SEMESTER I			
Core I	**Plant Diversity I (Algae, Bryophyte, Fungi and Lichen)**		
Course Code:21PBOC11	**Hrs/week: 6**	**Hrs/Semester: 90**	**Credit: 4**

Objectives:

- To have a comprehensive idea on cryptogams.
- To understand the taxonomy, characteristics and uniqueness of primitive plants and theircharacteristics.
- To have a broad knowledge on economic importance and ecological significance of lowerplants.

Course Outcomes

CO. NO	Upon completion of this course, students will beable to	PSO addressed	CL
CO-1	recall the distinguishing features of algae, bryophytes, fungi and lichens and appreciate their uniqueness	1, 2	An
CO-2	understand the status of cryptogams in evolutionof advanced plant groups	1, 2	Cr
CO-3	understand the basic skills and techniques in micropreparation and formulate methods to identify different plant groups	1, 6	Ap
CO-4	apply the practical knowledge to identify a particular group from a mixed group in the laboratory and in the field	6	Ap
CO-5	know the adaptive features of cryptogams to theirhabitats	1, 2	Un
CO-6	analyse the phylogenetic relationship between thedifferent groups	1, 2	Ap
CO-7	evaluate the economic and ecological significance of lichen	1, 2	Re
CO-8	critically think on the origin and evolution of Bryophyte	1, 2	Un

SEMESTER I			
Core I	**Plant Diversity I (Algae, Bryophyte, Fungi and Lichen)**		
Course Code: 21PBOC11	**Hrs/week: 6**	**Hrs/Semester: 90**	**Credit: 4**

UNIT I: Algae: Classification of algae by F.E.Fritsh (1945), Parker (1982). Contribution of Indian Phycologists: M.O.P. Iyengar, T.V. Desikachary and V.K. Krishnamurthy.

Coastal line of India: South East coast of India, West coast of India.

General characteristics and life cycle pattern of algae. Special structural features of the algal cell – nucleus, centrosomes, flagella, eye spots, contractile vacuoles, chloroplast, pyrenoid and reserve foods. Phylogenetic relationships with other plant groups. Economic importance of algae.

UNIT II: General characteristics, ecological, morphological and interrelationships of Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae, Rhodophyceae and Myxophyceae. Fossil algae.

UNIT III: Bryophyta: Classfication of Bryophytes by Rothmaler (1951). Origin of Bryophytes. General characteristics. Morphological, anatomical structure, vegetative, sexual reproduction and alternation of generation and interrelationship of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales and Polytrichales. Spore dispersal mechanism in bryophytes. Economic and ecological importance of Bryophytes.

UNIT IV: Fungi: Classification of Fungi by Alexopoulos and Mims (1979). General characteristics. Diversity of somatic, reproductive and fruiting structures of Myxomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Heterothallism, Heterokaryosis and Parasexuality in fungi. Economic importance of Fungi.

UNIT V: Lichens: A general account of lichens. Classification of lichens based on habitat, morphological features, internal structure, nature of fungal components. Occurrence and interrelationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Lichens as indicators of Pollution, Economic importance of Lichens.

Books for Reference:

Algae

1. Bilgrami K.S and Sinha L.B *A Text Book of Algae*. New Delhi: CBS Publication and distributors, 2004.
2. Fritsch F.E *The structure and reproduction of algae*.Vol.I & II. UK: Cambridge

UniversityPress, 1972.

3. Kamat, N.D *Topics in Algae*. Aurangabad: Saikripa Prakasam, 1982.
4. Robert Edward Lee *Phycology*. UK: Cambridge University Press, 2008.
5. South G.R and Whittick *Introduction to phycology*. London: Blank well Scientific Publications,1987.
6. Chapman V.J and Chapman D.J *The Algae.* London: The Macmillan Press Ltd., andBasingstoke, 1975.

Bryophyta

1. Cavers F *Inter relationship of the Bryophyta*. London: Dawsons of Pall Mall. 1964.
2. Peter George *Hand Book of Bryophyta.* New Delhi: Rajat Publications , 2010.
3. Rashid A *An introduction to Bryophyta*. New Delhi: Vikas Publishing House Pvt. Ltd. 1999.
4. Watson E.V *Structure and life of Bryophytes*. London: Hutchinson University Library,1971.
5. Alain Vanderpoorten and Bernard Goffinet *Introduction to bryophytes,* UK: CambridgeUniversity Press, 2009.

Fungi

1. Alexopoulos and Mim's *Introductory Mycology*, Hyderbad: Wiley Eastern Ltd. 1983.
2. Johri R.M Sneh Lata and Kavita Tyagi *Text Book of Fungi*. New Delhi: Dominant Publishers and Distributors Pvt. Ltd. 2010.
3. Smith G.M *Cryptogamic Botany* Vol.I New York : McGraw Hill Book Company, 1988.

Lichen

1. Ahmadjian, V and Mason E. Hale M.E *The Lichens.* New York: Academic Press, 1973.

Practical: Hrs/Week - 2

- **Algae:** Micropreparation of *Nostoc, Oscillatoria, Coleochaete, Caulerpa, Codium, Valoniopsis, Enteromorpha, Ulva, Padina, Turbinaria, Hypnea, Gracilaria*.

  Collection, identification and preservation of fresh water and Marine algae. Preparation of algal herbaria
- **Bryophyta:** *Targionia, Reboulia, Plagiochasma, Pallavicinia, Anthoceros, Sphagnum,Polytrichum*.
- **Fungi:** *Pilobolus, Peziza, Xylaria, Polyporus, Agaricus*
  Observation and study of fungi under natural habitat.
- **Lichens:** *Usnea, Parmelia*

Field visit: No of days: 4 (Collection of Algae, Bryophytes, Fungi and Lichens)

Submission - Record Note Book

Bottle specimens/herbarium specimens (any five)

Laboratory Manuals for Reference:

1. Ashok M Bendre and Ashok Kumar *A Text Book of Practical Botany – Volume I.*Meerut: Rastogi Publications, 2009.
2. Srivastava H.N *Practical Botany Volume I,* Jalandhar: Pradeep Publications, 1987.

SEMESTER I			
Core II	**Plant Microbe Interaction**		
Course Code: 21PBOC12	**Hrs/week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Objectives:

- To provide information on the growth and morphology of microbes
- To familiarize the interaction of plants with microbes
- To understand the basic principles related to plant diseases.

Course Outcomes

CO. No	Upon completion of this course, students will be able to:	PSO addressed	CL
CO-1	perform the techniques of isolation, characterization and measure the growth of bacteria	4	Re
CO-2	differentiate the mode of action of antibiotics	1	An
CO-3	outline the stages of disease pyramids and disease cycle.	2	Un
CO-4	know about the enzymes involved in plant diseases	1	Re
CO-5	understand the basic principles related to plant diseases.	2	Ap
CO-6	purify, detect and identify the plant viruses.	3	Re
CO-7	understand the general symptoms of bacterial disease, viral diseases and fungal disease	1	Un
CO-8	provide tools to design innovative, sustainable and tailored control methods to prevent plant diseases or to reduce theirimpacts	6	Cr

SEMESTER I			
Core II	**Plant Microbe Interaction**		
Course Code: 21PBOC12	**Hrs/week: 6**	**Hrs/Semester: 90**	**Credits: 4**

UNIT I: Early development of microbiology, contributions of Leeuwenhoek, Robert Koch, Edward Jenner, Alexander Flemming and Louis Pasteur. Isolation of pure culture and measurement of growth of bacteria. Purification and quantitative assay of plant viruses. Antimicrobial components: mode of action of penicillin, streptomycin and sulfonamides.

UNIT II: Introduction: Components of disease (disease pyramid); causes of disease; classification of diseases; stages in the development of disease (disease cycle); Enzymes in plant diseases-pectic enzymes, macerating enzymes and cellulolytic enzymes. Dissemination of plant pathogens, Integrated disease management.

UNIT III: Characteristic features of plant pathogenic bacteria, general symptoms of \bacterial diseases, Survival and spread of bacterial plant pathogens, control of bacterial disease. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Angular leaf spot of cotton, Citrus canker and Tundu disease of wheat.

UNIT IV: General characteristic of plant pathogenic fungi, survival, dissemination and spread, general symptoms, control of fungal diseases. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Wilt of cotton, Downy mildew of grapes and Ergot of rye.

UNIT V: General characteristic of plant viruses, translocation and distributions of viruses of plants, symptoms caused by plant viruses, Purification, detection and identification of plant viruses, control of plant viruses. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Bunchy top of banana, leaf curl of papaya and Yellow vein mosaic of bhindi.

Books for Reference:

1. Agrios G.N. *Plant Pathology*. London : Academic Press, 1997.
2. Caldwell D.R. *Microbial Physiology and Metabolism.* United states: Wm.C Brown publishers, 20 05.
3. Dubey R.C and Maheshwari D.K. *A text book of microbiology.* New Delhi:

S.Chand and company,2003.
4. Kumar H. D and Swati Kumar. *Modern concepts of Microbiology*. New Delhi: Vikas Publications, 2008.
5. Mehrotra R.S and Agarwal A. *Plant Pathology*. New Delhi: Tata McGraw Hill Publishing Company, 2003.
6. Pelczar H. and Reid R. *Microbiology* – Concepts and Applications. New Delhi:Tata Mc Graw Hill Publishing company Pvt.Ltd., 1998.
7. Pelzar M. J, C h a n E.C.S and Noel. R *Microbiology*, New Delhi: Tata Mc Graw Hill Publishing company Pvt.Ltd., 2010 .
8. Prasad T. V.S. *Soil Microbiology,* New Delhi: Dominant Publishers and distributors, 2011.
9. Prescott L.M, Harley J.P and Klein D.A *Microbiology*. London:Mc Graw hill, 2002.
10. Sharma P.D. *Plant Pathology*. NewDelhi: Narosa Publishing House Pvt. Ltd., 2006.

Practical: Hrs/week: 2

- Record of brief life history of scientist related to microbiology
- Methods of sterilization of glasswares
- Preparation of media
- Serial dilution technique
- Pure culture technique
- Effect of antibiotics on the growth of bacteria. Determination of MIC
- Micropreparation/ study of infected specimen prescribed in the syllabus
- Angular leaf spot of cotton
- Citrus canker
- Tundu disease of wheat
- Bunchy top of banana
- Leaf curl of papaya
- Yellow vein mosaic of bhindi.
- Wilt of cotton
- Downy mildew of grapes
- Ergot of rye

Submission - Record Note Book

Laboratory Manuals for Reference:

1. Lakshmanan M, Kunthala Jeyaraman, Jeyaraman and Gnanam, *Laboratory experiments in microbiology and molecular biology,* Higginbothams Pvt. Ltd., 1971.

2. Sharma P.D. *Plant Pathology*, NewDelhi: Narosa Publishing House Pvt. Ltd., 2006.

Semester I			
Core III	**Bioinstrumentation and Research Methods**		
Course Code: 21PBOC13	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

Objectives:

- To familiarize in collection of data and analysis of data for scientific solution
- To know the basic tools in research and to facilitate the students to undergo basic andapplication-oriented research
- To infuse the practical knowledge of using various scientific instruments to perform researchwork.
- To motivate the students to do research.
- To make them analyze the biological data.

Course Outcomes

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	know microscope as the basic tool for biological research.	6	Ap
CO-2	acquaint with different tools and techniques essential for research work	6	Cr
CO-3	understand the fundamentals of statistics and statistical analysis	4	Un
CO-4	do statistical analysis and communicate the results of statistical analyses accurately and effectively	4	Ap
CO-5	know and explain the importance of internet in research and gather reference materials	6	Un
CO-6	examine the basic framework of research process and able to learn how to address research problem and what is to be done to solve it.	6	An
CO-7	communicate the research findings to the scientific forums	6	Cr
CO-8	develop an understanding of the ethical dimensions of conducting applied research	7	An

Semester I			
Core III	**Bioinstrumentation and Research Methods**		
Course Code: 21PBOC13	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

UNIT I: Microscopy: Principles, working mechanism and applications of Simple, Compound, Phase- Contrast microscopes, Electron microscopy (SEM). Principles and operations: pH meter, Electrical conductivity meters. Centrifugation: working principle and applications -differential and density gradient centrifugations; types: clinical/ low-speed, high speed, micro and analytical ultracentrifuges.

UNIT II: Chromatography: Principles, working mechanism and applications- Paper, Thin Layer, HPTLC, Column, HPLC and GC-MS. Spectrophotometry: Principles, working mechanism and applications -UV- visible, AAS, FTIR,MALDI.

UNIT III: Electrophoresis - principles, electrophoretic mobility, factors affecting electrophoresis, isoelectric focusing, types - vertical and horizontal. Agarose and polyacrylamide gel electrophoresis, detection and recovery of electrophorogram, gel documentation systems. Tracer techniques – Autoradiography, XRD.

UNIT IV: Biostatistics: Practice of statistical methods in biological research. Descriptive statistics: Measures of Central Tendency - Mean, Median and Mode. Measures of Dispersion- Standard deviation, coefficient of variation and standard error. Simple correlation and linear regression analysis. Inferential Statistics: Tests of statistical significance - Chi-square, t-tests and Analysis of Variance (ANOVA- one way &two-way).

UNIT V: Types of research, scientific research: hypothesis, experimentation,theory. Preparation of Research Article – Layout of a Research Paper, review article, online publications, thesis writing, Citation, referencing and bibliography, editorial process and proof-reading symbols. Journals in Botany-predatory, peer-reviewed, online journal, SCI journals, Web of science journals. Impact factor of Journals, Ethical issues related to publishing. Citation, google scholar, i-10, H index. Plagiarism and Self- Plagiarism. Oral presentation of research papers in conference.

Books for Reference

1. Guruamni N. *Research Methodology for Biological Sciences*, Chennai: MJP Publishers, 2006.
2. Gurumani N. *Scientific thesis writing and paper presentation*. Chennai: MJP Publishers, 2010.

3. Boyer R F. *Modern Experimental Biochemistry*. America: 3rd edn. Prentice HallPubl, 2000.
4. Kothari C.R. *Research Methodology – Methods and techniques*, New Delhi: Newage International (P) Ltd., Publishers, 2004.
5. Veerakumari L. *Bioinstrumentation*, Chennai: M.J.P. Publishers, 2015.
6. Gurumani N. *An Introduction to Biostatistics*, Chennai: 2nd edition M.J.P.Publishers, 2005.
7. Satguru Prasad. *Fundamentals of Biostatistics*, New Delhi:4th edition EmkayPublications, 2003.
8. Veera Bala Rastogi. *Fundamentals of Biostatistics*, Chennai: 2nd edition AneBooks Pvt. Ltd., 2009.

Practical: Hrs/week: 2

- Preparation of Molar, Normal, ppm, percentage and buffer solutions.
- Thin layer chromatographic separation of amino acids
- Separation of protein by PAGE
- Separation of DNA by AGE
- Digital photographic display of anatomical samples/ microscopic samples.
- Estimation of Na and K using flame photometer
- Demonstration-AAS, Fluorimeter and FTIR
- Data analysis with statistical package (SPSS& Excel) -
  mean, median,mode, standarddeviation, standard error
  student t-test, ANOVA
- Preparation of bibliography using reference tool (Zotero)
- Calculation of citation Index
- Determination of Impact Factor of Author, Article and Journal.

Books for Reference

1. Jayaraman J. *Laboratory manual in biochemistry*, New Delhi:Wiley EasternLtd.,1985.
2. Palanisamy S and Manoharan M. *Statistical methods for biologists*, Palani: IIEdition Palani paramount publishers, 1994.
3. Ponmurugan P and Gangathara Prabhu B. *Biotechniques*. Chennai: MJPpublishers, 2012.

Semester I			
Core IV	**Phytochemistry and Pharmacognosy**		
Course Code: 21PBOC14	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

Objectives:

- Exploring the plant resources as pharmaceuticals and nutraceuticals.
- To acquire knowledge on identification, extraction and utilization of phytochemicalconstituents through teaching and training.

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO's addressed	CL
CO-1	confirm the promising role of the phytoconstituents as cytotoxicity and substantiate them for the treatment of fatal diseases	8	Re
CO-2	understand the importance of secondary metabolites and relate them in treating the ailments	6	Un
CO-3	identify and categorize medicinal potential of herbs based on their chemical constituents and therapeutic applications	1	Un
CO-4	associate the medicinal compounds with their natural resources	2	An
CO-5	analyse of qualitative and quantitative medicinal compounds in herbal drug preparation.	2	An
CO-6	extract essential oils from natural resources and utilize them effectively as pharamaceuticals and cosmeticals	7,8	Av
CO-7	evaluate the purity of the drugs and able to detect adulterations and substitutions	2,4	Ev
CO-8	screen and elucidate various pharmacologically important phytoconstituents to ascertain its medical quality	5	Ev

Semester I			
Core IV	**Phytochemistry and Pharmacognosy**		
Course Code:21PBOC14	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

UNIT I: Phytochemistry, Histochemistry, Biosynthetic pathway for secondary metabolites. Secondary metabolites - definition, classification, preliminary phytochemical screening. Glycosides: Definition, properties, classification, natural sources, pharmacological and toxicological effects of glycosides. Terpenoids- β-Sitosterol, Glycyrrhizin. Phenolics - Coumarins and Tannins. Steroids and alkaloids.

UNIT II: Flavonoids: Definition, properties, classification, natural sources and therapeutic applications offlavonoids. Medicinal uses of resins.

UNIT III: Extraction methods – Maceration, infusion, percolation, Decoction, soxlet extraction, supercritical fluid extraction, distillation, Counter-current Extraction, and cold extraction. Volatile oils - source, constituents, properties, extraction and utilization of Lemon grass oil, Vetiver oil, Clove oil and Eucalyptus oil. Intellectual property rights and trade of medicinal plants.

UNIT IV: Pharmacognosy: Definition, scope and applications of herbal medicine. Classification (morphological, therapeutic, chemical. and chemotaxonomic classifications): Collection and processing of crude drugs - adulteration of crude drugs. Pharmacognostical standards, synergy and polyvalent action of secondary metabolites.

UNIT V: Evaluation of crude drugs – Physico-chemical, organoleptic analysis. Botanical name, family, useful part, chemical constituents, adulterants and uses of the following drug Glycosides – Senna, Aloe, Digitalis, Liquorice; Terpenoids – Coriander, Fennel, Cinnamom; Alkaloids – Datura, Vinca, Pepper; Lipids - Castor, Neem, Sesame oil.

Books for Reference:

1. Agarwal S.S. and Paridhavi M. *Crude Drug Technology*, Hyderabad: Universities Press, 2007.
2. Evens W.C. *Pharmacognosy Medicinal and Aromatic Crops*, Singapore:Harcourt Brace and company Asian Pvt. Ltd., Universities press, 1987.
3. Farooqui A.A and B.S.Sreeramu B.S. *Cultivation of medicinal and aromatic crops*,Pune: Universities press, 2001.
4. Gurdeep Chatwal. *Organic Chemistry of Natural Products*, Mumbai: Himalaya ` Publishing house,1983.

5. Kokate C.K. Purohit A.P. and Gokhale S.R, *Pharmacognosy,* Pune: Nirali PrakshanPublishing House Ltd., 2004.
6. Tewari K.S, Vishogi N.K and Mehrotra S.N. *Text Book of Organic Chemistry* ,Uttaarpradesh:VikasPublishing House Ltd., 1998.
7. Trivedi P.C. *Medicinal Plant conservation and utilization,* Jaipur: Aavishkarpublishers,2004.
8. Trivedi P.C and Sharma N.K. *Ethomedicinal Plants,* Jaipur: Pointer Publishers , 2004
9. Wallis. *Text Book of Pharmacognosy*, New Delhi: CBS Publishers, 2003.
10. Yohanarasimban S.N. *Medicinal plants of India*, Jodhpur: 2004.

Practical: Hrs/Week: 2

- Morphology, histology and Powder characteristics, extraction and detection ofCinnamon,Clove, Fennel and Coriander.
- Isolation and detection of active principles:Caffeine from Tea dust Sennosides from Senna Curcumin from Turmeric
- Analysis of crude drugs by chemical tests for the detection of Glycosides - Senna, *Aloe*, LiquoriceTerpenoids – Coriander, Fennel, Cinnamom Alkaloids – *Datura, Vinca*, Pepper Lipids - Castor, Neem, Sesame, Groundnut oilResin – Ginger, Asafoetida. Volatile oil – Lemon and clove
- Distillation of Volatile oils and detection of phytoconstituents by TLS Jasmine and *Eucalyptus*

Books for Reference:

1. Kokate K.C and Gokhale S.B. Practical Pharmacognosy, Pune: 2008.
2. Chauhan M.G. and Pillai A.P.G, Microscopic Profile of Powdered Drugs Used in IndianSystems of Medicine. Jamnagar: *Institute of Ayurvedic Medicinal Plant Sciences*, 2005.

SEMESTER II			
Core V	**Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)**		
Course Code: 21PBOC21	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credit: 4**

Objectives:

- To have a comprehensive idea on vascular cryptogams and phanerogams.
- To get an idea on the past history of biosphere and evolution of seed plants.
- To understand the taxonomy, characteristics and uniqueness of vascular plants.

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	appreciate the uniqueness and distinguish between diverse groups of Pteridophytes and Gymnosperms using their characteristic features	1, 2	An
CO-2	discuss different life cycle patterns in different groups	1, 2	Cr
CO-3	know the basic skills and techniques in micropreparation and formulate methods to identify different groups	1, 6	Ap
CO-4	know the evolutionary significance of Pteridophyte	1, 2	Un
CO-5	infer pteridophytes are pioneer in the evolution of seedhabit	1, 2	Re
CO-6	compare and contrast the origin and evolution of steles,foliage, seed and seedless plants.	1, 2	An
CO-7	compare and contrast the seed and seedless plants.	1, 2	Ev
CO-8	review critically the biology, ecology of fossils andmethods of fossilization.	1, 7	Un

SEMESTER II			
Core V	**Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)**		
Course Code: 21PBOC21	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credit: 4**

UNIT I: **Pteriodophytes:** Classification of pteridophytes (PPG) by Erics (2016 (upto order level). Origin and evolution of pteridophytes. General characteristics. Telome concept. Stelar evolution in pteridophytes. Heterospory and seed habit. Theories and modifications of alternation of generations. Life cycle pattern in homosporous and heterosporous pteridophytes. Distribution of pteridophytes in India

UNIT II: Morphological, anatomical structure, asexual and sexual reproduction of Psilotales, Lycopodiales, Selaginellales,Isoetales, Equisetales, Ophioglossles and Polypodiales. Aposory, Apogamy, Vivipary, Parthenogenesis. Economic importance of pteridophytes.

UNIT III: **Gymnosperms:** Classification of gymnosperms by Christenhusz *et al.* (2011) (Upto family level). General characteristics. Distribution of gymnosperms in India. Morphological, anatomical structure and reproduction of Cycadaceae, Ginkgoaceae, Welwitschiaceae, Gnetaceae and Ephedraceae,

UNIT IV: Morphological, anatomical structure and reproduction of Araucariaceae, Podocarpaceae and Cupressaceae. Affinities of gymnosperms with angiosperms and pteridophytes. Economic importance of gymnosperms.

UNIT V: **Paleobotany:** Geological time scale – fossilization and fossil types: compressions, incrustation, casts, molds, petrifactions, coal balls and compactions. General characters of fossil pteridophytes: *Horneophyton, Sphenophyllum* and *Calamites*. Fossil gymnosperms: *Williamsonia* and *Cordaites*. Indian Paleobotanists: Birbal Sahni, D.D. Pant, M. Ramanujam, Osmani.

Books for Reference:

Pteridophytes:

1. Bower, F.D. *Primitive land plants*. Vol. I & 2. Jaipur : Arihant Publishers. 1988.

2. Pandey S.N., Trivedi P.S., Misra S.P. *A text Book of Botany* Vol. II. New Delhi: Vikas Publishing House Pvt. Ltd., 2006.
3. Parihar, N.S. *An introduction to Embryophyta, Pteridophyta.* Allahabad: Central Book Depot Publications in Botany. 1967.
4. Rashid, A. *An introduction to Pteridophyta*. New Delhi: Vani Educational Books. 1985.
5. Sundara Rajan S. *Introduction to Pteridophyta*. New Delhi : New Age International Publishers. 2009.

Gymnosperms:

1. Chamberlain, C.J. *Gymnosperms.Structure and evolution*. New Delhi: CBS Publishers &Distributors, 1986
2. Johri R.M., Sneh Lata and Kavita Tyagi. *Text Book of Gymnosperms*. New Delhi : Wisdom Press. 2010.
3. Sporne, K.R. *The Morphology of Gymnosperms*. New Delhi: B.I. Publications Pvt. Ltd., 1974.

Practical: Hrs/Week – 2

Pteridophytes:

- *Selaginella* – Habit, Section: T.S. of stem, rhizophore, L.S. of cone
- *Isoetes* - Habit, Section: T.S. of leaf
  Permanent slide: L.S. of male and female cone
- *Equisetum* - Habit, Section: T.S. of internode
  Permanent slide: L.S. of cone
- *Lygodium* – Habit, Section: T.S. of rachis
  Permanent slide: T.S. of pinnule
- *Osmunda* – Habit, Section: T.S. of rachis
  Permanent slide: L.S. of cone
- *Pteris* – Habit, Section: T.S. of rachis and pinnule
- *Adiantum*- Habit, Section: T.S. of rachis and sori
- *Salvinia* – Habit, Section: T.S. of stolon
  Permanent slide: L.S. of cone

Gymnosperms:

- *Cycas* – Twig, Section: T.S. of corolloid root, rachis and leaflet
  Permanent slide: L.S. of microsporophyll, male cone (entire), female cone (entire)
- *Gnetum* – Twig, T.S. of stem and leaf
  Permananent slides: L.S. of male and female cone, wood showing anomalous secondary thickening and seed (entire).
- *Araucaria* – Twig, Section: T. S. of stem

Permanent slide: L.S. of cone

- *Podocarpus* – Twig, Section: T.S, of stem, leaf
  Permanent slide: L.S. of cone
- *Cupressus*: Twig, Section: T. s. of stem
  Permanent slide: L.S. of male cone and female cone

Fossils:

Pteridophytes:

- *Sphenophyllum*
- *Calamites*

Gymnosperms

- *Williamsonia*
- *Cordaites*

Field study: No. of days 3 (Pteridophytes and Gymnosperms: Western Ghats)

Submission - Record Note Book

Lab manuals for Reference:

1. Ashok M. Bendre and Ashok Kumar. *A Text Book of Practical Botany*Volume1. Meerut : Rastogi Publications. 2009.
2. Srivastava H. N, *Practical Botany* Volume I, Jalandhar : Pradeep Publications, 1987.

SEMESTER II			
Core VI	**Marine Botany**		
Course Code: 21PBOC22	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credits: 4**

Objectives:

- To give elaborate account on marine environment and its role in controlling the Earth'sclimate.
- To understand the different types of marine habitats and the adaptation of life there in.
- To understand the role of marine products and their socio economic and environmental significance

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	analyze how marine organism adapt to their dynamic environment	5	Un
CO-2	recall how natural events and human activities affect coastal habitats	7	Re
CO-3	critically analyze and evaluate pollution issues, their sources and the influences humans have with the dynamic marine environment	7	An
CO-4	achieve practical skills in processing, preserving and culturing marine plants	6	Ev
CO-5	evaluate the uses of marine resources and realize the role of phytoplankton and bacteria in the economy of the ocean	5	Ap
CO-6	able to signify the characteristic feature of coral reefs and their role in biodiversity conservation	1	An
CO-7	able to identify and understand the role of mangroves in coastal protection and their adaptation to its hostile environment	5	Ap
CO-8	explain the ecological relationship between organisms and their environment	2	An

SEMESTER II			
Core VI	**Marine Botany**		
Course Code: 21PBOC22	**Hrs/week:5**	**Hrs/Semester: 75**	**Credits: 4**

UNIT I: Classification of marine habitat - ecology of pelagic, benthic and sublittoral zones, deep sea, sandy muddy and rocky shore. Characteristics of marine habitat – tides and chlorinity, upwelling, plate tectonics, tsunami, green house effect, carbon pump. Ocean andregulation of climate on earth.

UNIT II: Marine biodiversity –phytoplankton - characteristics, measuring and sampling. Marine bacteria, marine fungi, seaweeds and sea grasses. Threats and conservation of seaweeds and sea grasses. Nutrient cycling: carbon, nitrogen, sulphur and phosphorus.

UNIT III: Marine products - traditional uses; human food and agriculture. Marine colloids and hydrocolloids - Agar - agar, algin, alginates, carrageenan, diatomite, marine lipids, flavanoids, and carotenoids. Marine pharmacology – identification of bioactive compounds in marine organisms – mangroves, seaweeds, and sea grasses.

UNIT IV: Culture of micro algae –laboratory culture, preservation and maintenance of culture and mass culture. Commercial cultivation of seaweeds. Marine pollution –thermal pollution, oil pollution, heavy metal pollution, radioactive pollution and industrial pollution. Algal blooms. Global climate changes: impact on specific diversity and productivity, ocean as carbon sink, effect on coral bleaching. Biological rhythms.

UNIT V: Mangroves and salt marshes: geographical distribution, habit, adaptations, and trophic interactions. Present status and stresses on the mangroves with special reference to Sunderbans. Regeneration of mangroves. Coral reefs – ecology, species interaction, economic importance and conservation.

Books for Reference:

1. Cliton Jand Dawes. *Marine Botany.* New York: A wiley – Intersciences publication John Wiley andsons, 1981.
2. Dring M J. *The Biology of Marine plants.*London: Edward Arnold, 1982.
3. Kumudranjan Naskar and Rathindranath. *Ecology and Biodiversity of Indian mangroves. Vol. I & II,* Delhi: Daya publishing House, 1999.
4. Michael P. *Ecological methods for field and laboratory investigations*, Uttar Pradesh: Tata McGraw – Hill publishing Company Limited, 1986.
5. Sinha P.C. *Marine pollution,* New Delhi: Anmol publications Pvt. Ltd., 1998.

6. Tait R.V. *Elements of Ecology*, London: Butter worths, 1978.
7. Warren. *Biology and water pollution* control, London: W.B.Saunders Company, 1971.

Practicals: Hrs/Week: 2

- Determination of acidity
- Estimation of alkalinity
- Estimation of Salinity
- Collection and identification of phytoplankton.
- Determination of total hardness
- Estimation of nitrate (Spectrophotometry)
- Estimation of Phosphate (Spectrophotometry)
- Heavy metal analysis from mangrove sediments

Specimens / photographs / charts

- Plankton net
- Seaweeds
- Sea grasses
- Mangroves
- Alginates
- Carrageenan

Books for Reference

1. Murugesan A.G and Rajakumari. *Environmental Science and Biotechnology andBiotechnology Theory and Techniques, Chennai:*MJP Publishers, 2005.

SEMESTER II			
Core VII - Developmental Botany			
Course Code: 21PBOC23	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credit: 4**

Objectives

- To study the vegetative and reproductive development of seed-bearing plants
- This course is aimed at understanding the structural organization of tissues, organs and theirdevelopmental events controlled by environmental cues and genetic factors

Course Outcome

CO. No	Upon completion of this course ,students will be ableto	PSO addressed	CL
CO-1	understand the overview of essential aspects of development, organization and life cycle of seed bearing plants	3	Un
CO-2	know how embryo arises and the nature of signals that guide complex patterns of growth and differentiation in the embryo	4	Un
CO-3	explore and illustrate how the molecular and genetic approaches provide an insight into the mechanism that translate cues into organized pattern growth and development	4	Re, Un
CO-4	understand cell differentiation, organ development and network of gene signals that control developmental sequences	3	Un
CO-5	role of shoot and root apical meristem in vegetative growth and development	3	Re, Un
CO-6	know the biochemical and physiological changes associated with the development of sex organs, fertilization events and fruit development	4	Un,Ap
CO-7	know how the intrinsic programmes of development coupled to external influences such as nutrient levels, energy inputs and environmental signals.	4	Un
CO-8	acquire hands on training experience related to the course.	4	Re

SEMESTER II			
Core VII	**Developmental Botany**		
Course Code: 21PBOC23	**Hrs/week: 5**	**Hrs/Semester: 75**	**Credit: 4**

UNIT I: **Embryogenesis:** Basic concept of development. Polarity and cell linages. Principle of determinants in plant embryogenesis – axis and pattern formation – apical, basal and radial; Cell plasticity - Meristem and indeterminate growth; Types of meristem – Root apical meristem (RAM) – quiescent center - development of lateral root and root hair formation - position dependent signaling process- hormonal control and maintenance of RAM; Shoot apical meristem (SAM)- organization and activities of SAM, role of gene and transcription factors; vegetative organization, tissue differentiation, leaf initiation and differentiation, Genetic approaches on SAM.

UNIT II: **Seed germination and Seedling establishment**: Seed structure, seed dormancy- breaking of seed dormancy; Seed germination – phases, mobilization of stored resource, seedling growth – growth curve- response to environmental cues- trophism – gravitrophism, phototrophism, thigmotrophism – role of auxin distribution in trophism; phototrophism- photomorphogenesis- shoot differentiation- vascular tissue differentiation; root growth and differentiation – emergence of lateral growth and biochemical and physiological considerations.

UNIT III: **Vegetative growth and organogenesis**: Leaf initiation and determination of phyllotaxy, differentiation of epidermal tissues and appendages, mesophyll tissues; venation pattern, role of hormones; primary root system and shoot system architecture; secondary growth in stem and root- secondary tissue and cambial activity- vascular cambium and cork cambium- abnormal secondary growth.

UNIT IV: **Floral development:** Floral evocation and development of floral parts - Floral meristem, floral organ development – gene control mechanism, homeotic gene control organ identity, competency and determination in floral evocation. Integrating environmental cues – photoperiodism – monitoring day length, circardian ryhythm, vernalization- promoting flowering with cold- temperature control; physiological and molecular control of floral organ development and hormone signals in floral evocation –, gender expression in flowers, genetic control of floral symmetry.

UNIT V: **Developmental biology of floral organs:** Anther differentiation – tapetal behavior, microsporogenesis, pollen development and maturation. Male gametogenesis- pollen germination; megasporogenesis – development of female gametophyte- organization of embryo sac- gene regulation on megagametogenesis- pollen pistil interaction self incompatibility – causes – morphological, cyto genetical reasons – fertilization- development of seed and fruit formation.

Books for Reference:

1. Leyser O and Day S *Mechanisms in plant development*. France: Black Well Publishing Company, 2009.
2. Howell S.H *Molecular genetics of plant development*. NY: Cambridge UniversityPress, 1998.
3. Taiz L and Zeiger E *Plant Physiology and development*. USA: Sinauer Associates.Sixth Edition. 2010.
4. Ragavan V *Developmental Biology of flowering plants.* NY:Springer. 2000.
5. Ragavan V *Experimental Embryogenesis in Vascular plants*. London: Academic Press Inc., 1976.
6. Shivana K.R and Joshi B.M *The angiosperm pollen structure and function*. Singapore: John Wiley & Sons, 1985.
7. Benjamin H Willier and Jane M Oppenheimer *Foundations of Experimental Embryology.* New Delhi. Prentice of India Private Limited, 1968.

Practical: Hrs/week: 2

- Micropreparation of shoot apex/root apex/flower buds/ anther/ ovary/ epidermal appendages formicrotomy
- Directionality of pollen tube growth: protein extraction and protein gel electrophoresis
- Pollen viability test
- Pollen germination test
- Hand sectioning of anther and ovary
- Dissecting embryo and endosperm

Books for Reference

1. Chawla H.S *Introduction to Plant Biotechnology*. New Delhi: Oxford & IBH publishing company Pvt.,Ltd., 2009.

SEMESTER – II			
Core VIII	**Genetics and Bioinformatics**		
Course Code:21PBOC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Objectives:

- To develop an overall understanding on the concepts in genetics and their implications Gain skill on common Bioinformatics tools use in Biology
- To understand Mendel's and T. H. Morgan's theories, on inheritance and their applications
- To practice chromosome mapping, pedigree analysis and basic problems in population genetics
- To comprehend chromosomal aberrations and its implications
- To get trained on Bioinformatics tools used in DNA/RNA/protein sequence analysis
- To get trained on protein structure/visualization and phylogenetic software

Course Outcomes:

CO. No.	**Upon completion of this course, students will be able to**	**PSO addressed**	**C L**
CO-1	predict the possible outcome in a parental cross of known genes	4	Ap
CO-2	associate the physical basis of heredity and the mode of inheritance of a character	2	Un
CO-3	predict the unknown phenotype and genotype in a partially known pedigree	4	Ap
CO-4	map a gene and measure the distance between two genes	4	Ap
CO-5	understand various chromosomal aberrations and various chromosome banding techniques	1,2	An, Un
CO-6	comprehend the operations in population genetics	2	Un
CO-7	predict gene of unknown sequences, similarity between sequences, protein structure, phylogenetic relationships between large groups using genomic data	1, 4	An, Ap
CO-8	learn barcoding techniques and sequence submission	1,2	An, Un

SEMESTER – II			
Core VIII	**Genetics and Bioinformatics**		
Course Code: 21PBOC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

UNIT I: A brief account on Mendelian Principles. Sex linked inheritance. Formulating and testing genetic hypotheses: Chi-square test and probability theory in genetics. Pedigree analysis. Genetic counselling. Chromosome basis of inheritance. Linked genes, recombination and crossovers: Classical experiments in *Drosophila*. Chromosome mapping: two point and three point test cross, gene order and distance calculation. Somatic tests to assigning genes to chromosomes. Genetic recombination and gene mapping in eukaryotes e.g. *Neurospora*.

UNIT II: Chemical composition and packaging of eukaryotic chromosomes. Concept of gene. C-Value paradox, Cot-value and its significance. Chromosome structure in eukaryotes: Chemical composition of eukaryotic chromosomes, the three levels of DNA packaging, Ultra structure of centromere and telomere. Repeated nucleotide sequences, satellite DNA.Structural aberrations in chromosomes: Haploidy, Anueploidy, Polyploidy, and their types, cytological study and identification of autopolyploids and allopolyploids, Genetic consequences of ploidy alteration: Evolution of hexaploid wheat. Structural alteration in chromosome: Deletion, Duplication, Inversion & Translocation, hetrozygote. Chromosomal aberreation related syndromes. Chromosome banding: Q-band, G-band, R-band, C-band, *in situ* hybridization: GISH, FISH, Molecular maps.

UNIT III: Population genetics: History, Gene frequencies and Genotype frequencies, Gene pool. Systems of Mating: Random mating and Hardy-Weinberg Principle, Application of Hardy- Weinberg principles: Test for Random mating, Test for sex-linked trait, Test for carrier gene frequency, Test for mode of inheritance, Test for multiple gene. Non-random mating, Positive non-random mating, Negative non random mating.

UNIT IV: NCBI, DDBJ, EMBL. Submitting sequence: Sesquin. Sequence structure and mapping data bases. Comparing nucleotide and amino acid sequence: BLAST, Multiple sequence alignment: CLUSTALW, CLUSTAL omega. Protein databases: UniProtKB/Swiss-Prot, PIR, PDB, SCOP & CATH, ProDom, PFAM. Protein visualization tools: Swiss PDB Viewer, Pymol. Expasy proteomic tools: AA Compident and Peptide Mass. Motif andpatterns PROSITE, BLOCKS, CADD, Introduction to software: JPred, 3DPSSM, Modeller, ITASSER, Procheck**.**

UNIT V: The terminology of phylogenetics- Trees, Root, branches, Node, Leaf, Clade; lineagesorting, orthology, paralogy, xenology; "basal" lineages, crown vs. stem groups, Phylogram *vs*. cladogram. Multiple sequence alignment & Tree building software - ClustalW, Mega, Phylip, Phylodraw, Phyml, RaxML, Treeview.

Books for Reference

1. Benjamin Lewin, *Genes VII*. New Jersey: Pearson Prentice Hall, 2004.
2. David Preifelder. *Molecular Biology*. New Delhi : Narosa publishing House, 2006.
3. Dnyansagar, V. R.. *Cytology and Genetics*. Tata Mc Graw – Hill Publishing Company limited, 1986.
4. Robert H. Tamarin.. Principles of Genetics. New Delhi : Tata Mc. Graw - Hill publishing company Ltd, 2006.
5. Rastogi S.. C., Mendiratta N., and Rastogi, P. *Bioinformatics: Methods And Applications:(Genomics, Proteomics and Drug Discovery)*. New Delhi: PHI Learning Pvt. Ltd., 2013.
6. Sathyanarayana,U. *Biotechnology*. Kolkatha: Book and Allied (P). Ltd., 2006.
7. Singh B.D. *Genetics*. New Delhi: Kalyani Publishers, 2017.
8. Snustad D.P. and Simmons M. J. *Principles of Genetics*. New Jersey: Wiley Asia Student Edition. Wileyand Sons, Inc., 2012
9. Verma P.S. and Agarwal V.K. *Genetics*. New Delhi: S. Chand and Co., 1991
10. Vijendra Das L. D. *Genetics and plant breeding*. New Delhi: New age International (P) limited Publishers, 2005.

Practicals: Hrs/Week: 2

- Problems coming under Mendelian pattern of inheritance
- Problems using chi-square, probability theory and pedigree
- Countable slides for the metaphase anaphase spread to be prepared each for mitosis and meiosis,and submit at the end of the semester.
- Karyotyping
- Chromosome structural aberration – Translocation in *Tradescantia spathacea* (Rhoeo)
- General genetic tests for genetic toxicity
- Test for gene mutations in bacteria –Bacterial reverse mutation Test
- Chromosomal aberrations due to the effect of mutagens – EMS/2,4 – D/acridine orange in *Allium cepa*
- Sequence analysis using BLAST
- Multiple sequence alignment using CLUSTAL W and CLUSTALX
- Protein structure prediction – PDB, JPred, Modeller
- Create Phylogenetic tree using minimum three of the tools mentioned in the syllabus

Books for Reference:

1. Bendre Kumar. *A Text book of Practical Botany, Volume I & II (7th Edition)*. Merrut: RastogiPublications, 2014.
2. Proudlock R. *Genetic Toxicology Testing A Laboratory Manual*. USA: Academic Press, CA, 2016.