*, *Ectocarpus*, *fucus*, *Padina* and *Zonaria*.
- Rhodophyta: *Batrachosepermum*, *Gelidium*, *Gracillaria* and *Polysiphonia*
- *Gymnodinium* (Dinophyta), *Chryptomonas* (Cryptophyta), *Dinobryon* (Chrysophyta), *Prymnesium* (Prymnesiophyta), *Cyanophora* (Glaucophyta)
- Permanent slide preparation: *Oedogonium*, *Spirogyra* and *Saragassum*.

**Note: The students are required to collect and submit 10 algal specimens.**

**FUNGI, MICROBES AND PLANT PATHOGENS**

- To study morphology of following Myxomycetous fungi: *Trichia*, *Hemitrichia*, *Stemonitis*.
- To study comparative morphology of sporangiophores of following Oomycetous fungi: *Peronospora*, *Bremia* and *Sclerospora*.
- To study comparative morphology of Ascocarps
- To study symptoms and histopathological details of following: *Albugo candida*, *Synchytricum endobioticum*, *Protomyces microspors*, *Physoderma maydis*, *Erysiphe graminis*, *Urocystis tritici*, *Puccinia graminis tritici*, *P. recondita*, *P. striiformis*, *Alternaria solani*, *Cercospora arachidicola* and *Colletotrichum capsici*.
- To study different sopro stages in life cycle of *Puccinia* on primary and secondary host.
- Study of crustose, foliose and fruticose lichens.
- Study permanent slide of yeast.
- To study symptoms and spore morphology of *Ustilago*, *Sphaelotheca* and *Toliposporium*.
- To study range of variation in fructification of following basidiomycetous fungi: *Corticium*, *Thelephora*, *Clavaria*, *Polyporus*, *Trametes*, *Ganoderma*, *Agaricus*, *Boletus*, *Russula* and *Lactarius*.

**Note: The students are required to collect and submit 10 fungal specimens.**

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**BOT 106 (PRACTICAL II: BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS)**

L	T	P	Credit
0	0	1	1.5

**BRYOPHYTES**

Study of morphological, anatomical and reproductive parts of following **Bryophytes** genera

- Liverworts: *Marchantia*, *Porella*, *Reboulia*, *Plagiochasma*, *Targionia*.
- Hornworts: *Anthoceros*.
- Mosses: *Fimaria*, *Polytrichum* and *Bryum*.
- Specimen study: *Anthoceros*, *Sphagnum* and *Marchantia*.
- Collection and identification of bryophytes genera and slide preparation/T.S. of available material near university campus.
- Temporary mount preparation and study of: Gemma cups, gemmae and peristome teeth.

**PTERIDOPHYTES**

- Morphological study from specimens/class work material of *Psilotum nudum*, *Tmesipteris tannensis*, *Lycopodium cernuum*, *L. clavatum*, *L. squarrosum*, *Phylloglossum drummondii*, *Azolla microphylla*, *A. pinnata*, *Selaginella monospora*, *S. bryopteris*, *S. chrysorrhizas*, *S. pallidissima*, *S. adunca*, *S. subdiaphana*, *Isoetes panchanan*, *Equisetum debile*, *E. diffusum*, *E. ramossissimum*, *E. arvense*, *Marseilea*, *Salvinia*, *Pteris sp.*, *Dryopteris sp.*, *Asplenium sp.*
- Section cutting: *Equisetium*, *Sellaginella*, *Marsilea*, *Thelypteris*, *Pteris sp.*, *Dicranopteris sp.* and *Angiopteris evecta*.
- Collection and identification of pteridophyta genera and slide preparation/T.S. of available material near university campus.

**GYMNOSPERMS**

- Morphological studies from specimens of major genera of all the orders of Gymnosperms.
- To cut and study T.S., T.L.S. & R.L.S. of wood of *Pinus*, *Cedrus*, *Taxus*, *Thuja*
- To study wood elements by maceration of: *Pinus*, *Cedrus*.
- To study the anatomical details of the leaf/leaflet of *Pinus*, *Cedrus*, *Araucaria*, *Cycas*, *Thuja*.
- To study male cones of *Pinus*, *Cedrus*, *Thuja*, *Araucaria*, *Cycas*.
- To Study of female cones of *Pinus*, *Cedrus*, *Thuja*, *Araucaria*, *Cycas*.
- Study of fossil Gymnosperms specimen: *Taxus*, *Ginkgo*.
- To Collection and identification of gymnosperm genera and slide preparation/T.S. of available material near university campus.

**Note:** The students are required to collect and submit 50 (bryophyta, pteridophyta and gymnosperm) specimens.

*J. J. J.*

**SEMESTER-II**  
**BOT 201 (BIOLOGY AND DIVERSITY OF ANGIOSPERMS-I)**

L	T	P	Credit
4	0	0	4

**Unit I**

- Angiosperms: General introduction.
- Origin and evolution of Angiosperms (special reference to Bennettitalea, Gnetalean, Caytonialean and Herbaceous origin theories).

**Unit II**

- Systems of Angiosperm classification:
  1. Phenetic vs Phylogenetic system
  2. Relative merits and demerits of major systems of classification
- International code of Botanical Nomenclature: History, Principles & Rules, Type method, Principles of priority & its limitation, Names of Hybrids & cultivars

**Unit III**

- The Species Concept:
  1. Taxonomic hierarchy, species, genus, family and other categories.
  2. Principles used in assessing relationships, delimitation of taxa and attribution of rank.
- Modern Taxonomy:
  1. Inputs of taxonomy.
  2. Taxonomy in relation to anatomy, embryology, palynology, cytology, secondary metabolites in plants.

**Unit IV**

- Numerical Taxonomy: Concepts, characters & attributes.
- OUT's; Cluster analysis; Cladistics.
- Morphology of flowering plants: morphology and modification of Root

**Unit V**

- Morphology and modification of leaf.
- Systematics in practice:
  1. Importance and role of herbarium, specimens and their preparation.
  2. Botanical garden- importance and role.
  3. Value of computers and databases for identification.

**Books Recommended:**

1. Benson, L.D. (1962). Plant Taxonomy: Methods and Principles. Ronald Press. New York.
1. Coole, A.J. (1969). Numerical Taxonomy. Academic Press. London.
2. Cronquist, A. (1968). The evolution and classification of flowering plants. Houghton Mifflin, Boston.
3. Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press.
4. Davis, P.H. and Heywood, V. H. (1973). Principles of angiosperms taxonomy. Kreiger Publishing. Co. New York.
5. Gupta, R.K. (1981). Systematic Botany. Atma Ram and Sons. New Delhi.
6. Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw Hill. New Delhi.
7. Pandey, S.N. and Misra, S.P. (2008). Taxonomy of Angiosperms. Ane Books. India.
8. Sharma, O.P. (2002). Plant Taxonomy. Tata McGraw Hill Publishing Co. Pvt. Ltd. New Delhi.



## BOT 202 (CELL AND MOLECULAR BIOLOGY)

L	T	P	Credit
4	0	0	4

### Unit I

- Structural organization of plant and animal cell.
- Cell wall: structure, function and biogenesis.
- Plasma membrane: structure, models, functions, channels and pumps.
- Plasmodesmata: structure, role in movement of molecules.

### Unit II

- Chloroplast and Mitochondria: Structure, genome organization, biogenesis of mitochondria.
- Nucleus: Structure, nuclear pores, nucleosome organization, nucleolus.
- The cytoskeleton: Organization and role of microtubules and microfilaments, motor movements.
- Cell cycle and apoptosis: Control mechanisms, cytokinesis and cell plate formation, mechanisms of programmed cell death.

### Unit III

- DNA structure: A, B AND Z forms; Replication and DNA Repair.
- Transcription, promoters, and transcription factors, splicing, differences in prokaryotes and eukaryotes.
- Translation: Mechanism of translation, initiation, elongation and termination, structure and role of tRNA.

### Unit IV

- Regulation of gene expression in Prokaryotes.
- Regulation of gene expression in Eukaryotes.
- Protein sorting: Targeting of proteins to organelles

### Unit V

- Cells and tissues in immune system: General organization and functions
- Innate and adaptive immunity
- Antibody: Structure and Function
- Major histocompatibility (MHC) molecules

### **Books Recommended:**

1. Buchnan, B.B. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, Maryland.
2. Grierson, D. and Covey, S.N. (1998). Plant Molecular Biology. Blackie Academic and Professionals. London.
3. Gupta, P.K. (2004). Cell and Molecular Biology. Rastogi Publication. Meerut.
4. Karp, G.(1999). Cell and Molecular Biology. John Wiley & Sons. U.S.A.
5. Kindt, T.A., Goldsby ,R.A. and Osborne ,B.A(2007). Immunology. W.H. Freeman and Co.NewYork.
6. Lea, P.and Leegood , C. R.C. (1999). Plant Biochemistry and Molecular Biology. John Wiley and Sons, New York.
7. Lehninger, A. (1993).Principles of Biochemistry. Worth Publishers, New York.
8. Lewin, B.(2004). Gene VIII. Pearson Education International. Philadelphia.
9. Lodish, H., Berk ,A. and Darnell,J. (2000). Molecular Cell Biology. W.H. Freeman and Co. U.S.A.
10. Robert, D.D. (1978). Cell Biology – A Molecular Approach. Allyn and Bacon, Inc.

## BOT 203 (PLANT RESOURCE UTILISATION AND CONSERVATION)

L	T	P	Credit
4	0	0	4

### Unit I

- Plant Biodiversity: concept, status in India, utilization and concerns.
- Sustainable development: basic concept.

### Unit II

- Origin, Evolution, Botany, Cultivation and use of: food, forage and fodder crops. Fibre crops. Medicinal and aromatic plants. Vegetable oil yielding crops.
- Important fire-wood and timber yielding plants and nonwood forest products (NWFPS) such as bamboos, raw materials for papermaking, gums, tannins, dyes, resins and fruits.

### Unit III

- Green Revolution: benefits and adverse consequences.
- Plant used as avenue trees: for shade, pollution control and aesthetics.
- Principal of conservation: extinction, environmental status of plants based on IUCN.

### Unit IV

- Strategies for conservation- *in situ* conservation.
- International efforts and Indian initiatives.
- Protected areas in India: Sanctuaries, national parks, Biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.

### Unit V

- Strategies for conservation- *ex situ* conservation.
- Principles and practices: botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks.
- General account of the activities of botanical survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), Dept. of Biotechnology (DBT) for conservation, non formal conservation efforts.

### Books Recommended:

1. Anonymous 1997, National Gene Bank, Indian Heritage on Plant Genetic Resources (booklet). NBPGR, New Delhi.
2. Arora, R.K. and Nayar E.R. 1984. Wild relatives of crop plants in India. NBPGR Science monograph no 7.
3. Kocchar, S.L. 1998. Economic Botany of the tropical. 2 edition. Macmillan India Ltd. Delhi.
4. Anonymous. (1997). National Gene Bank: Indian Heritage on Plant Genetic resources. National Bureau of Plant Genetic Resource. New Delhi.
5. Anonymous. (1970,1972,1983). Indian Forest utilization. Forest Research Institute. Dehradun.
6. Anonymous. (1975). Underexploited tropical plants with promising value. National Academy of Sciences. Washington.
7. Anonymous. (1980). Firewood crops: shrubs and trees for energy production. National Academy of Sciences. Washington.
8. Arora, R.K. and Pandey, A. (1996). Wild edible plants of India. National Bureau of Plant Genetic Resource. New Delhi.

**BOT 204 (BIOSTATS AND COMPUTER APPLICATIONS)**

L	T	P	Credit
4	0	0	4

**Unit I**

- Definition and scope
- Probability, Discrete and continuous variables, Presentation of Data.
- Measures of central tendency: Mean, median, mode
- Standard deviation.

**Unit II**

- Analysis of variance, Correlation and regression.
- Sampling: techniques, Errors, Framing Hypothesis, Level of Significance,
- Hypothesis testing and ANOVA
- Student's t test, Chi Square test

**Unit III**

- Introduction of Digital computers, organization, Low and High level languages, Binary Number systems.
- Operating systems: DOS, WINDOWS.
- Application softwares: MS Word, MS Access, MS Excel, MS Power Point. Introduction to Internet and its Applications in biology.

**Unit IV**

- Definition & scope, Importance of bioinformatics.
- Bioinformatics Software and its Applications.
- Bioinformatics & drug discovery.

**Unit V**

- Definition; Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; sequencing.
- Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics.

**Books Recommended:**

1. Goon, A.M. and Dasgupta, B. (1983). Fundamentals of Statistics. Vol. I. World Press. Kolkotta.
2. Hunt, R. and J. Shelly (2002). Computer and Common Sense. 4th Ed. Prentice Hall. India.
3. Kanetker, Y. Let us 'C' (2006). B.P.B. Publication.
4. Rajaraman, V. (2004). Computer Programming in FORTRAN. 90 and 95. Prentice Hall. India.
5. Rajaraman, V. and Radhakrishnan, T. (2004). An Introduction to Digital Computers. Prentice Hall. India.
6. Sinha, P.K. (2003). Computer Fundamentals. B.P.B. Publication.

*Dilesh*

**BOT 205 (PRACTICAL III: ANGIOSPERMS, CELL AND MOLECULAR BIOLOGY)**

L	T	P	Credit
0	0	1	1.5

**ANGIOSPERMS**

- Study of the locally available plants and recording of the intraspecific variation.
- Description and identification at family, genus and species levels using Floras.
- Identification of key characters in a group of species of a genus and construction of keys.
- Construction of indented keys for the given material
- Simple Nomenclatural problems
- Identification of families studied based on flowers or essential parts of the flowers
- Knowledge of Herbarium techniques
- Record and Herbarium

**CELL BIOLOGY MOLECULAR BIOLOGY**

- To calculate the index of microscope at low and high power using ocular and stage micrometer.
- To calculate magnification of the microscope (10x, 40x lens) using Camera lucida.
- To measure the size of given pollen grains/spores/fibers with the help of ocular micrometer.
- To draw and measure the size of given pollen grains/spores/stomata using Camera lucida.
- To compare the stomatal index of upper and lower surface of the leaf. (Dicot, Monocot).
- To isolate chloroplasts from green leaves.
- Qualitative identification of carbohydrates: Molisch's test for carbohydrates, Iodine test for starch, Barford's test for monosaccharides, Seliwanoff's test for ketoses, Fehling's test for reducing sugars and Bial's test for pentoses.

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**BOT 206 (PRACTICAL IV: PLANT CONSERVATION AND BIOSTATISTICS AND  
COMPUTER APPLICATION)**

L	T	P	Credit
0	0	1	1.5

- To study different types of trees, soil.
- To undertake a field visit to understand the concept and consequences soil degradation and erosion.
- To study different types of plantation systems.
- Enlist herbicides / pesticides commonly used in near by region.
- Enlist plants cultivated/wild that are the sources of botanicals.
- Enlist various botanical pesticides available in the market.
- Enlist various weeds present nearby university area and collect at least 25 plants.
- Collect information regarding national parks, sanctuaries and biosphere reserve.
- To analyse data according to biostatic and use of various computer applications.

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7

**SEMESTER-III**  
**BOT 301 (BIOLOGY AND DIVERSITY OF ANGIOSPERMS- II)**

L	T	P	Credit
4	0	0	4

**Unit I**

- Morphology and modification of stem
- Apical, lateral and Intercalary meristems- their ultrastructure, histochemistry and organogenesis.
- Anomalous growth –stem
- Ecological anatomy.

**Unit II**

- Morphology and modification of flower/inflorescence and fruit.
- Male Gametophyte: Structure of Anthers, Microsporogenesis, Role of Tapetum, Pollen development, Male sterility, Sperm dimorphism, Pollen tube growth and guidance.
- Female Gametophyte: Ovule development, Megasporogenesis, Structure and organization of the embryo sac, Nutrition of the embryo sac.

**Unit III**

- Pollen pistil interaction, fertilization: Pollen-stigma interaction, sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects, in vitro fertilization).
- Seed Development: morphology and modification, Endosperm development during early, maturation and desiccation stages

**Unit IV**

- Embryogenesis, Ultra structure and nuclear cytology; cell lineages during late embryo development, Embryo culture
- Seed Dormancy: Importance and types of Dormancy.
- Overcoming seed dormancy.
- PALYNOLOGY: Basic techniques to study pollen; Pollen viability and storage.
- Pollen allergy

**Unit V**

- Anatomy of flowering plants: tissue, meristematic tissue, permanent tissue, tissue system
- Anatomy of Dicot and Monocot plants: root, stem, leaf.
- Secondary growth

**Books Recommended:**

1. Bhojwani, S.S. and Bhatnagar, S.P. (2000). The Embryology of Angiosperms. Vikas Publishing House. New Delhi.
  2. Bhojwani, S.S. and Razdan, M.K. (1983). Plant tissue culture. Elsevier, Amsterdam.
  3. Burgess, J. (1985). An introduction to plant cell development. Cambridge University Press.
  4. Fahn, A. (1982). Plant anatomy. Pergamon Press. Cambridge.
  5. Howell, S.H. (1998). Molecular genetics and plant development. Cambridge University Press, Cambridge.
  6. Ledon, R.F. (1990). Plant development: the cellular basis. Unin Human London.
  7. Shivana K.R. and Rangaswamy N.S. (1992). Pollen Biology: A Laboratory Manual. Springer Verlag. Berlin.
  8. Shivanna, K.R. and Johri, B.M. (1985). The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd. New Delhi.
- D. K.*

**BOT 302 (BASIC RESEARCH TECHNIQUES)**

L	T	P	Credit
4	0	0	4

**Unit I**

- Basic Principles of research techniques and safety measures: Aims of Lab investigation, Experimental designs, SI units, safety against Chemical, Physical and Biological hazards. Waste disposals.
- Cell culture techniques: Cell culture Laboratory, equipments, aseptic techniques and good culture practices, type of cultures, potential uses of cell culture.

**Unit II**

- Anatomical and histochemical techniques: Functioning and application of microtomy, stains and staining techniques; Maceration; Principle of fixation, types of fixatives and their applications.
- Principle and methods of histochemical localization of carbohydrates lipids, proteins, nucleic acids and enzymes.

**Unit III**

- Centrifugation: Principle, functioning and applications of low speed, high speed and ultracentrifugation.
- Spectroscopy: Principle, functioning and applications of UV-visible spectrophotometry, spectrofluometry.

**Unit IV**

- Electrophoresis: Principle, functioning and applications of simple and 2D gel electrophoresis.
- Chromatographic techniques: Principle and applications of paper chromatography column chromatography, thin layer chromatography, Ion Exchange, Gel filtration chromatography and Gas chromatography.

**Books Recommended:**

1. Wilson, Keith and Walker, John 2009. Principles and techniques of Biochemistry and molecular Biology. Cambridge Univ. Press, India.
2. Plummer, David T. 1996. An introduction to practical Biochemistry 3rd Ed. Tata McGraw Hill. Pub. Corp. Ltd., New Delhi.
3. Rao, B. S. and Deshpande, V. 2000. Experimental Biochemistry. A student companion. I. K. International Pvt. Ltd., New York

*Dilip*

## BOT 303 (CYTOGENETICS AND BIOTECHNOLOGY)

L	T	P	Credit
4	0	0	4

### Unit I

- Cell cycle and cell division. Metaphase chromosomes, centromere, kinetochore, telomere and its importance.
- Heterochromatin and Euchromatin.
- Chromosome Banding.

### Unit II

- Mendelian inheritance and its modification.
- Variation in chromosome, structure and number.
- Sex chromosomes, Polytene and Lampbrush chromosomes.

### Unit III

- Methods of Tissue culture.
- Haploid induction: fundamental aspects.
- Protoplasts- their isolation, culture and fusion
- Applied aspects of tissue culture: clonal propagation, Propagation of pathogen free plants.
- Germplasm storage and conservation

### Unit IV

- Biotechnology: Scope, significance.
- Microbes and microbial systems and their improvement for biotechnological use.
- Principles and techniques of plant and animal cell culture.

### Unit-V

- Principles and applications of DNA recombinant technology to agricultural and human diseases
- Aims and Strategies for the development of transgenics, Possible ecological risks and ethical concerns.
- Construction of genomic libraries, PCR and DNA fingerprinting.
- Fermentation Technology: Design, process, scale up and down stream processing, production of antibiotics, beverages, enzymes, Bioremediation, Biopesticides

### Books Recommended:

1. Gardner, E.J. and Anustad, D.P. Principles of Genetics. John Wiley and sons. New York.
2. Weaver, R.F. and Hedrick, P.W. Genetics. Brown Publishers. Boston.
3. Brown, T.A. Genetics- A molecular approach. Chapman and Hall. New York.
4. Futuyama, D.J. Evolutionary Biology. Suinuaer Associations INC Publishers. Dunderand.
5. Strikberger, M.W. Evolution. Jones and Barlett Publishers. Boston.
6. Introduction to Topology and Modern Analysis, G.F. Simmons, McGraw Hill.



### BOT 304 (PLANT PHYSIOLOGY)

L	T	P	Credit
4	0	0	4

#### Unit I

- Inorganic Nutrition: Occurrence, availability and physiological roles of various elements
- Ion uptake and active and passive transport, Role of calmodulin, phloem transport.
- Stomatal physiology: Chemiosmotic mechanism of stomatal movements, hormonal regulation and significance of calcium ions.

#### Unit II

- Photochemistry and Photosynthesis: Concepts and historical background, evolution of photosynthetic apparatus.
- Pigments and Light harvesting complexes, photooxidation of water, mechanism of electron and proton transport.
- Carbon assimilation: Calvin cycle, photorespiration, C<sub>4</sub> cycle, CAM pathway Biosynthesis of starch and sucrose, physiological and ecological considerations.

#### Unit III

- Respiration: Overview of plant respiration, Glycolysis, TCA Cycle, Electron transport and ATP synthesis, Structure and functions of ATP, Pentose phosphate pathway, glyoxylate cycle, alternative oxidase system.
- Nitrogen Fixation: Nitrogen and sulphur metabolism: overview, symbiotic and nonsymbiotic nitrogen fixation, biological nitrogen fixation, nodule formation, nod factors
- Mechanism of nitrate uptake and reduction, ammonium assimilation.
- Sulphate uptake, transport and assimilation

#### Unit IV

- Sensory Photobiology: History of discovery of phytochromes and cryptochromes, their photochemical and biochemical properties.
- Photobiology of light induced responses, cellular localization.
- Molecular mechanisms of action of photomorphogenetic receptors, signaling and gene expression.

#### Unit V

- Plant Growth regulators and elicitors: Physiological effects and mechanisms of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid.
- The flowering process: Photoperiodism and its significance.
- Endogenous clock and its regulation.
- Role of vernalization

#### **Books Recommended:**

1. Bidwell, R.G.S. (1979). Plant physiology. MacMillan Publishing Co. Inc. New York.
2. Buchanan. B.B., Gruissem. W. and Jones, R.L.(2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA.
3. Devlin, R.M., and Witham, F.H. (1986). Plant Physiology. C.B.S. Publishers. New Delhi.
4. Number Theory, David M. Burton, McGraw Hill.
5. Lawlor, D.W. (2001). Photosynthesis. Viva Books Pvt. Ltd. New Delhi.
6. Levitt, J. (1980). Responses of Plants to Environmental Stresses. Academic Press. London.
7. Malik, C.P. (2002). Plant Physiology. Kalyani Publishers. India.

*Chh*

**BOT 305 (PRACTICAL V: ANGIOSPERMS II)**

L	T	P	Credit
0	0	1	1.5

**ANGIOSPERMS**

- Collection and Study of the locally available plants and recording of the intraspecific variation.
- Description and identification at family, genus and species levels using Floras.
- Identification of key characters in a group of species of a genus and construction of keys.
- Construction of indented keys for the given material.
- Simple Nomenclatural problems.
- Identification of families studied based on flowers or essential parts of the flowers.
- Dissection and permanent slide making.
- Knowledge of Herbarium techniques.
- Record and Herbarium.

*Archi*

**BOT 306 (PRACTICAL VI: CYTOGENETICS AND PLANT PHYSIOLOGY)**

L	T	P	Credit
0	0	1	1.5

**CYTOGENETICS**

- Fixation of material in fixative.
- Preparation of various stains for cytogenetic studies.
- Preparation of different fixatives for cytogenetic studies.
- Detailed study of meiosis in *Allium cepa*.
- Detailed study of mitosis in *Allium*.
- Determination of chromosome number through meiosis in available monocots and dicots.
- Analysis of Karyotype from given diagram.
- Study of meiotic abnormalities like lagards, bridges, cytomixis, univalent/multivalent formation from permanent /temporary slides.
- To study the pollen fertility.

**PLANT PHYSIOLOGY**

- To demonstrate the phenomena of adsorption.
- To determine the water holding capacity of different types of soils.
- To demonstrate the operation of the solubility theory of permeability.
- To determine the osmotic pressure of the cell sap of the given plant material by Plasmolytic method.
- To determine the effect of temperature and alcohol on permeability and find out thermal death point.
- To determine the surface tension of alcohol by drop counting method.
- To study the effect of light on the relative loss of water vapour from leaves.
- To measure and compare the rate of transpiration under different environmental conditions with simple potometer.
- To compare the rate of transpiration from two sides of a leaf.
- To demonstrate suction due to transpiration (or transpiration pull).
- To demonstrate transpiration by using Ganong's potometer.
- To demonstrate the effect of CO<sub>2</sub>, light intensity and temperature with time on the rate of photosynthesis in twigs of *Hydrilla*.
- To demonstrate that light, chlorophyll and CO<sub>2</sub> is necessary for photosynthesis.
- To separate leaf pigments by (i) Column Chromatography (ii) Paper Chromatography.
- To separate chloroplast pigments from leaf by chemical method and to calculate their R<sub>f</sub> value.
- Quantitative determination of photosynthetic pigments from given plant material.
- To show that oxygen is released during photosynthesis.
- To demonstrate the phenomenon of anaerobic respiration.
- To demonstrate that O<sub>2</sub> is taken in and CO<sub>2</sub> is given out during respiration.
- To determine the respiratory quotient of given plant material by Ganong's respirometer.

*J. W.*

## BOT 401: BIOCHEMISTRY

L	T	P	Credit
4	0	0	4

### Unit I

- Structure of atoms, molecules and chemical bonds.
- Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc).

### Unit II

- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
- Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

### Unit III

- Primary, secondary, tertiary and quaternary structures of proteins.
- DNA: Double helical structure of DNA, DNA replication, recombination and repair.
- RNA :Structure of RNA, role of RNA in gene expression

### Unit IV

- Functional importance of lipid storage & membrane lipids
- Fatty acid metabolism: Synthesis and degradation of fatty acids
- Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins

### Unit V

- Basic concept of metabolism: Coupled and interconnecting reactions of metabolism; cellular energy resources and ATP synthesis.
- Concept of free energy and thermodynamic principles in biology.
- Oxidative phosphorylation & Pentose Phosphate Pathway

### Books Recommended:

- 1.Conn, E.E., P.K Stumpf., G.Bruening and R.H.DoI. (2006). Outlines of Biochemistry. John Wiley. India.
- 2.Deb, A.C. (2008). Fundamental of Biochemistry. New Central Book Agency Pvt. Ltd. Kolkatta.
- 3.Dey, P.M. and J.B. Harborne. (1997). Plant Biochemistry. Academic Press. London.
- 4.Hames, D. and Cooper, N. (2008). Biochemistry. Garland Science Publishers, U.S.A.
- 5.Jain, J.L., N. Jain and S. Jain. (2007). Fundamentals of Biochemistry. S. Chand and Co. Ltd. New Delhi.
- 6.Malik, C.P. and M.B. Singh. (1980). Plant Enzymology and Histoenzymology. Kalyani Publishers.
- 7.Mathews, K. and Vanhold, A. (2003). Biochemistry. Pearson Edu. Pvt. Ltd. New Delhi.

## SPECIAL PAPER I

### BOT 402 A: (ADVANCED MYCOLOGY)

L	T	P	Credit
4	0	0	4

#### Unit I

- Fungal habitats: soil, water and organisms; Mycorrhizal fungi, Endophytes, Plant pathogens, Lichenicolous fungi, Fungi from arthropod and invertebrate animals, soil fungi, fresh water fungi and marine fungi.
- Ecology of fresh water fungi, thermophiles and psychrophiles.
- Fungal diversity: Molecular methods to discover new species and identify fungal taxa.

#### Unit II

- Domestication and Mycophagy
  - i. Edible and poisonous mushrooms, mushroom toxins
  - ii. Cultivation technology for button and oyster mushroom
  - iii. Diseases and pests of button mushroom.
  - iv. Nutritive value of mushrooms

#### Unit III

- Growth, nutrition, differentiation and metabolites of fungi
- Methods of measurement
- Factors influencing growth, mineral requirements of fungi.
- Metabolites of fungi: useful metabolites, plant growth hormones and antibiotics, Enzymes activity and harmful mycotoxins

#### Unit IV

- Mycotoxins and their medical and veterinary effects
  - (i) Mycotoxins of food and feed stuffs, their producers
  - (ii) Diseases caused by the mycotoxins

#### Unit IV

- Effects of plant parasitic and other fungi on man
  - (i) Crop diseases and natural catastrophes
  - (ii) Ailments of man, Human mycoses, Fungi as allergens, Poisonous fungi
  - (iii) Fungi in medicine
  - (iv) Industrial enzymes, proteins and vitamins
  - (v) Fungi in food processing, Mycotoxins, Spoilage activity
  - (vi) AIDS and fungi
  - (vii) Fungal biotechnology

#### **Books Recommended :**

1. Anisworth, G.C. and Sussman, A.S. (1968). The fungi, Academic Press. New York.
2. Aneja, K.R. (1993). Experiments in Microbiology, Plant Pathology and Tissue Culture. Wiswa Prakashan. New Delhi.
3. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology. John Wiley and Sons Inc. New York.
4. Bilgrami, K.S. (1985). A text Book of Modern Plant Pathology, Vikas Publication House. New Delhi.
5. Burnett, H.L. (1968). Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication. Limited.
6. Dube, R.C. (2000). Practical Microbiology. S.Chand and Corp. Ltd.

## SPECIAL PAPER I

### BOT 402 B: (ECONOMIC BOTANY)

L	T	P	Credit
4	0	0	4

#### Unit I

- A brief account of the origin, botany, cultivation and uses of food crops.
  - (i) Cereal Crops - Wheat, Rice, Maize,
  - (ii) Sugar Crops - Sugarcane
  - (iii) Tuber Crops - Potato
- A brief account of the origin, botany, cultivation and uses of the following
  - (i) fibre crops: (Cotton, flax, Hemp, sisal) and
  - (ii) fodder crops (Sorghum, Barseem, Guar)

#### Unit II

- A brief account of the origin, botany, cultivation and uses of vegetable oil yielding plants.
  - (i) Mustard (ii) Coconut (iii) Groundnut (iv) Sunflower.
- A brief account of the origin, history, botany, cultivation, processing chemical composition and uses of the following beverages crops.
  - (i) Tea (ii) Coffee

#### Unit III

- A brief account of the origin, history, botany, cultivation, processing and uses of Tobacco and Para Rubber.
- Name, family, plant part yielding active principle and uses of the following:
  - (i) Medicinal Plants: Aconitum, Cinchona, Belladonna, Digitalis, Glycyrrhiza, Artemisia, Rauwolfia, Nux-vomica, Garlic, Neem, Tulsi, Papaver, Vasaka, aloe, Assafoetida, Genseng

#### Unit IV

- Name, family, plant part yielding active principle and uses of the following
  - (i) Aromatic Plants: Mentha, rosa, Jasminum, cymbopogon, Lavender, Hops, Camphor.
  - (ii) Spices and Condament: Ginger, Turmeric, Cinnamon, Cloves, Cardamom, Chllies, Pepper, Fennel, Coriander, Cumin, Nutmeg, Mace and Saffron.

#### Unit V

- Name, family, distribution and uses of important commercial timbers of India (Teak, Sal, Chir, Kail, Deodar, Sisham, Kikar). List of important fuel woods, trees for avenues, pollution control and aesthetics.
- A brief account of the following: (i) Gums (ii) Resin (iii) Tannis (iv) Dyes (v) Rattans (vi) Raw materials for Paper Industry (vii) Bamboos (viii) Wild Fruits.

#### **Books Recommended:**

1. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
2. Conway, G. 1999. The Doubly Green Revolution. Food for All in the 21<sup>st</sup> Century, Penguin Books.
3. Conway, G. and Barbier, E. 1990. After the Green Revolution, Earthscan Press, London.
4. Conway, G. and Barbier, E. 1994. Plant, Genes and Agriculture, Jones and Bartlett Publishers, Boston.
5. Council of Scientific and Industrial Research, (1948-76) The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000).
6. Kochhar, S.L. 1998. Economic Botany in the Tropics, 2<sup>nd</sup> Edition, MacMillan Indian Ltd., New Delhi.

## SPECIAL PAPER II

### BOT 403 A: (PLANT BIOTECHNOLOGY AND TISSUE CULTURE)

L	T	P	Credit
4	0	0	4

#### Unit I

- **Basic Techniques:** Nutrition Medium, Sterilization Techniques, Principles (Cyto-differentiations, Organogenic differentiation).
- **Types of culture:** Embryo culture, Callus culture and Organ culture.
- **Micropropagation:** Axillary bud Proliferation approach, Meristem & shoot tip culture, Bud culture, Organogenesis & Embryogenesis & their applications.

#### Unit II

- **Cell suspension culture:** Types of suspension cultures, Production of secondary metabolites and their applications.
- **Somaclonal Variation:** Selection of somaclonal variants, mechanism & their applications, Cryopreservation.
- **Haploid Production:** Androgenic Methods, Gynogenic Haploids, Chromosome elimination techniques, Distant hybridization, Embryo rescue.

#### Unit III

- Protoplast isolation, fusion. Section of hybrid cells, regeneration of hybrid plants, Applications & limitation, cybrids Hybrids, somatic hybrids, cytoplasm & Plastocyste.

#### Unit IV

- **Recombinant DNA technology:** Isolation, cloning vectors and amplification of genes & their applications.
- **Molecular markers & Marker assisted selection:** Morphological, Biochemical & Molecular markers. Non-PCR based approaches & PCR based techniques & their advantages & disadvantages Gene transfer in Plants: Vector & Vectorless.

#### Unit IV

- **Transgenics in Crop improvement:** Resistance to biotic & abiotic stress, Transgenics for quality & as bioreactors.
- Application of microbial biotechnology for human welfare.

#### Books recommended

1. Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-46-Transgenic Trees, Springer Pub., New York, USA
2. Bhojwani, S.S. and Razadan, M.K. 1996 *Plant Tissue Culture: Theory and Practice* (A revised Edition), Elsevier Science Pub., New York, U.S.A.
3. Brown, T.A. 1999. Genomes. John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. Chawla H.S. 2005 *Introduction to Plant Biotechnology*, Oxford & IBH Pub., New Delhi, India.
5. Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., Meerut, India.
6. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.

## SPECIAL PAPER II

### BOT 403 A: (PLANT BIOTECHNOLOGY AND TISSUE CULTURE)

L	T	P	Credit
4	0	0	4

#### Unit I

- **Basic Techniques:** Nutrition Medium, Sterilization Techniques, Principles (Cyto-differentiations, Organogenic differentiation).
- **Types of culture:** Embryo culture, Callus culture and Organ culture.
- **Micropropagation:** Axillary bud Proliferation approach, Meristem & shoot tip culture, Bud culture, Organogenesis & Embryogenesis & their applications.

#### Unit II

- **Cell suspension culture:** Types of suspension cultures, Production of secondary metabolites and their applications.
- **Somaclonal Variation:** Selection of somaclonal variants, mechanism & their applications, Cryopreservation.
- **Haploid Production:** Androgenic Methods, Gynogenic Haploids, Chromosome elimination techniques, Distant hybridization, Embryo rescue.

#### Unit III

- Protoplast isolation, fusion. Section of hybrid cells, regeneration of hybrid plants, Applications & limitation, cybrids Hybrids, somatic hybrids, cytoplasm & Plastocyte.

#### Unit IV

- **Recombinant DNA technology:** Isolation, cloning vectors and amplification of genes & their applications.
- **Molecular markers & Marker assisted selection:** Morphological, Biochemical & Molecular markers. Non-PCR based approaches & PCR based techniques & their advantages & disadvantages Gene transfer in Plants: Vector & Vectorless.

#### Unit IV

- **Transgenics in Crop improvement:** Resistance to biotic & abiotic stress, Transgenics for quality & as bioreactors.
- Application of microbial biotechnology for human welfare.

#### Books recommended

1. Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-46-Transgenic Trees, spinger Pub., New York, USA
2. Bhojwani, S.S. and Razadan, M.K. 1996 *Plant Tissue Culture: Theory and Practice* (A revised Edition), Elsevier Science Pub., New York, U.S.A.
3. Brown, T.A. 1999. Genomes. John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. Chawla H.S. 2005 *Introduction to Plant Biotechnology*, Oxford & IBH Pub., New Delhi, India.
5. Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., Meerut, India.
6. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.



## SPECIAL PAPER II

### BOT 403 B:(TAXONOMY OF ANGIOSPERMS)

L	T	P	Credit
4	0	0	4

#### Unit I

- General evolutionary trends and criteria of primitive and advance taxa of flowering plants.
- Morphology of stamens and carpels- a brief account. A brief account on various taxonomic tools like herbarium, Botanical gardens, floras, computers and GIS. Relevance of taxonomy to plant conservation

#### Unit II

- ✓ A brief account on the origin and phylogeny of Angiosperms.
- Plant systematics; an overview; Phylogenetic systematics: character analysis, cladogram construction and cladogram analysis.
- Plant molecular systematics, numerical taxonomy and serotaonomy: a brief account.

#### Unit III

- Salient features of various systems of classification (Bentham & Hooker, Engler and Prantl, Coronquist, Takhtajan, Hutchinson).
- Salient features of International code of Botanical Nomenclature (Principles, Ranks of taxa, typification, Principle of priority and citation of authors' names).

#### Unit IV

- Salient features and socio-economic importance of the following families of Dicots: Magnoliaceae, Nymphaeaceae, Tiliaceae, Meliaceae, Sapindaceae, Anacardiaceae, Myrtaceae, Rubiaceae, Sapotaceae, Asteraceae, Apocynaceae, Leguminosae, Apiaceae, Euphorbiaceae, Bignoniaceae, Scrophulariaceae, Lamiaceae, Polygonaceae, Chenopodiaceae and Moraceae.

#### Unit V

- Salient features and socio-economic importance of the following families of Monocots: Orchidaceae, Amaryllidaceae, Agavaceae, Cyperaceae and Graminae.

#### Books Recommended:

1. Davis, P. H. and Heywood V. H. 1973. *Principles of Angiosperm Taxonomy*, Robert E. Kreiger Pub. Co., New York.
2. Heywood, V. H. and Moore, D.M. 1984. *Current Concepts in Plant Taxonomy*, Academic Press, London.
3. Lawrence, H. M. 1969. *Taxonomy of Vascular Plants*, Oxford and IBH Publishing Co., New Dehli.
4. Stebbins, G. L. 1974. *Flowering Plant-Evolution Above Species Level*, Edward Arnold Ltd., London.
5. Sharma, O.P. 2005. *Plant Taxonomy*. Tata McGraw-Hill Publishing Company Limited, New Delhi
6. Simpson, Michael G. 2006. *Plant Systematics*. Elsevier Academic Press.
7. Singh G. 2004. *Plant Systematics: Theory and Practice*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
8. Stace, C. A. 1989. *Plant Taxonomy and Biosystematics* (2nd Edition), Edward Arnold Ltd., London.
9. Takhtajan. A. L. 1997. *Diversity and Classification of Flowering Plants*, Columbia University Press, New York.
10. Woodland D.W. 1991. *Contemporary Plant Systematics*, Prentice Hall, New Jersey.

**BOT 404 :(PRACTICAL VII: BIOCHEMISTRY)**

L	T	P	Credit
0	0	1	1

- Measurement of pH of biological liquids using pH strips .
  - a) Blood
  - b) Urine
  - c) Saliva
  - d) Tear
  - e) Soil
  - f) milk
- Measurement of pH of biological liquids using pH meter.
  - a) Blood
  - b) Urine
  - c) Saliva
  - d) Tear
  - e) Soil
  - f) Milk
- To prepare the buffer solutions.
- Titration of a mixture of a strong and a weak acid.
- Titration of a mixture of a strong acid with weak and strong base
- Identification of sugars in fruit juices using chromatography technique.
- Benedicts test for reducing sugars.
- Iodine test for polysaccharides.
- Estimation of carbohydrates.

**BOT 405 (PRACTICAL VIII: A: ADVANCED MYCOLOGY / ECONOMIC BOTANY,  
B: PLANT BIOTECHNOLOGY, TISSUE CULTURE / TAXONOMY OF ANGIOSPERMS.)**

L	T	P	Credit
0	0	1	1

**ADVANCED MYCOLOGY**

- Preparation of spawn, compost, spawning, casing,
  - (i) harvesting and postharvest handling of edible mushroom;
  - (ii) identification of various pathogens,
  - (iii) competitors of various mushroom.
- Detailed study of symptoms and host parasite relationship of important diseases of agricultural crops.
- Collection and dry preservation of diseased specimens of important crops.
- Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops
- Detailed comparative study of different groups of fungi;
  - (i) collection, identification and preservation of specimens.
  - (ii) Isolation and identification of plant pathogenic fungi.

**ECONOMIC BOTANY**

- To study the different type of starch grains: wheat, rice, maize, *Phaseolus*, Potato.
- To study the morphological and anatomical features of the following plants:
  - (i) Spices and Condiments.
  - (ii) Medical plants.
  - (iii) Fibers.
  - (iv) Oil seeds.
- To study of calcium carbonate crystals in *Ficus*.
- To study different types of woods for texture and density.
- Collection of various medicinal plants, fibers, spices/condiments and oil seed plants.

**PLANT BIOTECHNOLOGY**

- Preparation of complex nutrient medium (Murashige & Skoog's medium).
- To selection, Prune, sterilize and prepare an explant for culture.
- To demonstrate various steps of Micropropagation.
- To understand principle, working and handling of.
  - (i) Laminar Air Flow
  - (ii) pH meter
  - (iii) Autoclave
  - (iv) BOD Incubator
  - (v) Centrifuge
  - (vi) Micropipettes
  - (vii) Incubator Shaker
  - (viii) Water double-distillation unit
- Isolation of DNA from Plants.
- Separation of proteins by electrophoresis.
- Removal of chromium/ nitrate/ ammonia by immobilized cyanobacterial cells.
- Demonstration of DNA amplification by PCR.

## TAXONOMY OF ANGIOSPERMS

- General description of flower in technical terms. *Hibiscus. Crotalaria.*
- Description of different types of inflorescences and fruits in angiosperms.
- Description of leaf type on the basis of shape of lamina, margin, base, tips, phyllotaxy, venation, leaf modification and placentation.
- Description of following flowers in technical terms and their derivation up to the family level
- Preparation of Herbarium file (Minimum 100 Plants).



**SRI SAI UNIVERSITY**  
*Transforming Dreams into Reality*

DEPARTMENT OF BOTANY

MINUTES OF THE MEETING OF THE BOARD OF STUDIES (BOS), OF BOTANY DEPARTMENT, SSU, PALAMPUR HELD ON 08-07-2022 AT 3.30 PM AT SSU PALAMPUR

The following were present:

- |                                        |            |
|----------------------------------------|------------|
| 1. Dr. Anjana Negi                     | Chaiperson |
| 2. Dr. Narayan Singh                   | Member     |
| 3. Dr. Ankush Sharma (Interdepartment) | Member     |
| 4. Dr. Hitesh Kumar (Expert)           | Member     |

*Anjana Negi*  
*Narayan Singh*  
*8/7/22*

The following agenda items were discussed:

- The proposed syllabi for M.Sc. Botany were discussed in detail and same were approved.
- The subject codes of units and all the papers were standardised as per the norms of Sri Sai University.
- The committee further recommended that the proposed syllabi be implemented w.e.f. the session 2022-23 after the approval of the Academic Council.

The meeting ended with a vote of Thanks to the chair.

*Narayan Singh*  
*8/7/22*  
Member

*Hitesh Kumar*  
*8/7/22*  
External Expert

*Anjana Negi*  
*8/7/22*  
H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**SEMESTER - I**

**BOT-CC-411: BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>Algae in diversified habitat (terrestrial, fresh water, marine) classification and economic importance.</li><li>General account of thallus organization, reproduction and life history of Algae.</li><li>General characteristics, classification and economic importance of bryophytes in medicine, agriculture and food</li></ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>Recognize the morphology, anatomy, physiology, reproduction and life cycle pattern.</li><li>Their diversification and familiarize with various ecological niche.</li></ul>

**MODULE I**

- Algae in diversified habitats (terrestrial, freshwater, marine).
- Thallus organization.
- Cell ultrastructure.
- Reproduction (vegetative, asexual, sexual) and patterns of life cycle.
- Criteria for classification of algae: (pigments, reserved food, flagella).

**MODULE II**

- Fine structure of Algal plastids.
- Algal blooms.
- Algal biofertilizers.
- Economic importance of algae.
- General account of Lichens and their economic importance.

**MODULE III**

- Introduction, Classification and salient features of Bryophytes.
- Comparative account of gametophyte structure. Comparison among Cryptogamous plants.
- A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.

**MODULE IV**

- Substratum Ecology: Epiphytes, Epiphylls, Epiliths, Litter species, Fire mosses, Coprophilous species, Calcicoles and Calcifuges, Halophytes, Epizoic Bryophytes.

*Handwritten signature and date:*  
8/7/22<sup>3</sup>

Sri Sai University Palampur

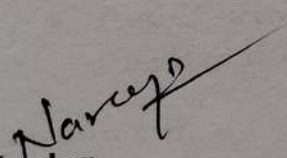
- Bryophytes as site indicators. Bryogeography and Conservation of bryophytes: Bryophyte endemisms. Threatened bryophytes; strategies to conserve bryodiversity at National and Global levels.
- Role of bryophytes in Ecosystem Dynamics and in carbon budget.

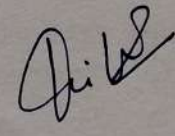
#### MODULE V

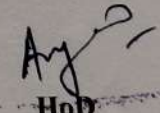
- Morphogenesis in Bryophytes.
- Distribution and ecology of Bryophytes in India with particular reference to Himachal Pradesh.
- Ecological and Economic importance of Bryophytes.

#### Books Recommended:

1. Fritsch, F.E. (1971). The structure and function of Algae. Vol I and II, London, Cambridge Univ. Press.
2. Kamat, N.D. (1982). Topics in Algae, Sai Kirpa Prakashan, Aurangabad
3. Kumar, H.D. (1985). Algal Cell Biology. Affiliated East-west Press Limited, New Delhi
4. Bierhorst D.W. (1971). Morphology of vascular plants. Mac Millan Publishers. New York.
5. Cavers, F. (1911). The interrelationship of Bryophytes. New Phytology. Reprint No. 4: 1203.
6. Chopra, R.S. (1976). The interrelationships of Indian Bryophytes. The Chronica Botanica. New Delhi.

  
Member

  
External Expert

  
H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-CC-412: BIOLOGY AND DIVERSITY OF MYCOLOGY AND PLANT  
PATHOLOGY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>To understand microbes with regards to their morphological and anatomical features, reproductive structures, their ecological and economic importance.</li><li>To identifies the major principles of plant pathology and to recognize their etiological agents of the diseases. To describe aspects of integrated pest management.</li></ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>To understand about the classification structures, role and infectious cycle of microbes.</li><li>Learning host-parasite interaction, recognition concept and infection, symptomatology.</li><li>Gain knowledge on disease management strategy.</li></ul>

**MODULE I**

- Introduction to Mycology: General characteristics of fungi, their significance to humans, organization of fungal cell, thallus, ultrastructure, reproduction (vegetative, asexual and sexual).
- Recent trends in classification.
- Comparative study of habits, habitats, somatic organization, anamorphs, teleomorphs and evolutionary trends in the life cycles of the members of the following: Ascomycota with emphasis on Yeast, *Penicillium*, *Aspergillus*, and *Neurospora*.

**MODULE II**

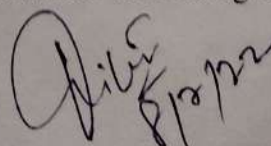
- General account of Powdery mildews and Discomycetes, Basidiomycota (basidiocarps types, development, general account of Hymenomycetes, Ustilaginomycetes and Urediniomycetes).
- General account of Deuteromycetes (sprouting structures), predaceous fungi, Dermatophytes, *Alternaria*, *Cercospora*, *Colletotrichum*, and *Fusarium*.

**MODULE III**

- Sex hormones in fungi, Heterothallism and parasexual cycle.
- Nutrition in fungi(saprophytes, parasites, predators, symbionts).
- Importance of fungi in different microbial and biotechnological processes: Fungi in food and food industry, as agents of biodeterioration and biodegradation, in agriculture, in medical biotechnology.

**MODULE IV**

- History of plant pathogens, concepts, diagnosis, classification, importance and identification of unknown diseases, symptomatology and disease development.
- Host- pathogen interaction at population level: Transmission and spread of plant pathogens, disease epidemics, modeling and disease forecasting to control crop losses.





Sri Sai University Palampur

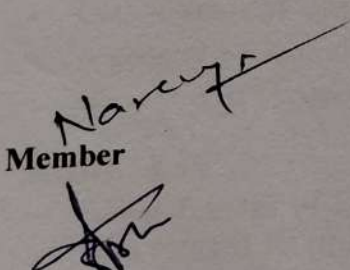
Management of plant diseases: Chemical and biological. IPM system development of transgenics, biopesticides, plant diseases clinics, quarantine.

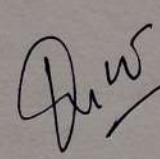
#### MODULE V

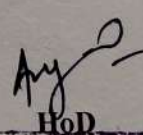
- Specific plant diseases caused by diverse pathogens: Black wart of potato, Club root of Crucifers, Damping of seedlings, Late blight of potato, Downy mildew of grapes and bajra, Stem gall of coriander, Powdery mildew of wheat and apple, Apple scab.

#### Books Recommended:

1. Barnett, J.H. (1968). Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
2. Bilgrami, K.S. and Dube, H.C. (1980). A text Book of Modern Plant Pathology. Vikas Publication House, New Delhi.
3. Butler, E.J. and Jones, S.G. (1986). Plant Pathology. Periodical Expert Book Agency, New Delhi.
4. Dube, R.C. and Maheshwari, D.K. (1999). A Text Book of microbiology, S.Chand and Co. Ltd. New Delhi.
5. Gupta, R. and Mukerji, K.G. (2001). Microbial Technology. APH Publishing Corp., New Delhi.
6. Kumar, H.D. (1988). Introductory Phycology. Affiliated East-west Press Limited, New Delhi
7. Moore-Landekar, E.J. (1972). Fundamentals of the Fungi. Prentice Hall, Englewood cliff.

  
Member

  
External Expert

  
H O.D. Botany  
Sri Sai University Palampur (H P.)

**BOT-CC-413: BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS**

	T	S	P	Credit
	4	0	0	4
<b>Course Objectives</b>	<ul style="list-style-type: none"><li>To understand the structure, evolution and economic importance of Pteridophytes and Gymnosperms.</li><li>To learn about their general characters and classification.</li></ul>			
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>Knowledge of morphological, anatomical, and reproductive diversity within Pteridophytes and Gymnosperms.</li><li>Understanding the economic importance of Pteridophytes and Gymnosperms and basic knowledge of fossils.</li></ul>			

**MODULE I**

- General introduction, Classification and Salient features of Pteridophytes; Comparison among Archigoniate.
- Introduction to Palaeobotany: Basic principles and techniques, Geological time scale.
- A general account of the following fossil Pteridophytes: *Rhynia*, *Horneophyton*.
- Salient features of PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA and PTEROPSIDA.

**MODULE II**

- Structure and Evolution of Stele system in Pteridophytes.
- TELOME THEORY or the Evolution of Sporophyte in Pteridophytes.
- Alternation of generations; Natural & Induced Implications of Apogamy and Apospory in Pteridophytes.
- Heterospory and Seed habit in Pteridophytes.
- Cytological Evolution and Economic Importance of Pteridophytes.

**MODULE III**

- General Introduction and salient features of Gymnosperms.
- Comparison among TRACHEOPHYTA.
- Classification of Gymnosperms (latest one).
- A general account of the following Fossil Cycadopsida: *Archaeopteris*, *Lyginopteris*, *Glossopteris*, *Cycadeoidea*, and *Pentoxylon*.

**MODULE IV**

- Salient features of Living CYCADALES, CONIFERALES (Including *Taxus*), and GINKGOALES (Emphasis not to be placed on Families and Type studies).
- A general account of EPHEDRALES, WELWITSCHIALES, and GENETALES.

**MODULE V**

- Structure, Identification and Evolution of wood and bark in Conifers.
- Evolution and economic importance of Gymnosperms.

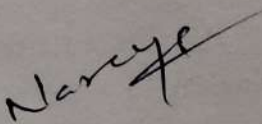
**Books Recommended:**

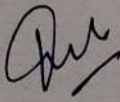
**Gymnosperms:**

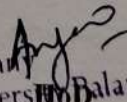
1. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms, New Age International Pvt. Ltd. New Delhi.
2. Bierhorst D.W. (1971). Morphology of vascular plants. McMillan Publishers. New York.
3. Biswas, C and Johri, B.N. (1997). The Gymnosperms. Narosa Publishing House. New Delhi.
4. Chamberlain, C.J. (1986). Gymnosperms: structure and evolution. CBS publishers. New Delhi.
5. Kubitzki, K. (1990). The families of vascular plants: Pteridophytes and Gymnosperms. SpringerVerlag. New York.
6. Sahni, K.C. (1990). Gymnosperms of India. Bishen Singh and Mahendrapal Singh and Co. Dehradun.
7. Sharma, O.P. (2002). Gymnosperms. Pragati Prakashan. Meerut.
8. Siddiqui, K.A. (2002). Elements of Palaeobotany. KitabMahal. Allahabad.
9. Singh, H. (1978). Embryology of Gymnosperms. In Encyclopedia of Plant Anatomy X. Gebryder, Bortragear, Berlin.
10. Sprone, K.R. (1965). The Morphology of Gymnosperms. Hutchinson and Co. London.

**Pteridophytes:**

11. Sharma, O.P (1990). Textbook of pteridophyta. Mac Millan India Ltd. New Delhi.
12. Smith, G.M. (1971). Cryptogamic Botany. Vol. II: Bryophytes and Pteridophytes. Tata McGraw Hill. New Delhi.
13. Sporne, K.R. (1982). The morphology of Pteridophytes. Hutichinson University Press. London.
14. Trivedi, A.N. 2002. Advances in Pteridology.

  
Member

  
External Expert

  
H O.D. Botany  
Sri Sai University Palampur (H P.)

**BOT-CC-415: PRACTICAL I based on BOT-CC-411, BOT-CC-412, and BOT-CC-413**

T	S	P	Credit
0	0	4	4

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>• This course aims to have practical knowledge of evolutionary diversification of early land plants and morphological and reproductive innovations in land plants.</li><li>• Study of morphology, anatomy, reproductive and developmental change.</li></ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>• The students can note visible differences in the morphology and anatomy of various plant forms.</li><li>• Students will learn about how the organ formation occurs in early land plants that resulted to the diversity of plant species.</li></ul>

**ALGAE**

Study of Morphological and reproductive parts of following genera:

- Cyanophyta: *Anabaena*, *Microcystis*, *Oscillatoria*.
- Chlorophyta: *Acetabularia*, *Chlorella*, *Oedogonium*, *Pithophora*, *Spirogyra*, *Volvox*, *Nostoc*, *Ulothrix*.
- Xanthophyta: *Vaucheria*
- Phaeophyta: *Dictyota*, *Ectocarpus*, *Fucus*, *Padina* and *Zonaria*.
- Rhodophyta: *Batrachospermum*, *Gelidium*, *Gracillaria* and *Polysiphonia*
- Permanent slide preparation: *Oedogonium*, *Spirogyra* and *Sargassum*.
- Quantification of total soluble carbohydrate in the algal samples.
- Estimation of reserve food material from the given algal samples.
- Study of metal uptake by algae.

**Note: The students are required to collect and submit 10 algal specimens.**

**BRYOPHYTES**

Study of morphological, anatomical and reproductive parts of following genera:

- Liverworts: *Marchantia*, *Porella*, *Plagiochasma*, *Targionia*.
- Hornworts: *Anthoceros*.
- Mosses: *Funaria*, *Polytrichum*.
- Specimen study: *Anthoceros*, *Sphagnum* and *Marchantia*.
- Collection and identification of bryophytes genera and slide preparation/T.S. of available material near university campus.
- Temporary mount preparation and study of: Gemma cups, gemmae and peristome teeth.

*Dilut*  
2/12/22

### FUNGI AND PLANT PATHOLOGY

- To study morphology of following Myxomycetous fungi: *Trichia*, *Hemitrichia*, *Stemonitis*.
- To study comparative morphology of sporangiophores of following Oomycetous fungi: *Peronospora*, *Bremia* and *Sclerospora*.
- To study comparative morphology of Ascocarps.
- To study symptoms and histopathological details of following: *Albugo candida*, *Synchytricum endobioticum*, *Protomyces microspors*, *Physoderma maydis*, *Erysiphe graminis*, *Urocysti stritici*, *Puccinia graminis tritici*, *P. recondita*, *P. striformis*, *Alternaria solani*, *Cercospora arachidicola* and *Colletotrichum capsici*.
- To study different spore stages in life cycle of *Puccinia* on primary and secondary host.
- Study of crustose, foliose and fruticose lichens.
- Study permanent slide of yeast.
- To study symptoms and spore morphology of *Ustilago*, *Sphaelotheca* and *Toliposporium*.
- To study range of variation in fructification of following basidiomycetous fungi: *Corticium*, *Thelephora*, *Clavaria*, *Polyporus*, *Trametes*, *Ganoderma*, *Agaricus*, *Boletus*, *Russula* and *Lactarius*.

**Note: The students are required to collect and submit 10 fungal specimens.**

### PTERIDOPHYTES

- Morphological study from specimens/class work material of *Psilotum nudum*, *Tmesipteris tannensis*, *Lycopodium cernuum*, *L. clavatum*, *L. squarrosum*, *Phylloglossum drummondii*, *Azolla microphylla*, *Selaginella monospora*, *S. bryopteris*, *S. chrysorrhizas*, *S. pallidissima*, *S. adunca*, *S. subdiaphana*, *Isoetes panchanan*, *Equisteum debile*, *E. diffusum*, *E. ramosissimum*, *E. arvense*, *Marsilea*, *Salvinia*, *Pteris sp.*, *Dryopteris sp.*, *Asplenium sp.*
- Section cutting: *Equisetium*, *Selaginella*, *Marsilea*, *Thelypteris*, *Pteris sp.*, *Dicranopteris sp* and *Angiopteris evecta*.
- Collection and identification of pteridophyta genera and slide preparation/T.S. of available material near university campus.

### GYMNOSPERMS

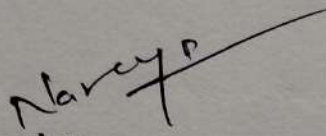
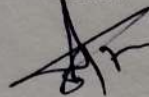
- Morphological studies from specimens of major genera of all the orders of Gymnosperms.
- To cut and study T.S., T.L.S. & R.L.S. of wood of *Pinus*, *Cedrus*, *Taxus*, *Thuja*
- To study wood elements by maceration of: *Pinus*, *Cedrus*.
- To study the anatomical details of the leaf/leaflet of *Pinus*, *Cedrus*, *Araucaria*, *Cycas*, *Thuja*.

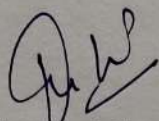
*D. K. S.*  
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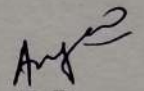
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- To study male cones of *Pinus*, *Cedrus*, *Thuja*, *Araucaria*, *Cycas*.
- To Study of female cones of *Pinus*, *Cedrus*, *Thuja*, *Araucaria*, *Cycas*.
- Study of fossil Gymnosperms specimen: *Taxus*, *Ginkgo*.
- To Collection and identification of gymnosperm genera and slide preparation/T.S. of available material near university campus.

**Note:** The students are required to collect and submit 50 (bryophyta, pteridophyta and gymnosperm) specimens.

  
Member  


  
External Expert

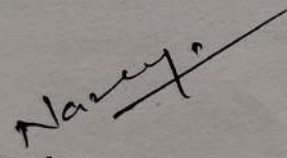
  
H O.D. Botany  
Sri Sai University Palampur (H P.)  
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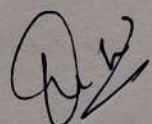
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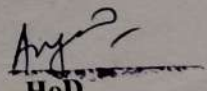
- Predation: Predator-prey interaction, Host parasite interaction, Role of predation in nature.
- Degraded ecosystems and their regeneration with special reference to waste lands, forests and aquatic ecosystem.

**Books Recommended:**

1. Begon, M. and Townsend, C.R. (1995). Ecology: Individuals, Populations and Communities. Blackwell Publishers.
2. Botkin, O. and Keller, E. (1995). Environmental Science. John Wiley Publishers. New York.
3. Chapman, J.L. and Reiss, M.J. (1994). Ecology Principles and Applications. Cambridge Univ.Press.
4. Dash, M.C. (1994). Fundamentals of Ecology. Tata McGraw Hill. New Delhi.
5. Pandey, B.N. and Kulkarni, G.K. (2006). Biodiversity and Environment. APH Publishing Corporation. New Delhi.
6. Ramakrishanan, P.S. (1991). Ecology of Biological Invasion. International Scientific Publications, New Delhi.
7. Odum, E.P. (1971). Fundamentals of Ecology.

  
**Member**

  
**External Expert**

  
H O.D. Botany **HOD**  
Sri Sai University Palampur (H P.)

**BOT-OE-425: PLANT DIVERSITY**

T	S	P	Credit
2	0	0	2

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>The course aims to have understanding of plant diversity, significance of diversity, need of classification, bases of classification, Plant adaptations, distribution of plants, evolutionary diversification.</li></ul>
<b>Course Outcomes</b>	The students will be learning: <ul style="list-style-type: none"><li>What is the significance of plant diversity?</li><li>What are the adaptations in plants in relation to habitat conditions?</li><li>Plant diversity at different levels.</li></ul>

**MODULE I**

- Plant diversity and Classification, Levels of biodiversity, various Phyla of Plants and their characteristics (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms).

**MODULE II**

- Ecosystem services, Human Food and Plant diversity, Bacterial diversity, Terrestrial Plant diversity, Marine Plant diversity, Inland water diversity, Rain Forest ecosystem and plant diversity, Landscape diversity

**MODULE III**

- Biodiversity Hotspots, Keystone species, Threats to Plant diversity, Desertification, Endangered plants, Plant invasions, Loss of Plant diversity, Plant Restoration

**MODULE IV**

- Indigenous people and plant diversity, Traditional plant conservation practices, Plants in Indian tradition and culture, Plant animal interactions.

**MODULE V**

- Use and Economic values of plant diversity.
- Tourism and Plant diversity.
- Climate change and plant diversity.

**Books recommended:**

- Kumar, U. and Sharma, A.K. (2001). Plant biotechnology and Biodiversity conservation. Agrobios, Jodhpur.
- Dobson, A. (1996). Conservation and Biodiversity. Palgrave MacMillan
- Levin, S.A. (2001). Encyclopedia of Biodiversity Vol 1 to 5. Academic Press New York
- Groombridge, B. and Jenkins, M.D. (2002). World Atlas of Biodiversity, Earth living

*Signature*  
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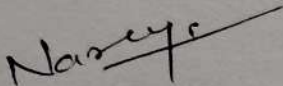


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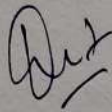
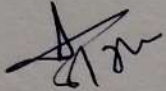
resources in the 21st Century. University of California Press

5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2008). Ecology, Environment and Resource conservation. Anamaya Publications, New Delhi

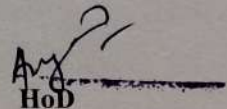
6. Krishnamurthy, K.V. (2003). Text Book of Biodiversity. Science Publishers.



**Member**



**External Expert**



H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-CP-426: PRACTICAL III based on BOT-CC-421 and BOT-CC-422**

T	S	P	Credit
0	0	4	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the students with the various ecological principles with practical knowledge on ground level.</li> <li>To impart knowledge of various components of ecosystem through different practical methods.</li> <li>To provide knowledge of morphological and anatomical structures of various parts of angiospermic plants.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>The students will be learning about the concepts, tools and techniques related to the ecology.</li> <li>The students will learn about the appearance of various cell/tissue type under the microscope and their relevance in the nomenclature.</li> </ul>

**ANGIOSPERMS**

- Study of the locally available plants and recording of the intraspecific variation.
- Description and identification at family, genus and species levels using Floras.
- Identification of key characters in a group of species of a genus and construction of keys.
- Construction of indented keys for the given material
- Simple Nomenclatural problems
- Identification of families studied based on flowers or essential parts of the flowers
- Knowledge of Herbarium techniques
- Record and Herbarium
- To study the anatomy of:
  1. Monocot root.
  2. Dicot root.
  3. Monocot stem.
  4. Dicot stem.
  5. Monocot leaf.
  6. Dicot leaf.

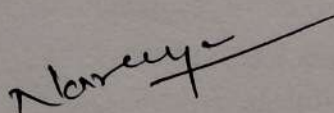
**ECOLOGY:**

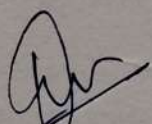
- A trip to the grass land/ forest/ water body to get acquainted with their plant species.
- Distribution pattern of different plant species determined by Quadrant/Transect/ Point centred Quarter methods.
- To determine minimum size and number of quadrats required to study grassland.
- Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover,
- Dominance, Abundance and IVI.
- To determine diversity indices (Shannon-Weiner, species richness, B-diversity) from given Data.

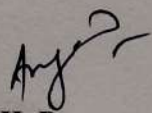
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- To determine gross and net phytoplankton productivity by light and dark bottle method.
- Analysis of soils of two different areas *i.e.* Cropland and forest/ grassland for certain nutrients,  $\text{CO}_3$ ,  $\text{NO}_3$ , Base deficiency.
- To study ecological adaptations of the given plants
- Study of diversity of freshwater and marine plants
- To study world formation on the basis of a biome through map provided to you.
- To study world soil map based bioclimatic zones.
- To determine free  $\text{CO}_2$  from given water samples.
- To determine dissolved  $\text{O}_2$  from given water sample.
- To determine alkalinity of given water sample.
- To test nitrate, ammonium, nitrite nitrogen, calcium, phosphorus and potassium in the crop land, grassland and forest soil samples.
- To estimate organic matter of given soil samples by Walkey-Black method.
- To study of effect of  $\text{SO}_2$  (a pollutant) on pollen tube emergence of given pollen samples.
- To study the conventional metrological instruments.

  
Member

  
External Expert

  
H O.D. Botany

HoD

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**RM-CC-022: RESEARCH METHODOLOGY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	This course will help to: Develops better insight into topic; Provides systematic structure; Enhance the research quality; Derive better solutions; Aids in decision making; Inculcates logical and systematic thinking.
<b>Course Outcomes</b>	At the end of this course, the students should be able to: <ul style="list-style-type: none"> <li>• understand some basic concepts of research and its methodologies</li> <li>• select and define appropriate research problem and parameters</li> <li>• prepare a project proposal (to undertake a project)</li> <li>• organize and conduct research (advanced project) in a more appropriate manner</li> <li>• write a research report and thesis</li> </ul>

**MODULE I**

- **Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
- **Problem Identification & Formulation** – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

**MODULE II**

- **Research Design:** Concept and Importance in Research – Features of a good research design Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.
- **Qualitative and Quantitative Research:** Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

**MODULE III**

- **Measurement:** Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
- **Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample– Practical considerations in sampling and sample size.

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**MODULE IV**

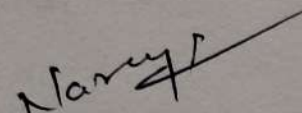
- **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
- **Interpretation of Data and Paper Writing** – Layout of a Research Paper, Journals in Chemical Sciences, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.


**MODULE-V**

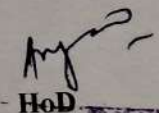
- Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. **Use of tools / techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

**Books recommended:**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R. Kothari
4. Select references from the Internet.

  
Member

  
External Expert

  
H.O.D. Botany - HoD  
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**BOT-EC-434: IMMUNOLOGY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>• The objective of this module on immunology is</li><li>• to provide a basic understanding of fundamentals of immunology.</li><li>• It will also provide conceptual understanding of the current tools and techniques available in the field of immunology.</li></ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>• The students will be learning about</li><li>• What is immunity and how various factors such as environmental and genetic makeup regulate it, how does immune system evolve?</li><li>• What are antigen and antibodies and how do they interact with each other?</li><li>• What happens at cellular level when a foreign antigen enters body?</li></ul>

**MODULE I**

- Introduction to Immunology: Innate and acquired immunity, characteristics of immune response, humoral and cellular immunity, benefits and damaging effects of immunology

**MODULE II**

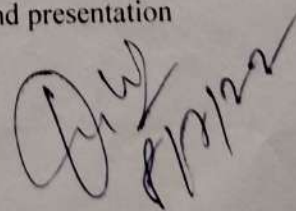
- Cell and tissues of immune system: Cell of immune system, primary and secondary lymphoid organs.
- Antigens: Immunogens, major classes of antigens, physical and chemical properties of antigens.
- Immunoglobulin's: Structure and functions of immunoglobulin's, classes and subclasses of human immunoglobulin's, polymorphism, primary and secondary immune response.

**MODULE III**

- Complement System: Complement proteins, pathways of complement activation 15
- Antigen- antibody reaction, Precipitation, agglutination, Immunofluorescence, radioimmunoassay, ELISA, immunoblotting.
- Monoclonal antibodies: Hybridoma, Isolation and characterization of monoclonal antibodies. Hypersensitivity Anaphylaxis, antibody-mediated cytotoxic and immune complex reactions, delayed -type hypersensitivity.

**MODULE IV**

- Immunogenetics: Immunoglobulin genes, Ig/TCR gene rearrangement and generation of diversity, introduction to immunogenetics and the MHC, antigen recognition by T cells, TCR, co-receptors, MHC structure, antigen processing and presentation

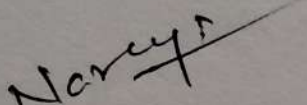
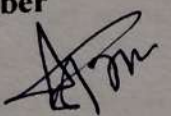



**MODULE V**

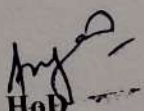
- Immunity in Health and Disease: Immune response to infectious diseases, immunodeficiency and AIDS, Hypersensitivity, transplant rejections, autoimmunity, Vaccines, Evolution of the immune system.

**Books Recommended:**

1. Immunology by Jaris Kuby.
2. Immunology by J. A. Bellanti.
3. Fundamentals of Immunology by W. e. Paul.
4. Essential Immunology by J. M. Roitt.
5. Immunology by E.S. Golub.
6. Immunology by E. Benjamini, R Coice and G. Sunshine.

  
Member  


  
External Expert

  
HoD  
H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-EC-435: PLANT RESOURCE UTILIZATION**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>Learn about basic of biosafety and good lab practices like safe chemical handling, hazardous waste management, safe and proper use of lab equipment.</li> <li>Learn about the principles of various basic and advanced microscopy.</li> </ul>

**MODULE I**

- A brief account of the origin, botany, cultivation and uses of food crops.
  - Cereal Crops - Wheat, Rice, Maize,
  - Sugar Crops - Sugarcane
  - Tuber Crops - Potato
- A brief account of the origin, botany, cultivation and uses of the following
  - Fiber crops: (Cotton, flax, Hemp, sisal) and
  - Fodder crops: (Sorghum, Barseem, Guar)

**MODULE II**

- A brief account of the origin, botany, cultivation and uses of vegetable oil yielding plants.
  - Mustard (ii) Coconut (iii) Groundnut (iv) Sunflower.
- A brief account of the origin, history, botany, cultivation, processing chemical composition and uses of the following beverages crops.
  - Tea (ii) Coffee

**MODULE III**

- A brief account of the origin, history, botany, cultivation, processing and uses of Tobacco and Para Rubber.
- Name, family, plant part yielding active principle and uses of the following:
  - Medicinal Plants: Aconitum, Cinchona, Belladonna, Digitalis, Glycyrrhiza, Artemisia, Rauwolfia, Nux-vomica, Garlic, Neem, Tulsi, Papaver, Vasaka, Aloe, Asafoetida, Genseng.

**MODULE IV**

- Name, family, plant part yielding active principle and uses of the following
  - Aromatic Plants: Mentha, rosa, Jasminum, cymbopogon, Lavender, Hops, Camphor.
  - Spices and Condament: Ginger, Turmeric, Cinnamon, Cloves, Cardamom, Chllies, Pepper, Fennel, Coriander, Cumin, Nutmeg, Mace and Saffron.

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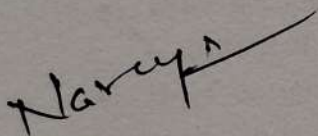
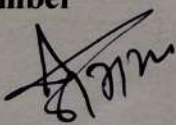
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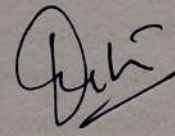
### MODULE V

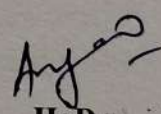
- Name, family, distribution and uses of important commercial timbers of India (Teak, Sal, Chir, Kail, Deodar, Sisham, Kikar). List of important fuel woods, trees for avenues, pollution control and aesthetics.
- A brief account of the following: (i) Gums (ii) Resin (iii) Tannins (iv) Dyes (v) Rattans (vi) Raw materials for Paper Industry (vii) Bamboos (viii) Wild Fruits.

### Books Recommended:

1. Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.
2. Conway, G. 1999. The Doubly Green Revolution. Food for All in the 21<sup>st</sup> Century, Penguin Books.
3. Conway, G. and Barbier, E. 1990. After the Green Revolution, Earthscan Press, London.
4. Conway, G. and Barbier, E. 1994. Plant, Genes and Agriculture, Jones and Bartlett Publishers, Boston.
5. Council of Scientific and Industrial Research, (1948-76). The Wealth of India.

  
Member  


  
External Expert

  
HoD  
H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-CP-437; PRACTICAL V based on BOT-CC-431 and BOT-CC-432**

T	S	P	Credit
0	0	4	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To impart students the practical knowledge regarding the mechanisms underlined absorption of water and minerals, solute transport, photosynthesis, respiration and nitrogen metabolism.</li> <li>To acquaint the students about the interactions of various molecules and their functioning including the analytical techniques for qualitative and quantitative estimations.</li> </ul>
<b>Course Outcomes</b>	<p>The students will:</p> <ul style="list-style-type: none"> <li>Gain knowledge of plant cellular processes and their mechanisms helpful for the growth and development and their survival.</li> <li>Learn about the various biomolecules present in the plant systems and their estimation procedures.</li> </ul>

**PLANT PHYSIOLOGY**

- To demonstrate the phenomena of adsorption.
- To determine the water holding capacity of different types of soils.
- To demonstrate the operation of the solubility theory of permeability.
- To determine the osmotic pressure of the cell sap of the given plant material by Plasmolytic method.
- To determine the effect of temperature and alcohol on permeability and find out thermal death point.
- To determine the surface tension of alcohol by drop counting method.
- To study the effect of light on the relative loss of water vapour from leaves.
- To measure and compare the rate of transpiration under different environmental conditions with simple potometer.
- To compare the rate of transpiration from two sides of a leaf.
- To demonstrate suction due to transpiration (or transpiration pull).
- To demonstrate transpiration by using Ganong's potometer.
- To demonstrate the effect of CO<sub>2</sub>, light intensity and temperature with time on the rate of photosynthesis in twigs of *Hydrilla*.
- To demonstrate that light, chlorophyll and CO<sub>2</sub> is necessary for photosynthesis.
- To separate leaf pigments by (i) Column Chromatography (ii) Paper Chromatography.
- To separate chloroplast pigments from leaf by chemical method and to calculate their R<sub>f</sub> value.
- Quantitative determination of photosynthetic pigments from given plant material.
- To show that oxygen is released during photosynthesis.
- To demonstrate the phenomenon of anaerobic respiration.
- To demonstrate that O<sub>2</sub> is taken in and CO<sub>2</sub> is given out during respiration.

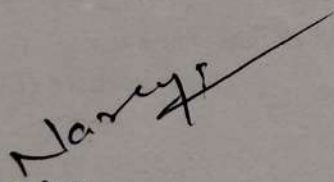
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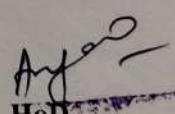
- To determine the respiratory quotient of given plant material by Ganong's respirometer.

### BIOCHEMISTRY

- Measurement of pH of biological liquids using pH strips.
  - a) Blood
  - b) Urine
  - c) Saliva
  - d) Tear
  - e) Soil
  - f) Milk
- Measurement of pH of biological liquids using pH meter
  - Blood
  - Urine
  - Saliva
  - Tear
  - Soil
  - Milk
- To prepare the buffer solutions.
- Titration of a mixture of a strong acid and a weak acid.
- Titration of a mixture of a strong acid with weak and strong acid.
- Identification of sugars in fruit juices using chromatographic techniques.
- Benedict's test for reducing sugar.
- Iodine test for polysaccharides.
- Estimation of carbohydrates.

  
Member

  
External Expert

  
H.O.D. Botany  
Sri Sai University Palampur (H.P.)

SEMESTER – IV

BOT-CC-441: PLANT BIOTECHNOLOGY AND TISSUE CULTURE

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• Understand basic knowledge of tissue culture tools, medium sterilization and techniques of tissue culture.</li> <li>• To learn about basic concepts of recombinant DNA technology.</li> <li>• Course aims at the concept, scope, instrumentation, basic requirements and applied aspects of plant tissue culture.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>• The students will be learning about scope and application of the biotechnology and biotechnological utilization of regeneration potential.</li> <li>• Learn the specific and non-specific methods of gene transfer.</li> </ul>

**MODULE I**

- **Basic Techniques:** Nutrition Medium, Sterilization Techniques, Principles (Cytodifferentiations, Organogenic differentiation).
- **Types of culture:** Embryo culture, Callus culture and Organ culture.
- **Micropropagation:** Axillary bud Proliferation approach, Meristem & shoot tip culture, Bud culture, Organogenesis & Embryogenesis & their applications.

**MODULE II**

- **Cell suspension culture:** Types of suspension cultures, Production of secondary metabolites and their applications.
- **Somaclonal Variation:** Selection of somaclonal variants, mechanism & their applications, Cryopreservation.
- **Haploid Production:** Androgenic Methods, Gynogenic Haploids, Chromosome elimination techniques, Distant hybridization, Embryo rescue.

**MODULE III**

- Protoplast isolation, fusion. Section of hybrid cells, regeneration of hybrid plants, Applications & limitation, Cybrids, Hybrids, somatic hybrids, cytoplasm & Plastocyt.

**MODULE IV**

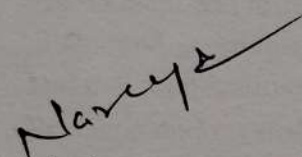
- **Recombinant DNA technology:** Isolation, cloning vectors and amplification of genes & their applications.
- **Molecular markers & Marker assisted selection:** Morphological, Biochemical & Molecular markers. Non-PCR based approaches & PCR based techniques & their advantages & disadvantages Gene transfer in Plants: Vector & Vectorless.

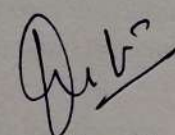
**MODULE-V**

- **Transgenics in Crop improvement:** Resistance to biotic & abiotic stress, Transgenics for quality & as bioreactors.
- Application of microbial biotechnology for human welfare.

**Books recommended:**

1. Bajaj, Y.P.S. (2000). Biotechnology in Agriculture and Forestry-46-Transgenic Trees, Springer Pub., New York, USA
2. Bhojwani, S.S., and Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice (A revised Edition), Elsevier Science Pub., New York, U.S.A.
3. Brown, T.A. (1999). Genomes. John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. Chawla, H.S. (2005). Introduction to Plant Biotechnology, Oxford & IBH Pub., New Delhi, India.
5. Gupta, P.K. (1996). Elements of Biotechnology, Rastogi & Co., Pub., Meerut, India.
6. Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) (1999). Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.

  
**Member**

  
**External Expert**

  
**HOD**

H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-EC-442: ANALYTICAL BOTANY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the available techniques for designing a qualitative research.</li> <li>To gain knowledge on working principles of various techniques.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>Learn about basic of biosafety and good lab practices like safe chemical handling, hazardous waste management, safe and proper use of lab equipment.</li> <li>Learn about the principles of various basic and advanced microscopy.</li> </ul>

**MODULE I**

- Basic Principles of research techniques and safety measures: Aims of Lab investigation, Experimental designs, SI units, safety against Chemical, Physical and Biological hazards. Waste disposals.
- Cell culture techniques: Cell culture Laboratory, equipment's, aseptic techniques and good culture practices, type of cultures, potential uses of cell culture.

**MODULE II**

- Anatomical and histochemical techniques: Functioning and application of microtomy, stains and staining techniques; Maceration; Principle of fixation, types of fixatives and their applications.
- Principle and methods of histochemical localization of carbohydrates lipids, proteins, nucleic acids and enzymes.

**MODULE III**

- Centrifugation: Principle, functioning and applications of low speed, high speed and ultracentrifugation.
- Spectroscopy: Principle, functioning and applications of UV-visible spectrophotometry, spectrofluorometry.

**MODULE IV**

- Electrophoresis: Principle, functioning and applications of simple and 2D gel electrophoresis.
- Chromatographic techniques: Principle and applications of paper chromatography column chromatography, thin layer chromatography, Ion Exchange, Gel filtration chromatography and Gas chromatography.

**MODULE V**

- Definition; Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; sequencing.

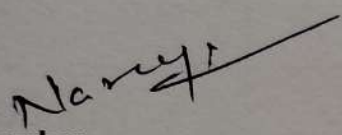
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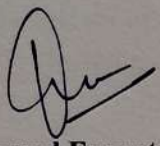
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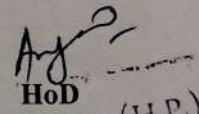
- Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics.

**Books Recommended:**

1. Wilson, K. and Walker, J.(2009). Principles and techniques of Biochemistry and molecular Biology. Cambridge Univ. Press, India.
2. Plummer, David T. (1996). An introduction to practical Biochemistry 3rd Ed. Tata McGraw Hill. Pub. Corp. Ltd., New Delhi.
3. Rao, B. S. and Deshpande, V. (2000). Experimental Biochemistry. A student companion. I. K. International Pvt. Ltd., New York.

  
**Member**

  
**External Expert**

  
**HoD**  
H O.D. Botany  
Sri Sai University Palampur (H P.)

**BOT-EC-443: ENVIRONMENT BOTANY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>After going through the content of this course, the students are expected to understand and appreciate the current ecological and environmental problems confronted by man at local, regional, national and global level. For the present and the future scenario, especially pollutions of different types, conservation for posterity apart from issues of climate change and biodiversity will be main agenda for study.</li> </ul>
<b>Course Outcomes</b>	<p>The students will be learning:</p> <ul style="list-style-type: none"> <li>Why conservation biology is necessary to understand for protecting biological resources in changing environment? Where is the role of each and every species in nature and Environment?</li> <li>How a degraded ecosystem could be converted into its original state and then possible for further use?</li> <li>What are main drivers of conservation biology actually work so far to cope up with changing environment?</li> </ul>

**MODULE I**

- Conservation Biology: Definition, scope, objectives and principles of conservation biology, protected areas, National and International organizations involved in conservation practices, Conservation of plant genetic diversity.
- Restoration Ecology: Definitions, Scope, Mechanisms, Pattern process and action of restoration ecology, case study from India; concept and mechanisms of ecological restoration, land use change and habitat degradation, soil restoration and soil degradation.
- Importance of Restoration Ecology for Ecosystem, Biodiversity and natural resource conservation practices in India.

**MODULE II**

- Management and Conservation of Natural Resources: Types of resources, Sustainable development and ecological economics. Sustainable utilization of natural resources (economic, sociological, ecological and socio-cultural dimension).
- Management and Conservation of Biological Resources: Biodiversity Concept, definition(s), Scope and limitations of Biodiversity Science, Scales and composition of Biodiversity: Genetic, Species, Ecological/Ecosystem Diversity, cultural, rituals role in biodiversity saving. Biodiversity threats and measurements. Values and applications with humankind; Indian case studies especially - Project Tiger and Elephant.
- Biosphere Reserves and Biodiversity hotspots: The concept, major functions and current status in India and world; Risk categories of plants: Major risk categories, IUCN Red List of threatened species, RLI.

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### MODULE III

- Global Environmental Changes: Global warming, climate change, Reasons, possible effects and measures to combat the problem.
- Ozone Depletion: Phenomenon, reasons, possible ecological effects and measures to check the depletion of ozone.

### MODULE IV

- Invasion Ecology: Definition, factors (both Intrinsic and extrinsic) affecting invasion, Status and impact of plant invasion on native flora; use and ecological role of weeds in Indian Agro-ecosystems, Major-weeds of the world; Ecological approach to weed management.
- Field Experiments and Methods: Vegetational analyses, Ecosystem analyses, Biodiversity quantification, analyses of synthetic and analytical characters of local plant community.

### MODULE V

- Protection of Environment: International concern and efforts for environmental protection, global plan, Stockholm Summit, priority issues; Earth Summits.

### Books Recommended:

1. Singh, J.S., Singh S.P. and Gupta, S.R. Ecology, Environment Science and Conservation, S. Chand & Company, Private Ltd., New Delhi, 2014.
2. Martha, J.G. Principles of Conservation Biology, Sinauer Associates, Inc., Publishers, USA, 2006.
3. Andel, J.V. and Arnoson, J. 2012. Restoration ecology –the new frontier, 2nd edition, John Willey & sons, Ltd., The Atrium, Southern Gate, Chichester, West Sussex, PO198SQ, UK.
4. Sodhi, N.S. and Ehrlich, P.R. Conservation Biology for All, Oxford University Press, New York, USA, 2010.
5. Botkin, D. and Keller, E., Environmental Science, John Wiley, New York, U.S.A., 1995.
6. Newman, E. I. Applied Ecology, Blackwell Scientific Publishers, UK, 1994.
7. Odum, E. P. Fundamentals of Ecology, Saunders Toppan, U.S.A, 1971.
8. Rice, E.L., Allelopathy, Academic Press Inc., U.S.A., 1987.
9. Cain, M. Bowman, W.D. and Hacker, S.D., Ecology, Third Edition, Sinauer Associates, Inc., Publishers, U.S.A., 2013.
10. Andel, J.V. and Arnoson, J. 2006. Restoration ecology –the new frontier, published by Blackwell Science Ltd.UK.

Member

External Expert

H.O.D. Botany  
Sri Sai University Palampur (H.P.)

HoD

**BOT-EC-444: EMBRYOLOGY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To understand the various aspects of plant floral parts, development and reproduction.</li> <li>To understand the various aspects of embryology and apomixis.</li> </ul>
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ul style="list-style-type: none"> <li>Discuss the structural elements of plants floral parts and reproduction.</li> <li>Discuss the Pollination, embryology and apomixis.</li> </ul>

**MODULE I**

- Historical account of plant Reproduction; Microsporangium: Anther Wall, Endothecium Middle layers, Tapetum, Nuclear behavior in tapetal cells, Sporogenous tissue.
- Male Gametophyte: Formation of vegetative and generative cells, Formation of Sperms, Pollen wall, Abnormal features. Megasporangium: Types of ovule, Integuments, Nucellus, Megasporogenesis, Special features.
- Female Gametophyte: Types of female gametophytes, ultra structure of mature Embryo sac, Haustorial behavior of embryo sac, Nutrition of Embryo sac.

**MODULE II**

- Pollination: Anther dehiscence, pollen transfer, self-pollination, cross-pollination, artificial pollination.
- Fertilization: Pollen germination and pollen-tube growth. Path of pollen-tube, pollentube discharge, Double fertilization, Syngamy.

**MODULE III**

- Endosperm: Types of endosperm, ruminant endosperm, cytology of endosperm. Functions of endosperm.
- Embryo: Embryogeny in dicotyledons, Embryogeny in monocotyledons. suspensor, under developed and reduced embryos, Nutrition of embryo. Polyembryony: Causes of polyembryony, experimental induction of polyembryony, classification of polyembryony practical value of polyembryony.

**MODULE IV**

- Apomixis: Vegetative reproduction, apospory, causes of apomixis, significance of apomixis.
- Seed: Seed development, importance of seeds, Seed dispersal, Seed Dormancy.

**MODULE-V**

- Embryology in relation to Taxonomy: importance of Embryological characters in taxonomic considerations, families with special embryological features.

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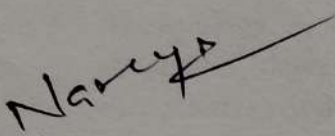
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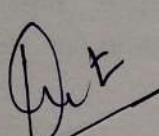
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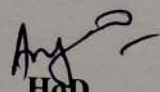
- Role of Palynology in taxonomy; Experimental Embryology; Embryo rescue and its culture, Parthenocarpy, parasexual hybridization.

**Books Recommended:**

1. Maheswari, P. A. (1950). Introduction to Embryology of Angiosperms.
2. Shivanna, K.R. and John, B.M. (1989). The Angiosperm Pollen structure and Function, Wiley Eastern Ltd. Publications.
3. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms, Vol. I & II, Springer Verlag.
4. Bhojwani, S.S. and Bhatnagar, S.P. (1971). The Embryology of Angiosperms.

  
Member

  
External Expert

  
HOD  
O.D. Botany  
Sri Sai University Palampur (H P.)

**BOT-EC-445: AGRICULTURAL ECOLOGY**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>This course aims to introduce the students to the application of concepts and principles of ecology to human managed ecosystems <i>i.e.</i> agroecology.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>The students will be learning:                             <ol style="list-style-type: none"> <li>The meaning of terms agriculture, domestication and selection.</li> <li>What are the ecological principles that are applicable in managed ecosystems such as agriculture systems?</li> <li>The relationship of domesticated biodiversity with its wild biodiversity?</li> <li>How ecological problems influence the agriculture and human food security?</li> </ol> </li> </ul>

**MODULE I**

- Agroecology – definitions of terms, scope of the discipline, approaches and viewpoints, domestication, selection and protection of crop plants and farm animals, wild relatives of the crops.
- Ecological experimentation in agriculture.

**MODULE II**

- Ecosystem functioning of farming systems – energy and material flows, trophic relations, spatial scales and ecological footprints, organic farming.
- Genetically modified organisms and their implications.

**MODULE III**

- Climate change – agriculture and adaptation mechanisms.
- Ecological problems of crop cultivation and solutions – pollution, leakage and erosion, land development, diseases, weeds and pests.
- Chemical, biological and ecological control.

**MODULE IV**

- Interactions between farming systems and biodiversity – biodiversity in farming systems, landscape fragmentation, relationships and interdependencies of biodiversity within farming systems with outside farming systems.

**MODULE V**

- Case studies of farming systems of India.

**Books Recommended:**

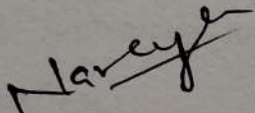
- Gliessman, S.R. (2015). Agroecology: The Ecology of Sustainable Food Systems. CRC Press.
- Altieri, M.A. (2018). Agroecology: The Science of Sustainable Agriculture. Second Edition.

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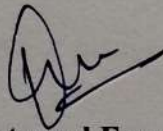
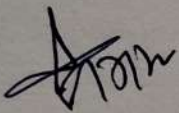
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Edition. CRC press.

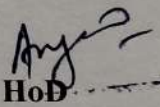
3. Gliessman, S.R. (2014). Field and Laboratory Investigations in Agroecology. Third Edition. CRC Press.
4. Wojtkowski, P.A. (2006). Introduction to Agroecology: Principles and Practices. Food Products Press.
5. Alagh, Y.K. (2013). The Future of Indian Agriculture.
6. Mazoyer, M. and Roudart, L. (Translated by Membrez, J.H.). (2014). A History of World Agriculture: From the Neolithic Age to the Current Crisis. Monthly Review Press, New York.



Member



External Expert



H.O.D.

H.O.D. Botany  
Sri Sai University Palampur (H.P.)

**BOT-EC-446: MOLECULAR INTERACTIONS OF PLANTS WITH SYMBIONTS,  
PATHOGENS AND PESTS**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<ul style="list-style-type: none"><li>This paper aims to introduce various aspects of biochemical and molecular interactions of plants with symbionts, pathogens and pests at an advanced level.</li></ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"><li>The students will:<ol style="list-style-type: none"><li>Understand plant responses to biotic components of their environments.</li><li>Learn concepts, techniques and applications related to the plant interactions with microbes, pathogens and herbivores.</li></ol></li></ul>

**MODULE I**

- Introduction to the biotic interactions of plants.

**MODULE II**

- Recent advances in plant-pathogen and plant-insect interactions: Stages of pathogenesis, Structural and biochemical host defense mechanisms against pathogens and pests, Basal resistance, Non-host resistance, PTI and ETI. Distinction between necrotrophic and biotrophic pathogens.
- Plant defense against necrotrophs and biotrophs. Systemic acquired resistance, Induced systemic resistance. Induced resistance, signaling pathways, cross-talk between SA and JA-dependent defense responses.

**MODULE III**

- Genetics, genomics and applications: Genetics, genomics and applications: Gene-for-gene concept, Models for perception of effector proteins by plants, Cloning of resistance genes (R genes) and avirulence genes (Avr genes) from plants and pathogens, Induced responses to herbivory.

**MODULE IV**

- Recent advances in symbiotic interactions with plant with special references to mycorrhizae and root nodule symbiosis.

**MODULE V**

- Genetic engineering for the production of resistance plants to pathogens and pests.

**Books Recommended:**

- Karban, R. and Baldwin, I.T. (1997). Induced responses to herbivory, Chapter 3, 47-100. Chicago University Press.
- Hull, R. (2001). Mathew's Plant Virology. Academic Press, NY.
- Strange, R.N. (2003). Introduction to Plant Pathology. John Wiley & Sons, USA.33
- Dickinson, M. (2003). Molecular Plant Pathology, Bios Scientific Publishers, London.

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5. Burchett, S. and Burchett, S. (2018). Plant Pathology. Garland Science, USA.
6. Mehrotra, R.S. (2017). Plant Pathology, 3rd Edition, McGraw-Hill Education, New Delhi.
7. Recent and important review articles from scientific journals.

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Sri Sai University Palampur (H P.)

**BOT-EC-447: URBAN ENVIRONMENT**

T	S	P	Credit
4	0	0	4

<b>Course Objectives</b>	<p>This course will help the students to understand:</p> <ul style="list-style-type: none"> <li>• The impacts of diverse and complex themes of urbanization</li> <li>• How urbanization affects patterns of biodiversity</li> <li>• How urbanization is changing climate.</li> <li>• Urban pollution and management strategies.</li> </ul>
<b>Course Outcomes</b>	<ul style="list-style-type: none"> <li>• This course explores the ecology and biophysical environment of urban ecosystems.</li> <li>• The students will interpret and synthesize literature on climate and water patterns, nutrient cycling, monitoring, and management strategies of conservation of biodiversity in urban ecosystem.</li> <li>• The students will effectively communicate scientific knowledge of how urban ecosystem are structured and function and the problems of emerging pollutants. They will be acquainted about societal issues related to urban areas.</li> </ul>

**MODULE I**

- Introduction to urban environment:—Why should we study it? Urbanization patterns; The dynamics of urban environment; What makes urban ecosystem different; Classification of urban life; Urban habitats.

**MODULE II**

- Urban Ecology:—Urban climate; Urban nutrient dynamics; Urban water cycle; Homogenization of urban ecosystem; Species interactions in urban environment; Concept of green roofs.

**MODULE III**

- Pollution in urban areas:— Sources of urban air pollution, implications and health issues; Grey water pollution, implications and health issues; Soil contamination in urban areas in India; Light and Noise pollution; Waste water collection, treatment and disposal; Most polluted urban cities in India.

**MODULE IV**

- Environmental problems and solutions of urban areas:—Urbanization and climate change; Urban heat islands and human health.

**MODULE V**

- Problems of slums and shanty towns; Invasive species; Solid waste management; Traffic congestion.

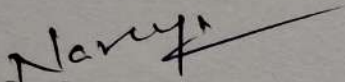
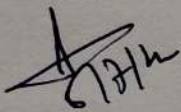
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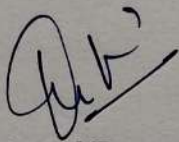


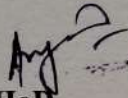
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**Books Recommended:**

1. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
2. Hall, M.H.P. and Balogh, S.B. 2019. Understanding Urban Ecology. An Interdisciplinary Systems Approach. Springer, New York.
3. Leinbach, K. 2017. Urban Ecology: A Natural Way to Transform Kids, Parks, Cities, and the World. Morgan James Publishing, USA.
4. Parris, K.M. 2016. Ecology of Urban Environments. Wiley-Blackwell, USA.

  
Member  


  
External Expert

  
H O.D. Botany HoD  
Sri Sai University Palampur (H P.)

**BOT-CP-448: Practical VII based on BOT-CC-441**

T	S	P	Credit
0	0	2	2

<b>Course Objectives</b>	<p>This course will help the students to understand:</p> <ul style="list-style-type: none"> <li>• About the basic requirements for plant tissue culture in laboratory and how to prepare culture media and aseptic room.</li> <li>• About the working of various instruments required for the tissue culture and recombinant DNA technology.</li> <li>• About the handling of Genetic material.</li> </ul>
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ul style="list-style-type: none"> <li>• To prepare the suitable media for various explants.</li> <li>• Handle different instruments</li> <li>• Isolate and process DNA.</li> </ul>

**CONTENT**

- Preparation of complex nutrient medium (Murashige & Skoog's medium).
- To selection, Prune, sterilize and prepare an explant for culture.
- To demonstrate various steps of Micropropagation.
- To understand principle, working and handling of
  - (i) Laminar Air Flow
  - (ii) pH meter
  - (iii) Autoclave
  - (iv) BOD Incubator
  - (v) Centrifuge
  - (vi) Micropipettes
  - (vii) Incubator Shaker
  - (viii) Water double-distillation unit
- Isolation of DNA from Plants.
- Separation of proteins by electrophoresis.
- Removal of chromium/ nitrate/ ammonia by immobilized cyanobacterial cells.
- Demonstration of DNA amplification by PCR.

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Palampur (H.P.)

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**BOT-EP-449A: Practical VIII Based on BOT-EC-442 to BOT-EC-444**

T	S	P	Credit
0	0	2	2

<b>Course Objectives</b>	<p>This course will help the students to understand:</p> <ul style="list-style-type: none"> <li>• The working of some lab instruments.</li> <li>• The pollen structure under microscopy and to prepare their permanent slides.</li> <li>• The various components of the environment.</li> </ul>
<b>Course Outcomes</b>	<p>The students will be able to:</p> <ul style="list-style-type: none"> <li>• Handle lab instruments without any help.</li> <li>• Prepare permanent slides of pollen grains without destroying them.</li> <li>• Understand what cause pollution and how can they identify its direct or indirect effect on nature.</li> </ul>

**ANALYTICAL BOTANY**

- Use of spectrophotometer in biochemical estimations- chloroplast pigments, proteins, carbohydrates etc.
- Demonstration of instruments: Gel Electrophoresis, Microtome, pH meter, oven, incubator, autoclave and centrifuge.

**EMBRYOLOGY**

- Prepare of smear for the study of gametophyte.
- Micro- dissection techniques for embryo and embryo sac.
- Elementary techniques for pollen germination.
- Study for various stages in reproduction from permanent slides, pre and post fertilization in embryo sac.

**ENVIRONMENT BOTANY**

- Physico-chemical analysis of polluted water- color, acidity, alkalinity, taste, turbidity, total solids, total dissolved solids, conductivity, hardness, pH, Biological oxygen demand, Dissolved oxygen, Chemical oxygen demand.
- Biological examinations of polluted water- microscopic and culturing method (Density count).
- Physico-chemical analysis of polluted soil, pH, Electric conductivity, soluble cations and anions, heavy metals (base deficiency).
- To analyze distribution pattern of selected species in an ecosystem.
- To measure the photosynthetic rate (A) and the specific leaf area of five tree species and observe relation between them.
- Preparation of ethnobotanical herbarium.

Member

External Expert

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Palampur (H.P.)

**BOT-EP-449B: PRACTICAL IX based on BOT-EC-445 to BOT-EC-447**

T	S	P	Credit
0	0	2	2

<b>Course Objectives</b>	This course will help the students to understand: <ol style="list-style-type: none"><li>1. How plants interact with the different symbionts and pests in nature?</li><li>2. About the various components of made-made ecosystem <i>i.e.</i> agroecosystem and how it can affect the surroundings.</li><li>3. How urbanization affects patterns of biodiversity.</li><li>4. Urban pollution and management strategies.</li></ol>
<b>Course Outcomes</b>	The students will be able to: <ul style="list-style-type: none"><li>• Differentiate between positive and negative interactions.</li><li>• Evaluate the composition of the soil and for which crop it is most suitable.</li><li>• The students will effectively communicate scientific knowledge of how urban ecosystem are structured and function and the problems of emerging pollutants. They will be acquainted about societal issues related to urban areas.</li></ul>

**MOLECULAR INTERACTION OF PLANTS WITH SYMBIONTS AND PATHOGENS AND PESTS**

- To study the nature and extent of damage to vegetable crops.
- Isolation of rhizosphere and soil microorganisms.
- Isolation of phyllosphere microorganisms.
- Antagonism study among the fungal organisms.
- Identification of few plant pathogenic microorganisms.

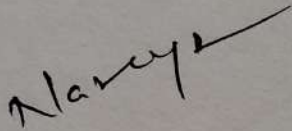
**AGRIECOLGY**

- To estimate soil moisture content at different agricultural systems.
- To estimate soil pH at different agricultural systems.
- To estimate soil organic matter content at different agricultural systems.
- To study soil nutrient contents (N, P, K) at different agricultural systems.
- To study plant species diversity/crop diversity in different agricultural systems.
- Seed viability test.
- To study faunal species diversity at different agricultural systems.
- To study management practices at different agricultural systems and prepare group and/or individual reports.
- Weed seed bank.
- Case studies/field reports (pollinators).

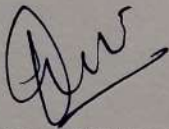
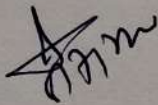
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**URBAN ENVIRONMENT**

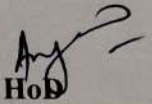
- Physico-chemical analysis of polluted water- color, acidity, alkalinity, taste, turbidity, total solids, total dissolved solids, conductivity, hardness, pH, Biological oxygen demand, Dissolved oxygen, Chemical oxygen demand.
- Biological examinations of polluted water- microscopic and culturing method (Density count).
- Physico-chemical analysis of polluted soil, pH, Electric conductivity, soluble cations and anions, heavy metals (base deficiency).
- To analyze distribution pattern of selected species in an urban ecosystem.



Member



External Expert



H.O.D. Botany  
Sri Sai University Palampur (H.P.)



DEPARTMENT OF BOTANY

**MINUTES OF THE MEETING OF THE BOARD OF STUDIES (BOS), OF BOTANY DEPARTMENT, SSU, PALAMPUR HELD ON 04-12-2023 AT 2.30 PM AT SSU PALAMPUR**

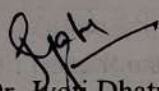
The following were present: -

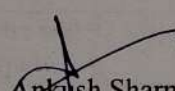
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|----------------------------------------|----------|
| 1. Dr. Narayan Singh                   | Convener |
| 2. Dr. Jyoti Dhatwalia                 | Member   |
| 3. Dr. Ankush Sharma (Internal Expert) | Member   |
| 4. Dr. Usha Rana (External Expert)     | Member   |

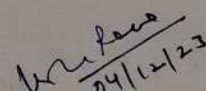
**The following agenda items were discussed:**

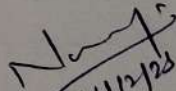
- The proposed syllabi for B.Sc. (Hons.) with research in Botany, as per the guidelines of the NEP 2020, were discussed in detail and same were approved.
- The subject codes of units and all the papers were standardised as per the norms of Sri Sai University.
- The committee further recommended that the proposed syllabi be implemented w.e.f. the session 2023-24 after the approval of the Academic Council.

The meeting ended with a vote of Thanks to the chair.

  
Dr. Jyoti Dhatwalia  
Member

  
Dr. Ankush Sharma  
Internal Expert

  
Dr. Usha Rana  
External Expert

  
Dr. Narayan Singh  
Convener

H.O.D. Botany  
Sri Sai University Palampur (I)

**BSEC-002: MUSHROOM CULTIVATION**

L	T	P	Credit
2	0	1	3

**Course Objective**

- To make the learners self-reliant to identify several kind of mushroom
- To provide knowledge to the students on Mushroom cultivation, production and processing techniques.

**Course Outcomes**

- Students will able to know about the importance, benefits and medicinal value of Mushroom.
- Able to identify the edible and poisonous variety of Mushroom.

**MODULE I**

Mushroom morphology: Different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate Edible from Poisonous mushrooms.

**MODULE II**

Mushroom Classification: Based on occurrence- Epigenous & Hypogenous, Natural Habitats, Colour of spores- white, yellow, pink, purple brown & black, Morphology, Ainsworth et al. (1973) classification. Recent Classification- 8<sup>th</sup> edition of Ainsworth & Busby's 'Dictionary of Fungi'.

**MODULE III**

Cultivation System & Farm design: Fundamentals of cultivation system- small village unit & larger commercial unit. Principles of mushroom farm layout- location of building plot, design of farm, bulk chamber, composting platform, equipment's & facilities, pasteurization room & growing room

**MODULE IV**

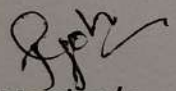
Cultivation of Button, Oyster and Straw Mushrooms: Collection of raw materials, compost & composting, spawn & spawning, casing & case run, cropping & crop management, picking & packing.

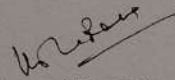
## MODULE V

Nutrient Profile and health benefits of Mushroom: Protein, amino acids, calorific values, carbohydrate, fats, vitamins & minerals. : Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect, haematological value cardiovascular & renal effect, in therapeutic diets, adolescence, for aged persons & diabetes mellitus.

### Practicals:

- Orientation to a mushroom farm.
- Preparation of pure culture and maintenance of culture.
- Preparations of mother-spawn, commercial spawn and its storage.
- Compositing methods.
- Spawning, casing, cropping and post- harvest handling.

  
Member/s

  
External Expert

  
HoD

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Sri Sai University Palampur (H.P.)