Institute of Science, Nagpur

(An Autonomous Institute of Govt. of Maharashtra)

Department of Botany

DIRECTION NO. 2 OF 2024

REVISED DIRECTION RELATING TO THE EXAMINATION LEADING TO THE TWO YEAR / ONE YEAR MASTER OF SCIENCE DEGREE WITH SEMESTER PATTERN IN INSTITUTE OF SCIENCE, NAGPUR AS PER NEP 2020

M. Sc. Semester I, II Syllabus as per NEP 2020

To be implemented from 2024-2025

Teaching and Examination Schemes:

Teaching and Examination Schemes Two Year M.Sc. (of four semesters) programme is as follows.

Table 4: M.Sc. Semester I

Sr No	Course Category	Name of the course (Title of the Paper)	Paper Code	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical					
					Th	Tu	P		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
1	DSC	Paper 1:- Cell and MolecularBiology	M-BO511T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Ethnobotany andMedicinal Plants	M-BO512T		4	--	--	4	3	60	40	50
2	DSE	Elective:- a.Phycology b.Palynology	M-BO513TPC M-BO513TPN		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on DSC and DSE)	M-BO514P		--	--	12	6	6-8	180	120	150
4	RM	Research Methodology	M-BO515TRM		4	--	--	4	3	60	40	50
					16	--	12	22		420	280	--

Table 5: M.Sc. Sem- II

Sr No	Course Category	Name of the course (Title of the Paper)	Coursecode	Level	Teaching Scheme (hrs)			Total Credit	Evaluation Scheme			
					Theory	Tutorial	Practical		Duration of Examination (Hrs)	End Semester Evaluation (ESE)	Continuous Internal Evaluation (CIE)	Minimum Passing Marks
					Th	Tu	P					
1	DSC	Paper 1:- PlantMetabolism	M-BO521T	6.0	4	--	--	4	3	60	40	50
		Paper 2:- Plantbiodiversity&Conservation	M-BO522T		4	--	--	4	3	60	40	50
2	DSE	Elective:- a.Hydrobiology b. Paleobotany	M-BO523THY M-BO523TPB		4	--	--	4	3	60	40	50
3	DSE /DSC	Lab (Based on DSC and DSE)	M-BO524P		--	--	12	6	6-8	180	120	150
4	OJT / FP	Internship / Apprenticeship / Field Project (Related to DSC)	M-BO525P		--	--	8	4	---	--	200	100
					12	--	20	22		360	440	--
	Cumulative Credits for : PG Diploma in Major Subject Core = 28 Electives = 8 RM = 4 OJT / FP = 4							44				
	Exit option: PG Diploma after First Year PG Degree :- Cumulative Credits required for PG Diploma (After First Year Degree) = 44											

Table 8: Table showing total marks in theory and Practical semester wise

Semester	Theory	Practical	Total Marks
1	400	300	700
II	300	500	800

Total Credits:

Cumulative Credits required for PG in Major Subject (One Year PG Degree) = 44

Cumulative Credits required for PG in Major Subject (Two Year PG Degree) = 88

M. Sc. Semester-I

Discipline Specific Course –DSC Paper 1

Cell and Molecular Biology

M-BO511T

Objectives:

1. Understanding the structures and functions of the cell wall, plasma membrane and plasmodesmata
2. Understanding the structures and functions of cell organelles, cytoskeleton, nuclear envelope, and structure of DNA
3. Understanding various types of stresses and defense mechanisms in plants and apply this knowledge.

Outcomes:

After successful completion of the course the students will be able to

1. Know the cell wall & cellular organization of the eukaryotic and prokaryotic cells
2. Learn the cell cytoskeleton and its role
3. Learn and apply techniques of stress related problems in plants

DSC-Paper 1	**Hours: 4 Hours/Week**	**Marks: 60+40=100**	**Credit: 4**

Unit-I

1. Cell wall: Structure; function; biogenesis and growth. 2. Plasma membrane: Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport-ion carriers, channels, pumps and aquaporins; receptors. 3. Plasmodesmata: Structure, role in movement of molecules and macromolecules; comparison with gap junction.	15 Hrs

Unit-II

1. Cellular organelles: Ultra-structure and function of golgi complex, lysosomes, peroxisomes, endoplasmic reticulum, mitochondria, chloroplast and plant vacuoles. 2. Cell shape and motility: The cytoskeleton; organization and role of microfilaments, intermediate filaments and microtubules; motor movements, implications in cell division, flagellar & other movements.	15 Hrs

Unit-III

1. Nucleus: Ultrastructure, nuclear pores, nucleolus, DNA structure A, B and Z forms, replication in prokaryotic and eukaryotic cells, DNA replication proteins, damage and repair. 2. Nucleic acids: Structure of nitrogenous bases; Structure and function of	15 Hrs

nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; 3. Types of RNA; Structure of tRNA.	
Unit-IV	
1. Stress biology: Definition and classification of stress. 2. Biotic stress: Plant defence mechanism (passive and active); HR and SAR; modulation of plant metabolism in response to biotic stress: early and late response; production of ROS, induction of enzymes; PR proteins; R-genes. 3. Abiotic stress: Effect of water, temperature, salt and light stress on plants; developmental and physiological mechanisms protecting plants against environmental extremes.	15 Hrs

Suggested readings

1. Atherly, A.G., Griton, J.R. and Mc Donald, J. F. 1999.The Science of Genetics.Saunders
   College Pub. Fort Worth, USA
2. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.
3. Bush, H. Rothblum, L. 1982. Vol. X. The Cell Nucleus RDNA part A. Academic Press.
4. Dc, D. N. 2000 Plant cell vacuoles: An introduction. CSIRO Publication, Collingwood,
   Australia.
5. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8Ed. B. I. Waverly Pvt. Ltd., New Delhi.
6. Jones R, Ougham H, Thomas H and Waaland S 2013 The Molecular life of plants. Wiley-Blackwell Publ., USA
7. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
8. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2ndEdi.)Harper Collins Coll. Publisher, New York, USA.
9. Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida
10. Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Dar nell, J. 2000
    Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA
11. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA
12. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA
13. Taiz, L. and Zeiger, E. 1998: Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA

M. Sc. Sem. I

Discipline Specific Core Course (DSC-2)

Ethnobotany and Medicinal Plants

M-BO512T

Objectives:

1. The course is designed to provide an understanding for the contribution of plants to traditional (alternative) and modern medicines worldwide.
2. To provide traditional knowledge of plants and medicine,
3. Understanding therapeutic uses of plants.
4. Contribution of medicinal plants to alternative and modern medicines, some medicinal plants of the India, and the future of medicinal plants will be discussed.

Course Outcome

After studying this course, the students will:-

1. Understand the utility of plants as medicines
2. Able to Prepare of basic herbal medicinal products
3. Apply the cultivation practices
4. Understand The storage, packaging and marketing of herbal medicines
5. Able to work with individual plant and plant products

DSC-II Theory	**Hours: 4Hours/Week**	**Marks: 60+40=100**	**Credit: 4**

Unit-I

Ethnobotany — 15 Hrs

1. Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.
2. Methodology of Ethnobotanical studies :a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin plants used in ayurvedic treatments. Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit-II

Role of ethnobotany in modern Medicine *1.* Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauwolfiaserpentina*, *Trichopuszeylanicus, Artemisia,Withania.* *2.* Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.	15 Hrs
Unit-III	
Important Indian Medicinal Plant 1.1 Plant parts used as powder: Identification and utilization of Amla (Embelica officinalis), Behra (Terminalia bellerica), Harad (Terminalia chebula), Turmeric (Curcuma longa), Garlic (Allium sativum), Bitter guard (Momordica charantia), Black plum (Syzygiumcumini), Fenugreek (Trigonella foenumgraecum), Cinnamon (Cinnamomum verum), Sarpgandha (Rauwolfia serpentina), Black pepper (Piper nigrum), Ashwagandha (Withaniasomnifera), Psyllium husk (Plantego ovata) 1.2 Plant parts used as juice/ decoctation: Identification and utilization of Amla (*Embelica officinalis*), Ginger (*Zingiber officinalis*), Onion (*Alium cepa*), Bottle guard (*Lagenaria siceraria*), Basil (*Oscimumsantum*), Arjun (*Terminalia arjuna*), Neem (*Azadirachta indica*), Gwarpatha (*Aloe vera*), Brahmi (*Bacopa monnieri*), Giloy (*Tinospora cordifolia*), Shankhpushpi (*Convolvulus prostrate*), Bael (*Aegle marmelos*) 1.3 Plant Parts Used as Lotion and Ointments: Identification and utilization of Gwarpatha (*Aloe vera*), Fenugreek (*Trigonella foenumgraecum*), Pot marigold (*Calendula officinalis*), Neem (*Azadirecta indica*) 1.4 Plant Parts Used as Oil: Clove (*Syzygiumaromaticum*), Neem (*Azadirecta indica*), Coconut (*Coccus nucifera*), Nilgiri (*Eucalyptus* sp.) 1.5 Plant Parts Used as Surgical Fibres, Sutures and Dressings: Identification and utilization of cotton (*Gossipium* sp.), Jute (*Corchorus capsularis*), Banana (*Musa* sp.) 1. 1.6 Plant Parts Used as Poultice: Identification and utilization of Turmeric	15 Hrs

(*Curcuma longa*), Nilgiri (*Eucalyptus* sp.), Ginger (*Gingiber officinalis*), Garlic (*Allium sativum*), Onion (*Alium cepa*), Dhatura (*Dhatura* sp.), Aak (*Calotropis* sp.), Arandi (*Ricinus communis*)	
Unit IV	
Ethnobotany and legal aspects 1. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. 2. Biopiracy, Intellectual Property Rights and Traditional Knowledge. Definition: endemic and endangered medicinal plants, Red list criteria; 3. In situ conservation: Biosphere reserves, sacred groves, National Parks; 4. Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.	15 hrs

M. Sc. Semester-I

DSC Lab

Cell and Molecular Biology and Ethnobotany and Medicinal Plants- Laboratory work

DSC-I Lab1		Paper Code – M-BO514P	Credit: 4

Part 1: Cell and Molecular Biology

1. To study salivary gland chromosomes of Chironomas and Drosophila.
2. To isolate mitochondria and determine the activity of its marker enzyme SDH.
3. To isolate bacterial and plant DNA and quantify them by spectrophotometric method.
4. To demonstrate the semi-permeability of the plasma membrane.
5. To study the activity of Na/K ATPase.
6. To demonstrate different components of cytoskeleton in the suitable material.
7. To perform flagellar staining.
8. Isolation of DNA and preparation of Cot-curve.
9. Demonstration of vital structure and functions of cell
10. To study the activity of PAL in the seedlings challenged with elicitors.
11. To study the induction of antioxidant enzymes in the seedlings challenged with elicitors.
12. To study the effect of water stress on the seedling growth and its chlorophyll content.
13. To study the effect of temperature stress on the seedling growth and its chlorophyll content.
14. To study the effect of salt stress on the seedling growth and its chlorophyll content.

Part 2: Ethnobotany and Medicinal Plants

1. Identification of locally available common medicinal plants
2. Basic preparation of herbal products as kadha, powder (Ex. Neem leaf, moringa leaf, tulsi leaf, giloy, arandana),
3. Preparation of Juice (Ex. Amla, Aloe vera), Trifala,
4. Preparation of Chyavanprash,
5. Preparation of Amla candy, herbal tea, etc.
6. Study the various plants product having medicinal properties available in kitchen.
7. Study and documentation of commercial production of at least five medicinal plants. (Using website/ You Tube)
8. Submission of digital photo album of at least ten medicinal plants with brief description.
9. Study of basic tools/ instruments/ apparatus used in making herbal medicines.

10. Cultivation maintenance and reporting of at least five medicinal plants within college campus.
11. Educational visit to herbal medicine factory/small processing unit/ medicinal agriculture field and submission of project report. (At least 01)

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
3. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
4. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
5. Lone et al,.Palaeoethnobotany
6. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
7. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.
8. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
9. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah.
10. Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-19969) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.
11. CSIR – Cultivation and Utilization of Medicinal Plants

M.Sc. Semester-I

DSC and DSE Lab

Cell and Molecular Biology and Ethanobotany

M-BO514P

Question paper

Time : 6-8 Hours **Max marks : 180**

1.	One experiment from DSC Paper-1	20 Marks
2.	One experiment from DSC Paper-1	10 Marks
3.	One experiment from DSC Paper-2	20 Marks
4.	One experiment from DSC Paper-2	10 Marks
5.	One experiment from DSE	20 Marks
6.	One experiment from DSE	10 Marks

7. Spotting: (5 marks for each spot) **30 Marks**

G. DSC Paper-1
H. DSC Paper-1
I. DSC Paper-2
J. DSC Paper-2
K. DSE
L. DSE

8. Viva-voce **30 Marks**

9. Record and excursion report (submission is compulsory) **30 Marks**

M. Sc. Semester-I

Discipline Specific Elective (DSE-I)-

Phycology

M-BO513TPC

Objectives

1. To understand the salient features and economic importance of algal diversity
2. To study the structure and reproduction of various genera mentioned in the field of lower plants.
3. To familiarize the salient features and economic importance of various algal groups.

Outcome of the course

1. Students will understand the morphology and organization of the thallus and their role in medicine, industrial and food.
2. Students will understand the interrelationship of various algal groups
3. Understand the contributions of famous Indian phycologists and centers of Algal Research in India.
4. Study their ecological and economic importance.

DSE-I Theory Elective	Hours: 4Hours/Week	Marks: 60+40=100	Credit: 4

Unit-I

1. General account of phycology, Contributions of Indian Phycologist, 2. Classification and general characters of Algae, Criteria for algal classification, F.E. Fritch classification of algae, 3. Diverse habitats of Algae, Range of thallus organization, Algal pigments and its significance in classification, ultra-structure of flagella, eyespot and pyrenoids, 4. Algal reproduction- (vegetative, asexual and sexual), life cycles and molecular phylogeny of algae, fossil algae.	15 Hrs

Unit-II

1. General features, range of vegetative structure, reproduction, life cycle and phylogeny, brief knowledge of the following genera 2. Chlorophyta :*Chlamydomonas, Hydrodictyon, Ulva, Cladophora, Pithophora, Chara and Nitella.*	15 Hrs

3. Xanthophyta :*Botrydium and Vaucheria* 4. Bacillariophyta : *Nitzhia and Cyclotella* 5. Phaeophyta : *Ectocarpus, Dictyota, Padina and Sargassum* 6. Rhodophyta : *Polysiphonia, Ceramium, Gelidium and Gracilaria* 7. Cyanophyta : *Anabaena, Spirulina, Oscillatoria and Lyngbya* 8. General characteristic of the following divisions Cryptophyceae, Dinophyceae, Euglenophyceae and Chrysophyceae,	
Unit-III	
1. Useful and harmful aspects of Algae -Algae as source of food for human, animal feed, Nutraceuticals; Pharmaceuticals, biofuel, bio-ethanol, biofertilizers, industrial applications of algae. 2. Role of algae in CO2 sequestration, pollution indicator, bioremediation and soil fertility. 3. Sources of Nitrogen and its assimilation, importance and activity of biofertilizers, biotechnological implication and Biological Nitrogen fixation. 4. Symbiotic algae and their role in other plants.	15 Hrs
Unit-IV	
1. Mass cultivation of algae- seaweed cultivation methods , Microalgae Culturing techniques and photo bioreactor-based production; Downstream processing. heterotrophic production. 2. Algal Bloom - Bioluminescence, Bloom formation and Eutrophication; 3. Harmful algal blooms and toxin production; Bloom control measures and algal toxins. 4. Spirulina- Nutritional Value, Cultivation, market value.	15 Hrs

Suggested Readings

1. Fritsch, F.E. 1979. The structure and Reproduction of Algae Vol. I & II. Bishan Singh, Mahendra Pal Singh, Dehradun. Delhi.651 pp.1999.
2. O.P. Sharma. 2011, Algae, TATA McGraw-Hill, India.
3. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun.
4. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New
5. Morris, I. 1986. An introduction of Algae. Cambridge University Press U.K.
6. R. E. Lee. 2008.Phycology, 4th Ed. Cambridge University Press
7. V.J. Chapman. 2015. The algae, Springer
8. Pandey, S.N., S.P.Misra and P.S. Trivedi. 2002. A Textbook of Botany Volume II. Vikas Publishing House Pvt Ltd, New Delhi.

9. Sharma, O.P. 2008. Textbook of Algae, Tata McGraw Hill
10. Round, F.E.1986. The Biology of Algae. Cambridge University Press, Cambridge
11. Desikachary, T.V. (1984). Cyanophyta. ICAR, New Delhi.

Discipline Specific Elective (DSE-I)

Phycology

M-BO513TPC

DSE-I Practical			**Credit: 2**

1. Classification and type study of the following classes:

Chlorophyta : *Chlamydomonas, Hydrodictyon, Ulva, Cladophora, Pithophora, Chara and Nitella.*
Xanthophyta *: Botrydium and Vaucheria*
Bacillariophyta : *Nitzhia and Cyclotella*
Phaeophyta : *Ectocarpus, Dictyota, Padina and Sargassum*
Rhodophyta : *Polysiphonia, Ceramium, Gelidium and Gracilaria*
Cyanophyta : *Anabaena, Spirulina, Oscillatoria and Lyngbya*

2. Separation of algal pigments by paper chromatography method
3. Cultivation of algae in laboratory and Mass cultivation
4. Identification of algal genera from natural habitat
5. Preparation of algal culture extract.

M. Sc. Semester-I

Discipline Specific Elective Course –DSE-I

Palynology

M-BO513TPN

Course Objectives:

1. Understanding the structure of pollen & pistil and their importance.
2. To Study pollen morphology, pollination, floral adaptations to diff. Pollinators, applications of pollen biology.
3. Knowledge on different types of honeys.

Course Outcomes:

4. After successful completion of the course the students will be able to
5. Understand the different aspects of pollen, pistil and pollination Applying knowledge with reference to agriculture, horticulture, medicine.
6. To get acquainted with reproductive plant organs as stamen & Pistil
7. To know the various pollination methods, plant-pollinator interactions, various pollinating agents useful for plant breeding experiments.

DSE-Theory Elective	**Hours: 4Hours/Week**	**Marks: 60+40=100**	**Credit: 4**

Unit-I

1. General aspects of Palynology- Historical background,Defination,Basic concept,scope interrelationship with other branches of Botany,Applications ,Indian work on Palynology,palynological centers in India **2. Microsporogenesis:** Stamen initiation, anther differentiation- anther initiation, Anther wall, Tapetum, structure and functions, its role in pollen development, Pollen/microspore and wall development, production and deposition of sporopollenin. **3. Pistil:** Structure and function of stigma and style, stigma receptivity and its importance	15 Hrs

Unit-II

1. **Pollination Biology -**Origin of pollination biology,spore and pollen dispersal in lower plants and gymnosperm, Pollination in angiosperms-types of pollination, 2. floral adaptation to different pollinators (mode, style) flowers pollinated biotically and abiotically (wind, water), 3. Pollination-plant interactions, special devices associated with pollinator attraction - pollen, nectar, Elaiophores, resin glands, osmophores, floral	15 Hrs

scent and perfume flowers. 4. Palaeopalynology-palynomorphs,their preservation in divers lithic types techniques involved in the recovery and concentration of spores and pollen from clays, shales,coals and lignites.Maceration techniques,Application of palynology in relation to oil and coal exploration,Role of spores and pollen stratigraphy,index spores.	
Unit-III	
1. **Phylogeny of Pollen and spores**, Systematic palynology-monocotyledoneae and dicotyledoneae, evolutionary trends amongpollen grains based on palynotaxonornical works,Palynology of spores/pollen – Algae,Fungi,Bryophyte,Pteridophyte and pollen types of Gymnosperms. 2. **Pollen morphology of Angiosperms.:** Introduction- Pollen units, polarity, symmetry, Shape, size, Apertures size, shape of the pollengrain, sporoderm stratification, 3. Apertures-NPC System of classification, Apertural types, Exine ornamentation, LO analysis, evolutionary trends in exine structure,trends of evolution in apertural pattern, 4. Techniques for the preparation of pollen slides, LM, SEM and TEMstudies of pollen and its significance.	15 Hrs
Unit-IV	
2. **Melittopalynology-** Pollen analysis of honey-methods, qualitative and quantitative, social organization of honey bees,adulteration of honey,physical characteristic of Honey ,Deterioration of honey ,heavy metal contamination in honey,honey as environmental moniters , foraging behavior, geographical and floral origin of honey, unifloral and multifloral honey, 3. **Applied Melissopalynology -** Bees as pollinators, role of apiaries in crop production, Role in Agriculture/ Horticulture, Pollen loads, analysis,Bee pollen, chemical composition, utility, and its role in curing various human ailments.Use of honey in medicine,cosmetics,confectionary and other applications	15 Hrs

Suggested Readings:

1. Agashe S. N. - Paleobotany (1997) -Plants of the past their evolution paleoenvironment and applications in exploration of Fossil.
2. Agashe S. N. - Palynology and its Applications - Oxford and IBH Publishing Co. Pvt. Ltd. NewDelhi. Alexander M.P. (1969). Differential staining of aborted and non-aborted pollen Stain Techno144:117-122.
3. Alexander, M.P. (1987). A method for staining pollen tubes in pistil. Stain Technol 62, 107- 112.
4. Alexander, M.P., Ganeshan S. (1990).An improved cellophane method for in vitro germination of recalcitrant pollen. Stain Technol 64:225-227. Archaeology, Rev. Palaeobot. Palyno/21:171-185,
5. Baker, H.G. 1954. Aperture membranes in Studies of Pollen Morphology and Taxonomy. Newphytologist,54(3),
6. Bane1jee, U.C. 1965,etal.Exine plasticity during pollen grain maturation. J.palynol.:70-89,
7. Bane1jee, U.C.1967.ULtrastructureof the tapetal membranes in grasses. Grana palynologia: 7,2-3,
8. Bhattacharya K., Majumdar M. and Gupta Bhattacharya S. (2006). A text book of Palynology.New Central Book Agency(P)Ltd.,Kolkata
9. Bhojwani, S .S. and S.P. Bhatnagar. 1978. The Embryology of Angiosperms. Vikas Publishing House, NewDelhi,
10. Bir Bahadur 1998. Nectary biology. Dattsons publications, NagpurBombay, Bradley, D. E. 1958. The study of pollen grain surfaces in the electron microscope NewPhytologist Volume57, Issue2: 226-229
11. Caulton Eric, Agashe S. N. -Pollen and Spores applications with special emphasis on Aerobiology andAl lergy15.
12. Cresti, M., Gori P., Pacini E. (eds.) (1988) Sexual reproduction in higher plants. Springer, Berlin Heidelberg New YorkTokyo.
13. Cronquist, A. 1968. The evolution and classification of flowering plants, Nelson,London Dafni Amots, Hesser Michel, Paeini Ettore - Pollen and Pollination-Springer Wien New York
14. Davis. P.H. and V.H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd.London,
15. Doyle James A(2005) Early evolution of angiosperm pollen as inferred from molecular and morphological phylogenetic analyses, Grana, 44:4, 227-251, DOI: 10.1080/00173130500424557
16. EI-Gazzar and M.K. Hamza. 1973. Morphology of the twin Pollinia of Asclepiadaceae. Pollen et spores XV(3-4)
17. Erdtman, G. 1945. Pollen Morphology and Plant Taxonomy IV Labiatae, Verbenaceae, Avicenniaceae. SvenskBotanisk Tidskrift.39(3),
18. Erdtman, G. (1966). Pollen morphology and plant taxonomy angiosperms hafner. New York. Erdtman, G. (1969). Handbook of Palynology. Hafner, NewYork
19. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy (An Introduction to Palynology-1, Angiosperms). Aimqvist, and Wicksell,Stockholm,
20. Erdtman, G. 1956. Current Trends in Palynological Research Work Grana Palynologica (N.S.)1:2, Erdtman, G. 1960. The Acetolysis method revised description Su. Bot. Tidskr.54(4).
21. Erdtman, G. 1964. Palynology. In: W.B. Turrill (Editor) Vistas in Botany. Macmillan

Go., New York, Vol.4:23-54.
22. Faegri, K. 1975..(3rd Revised Ed.) Text Book of Pollen Analysis. Blackwell ScientificPubl. Oxford, Heslop-Harrison, J. (1987). Pollen germination and pollen tube growth. Int. Rev. Cytol. 107:1-78.
23. Heslop-Harrison, J. 1962.Origin of Exine. Nature, 195 (4846):1069-1071
24. Heslop-Harrison, J. 1971. (Editor). Pollen: Development & Physiology. Butterworths, London,
25. Heslop-Harrison, J. 1976. The adaptive significance of the exine.Academic Press. London, Linn. Soc. Symp. Serl:27-37,
26. Shivanna K.R. (1984). The evaluation of pollen quality and a further appraisal of the fluorochromatic (FCR) test procedure. Theor. Appl. Genet 67:367-375.

27. Jain A., Shivanna, K.R. (1988a). Storage of pollen grains in organic solvents: effect of organic solvents on ieaching of phospholipids and its relationship to pollen viability. Ann. Bot. 61:325-330
28. Jain A., Shivanna, K.R. (1988b). Storage of pollen grains in organic solvents. Effects of solvents on pollen viability and membrane integrity. J. Plant Physiol.132:499-502.
29. Knox. R.B., Williams, E.G., Dumas, C. (1986). Pollen, pistil and reproductive function in crop plants.Plant Breed.Rev.4:9-79.
30. Maheshwari, P, 1978. An Introduction to the Embryology of Angiosperms, Tata McGraw- Hill Publ. Co. NewDelhi
31. Nair, P.K.K. 1966.Essentials of Palynology. Asia Publ. House,Bombay,
32. Nair, P.K.K-. 1970.Pollen morphology of Angiosperms. Scholar Publ. House,Lucknow,
33. Nair. P.K.K. 1965.Pollen Grains of Western Himalayan Plants.Asia Publ. House.of pollen vedamse Book (P) Ltd. NewDelhi.
34. Plummer, D.T (1987), An introduction to practical biochemistry (3rd edn). MeGraw-Hill.London (Tata Mc-Graw-Hill Edition,1988).
35. Rowley, J.R. 1967. Fibrils, rnicrotubules and lamellae in Pollen grains. Rev. Palaeobotan. Palynol3:213-226,
36. ShiD.-Q. and W.-C. Yang 2010. Pollen Germination and Tube Growth Plant Developmental Biology - Biotechnological Perspectives: Volume 1, Page 245-282 Pua, Eng Chong; Davey, Michael R. (Eds.) Springer-Verlag Berlin Heidelberg
37. Shivanna, K, R. (1982,). Pollen-pistil-interaction and control of fertilization. In: Johri B.M. (ed.). Experimental embryology of vascular plants. Springer, Berlin Heidelberg New York, pp, 131-174.
38. Shi vanna, K.R. and Johri, BM 1989. The Angiosperm Pollen:Structureand Function. Wiley Eastern Ltd., NewDelhi
39. Shivanna, K.R. and Rangaswami, N.S. 1992. Pollen Biology: A laboratory manual. Narosa Publishing House, NewDelhi..
40. Stanley, R.G. and H.F. Linskens. 1974. Pollen. Biology, Biochemistry management, Springer• Verlag, Berlin,
41. Swamy, B.G.L. and K.V. Krishnamurthy. 1980 From Flower to Fruit. Tata McGraw-Hill Publisher, Talde U.K. 1994.Advances in Mycology and Aerobiology-Dr ST Tilak commemoration volume.
42. Tilak S.T. 1982. Aerobiology, VaijyantiPrakashan, Aurangabad
43. Tilak S.T.1989. Recent researches in Ecology, Environment and Pollution. Today & Tomorrow Pub., New Delhi
44. Tilak S.T. 1987 "Air monitoring practical Manual", VaijantiPrakashan, Aurangabad.

Tilak S.T. 2009. Aeromycology. Bharati Printing Press,Pune.
45. Tilak S. T. 1989. Atlas of airborne pollen grains and fungal spores. Vaijayanti Prakashan, Aurangabad. Tilak S. T. 1989. Env. Ecology and Aerobiology. Today & Tomorrow. s Printers, New Delhi.
46. Vishnu-Mittre. 1964. Contemporary thought in Palynology. Phytomolphology. 14(1): 101.
47. Walker, J.W. and J.A. Doyle. 1975. The basis of angiosperm phylogeny: Palynology. Ann. Missouri. Bot. Gard, 62. 664-723,

Discipline Specific Elective Course Laboratory Exercise

Palynology M-BO513TPN

Laboratory Exercise	**Hours: 4 Hours/Week**		**Credit: 2**

Section A. Basic aspects/ Pollen Morphology (At least any FIVE expts.)

1. To study structure of stamen.
2. Study of permanent slides of Microsporogenesis.
3. Field study on different pollination mechanism.
4. To study structure of pistil
5. Preparation of glycerin jelly
6. Preparation of pollen- Acetolysis technique
7. Preparation of pollen – Wodehouse technique.
8. Study of pollen types using acetolysed and non-acetolysed pollen.
9. Pollen morphology polarity, symmetry, shape, size, sporoderm stratification aperture NPC(To study the pollen types from at least 30 different species, Angiosperms preparation of permanent slides.)
10. Preparation and palynological description in technical language (at least 10 species of Angiosperms).
11. Interpretation of selected electron micrographs (SEM, TEM) of pollen.

Section B. Aeropalynology/Melittopalynology/Palaeopalynology (At least two expts.)

13. Use of pollen traps to study local air-spora.
14. Analysis of aerospora slides.
15. Preparation of reference slides by different techniques, culture method (culture of fungi/Algae)
16. Preparation of slides honey samples.
17. Analysis of honey samples for qualitative and quantitative study of pollen contents.

18. Estimation of pollen load from bee hive or bees/pollinator

19. Analysis of coal samples for microfossils with special reference to pollen and spores.

20. Preparation of allergenic extract of pollen.

Section C Pollen Physiology/ecology/biochemistry/ecology. (At least three expts)

21. To study pollen production of the given flowers.

22. To study pollen viability of the given flowers.

23. To study percentage of pollen germination & rate of pollen tube growth.

24. To study different techniques of pollen storage

25. Effect of temperature and relative humidity on viability of stored pollen

26. Effect on Boron and Calcium on pollen germination and tube growth.

27. Semi-vivo technique to study pollen germination and pollen tube growth.

28. Multiple staining for localizing pollen tubes in the pistil

29. To study pollen germination and pollen tube growth in the pistil by employing aniline-blue fluorescence method

30. Cytochemical localization of esterase on stigma surfaces

31. Cytochemical analysis of pollen and pollen tube for various metabolites like proteins, amino acids, carbohydrates, starch, ascorbic acid, DNA, RNA, lipids, lignin, pectin, cellulose, etc (at least five metabolites)

32. Study of pollen contents by paper chromatography/TLC.

33. Colorimetric estimation of proteins/carbohydrates of pollen grains

M. Sc. Semester-I

Research Methodology

M-BO515TRM (Credits 4)

RM-Theory	Hours: 4 Hours/Week	Marks: 60+40=100	Credit: 4

Course Objective:

- Aquire comprehensive understanding of research methodology and its fundamental concepts.
- Enhance the ability to critically evaluate and select appropriate research methods for different types of research.
- Acquire skills in data collection, analysis, and interpretation using various statistical techniques.
- Developing the proficiency in technical writing, research reporting, and adhere into research ethics and academic integrity.

Course Outcome: After learning research methodology course, students will be able to

- Understand and describe the characteristic so different type of research, including basic, applied, and patent-oriented research.
- Apply scientific thinking and problem identification techniques in the research process.
- Apply descriptive and inferential statistical analysis techniques to analse and Interpret research data and understand the concept of hypothesis and its importance in research, and apply appropriate research methods.
- Develop skills in technical writing, research reporting, and the proper structure and organization of research documents and gain awarenesss of research ethics ,academic integrity ,and the importance of avoiding plagiarism and academical practice.

Unit-I

Research basics and perception of research — 15 Hrs

i. Definition, General and specific characteristics of research ,types of research (basic, applied and patent oriented).

ii. Steps of Action (basic) research,objectives of basic research, characteristics of investigators.

iii. Scientific thinking- characters, steps in process of scientific thinking ,Steps in probe identification, criteria for selecting problem, and sources of scientific problems.

iv. Review of literature- meaning, need ,and objectives, structure of review of literature, sources of literature collection of ,Simple rules of reading/understanding paper (review, method paper, thesis), Simple rules of structuring (writing) literature review.

Unit-II	
Basics of hypothesis and research methods **i.** Definition of hypothesis, assumption, and postulate, nature, function and importance of hypothesis, characteristics of goodhypothesis, kinds of hypothesis **ii.** Definition and types of research methods, characteristics of survey methods, Types of survey methods: Questionnaire survey and their advantages **iii.** Experimental method- definition, basic assumption, Types of variables (controls) in experiments, Steps of experimental methods, Classification of experiments or experimental procedures. **iv.** Case study method- definition, objectives, types of case study methods, Steps of case study methods. .	15 Hrs
Unit-III	
Data collection, tables and graphs: 1. Need for data collection, meaning of data ,Nature of data, variables, characters of quantitative data. 2. Types of data (variables) :Nominal variable, Ordinal or rank variable, interval and ratio variable, Ethical consideration during data collection. 3. Statistical analysis of data :Descriptive and inperennial ,Meaning of parameters ,sample, populations, Concept of central tendency of data ,Median ,Mode, Mean (and types of means). 4. Basic structure Range, Quartile Deviation, Mean ,absolute deviation, Standard deviation,standard errors, merits, and demerits of measures, tables and graphs showing descriptive measures 5. Probability distribution, Shape of normal curve, Areas under standard normal curve,Hypothesis, basic concepts concerning testing of hypotheses, Procedure for hypothesis testing, chi-square test, Type –I and Type-II error, one way ANOVA ,Structure of ANOVA table 6. Basic structure of Graph, bar, piechart, histogram, scatter plot, time series graph, Line graph, Basic structureof table, Meaningful tables	15 Hrs

Unit-IV **Technical writing ,research reporting, research thesis and plagiarism:** i. Structure of thesis, structure of research paper, structure of project report ,structure of project proposal.	15 Hrs
ii. Annotated bibliographies: Structure and organization ,Critical thinking ,Evaluating information. iii. Academic integrity ,skills (rules) for good academic practice, understanding plagiarism and academic malpractice. iv. To get acquainted with the laboratory Equipment's) Laminar air flowchamber / Table v. Environmental growth cabinet b)Vortex shaker/ Mixer c)Electrophoretic unit vi. Serological water bath (with shaking facility)	

References/Books:

1. Shanti Mishra, & Alok, S. (2011). *Handbook of Research Methodology: A Compendium forScholars& Researchers*.EducreationPublishing.
2. Singh, Y. kumar. (2006). *Fundamentals of Research Methodology and Statistics*. New AgeInternationalPublishers.
3. Walliman,N.(2010).*ResearchMethodsTheBasics*.RoutledgeTaylorandFrancisGrou

M. Sc. Semester-II

Discipline Specific Core Course –DSC-III

Plant Metabolism

M-BO521T

Objectives :

1. To know Carbohydrates Metabolism in living plant system.
2. To understand Amino Acid Metabolism and Lipid Metabolism.
3. To understand Nitrogen and sulphur Metabolism.

Course Outcome

After completion of this course students will able to know

1. Importance of Carbohydrates Metabolism in living plant system.
2. Importance of Amino Acid Metabolism and Lipid Metabolism.
3. Importance and role of Nitrogen and sulphur Metabolism.

DSC-I Theory	**Hours: 4 Hours/Week**	**Marks: 60+40=100**	**Credit: 4**

Unit-I

1. **Concept of Metabolism:** Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes). — 15 Hrs
2. **Carbohydrate Metabolism:** Composition, structure and function of carbohydrates
3. Biosynthesis of starch and sugars, catabolism (degradation) of starch and sucrose.

Unit-II

1. **Lipid Metabolism:** Composition, structure and function of lipids — 15 Hrs
2. Fatty acid biosynthesis, membrane lipids, structural lipids and storage lipids.
3. Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, α oxidation.

Unit-III	
1. **Metabolism of amino acids:** Composition, structure and function of amino acids, Amino acid biosynthesis in Plants 2. **Protein metabolism:** Composition, structure (Ramchandran plot. secondary, tertiary and quaternary structure) and function of Proteins	15 Hrs
Unit-IV	
1. **Nitrogen metabolism:** Overview of nitrogen fixation, Nitrate and ammonium assimilation 2. **Sulphur Metabolism:** Uptake and transport, reductive sulphate assimilation pathways, synthesis and function of glutathione and its derivatives. 3. **Secondary metabolites:** Cutin, Waxes, Suberins, Biosynthesis of terpenes, phenolic compounds. Nitrogenous compounds and their roles.	15 Hrs

Suggested Readings

1. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biologyof Plants,American Society of Plant Physiologists, USA.
3. Davies P J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rdEdition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
4. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley andSons, U.S.A. 4th Edition.
5. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.).W.H.Freeman& Co., New York.
6. Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6 Th Edit

M. Sc. Semester-II

Discipline Specific Core Course –DSC-IV

Plant Biodiversity and Conservation

M-BO522T

Objective:

1. Understanding Biodiversity of India and World.
2. Understanding need of plant conservation;
3. Understanding importance of National parks, Biospheres, botanical gardens etc.
4. Understand the vegetation types around them.

Outcome:

1. Learn and apply the knowledge of Biodiversity and conservation methods.
2. Learn and apply the knowledge of conservation methods.
3. Learn and apply techniques of Botanical gardens etc.
4. Learn and understanding value of rare and threatened plant.

DSC-IV Theory	**Hours: 4 Hours/Week**	**Marks: 60+40=100**	**Credit: 4**

Unit-I

1. **Theory of land bridge**, theory of continental drift, polar oscillations and glaciations. 2. **Centre of origin of plant** – Vavilov's concept, types. Phytogeographical regions – concept, phytogeographical regions of India. 3. **Vegetation types of India**– Composition and distribution of evergreen, semi evergreen, deciduous, scrub, mangroves, shoal forests and grasslands. An account of the vegetation of the Western Ghats.	15 Hrs

Unit-II

1. **Biodiversity:** Definition, types of biodiversity - habitat diversity, species diversity and genetic diversity, **2. Global and Indian species diversity**. SDG's in biodiversity conservation. Values of Biodiversity – Economic and aesthetic value, Medicinal and timber yielding plants. NTFP. Threats to biodiversity**.**	15 Hrs

Unit-III

1. **Biodiversity Hotspots and Hottest hotspot**, Biodiversity hot spots of India, Concept of endemism and endemic species. 2. **Conservation methods** – In-situ and ex-situ methods, 3. **Conservation of Biodiversity:** Conservation of genetic diversity, species diversity and ecosystem diversity, Social approaches to conservation,	15 Hrs

Biodiversity awareness programmes, Sustainable development	
Unit-IV	
1. **IUCN-** General Account, categories, Commissions, role in conservation; Red Data Book 2. **Protected areas-** Sanctuaries, National parks, Biosphere reserves. 3. **Wetlands and Mangroves Coral Reefs-** Types, importance, artificial reefs, conservation measures Botanical gardens, Seed Banks; In-vitro repositories; Cryobanks,	15 Hrs

Discipline Specific Core Course Laboratory Exercise

Plant Metabolism and Plant Biodiversity and Conservation(M-BO524P)

Laboratory Exercise	Hours: 12 Hours/Week		Credit: 4

Part 1: Plant Metabolism

1. To prove lambert-beer law using suitable solution

2. Estimation of stress induced amino acid (Proline)

3. Determination of total carbohydrates by Anthrone method.

4. Extraction of seed proteins depending upon solubility.

5. Extraction of chloroplast pigment from leaves and preparation of absorption spectrum of chlorophyll and carotenoids.

6. To determine the chlorophyll a/chlorophyll b ratio in C3 plants.

7. Estimation of total fats in fatty seeds.

8. Separation of Alkaloids/Phenols by TLC.

9. Prepration of Standard curve of protein (BSA)and protein estimation by Lowry's method.

10. Extraction of secondary metabolites from callus tissue.

11. Qualitative analysis of secondary metabolites.

12. Detection of secondary metabolites by TLC (any one)

13. To determine reducing sugar by Nelson-Somogyi method.

14. Separation of Amino acids by chromatographic techniques

Part 2: Plant Biodiversity and Conservation

1. A trip to the grass land/ forest/ water body to get acquainted with their plant species.
2. Demonstration of different types of vegetation sampling methods – transects and quadrats.
3. To determine minimum size and number of quadrats required to study grassland.

4. To determine minimum size and number of quadrats required to study Forest area.
5. Qualitative parameters of distribution of plant species, Frequency, Density, Basal cover, dominance, Abundance and IVI.
6. To determine the homogeneity of vegetation by Raunkier's frequency diagram.
7. To determine diversity indices (Shannon-Weiner, species richness, B-diversity) from given data.
8. Population structure study of dominant tree species of the locality.
9. To study the various methods of conservation- In-situ and Ex-situ.

Based on Biostatistics

1. Calculate mean, variance, standard deviation and coefficient of variation for comparing two means related to given ecological data.
2. Calculate mean, variance, and to use t-test for comparing two means related to given ecological data.
3. To find out association between important grassland species from the given data using chi• square test.
4. To find out relationship between two ecological variables using correlation analysis.
5. To perform the one-way ANOVA from the given data.

Suggested Readings:

1. Sharma, P.D. 2018. Fundamentals of Ecology.Rastogi Publications.

2. Odum E.P. (1975): Ecology By Holt, Rinert& Winston.

3. Oosting, H.G. (1978): Plants and Ecosystem Wadworth Belmont.

4. Kochhar, P.L. (1975): Plant Ecology. (9th Edn.,) New Delhi, Bombay, Calcutta-226pp., 5. Kumar, H.D. (1992): Modern Concepts of Ecology (7th Edn.,) Vikas Publishing Co., New Delhi.

6. Kumar H.D. (2000): Biodiversity & Sustainable Conservation. Oxford & IBH Publishing Co Ltd. New Delhi.

7. Newman, E.I. (2000): Applied Ecology, Blackwell Scientific Publisher, U.K.

8. Chapman, J.L&M.J. Reiss (1992): Ecology (Principles & Applications). Cambridge University Press, U.K.

9. Malcolm L. Hunter Jr., James P. Gibbs, Viorel D. Popescu, 2020. Fundamentals of Conservation Biology, 4th Edition.Wiley-Blackwel.

10. Saha T. K., 2017. Ecology and Environmental Biology.Books and Allied Publishers

M.Sc. Semester-I

DSC and DSE Lab

Cell and Molecular Biology and Ethanobotany

M-BO514P

Question paper

Time : 6-8 Hours **Max marks : 180**

1.	One experiment from DSC Paper-III	20 Marks
2.	One experiment from DSC Paper-IV	10 Marks
3.	One experiment from DSC Paper-III	20 Marks
4.	One experiment from DSC Paper-I V	10 Marks
5.	One experiment from DSE	20 Marks
6.	One experiment from DSE	10 Marks

7. Spotting: (5 marks for each spot) **30 Marks**

M. DSC Paper-III
N. DSC Paper-IV
O. DSC Paper-III
P. DSC Paper-IV
Q. DSE
R. DSE

8. Viva-voce **30 Marks**

9. Record and excursion report (submission is compulsory) **30 Marks**

M. Sc. Semester-II

Discipline Specific Elective (DSE)DSC II

Palaeobotany

M-BO523TPB

DSE-II Theory Elective	Hours: 4 Hours/Week	Marks: 60+40=100	Credit: 4

- **Course Objective:** Understanding the Science of Petrology,Classification of Rocks, Geological Phenomenon,Geological Time Scale
- Learn Systematics ,Reconstruction and Nomenclature,Types of preservation
- Learn early land Plants
- Understanding Diversification in Primitive Gymnosperm
- Understanding formation of Deccan traps and Intertraps, age and its floristic composition Deccan Intertrappean flora of India

Course Outcome: After completion of the course the students will able to

- Learn various types of rocks, Geological Time Scale
- Learn Systematics ,Reconstruction and Nomenclature, types of Preservation
- Learn and Early land plants
- Understand Diversification in Primitive Gymnosperm
- Understand the formation of Deccan traps and Intertraps, age and its floristic composition Deccan Intertrappean flora of India

Unit-I

1. Introduction to the Science of Petrology: The classification of rocks i.e.Endogenetic and Exogenetic (Igneous, Metamorphic and Sedimentary) and their brief account. 2. Geological column and time scale. 3. **Fossilisation:**Modes of Preservation (Types) 4. Preparation and age determination techniques. 5. **Systematics, Reconstruction and Nomenclature**. **6. Application of Palaeobotany in oil exploration.**	15 Hrs

Unit-II

1. Life in Precambrian **2. Greening of Earth –Speculation.** ***3.*** Rhyniopsida- *Rhynia* ***4.*** Horneophytopsida-*Horneophyton* **5. Arborescent Lycopods of Carboniferous:** **6.** Lepidodendron, Lepidophlois, Lepidocarpon, Lepidostrobus,Stigmaria. **7. Diversity of Devonian:-Shpenopsida**-Its origin and evolutionary consideration . **8.** Sphenophyllales-Sphenophyllum **9.** Calamitales-Calamites	15 Hrs

Unit-III	
1. **Pteridosperms:-**Lyginopteridales: Lyginopteridaceae, 2. **Diversification in primitive Gymnosperm;-**Cycadeoidales-Cycadeoidaceae, Williamsoniaceae 3. Caytoniales-Caytoniaceae 4. **More Diversification in Primitive Gymnosperm** contd.:-Cordaitales, Glossopteridales ,Pentoxylales.	15 Hrs
Unit-IV	
1. **Study of Deccan Intertrappean flora of India:** Formation of Deccan traps and Intertraps, age and its floristic composition in relation to Pteridophytes (*Azolla, Salvinia, Surangea*), 2. Gymnosperms (*Mohgaostrobus, Harrisostrobus*) 3. Angiosperms (*Palmoxylon,Palmocarpon,Triccoccites,Enigmocarpon,Chitaleypushpam, Sahnianthus, Sahnipushpam*). 4. Paleoclimate and Paleogeography of Deccan Intertraps.	15 Hrs

*Note:- Different plant groups are to be studied with key genera for their morphology and anatomy of vegetative and reproductive parts

List of Books / References / Online Resources

1. Agashe S.N.(1995)-Palaeobotany , Plants of the past ,their evolution, palaeoenvironment and application in exploration of fossil fuels.Oxford &IBH publishing company-New Delhi.
2. Andrews H.N.(1961)-Studies in Palaeobotany, Willey and Sons –New York.
3. Arnold,C.A.(1947)-An Introduction to Palaeobotany ,MC-Graw Hills.,New York
4. Beck,C.B.and Wight, D.C.(1988)-Progymnosperm, In origin and evolution of Gymnosperms,Columbia Uni. Press-New York.
5. Beck, C.B.(1976)-Current status of the Progymnospermosida, Review of Palaeobotany and Palynology
6. Darrah, W.C.(1960)-Principles of Paleobotany.
7. Erdtman,G(1957)-Pollen and Spore morphology and plant taxonomy.(An introduction to palynology) Hafner Publishing Comp-New York.
8. Chandra,S.and Surange, K.R.(1979)-Revision of the Indian species of Glossopteris, Monograph,Birbal Sahni Institute of Palaeobotany.
9. Hoffmeister,W.S.(1960)-Palynology has an important role in oil exploration.World oil-150:1001-140.
10. Meyen, S.V.(1987) – Fundamentals of Palaeobotany Chapman and Hill,London,New York.
11. Parihar ,N.S.(1995) –Essentials of Palaeobotany,Central Book –Allahabad.
12. Sahni, B.(1964)- Revisions of Indian fossils plants, -III(Monocotyledons) –BSIP-Lucknow.
13. Stewart, W.N.& Rothwell,G.V. (1993)-Palaeobotany and Evolution of Plants,Cambridge Univ., Press-Cambridge.

14. Venkatchala, B.S & Maheshwari,H.K.(1991)-Palaeobotanical Researches in India.Jour.Ind.Bot.Society-70;1-12
15. Wadia, D.N(1953)-Geology of India,Mac,Millan-Co.London.
16 Prasad, K.N. (1999). - An introduction to palaeobotany, APH Pub.
17. Cleal, J. Christopher. &B.A.Thomas (2009)Introduction to Plant Fossils, Cambridge Univ., Press-Cambridge.
18. Willis, K.J. & McElwain, J. C.(2014). The Evolution Of Plants(second edition)OXFORD University Press

M. Sc. Semester-II
Discipline Specific Elective

Palaeobotany - M-BO523TPB

DSE-I Practical			Credit: 2

1. Geological Maps of India
2. Geological column and time scale.
3. Study of different rocks.
4. Different techniques to study fossils. (Ground sectioning, peel technique)
5. Study different types of fossils.
6. Study of plant fossils as per syllabus based on specimens and slides.
7. Study of Rhyniopsida (primitive vascular plants)
8. Arborescent Lycopods of Carboniferous- Study of Lepidodendrales members
9. Sphenophyllales, Calamitales members.
10. Study of plant fossils as per syllabus based on specimens and slides.
11. Gymnosperm- Caytoniales, Glossopteridales, Pentoxylales, Cordaitales.
12. Lyginopteridales-Lyginopteridaceae, Medullosaceae, Cycadeoidales-Cycadeoidaceae, Williamsoniaceae,
13. Study of Deccan Intertrappean flora of India. Pteridophytes, Gymnosperms and Angiosperms-flowers and fruits.
14. Study of wood anatomy of fossils.
15. Exploration and excursion to different fossiliferous localities.
16. Preparation of practical record/submission of collection and tour report of excursion.

M. Sc. Semester-II

Discipline Specific Elective – Hydrobiology

M-BO523THY

Course Objectives

1. To study Physical, chemical and Biological parameters of the Inland Water bodies
2. To Know Distribution and dynamics of freshwater bodies
3. To know Classification and general characteristics of lotic and lentic water bodies.
4. To understand the impact of human activities on water bodies.

Course Outcomes :

Students will develop an understanding of

1. The diversity of biological, physical and chemical characteristics of lakes
2. Lake ecosystem function (energy flow and biogeochemical cycling)
3. The diversity and ecology of organisms in lakes
4. Human impacts on lakes (e.g., water quality) and remediation strategies
5. The role of aquatic ecosystem science in society

DSE II Theory Elective	**Hours: 4 Hours/Week**	**Marks: 60+40=100**	**Credit:4**

Unit-I

1. Physical and chemical characteristics of water , freshwater environment 2. Lentic environment: General consideration, physico-chemical factors, and their influence, 3. Lotic environment: General consideration, physico -chemical factors, and their influence. .	15 Hrs

Unit-II

1. Phytoplankton nature and adaptation of plankters, periodicity and succession, vertical distribution, productivity and factors influencing it. 2. Study of phytoplanktons : Terminology, population, adaptations Distribution, productivity and succession Primary productivity and measurement of growth rate and natural mortality.	15 Hrs
Unit-III	
1. Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. 2. Eutrophication and algal blooms: Definition factor: responsible for water quality, use of algal blooms and their control measures.	15 Hrs
Unit-IV	
1. Distribution, community structure in fresh and marine water. Role of algae as indicators of pollution and its concept. 2. Algae in waste water treatment, use of algal bacterial system in sewage and other waste effluents, Bio monitoring of water quality. Algae stabilization pond.	15 Hrs

Suggested Readings

1. Reynolds, C.S.2007. Ecology of Phytoplankton. Cambridge, Cambridge University Press.
2. Bronmark, C. and L.A. Hansson. 2017. The biology of lakes and ponds. 3rd Edition. New York, Oxford University Press
3. Wetzel, R. G. (2001). Limnology: lake and river ecosystems. San Diego, Academic Press.
4. Lynn, K and Cech, T. (2010). Introduction to Water Resources and Environmental Issues. Cambridge, Cambridge University Press.

M. Sc. Semester-II
Discipline Specific Elective

Hydrobiology - M-BO523THY

DSE-I Practical			**Credit: 2**
1. Determination of physical characteristics and chemical characteristics of lentic water bodies. 2. Determination of physical characteristics and chemical characteristics of lotic water bodies. 3. Collection and identification of fresh water phytoplankton. 4. Collection and identification of aquatic plants from different fresh water bodies 5. Estimation of primary productivity in fresh water bodies 6. Field visit to lotic and lentic water bodies.			

M. Sc. Semester-II Internship/Apprentiship (Related to DSC) M-BO525P			
	Hours: 8 Hours/Week	**Marks: 80+20=100**	**Credit: 4**