DURG VISHWAVIDYALAYA, DURG (C.G.)

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SCHEME OF EXAMINATION
&
SYLLABUS
of
M.Sc. (Botany) Semester Exam

UNDER

FACULTY OF SCIENCE

Session 2017-19

(Approved by Board of Studies)
Effective from July 2017

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SCHEME OF EXAMINATION, 2017-2018

M.Sc. I SEMESTER, BOTANY

THEORY

PAPER	TITLE	MAX. MARKS	Internal Assessment/ seminar	Total marks
I	CYTOLOGY	80	20	100
II	GENETICS	80	20	100
III	MICROBIOLOGY,PHYCOLOGY AND MYCOLOGY	80	20	100
IV	BRYOPHYTA,PTERIDOPHYTA AND GYMNOSPERM	80	20	100

PRACTICAL

LAB COURSE-I	BASED ON PAPER I & III	80	20	100
LAB COURSE-II	BASED ON PAPER II & IV	80	20	100
	TOTAL MARKS (Theory and Practical)			**600**

M.Sc. II SEMESTER, BOTANY

THEORY

PAPER	TITLE	MAX. MARKS	Internal Assessment /Seminar	Total marks
I	TAXONOMY AND DIVERSITY OF PLANTS	80	20	100
II	MOLECULAR BIOLOGY	80	20	100
III	PLANT PHYSIOLOGY	80	20	100
IV	PLANT METABOLISM	80	20	100

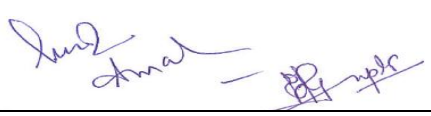
Choice Based Credit System: Semester II **Course Forestry seed Technology.**
Marks 100 , Credit Points -03, Total Hours -50

PRACTICAL

LAB COURSE-I	BASED ON PAPER I & II	80	20	100
LAB COURSE-II	BASED ON PAPER III & IV	80	20	100
	TOTAL MARKS (Theory and Practical)			**600**

TOTAL MARKS OF SEMESTER I & II - 1200

NOTE : Botanical excursion (within or outside Chhattisgarh) is compulsory for the Students of M.Sc.



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PRACTICAL SCHEME, LAB COURSE- I
M.Sc. I SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Cytology	20 Marks
2.	Exercise based on Phycology	20 Marks
3	Exercise based on Mycology	15 Marks
4.	Spotting	15 Marks
5.	Viva-voce	10 Marks
6.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

PRACTICAL SCHEME, LAB COURSE-II
M.Sc. I SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Genetics	10 Marks
2.	Exercise based on Bryophyte	15 Marks
3.	Exercise based on Pteridophyta	15 Marks
4.	Exercise based on Gymnosperm	15 Marks
5.	Spotting	15 Marks
6.	Viva-voce	10 Marks
7.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

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PRACTICAL SCHEME, LAB COURSE- I
M.Sc. II SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Molecular biology	20 Marks
2.	Exercise based on plant description (2 plants)	35 Marks
3.	Spotting	15 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

PRACTICAL SCHEME, LAB COURSE-II
M.Sc. II SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Paper-III	30 Marks
2.	Exercise based on Paper-IV	25 Marks
3.	Spotting	15 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

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M.Sc. SEMESTER - I

PAPER - I
CYTOLOGY

MAX.MARKS-80

UNIT-I

- The dynamic cells, Structural organization of the plant cell, specialized plant cell type chemical foundation, biochemical energetics.
- Cell wall - Structure and functions, biogenesis growth.
- Plasma membrane; structure, models and functions, site for ATPase, ion carriers channels and pumps, receptors.

UNIT-II

- Chloroplast-structure, genome organization, gene expression, RNA editing.
- Mitochondria; structure, genome organization, biogenesis.
- Plant Vacuole – Tonop last membrane, AT Pases transporters as a storage organelle.

UNIT-III

- Nucleus: Structure, nuclear pore, Nucleosome organization.
- Ribosome- Structure and functional significance.
- Cell cycle and Apoptosis; Control mechanisms, role of cyclin dependent kinases.
- Retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.

UNIT-IV

- Other cell organelles: Structure and functions of microbodies, microtubules, microfilaments, Golgi apparatus, lysosome, endoplasmic reticulum.
- Techniques in cell biology: Immune techniques, in situ hybridization to locate transcripts in cell types FISH, GISH, Confocal microscopy.

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LIST OF PRACTICALS

- Identification of different stages of mitosis from suitable plant material. (onion root tips, garlic root tips).
- Identification of meiosis from suitable plant material. (Onion floral buds).
- Isolation of cell organelles: Mitochondria, Chloroplast, Nucleus, Lysosomes and there assay by succinate dehydrogenase activity (Mitochondria), acid phosphatase activity (Lysosome), acetocarmine staining (Nucleus) and microscopic observation (Chloroplast).
- Study of mitotic index from suitable plant material.
- Study of cyclists in cells of suitable plant material.

Suggested Reading:-

1. De Robertis and De Robertis 2005 (Eight edition) (Indian) Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].
2. Sad ova David – 2004 (First Indian Edition). Cell Biology, New Delhi.
3. Albert Etal 2002 (Fourth Edition). Molecular Biology of the cell, Garland Science (Iaylar and Francis) New York Group (wt.)
4. Lodish Etal 2004 (Fifth Edition). Molecular Cell Biology, W H Freeman and company, New York.
5. Giese Arthur 1979 (Fifth Edition). Cell Physiology, Toppan company Ltd., Tokyo, Japan.
6. Cooper G.M and Hausman R.E 2007 (Fourth Edition). The Cell molecular approach Sinauer associate, Inc, Suderland (USA).
7. Powar C.B 2005 (Third Edition). Cell Biology, Himalaya Publishing, Mumbai.
8. Roy S.C and KKDe 2005 (Second Edition). Cell Biology, New central Book Agency Private Ltd., Kolkata.
9. Krishnamurthy, K.V 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
10. Buchanan B.B, Gruissm W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plant. American Society of Plant Physiologist, Maryland, USA.
11.. De D.N 2000. Plant Cell Vacuoles : An Introduction. CISRO Publication, Collingwood, Australia.
12. Kleinsmith L.J and Kish V.M 1995. Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York, USA.
13. Lodish H., Berk A., Zipursky, S.L Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular Cell Biology (Fourth Edition). W.H. Freeman and Company, New USA.
14. David Freifelder 1996. Essentials of Molecular Biology, Panima Publishing Company
15. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and Scne Ine., USA

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PAPER - II

GENETICS

MAX.MARKS-80

UNIT-I

- Chromatin Organization **:** Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, chromatin and heterochromatin, Karyotype, banding pattern specialized types of chromosomes, polytene, lamp brush, B chromosomes and sex chromosomes.

- Molecular basis of chromosome pairing chromosomal aberration and polyploidy.

UNIT-II

- Mapping of Bacteriophage genome, Phage phenotype, recombination in phage, genetic transformation and transduction in bacteria.

UNIT-III

- Genetic recombination & genetic mapping; Mechanism of crossing over, molecular mechanism of recombination, role of Rec-A ,Rec-B, Rec- C and Rec-D enzymes, site specific recombination, linkage, linkage group, genetic marker.

UNIT-IV

- Alien gene transfer through chromosome manipulation; Transfer of whole genome examples from wheat, a rachis & brassica. Transfer of individual chromosomes & chromosome segment, methods for detecting alien chromatin, production.

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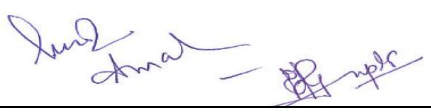
LIST OF PRACTICALS-

- Staining of salivary gland chromosomes of Chironomas larva or Drosophila.
- Isolation of DNA and its quantification by UV- spectrophotometric method.
- Isolation of RNA and its quantification by UV- spectrophotometric method.
- Isolation of DNA by Agarose gel electrophoresis.
- Transformation in Bacteria
- Transduction in Bacteria.

Suggested Readings:

1. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter 1989, Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
2. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.
3. Burnham, C.R 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
4. Busch, H. and Rothblum. L 1982. Volume X. The Cell Nucleus rDNA part A. Academic Press.
5. Hartk D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.
6. Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
7. Karp, G. 1999. Cell and Molecular Biology : Concept and Experiments. John Wiley and Sons, Inc., USA.
8. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
9. Lewis, R. 1997. Human Genetics : Concepts and Application (Second Edition). WCB McGraw Hill, USA.
10. Malacinski, G.M and Freifelder, D. 1998 : Essentials of Molecular Biology (Third Edition). Jones and B. Artlet Publisher, Inc., London.
11. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.
12. Snustad, D.P and Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA.
13. Gardner and Simmons Snustad 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
14. Sariu C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
15. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.
16. Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
17. Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.
18. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
19. Verma and Agarwal, Genetics, S. Chand Co, New Delhi..
20. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.
21. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.



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PAPER – III

MICROBIOLOGY, PHYCOLOGY AND MYCOLOGY

MAX.MARKS-80

UNIT-I

- **Archaebacteria and Eubacteria** : General account, ultra structure, nutrition and reproduction, biology and economic importance.

- **Cyanobacteria :** Salient feature and biological importance.

UNIT-II

- **Viruses :** Characteristics and ultra-structure of virons, isolation and purification of viruses, chemical nature, replication, transmission of viruses, economic importance.

- **Phytoplasma :** General characteristic and role in causing plant diseases.

UNIT-III

- **Phycology :** Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultra-structure, reproduction (vegetative, asexual, sexual).

- Criteria for classification of Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

- Economic importance of algae.

UNIT-IV

- **Mycology :** General characters of fungi, substrate relationship in fungi, cell structure unicellular and multicellular organization, cell wall composition, nutrition (saprobic biotrophic, symbiotic) reproduction, (vegetative, asexual, sexual) heterothallism, heterokaryosis, Para sexuality, recent account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina, Mycorrhiza, fungi as biocontrol agent.

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LIST OF PRACTICALS

ALGAE: -

a. Cyanophyta: - Range of thallus organization and reproductive structures, types showing unicellular, gonical, conical, filamentous, branched (pseudo and true branched) .

b. Chlorophyta: - Chlamydomonas, Gonium, Pandorina, Eudorina, Volvox, Chlorella, Pediastrum, Hydrodictyon, Scenedesmus, Ulothrix, Cladophora, Draparnaldia, Draparnaldiopsis, Fristschiella, Chara, Nitella, Coleochaete, Ulva,, Caulerpa, Oedogonium, Zygnema, Spirogyra, .

c. Phaeophyta: -Ectocarpus, , Dictyota, Padina, Sargassum.

d. Rhodophyta: -Porphyra, Batrachospermum, Gelidium, Gracillaria, Champia,Polysiphonia.

FUNGI: -

Thallus organization, Spore producing organs, Tissue differentiation and accessory structures of following –

a. Mastigomycotina: - Synchytrium ,Saprolegnia, Achlya, Peronospora, Plasmopora, Albugo, Sclerospora.

b. Zygomycotina: -Mucor, Rhizopus, Pilobolus.

c. Ascomycotina: - Taphrina, Protomyces, Erotium, Trichoglossum, Erysiphe, Phyllactinia, Uncinula.

d. Basidiomycotina: -Uromyces, Ravenelia, Monosporidium, Melampsora,Ustilago, Agaricus, Pleurotus, Ganoderma,Polyporus, Cyathus, Lycoperdon, Phallus, Geaster.

e. Deuteromycotina: - Aspergillus, Penicillium, Fusarium, Cercospora, Colletotrichum, Alternaria.

Suggested Readings : -

1. Alexopoulus C.J , Mims C.W. and Blackwel M.I 1996. Introductory Mycology. John Wiley and Sons Inc.
2. Kumar H.D. 1988. Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Mehrotra R.S and Aneja R.S 1998. An introduction to Mycology. New Age Intermediate Press.
4. Rangaswamy G. and Mahadevan A. 1999. Diseases of crop plants in India (Fourth Edition) Prentice Hall of India Pvt. Ltd. New Delhi.
5. Webster J. 1985. Introduction to Fungi. Cambridge University Press.
6. Hawker L.E. 1967. An Introduction to Fungi Cambridge.
7. Kamat M.N 1959. Hand Book of Mycology, Prakash Publication.
8. Vashista B.R & A.K Sinha 2005. Botany for degree students – Fungi, S.Chands Publication.
9. Vashista B.R & A.K Sinha 2005. Botany for degree students – Bryophta, S.Chands Publication.
10. Ainsnorth G.C 1973. The Fungi Vol IV A, IV B Academic Press.
11. Bessey 1950. Morphology and Taxonomy of fungi. The Blakistan Co.
12. Burnett J.H. 1968. Fundamentals of Mycology. Edwards Arnold Publication.
13. Morries I 1986. An Introduction to the Algae. Cambridge University Press, U.K.

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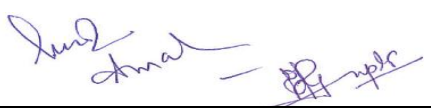
14. Round F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge
15. Vashista B.R & A.K Sinha 2005. Botany for degree students – Algae, S.Chands Publication
15. Vijayraghavan M.R and Bela Bhatia (1997), Red Algae : Structure, ultrastructure and Reproduction, APH publishing Corporations, New Delhi.
16. Vijayraghavan M.R and Bela Bhatia (1997), Brown Algae : Structure, ultrastructure and Reproduction, APH publishing Corporations, New Delhi.
17. Fritsch F.E (1945). The structure and reproduction of the algae Volume I and II, Cambridge University Press.
18. Chapman V.J and Chapman D.J (1973). Thje Algae Macmillon and company, New York.
19. Bold H.C and Wynne M.J (1975). Introduction to the Algae structure and reproduction prentice hall Biological Science Series.
20. Pandey S.N. A Text-book of Botany Volume I, Vikas Publications.



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PAPER - IV

BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERM

MAX.MARKS-80

UNIT-I

- **Bryophyta :** morphology, structure, reproduction, life history, distribution, classification.

- General account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Economic and ecological importance.

UNIT-II

- **Pteridophyta :** morphology, anatomy and reproduction, classification, evolution of stele.
- Heterospory and origin of seed habit, general account of fossil pteridophyta .
- Introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

UNIT-III

- Gymnosperm : General characters of gymnosperm mentioning diversity.
- Classification of gymnosperm.
- Resemblances and difference amongst gymnosperm, pteridophyta and angiosperm.
- Gymnosperm distribution in India.
- Gymnosperm Biotechnology.
- Economic importance of gymnosperm.
- Origin and evolution of gymnosperm stele.
- Structure and theories regarding origin of Paleozoic ovule.

UNIT-IV

- Extinct gymnosperm : general account of pteridospermales, Glossopteridales, Caytoniales, Pentoxylales.
- Extant gymnosperm : Cycadales, Ginkgoales, Coniferales, Ephidedrales Gnetales, and Welwistschiales.

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LIST OF PRACTICALS

Bryophyta: -

a. Hepaticopsida: - Riccia, Marchantia, Targionia, Astrella, Porella, Cyathodium, Plagiochasma,
b. Anthocerotopsida: -Anthoceros, Notothyllus.
c. Bryopsida: -Sphagnum, Funaria, Polytrichum,

Pteridophyta :-

a. Study of the following members to observe arrangement of Sori on a receptacle : - Isoetes, Osmunda, Angiopteris, Ceratopteris, Achrostichum,Gleichinia
b. Morphology, Anatomy and reproductive structures of : - Psilotum, Selaginella, Lycopodium, Equisetum, Ophioglossum, Lygodium, Pteris, Pteridium, Salvinia, Adiantum, Azolla.

Gymnosperms: -

Morphology, Anatomy and reproductive structures of –Cycas, Zamia, Ginkgo, Pinus, Cryptomeria, Juniperous, Araucaria, Taxus, Cedrus Thuja, Podocarpus, Gnetum, Ephedra.

Suggested readings:

1. Sporne K.R. 1991. The Morphology of Pteridophytes. B.I Publishing Pvt. Ltd. Bombay.
2. Stewart W.N. and Rathwell G.W. 1993. Paleobotany and the Evolution of plants. Cambridge University Press.
3. Bhatnagar S.P and Moitra Alok 1996. Gymnosperms. New Age International Pvt. Ltd. Publishers, New Delhi, 470 pp.
4. Biswas C and Johari B.M 2004. The Gymnosperms Narosa Publishing House, New Delhi. 497 pp.
5. Sporne K.R 1965. The Morphology of Gymnosperms London, pp. 216.
6. Bierhorst D.W. 1971. Morphology of Vascular Plants. New York and London.
7. Chamberlain C.J 1934. Gymnosperms-Structure and Evolution, Chicago.(Page 19)
8. Coulter J.M. and Chamberlain C.J. 1917. Morphology of Gymnosperms, Chicago.
9. Foster A.S and Gifford E.M 1959. Comparative Morphology of Vascular Plants. San Francisco.
10. Maheshwari P. and Vasil, Vimla 1961. Gnetum, Delhi.
11. Vashishta P.C., A.R. Sinha, Anil Kumar. 2006. Gymnosperms. S.Chand. Publication
12. Vashishta P.C. 2006. Pteridophytes. S. Chand.
13. Parihar N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad
14. Parihar N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
15. Puri P. 1980. Bryophytes. Atma Ram and Sons, Delhi.
16. Vashista B.R & A.K Sinha 2005. Botany for degree students – Bryophta, S.Chands Publication
17. Sporne. Morphology of Bryophytes, Oxford Publishing House
18. Rashid A (1998). An introduction to Bryophyta. First edition, Vikas Publishing House Pvt. Ltd, New Delhi.

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SEMESETR II

PAPER - I

TAXONOMY AND DIVERSITY OF PLANTS

MAX.MARKS-80

UNIT-I

- Plant nomenclature : Binomial Nomenclature, International code of Botanical nomenclature.
- Plant identification : Herbaria, Botanical gardens, Taxonomic literature, Taxonomic-keys.
- Taxonomic hierarchy - Major categories, minor categories ,species concept.
- Taxonomic evidences - Morphology, Anatomy, Palynology, Embryology, Cytology, Photochemistry, Genome analysis and Nucleic acid hybridization.
- Geographical information system (GIS).

UNIT-II

- Pre Darwinian Classification Based on form relationship (Benthem and Hooker)
- Post Darwinian classification Engler and Prantl, Bessey's, Hutchinson, Takhtajan and Cronquist.
- Recent modifications : Dahlgren's system of classification.
- Fossil angiosperm.

UNIT-III

- Study of following families with particular reference to systematic position, phylogeny, evolutionary trends and economic importance. Dicot families; Ranunculaceae, Magnoliaceae, Nymphacaceae, Sterculiaceae, Meliaceae, Fabaceae, Cucurbitaceae, Umbelliferae, Asteraceae, Sapotaceae. Bignoniaceae, Labiatae, Verbenaceae, Euphorbiaceae, Moraceae.

UNIT-IV

- Study of following families with particular reference to systematic position, phylogeny, Evolutionary trends and economic importance, Monocot families-Orchidaceae, Zingiberaceae, Commelinaceae, Cyperaceae, Poaceae study of local available families.

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LIST OF PRACTICALS:-

Angiosperms: -

1. Methods of non-destructive field collection and documentation.
2. Techniques of herbaria preparation.
3. Morphological characterization of selected families of dicots and monocots and identification upto families.
4. Preparation of artificial key based on appropriate character combination.
5. Identification of genus and species from Monocots and Dicots
6. Identification of given plant up to species with the help of modern flora keys.

Suggested readings: -

1. Blatter E and W.S Millard. 1929. Some Beautiful Indian Trees J.Bom. Nat Hist Soc. 33:624-635.
2. Bor N.L 1943. Manual of Indian Forest Botany. London.
3. Cliford H.T and W. Stephenson. 1975. An Introduction to Numerical Taxonomy. Academic Press, N.Y.
4. Cole A.J (Ed.) 1969. Numerical Taxonomy. Academic Press,N.Y.
5. Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Thomas Nel and Sons, Ltd. London.
6. Davis P.H and V.H Heywood 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd London.
7. Heywood V.H 1967. Plant Taxonomy, London.
8. Lawrence, G.H.M 1951. Taxonomy of Vascular Plants. N.Y.
9. Lawrence G.H.M 1955. An Introduction to Plant Taxonomy N.Y.
10. Rendle A.B. 1925. The Classification of flowering plants. 2 Vols. London.
11. Santapau H. 1953. The Flora of Khandala on the Western Ghats of India.
12. Singh V. and D.K Jain, 1981 Taxonomy of Angiosperms. Rastogi Publication, Meerut.
13. Swingle D.B. 1946. A Text book of Systematic Botany. Mc Graw Hill Book Co. New York.
14. Pande B.P 1997. Taxonomy of Angiosperms. S.Chand Publication.
15. Takhtajan A. 1969. Flowering Plants; Origin and Disposal.

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PAPER – II

MOLECULAR BIOLOGY

MAX.MARKS-80

UNIT-I

- RNA and DNA Structure. A, B and Z Forms, replication, damage and repair, transcription, translation.

UNIT-II

- Molecular Cytogenetics **:** Nuclear DNA content, C-value paradox, Cot curve and its Significance, restriction mapping - concept and techniques, multigene families and their evolution, *in situ* hybridization and techniques, chromosomes micro dissection and micro cloning, flow cytometry and confocal microscopy and karyotype analysis.

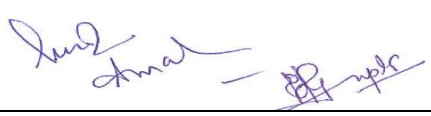
UNIT-III

- Gene structure and expression : fine structure of gene, Cis-trans test, fine structure analysis of eukaryotes, introns and their significance. RNA splicing, regulation of gene expression in prokaryotes and eukaryotes.

- Protein sorting: Targeting proteins to organelles.

UNIT-IV

- Mutation: Spontaneous and induced mutation, physical and chemical mutagens molecular basis of gene, transposable elements in prokaryotes and eukaryotes, mutation induced by transposones, site directed mutagenesis, inherited human diseases and defects in DNA repair, translocation, intersect Robertsonian translocation, B-A translocation.



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Suggested readings: -

1. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter 1989, Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
2. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.
3. Burnham, C.R 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
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5. Hartk D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.
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8. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
9. Lewis, R. 1997. Human Genetics : Concepts and Application (Second Edition). WCB McGraw Hill, USA.
10. Malacinski, G.M and Freifelder, D. 1998 : Essentials of Molecular Biology (Third Edition). Jones and B. Artlet Publisher, Inc., London.
11. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.
12. Snustad, D.P and Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA.
13. Gardner and Simmons Snustad 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
14. Sariu C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
15. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.*(Page 12)*
16. Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
17. Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.
18. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
19. Verma and Agarwal, Genetics, S. Chand Co, New Delhi..
20. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.
21. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.

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PAPER - III

PLANT PHYSIOLOGY

MAX.MARKS-80

UNIT-I

- **Membrane transport and translocation of water and solutes:** Plant-water relation, mechanism of water transport through Xylem, root microbe interaction in facilitating nutrient uptake. Comparison of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport system.

UNIT-II

- **Signal Transduction :** Overview, receptors and G proteins, Phospholipids signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanism- two component sensor regulatory system in bacteria.

UNIT-III

- **Stress physiology :** Plant responses to biotic and abiotic stress, mechanism of biotic and abiotic stress tolerance, HR Fundamental and SAR, water deficit and drought resistance salinity stress, metal toxicity, freezing and heat stress, oxidative stress.

UNIT-IV

- **Fundamentals of enzymology :** General aspects of allosteric mechanism, regulatory & active sites, isozymes, kinetics of enzymatic catalysis, Michaelis-Menton equation and its significance.

- Sensory photobiology, History of discovery of phytochromes and cryptochroms and their photo chemical and biochemical properties, photophysiology of light under responses ,cellular localization, and molecular mechanism of action of enzyme.

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Suggested Reading :-

1. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
2. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
3. Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.
4. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis.Narosa Publishing House, New Delhi.
5. Taiz L. and Zeiger E. 1998. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
6. Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
7. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.
8. Lehninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint)

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PAPER - IV

PLANT METABOLISM

MAX.MARKS-80

UNIT-I

- **Photosynthesis :** General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photo oxidation of water, mechanism of electron and proton transport, Carbon assimilation ,the Calvin cycle, photorespiration and its significance, the C_4 cycle, the CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.

UNIT-II

- **Respiration and lipid metabolism :** Overview of plant respiration, glycolysis, Kreb cycle (TCA cycle), electron transport and ATP synthesis, Pentose phosphate pathway, alternative oxidase system, structure and function of lipids, fatty acid biosynthesis, synthesis of membrane lipids ,structural lipids and storage lipids and their catabolism Glyoxylate cycle.

UNIT-III

- **Nitrogen and Sulphur metabolism :** Overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction ,ammonium assimilation, sulphur uptake, transport and assimilation.

UNIT-IV

- **Plant growth regulators and elicitors :** Physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylenes, absicisic acid, brassinosteroid, polymines ,jasmonic acid and salicylic acid, hormone receptors.

- The flowering process:- Photoperiodism and its significance, endogeneous clock and its regulation, floral induction and development, Genetic molecular analysis, role of vernalization.

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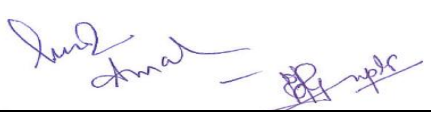
LIST OF PRACTICALS:- (Paper III and IV)

1. Determination of osmotic pressure of cell sap by plasmolytic method.
2. Determination of Diffusion pressure deficit in potato tuber.
3. Determination of 25imbibitions pressure of seeds of different categories (protein, lipid, carbohydrate containing seeds).
4. To compare the rate of imbibition of fatty and starchy seeds.
5. Determination of osmotic pressure of cell sap by plasmolytic method.
6. Determination of effect of temperature on the permeability of plasma membrane of beet root.
7. Determination of effect of different organic solvents (alcohol, formaline, benzene) on the permeability of plasma membrane of beet root.
8. Determination of effect of different concentration of organic solvents (alcohol, formaline, benzene) on the permeability of plasma membrane of beet root.
9. Determination of effect of different Phytohormones on the germination of seeds.
10. Determination of effect of different concentration of auxins on the germination of Seeds.
11. Determination of the rate of respiration by Ganong's Respirometer.
12. Determination of the rate of respiration by Pipette manometer.
13. Determination of R.Q. of carbohydrates by Ganong's Respirometer.
14. Determination of R.Q. of lipids by Ganong's Respirometer.
15. Determination of R.Q. of proteins by Ganong's Respirometer.
16. Separation of chlorophyll pigments by paper chromatography.
17. Separation of chlorophyll pigments by circular paper chromatography.
18. Qualitative analysis of Organic acids by paper chromatography.
19. Qualitative analysis of amino acids by paper chromatography.
20. Qualitative analysis of sugars by paper chromatography.
21. Separation of A.A by thin layer chromatography method.
22. Separation of chlorophyll by thin layer chromatography.
23. Determination of the effect of CO_2 concentration on the rate of photosynthesis by inverted funnel method.
24. Determination of the effect of CO_2 concentration on the rate of photosynthesis by wilmot's bubbler.
25. Determination of the effect of intensity of light on the rate of photosynthesis by wilmot's bubbler.
26. Determination of the effect of intensity of light on the rate of photosynthesis by inverted funnel method.
27. Determination of the effect of quality of light on the rate of photosynthesis by inverted funnel method.
28. Determination of the effect of quality of light on the rate of photosynthesis by wilmot's bubbler.



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MINOR EXPERIMENTS

1. Preparation of molar and molal solutions .
2. Preparation of percentage solution.
3. Preparation of normal solution of solute.
4. Preparation of normal solution of acid and base.
5. Demonstration of Brownian movement in the latex of Calotropis.
6. Demonstration of tyndall effect.
7. Demonstration of plasmolysis and deplasmolysis in plant cell.
8. Demonstration of exosmosis and endosmosis in grapes and resins.
9. Demonstration of the rate of respiration of flower buds by pipette mano-meter.
10. Demonstration of evolution of O_2 during photosynthesis by inverted funnel method.
11. Demonstration of the rate of photosynthesis by inverted funnel method.
12. Demonstration of the rate of photosynthesis by wilmot's bubbler.
13. Determination of the effect of temperature on the rate of photosynthesis by inverted funnel method.
14. Demonstrationof the rise of temperature during seed germination
15. Demonstration of evolution of CO_2 during respiration.
16. Demonstration of fermentation by Kuhns tube.
17. Demonstration of Determination of R.Q. of organic acids by Ganong's Respirometer.
18. Effect of phytohormones on the growth of seedling.

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BIOCHEMISTRY PRACTICALS

1. Qualitative estimation of amylase enzyme activity in the germinating seeds of wheat.
2. Qualitative estimation of amylase enzyme activity in potato tuber.
3. Qualitative estimation of catalase enzyme activity in the germinating seeds of wheat.
4. Qualitative estimation of catalase enzyme activity in potato tuber.
5. Effect of enzyme concentration on the rate of catalase enzyme activity in potato tuber.
6. Effect of enzyme concentration on the rate of catalase enzyme activity in the germinating seeds of wheat.
7. Effect of enzyme concentration on the rate of amylase enzyme activity in of potato tuber.
8. Effect of enzyme concentration on the rate of amylase enzyme activity in the germinating seeds of wheat.
9. Effect of substrate concentration on the rate of catalase enzyme activity in the germinating seeds of wheat.
10. Effect of substrate concentration on the rate of catalase enzyme activity in potato tuber.
11. Effect of substrate concentration on the rate of amylase enzyme activity in the germinating seeds of wheat.

Suggested readings

1. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
2. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
3. Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
4. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
5. Taiz L. and Zeiger E. 1998. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
6. Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
7. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.
8. Leninger A.C 1987. Principles of Biochemistry, CBS Publishers and Distributers (Indian Reprint)

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SEMESTER EXAMINATION

SCHEME OF EXAMINATION,

M.Sc. III SEMESTER, BOTANY

THEORY

PAPER	TITLE	External Marks	Internal Assessment/ Seminar	Total marks
I	PLANT DEVELOPMENT & PLANT RESOURCES	80	20	100
II	PLANT ECOLOGY – I **(E**cosystem and vegetation ecology)	80	20	100
III	BIOTECHNOLOGY-I (Biotechnology and genetic engineering of plants and microbes)	80	20	100
IV	ELECTIVE- I Molecular plant pathology-I ELECTIVE-2 Limnology - I ELECTIVE-3 Ethno botany – I	80 80 80	20 20 20	100 100 100

PRACTICAL

LAB COURSE-I	BASED ON PAPER I & II	80	20	100
LAB COURSE-II	BASED ON PAPER III & IV	80	20	100
	GRAND TOTAL OF MARKS			600

Choice Based Credit System: Semester III **Course Environmental Science. Marks 100 , Credit Points -03, Total Hours -50**

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SCHEME OF EXAMINATION

M.Sc. IV SEMESTER, BOTANY

THEORY

PAPER	TITLE	External / Internal Assessment Marks Seminar		Total marks
I	PLANT REPRODUCTION AND UTILIZATION OF RESOURCES	80	20	100
II	PLANT ECOLOGY-II (Pollution and biodiversity conservation)	80	20	100
III	BIOTECHNOLOGY-II (Plant cell, tissue culture and organ culture)	80	20	100
IV	ELECTIVE- I Molecular plant pathology-II ELECTIVE-2 Limnology -I I ELECTIVE-3 Ethnobotany - II	80 80 80	20 20 20	100 100 100

PRACTICAL

LAB COURSE-I	BASED ON PAPER I & II	80	20	100
LAB COURSE-II	BASED ON PAPER III & IV	80	20	100
	GRAND TOTAL OF MARKS			600

NOTE:

- Botanical excursion (within or outside Chhattisgarh) is compulsory for the Students of M.Sc.

- In each semester, each theory paper there will be five questions of equal marks. First question will be based on complete syllabus with no internal choice whereas rest question will be unit wise.

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PRACTICAL
SCHEME, LAB
COURSE-I
M.Sc. III SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Practical based on Paper-I	30 Marks
2.	Practical based on Paper II	25 Marks
3.	Spotting	15 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

PRACTICAL SCHEME, LAB COURSE-II
M.Sc. III SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Practical based on Paper-III	25 Marks
2.	Practical based on Paper-IV	30 Marks
3.	Spotting	15 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

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PRACTICAL SCHEME,
LAB COURSE-I
M.Sc. IV SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Paper-I	25 Marks
2.	Exercise based on Paper-II	25 Marks
3.	Spotting	20 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

PRACTICAL
SCHEME, LAB
COURSE-II
M.Sc. IV SEMESTER (BOTANY)

Time-5 Hours **Maximum Marks 100**

1.	Exercise based on Paper-III	25 Marks
2.	Exercise based on Paper-IV	25 Marks
3.	Spotting	20 Marks
4.	Viva-voce	10 Marks
5.	Sessional (Internal Assessment)	20 Marks

Total- 100 Marks

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M.Sc. SEMESTER - III
PAPER - I
PLANT DEVELOPMENT AND PLANT RESOURCES
MAX.MARKS-80

UNIT-I

Introduction: Unique features of plant development. Metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms; control of cell division, Programmed cell death in the life cycle of plants, Seed germination, Hormonal control of Seedling growth. Seed dormancy, Over coming of seed dormancy, Bud dormancy.

Root development : Organization of root apical meristem (RAM), Cell fates and lineages, Vascular tissue differentiation of root, Lateral roots, Root hairs, Root microbe interaction.

UNIT-II

Shoot development : Organization of shoot apical meristem (SAM), Cytological and molecular analysis of SAM. Control of tissue differentiation; especially Xylem and Phloem, Vascular cambium. Secretary ducts and laticifers, Wood development in relation to environmental factors.

UNIT-III

Leaf development : Development, Phyllotaxy, Control of leaf form, Differentiation of epidermis (with special reference to Stomata and Trichome) and Mesophyll cell. Senescence, Influences of hormones and environmental factors on senescence.

Flower development : Floral characteristics, Flower development, Genetics of floral organ differentiation: Homeotic mutant in Arabidopsis and Antirrhinum, Sex determination.

UNIT-IV

Plant resources : Origin, Evolution, Cultivation and Uses of (i) Food, Forage and Fodder crops, (ii) Fiber crops, (iii) Medicinal and Aromatic plants, (iv) Vegetable Oil-yielding crops (v) fruits.

Important fire-wood, Timber-yielding plants and Non-wood forest products (NFPs) such as bamboos, gums, tannins, dyes and resins.

SUGGESTED LABORATORY / FIELD EXERCISES

- Effect of gravity, unilateral light and plant growth regulators on the growth of young seedling.
- Role of dark and red light / far-red light on the expansion of cotyledons and epicotylar hook opening in pea.
- Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla.*
- Study of monocot and dicot stem.

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- Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such *Coleus, Kalanchoe,* and *Tobacco.* Examinations of shoot apices in monocotyledons in both T.S. and L.S. to show the origin and arrangement of leaf primordial.
- Study of alternate and distichous, alternate and superposed, opposite sand superposed, opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
- Microscopic examination of vertical section of leaves such as *Cannabis*, *Tobacco*, *Nerium*, *Maize* and *wheat* to understand the internal structure of leaf tissues and trichomes, glands etc.
- Study the C3 and C4 leaf anatomy of plants.

- Study of epidermal peels of leaves such as *Coccinia, Gailardia, tradescantia*, *Notonea*, etc. To study the development and final structure of stomata and stomatal index. Demonstration of the effect of ABA on stomatal closure.
- Study of whole roots in monocots and dicots.
- Examination of L.S. of root from a permanent preparation to under stand the organization of root apical meristem and its derivatives. (Use *Maize*, Aerial roots of *Banyan*, *Pistia*, *Jussieua* etc.).
- Origin of lateral roots.
- Study of leguminous roots with different types of nodules.
- Food crops: Wheat, Rice, Maize, Chickpea, Potato, Tapioca, Sweet Potato, Sugar cane, Morphology, Anatomy, Micro chemical tests for stored food material.
- Forage/Fodder crops: Study of any five important crops of the locality (For example fodder sorghum, Bajra, Bersem, Clove, Guar bean, Gram, Ficus sp.)
- Plant fibers: (i) Textile fibers: Cotton, Jute, Linen, Sunn hemp, Cannabis. (ii) Cordage fibers; Coir (iii) Fibers for stuffing: Silk and Cotton.

SUGGESTED READINGS :

- Bewley, J.D. and Black. M. 1994 Seeds : Physiology of development and germination. Plenum Press, New Yor.
- Bendre, A. and Kumar, 2004 A. Rastogi pub. Meerut, India.
- Crocker, W. and Barton V.1953 Physiology of seeds. Waltham, Mass, U.S.A
- Santra, S.C., Chatterjee. T.P. and Das, 2005. A.P. College Botany Practical Vol. Li New Central pub. India.
- Parihar, NS. 1964, Hormonal control of plant growth. Asia pub. House, London.
- Wareing P.F. and Phillips I.D.J. 1973, Pergamon press. Oxford.

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M.Sc. SEMESTER - III
PAPER - II
PLANT ECOLOGY- I

(ECOSYSTEM AND VEGETATION ECOLOGY)

MAX.MARKS-80

UNIT-I

ECOSYSTEM ORGANISATION:- Structure and functions, primary production (Methods of measurement, global pattern, controlling factors), Energy dynamics (trophic organization, energy flow pathways, ecological efficiencies), Litter fall and decomposition, (mechanism, substrate quality, and climatic factors), global biogeochemical cycles of C, N, P, and S, mineral cycles (pathways, processes and budgets) in terrestrial and aquatic ecosystems.

UNIT-II

ECOSYSTEM STABILITY AND MANAGEMENT
Concept (resistance and resilience), Ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems, ecology of plant invasion, environment impact assessment, ecosystem restorations. Concept of Sustainable development, sustainability indicators.

UNIT-III

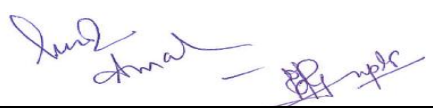
VEGETATION ORGANISATION:-
Concepts of community and continuum, analysis of communities (analytical and synthetic characters), Community coefficients, inter specific associations, ordination, and concept of ecological niche.

UNIT-IV

VEGETATION DEVELOPMENT :-
Temporal changes (cyclic and non cyclic), mechanism of ecological succession (relay floristic and initial floristic composition, facilitation, tolerance and inhibition models), change in ecosystem properties during succession.

REFERENCE BOOKS :

Smith, R.L. 1996. Ecology and field biology, Harper Collins, New York.
Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
Odum, E.P. 1983. Basic ecology, Saunders, Philadelphia.
Kormondy, E.J. 1996. Concepts of Ecology, Prentice Hall of India Pvt.Ltd. New Delhi.
Moldan, B. and Billharz, S. 1997 Sustainability indicators, John Wiley and Sons, New York.



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Muller-Dombosis, D and Ellenberg, H 1974 Aims and methods of vegetation ecology, Wiley, New York.
Begon M, Harper, J.L. Townsend, C.R.1996. Ecology, Blackwell science, Cambridge, USA.
Ludwig, J. and Reynolds, J,F, 1988 Statistical ecology, John Wiley and Sons. Barbour, M.G. Burk, J.H. and Pitts, W.D.1987. Terrestrial plant ecology, Benjamin Cummings Publication Company, California.
Chapman, J.L. and Reiss, M.J.1988 Ecology principles and applications,
Cambridge University press, Cambridge, U.K.

****

LIST OF PRACTICALS

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grassland.
2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To analyze plant communities Bra Curtis ordination method.
4. To estimate IVI of the species in a woodland using point centered quarter method.
5. To calculate mean, variance, standard deviation, standard error, coefficient of variations and to use t test for comparing two means related to ecological data.
6. To find out the relationship between two ecological variables using correlation and regression analysis.
7. To find out important grassland species using chi square test.
8. Scientific visits to a protected area, a wet land, a mangrove, NBPGR, BSI, CSIR, ICAR labs and a recognized botanical gardens or a museum.

REFERENCE BOOKS :

Ludwing, J.A. and Reynolds, J.F. 1988, Stastical Ecology, Willey New York.
Krebs, C.J. Ecological methodology, Herper and Row, New York, USA
Pielou, E.C.1984. The interpretation of ecological data, Wiley, New York.
Moore, P.W. and Chapman, S.B.1986. Methods inplant Ecology, Blackwell scientific publications.
Misra, R. 1968. Ecology work book, Oxford & IBH, New Delhi.
Smith, R.L. 1996. Ecology and Field Biology, Harpercollins, New York.
Muller-Dombois, D and Ellenberg, H. 1974. Aims and methods of vegetation ecology, Wiley, New York.
Sokal, R.R. and Rohlf, F.J. 1995. Biometry, W.H. Freeman & Co. San Francisco.

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M.Sc. SEMESTER - III
PAPER – III
BIOTECHNOLOGY AND GENETIC ENGINEERING OF PLANTS AND MICROBES
MAX.MARKS-80

UNIT-I

BIOTECHNOLOGY - Basic concepts, principles and scope.

RECOMBINANT D.N.A. TECHNOLOGY : Gene cloning principles, Tools - Restriction Endonucleases, DNA modifying enzymes, Choice of Vectors, Plasmid, Cosmid, Bacteriophage vectors, phagmids, Artificial chromosomes. Shuttle vectors, Yeast vectors, Expression vectors and techniques, construction of genomic / cDNA libraries.

UNIT-II

MICROBIAL GENETIC MANIPULATION: Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology.

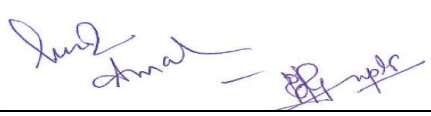
GENETIC ENGINEERING OF PLANTS : Aims, strategies for development of transgenies (with suitable examples), Gene transfer methods - Vector mediated gene transfer-Agrobeacterium the natural genetic engineer. t-DNA mediated DNA transformation. Virus mediated gene transfer, Vectorless or direct DNA transfer.

UNIT-III

DNA SYNTHESIS AND SEQUENCING : Chemical synthesis of gene, Polymerase chain reaction, its variation, application, advantages and limitations, DNA sequencing - Sanger and Coulson method, Maxam Gillbert method, High throughput DNA sequencing, DNA finger printing.

UNIT-IV

GENOMICS AND PROTEOMICS : Genetic and physical mapping of genes, molecular markers for integression of useful traits, Transposon mediated gene tagging, genome projects, bioinformatics, functional genomics, microarrays, protein profiling and its significance.



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Suggested Reading :

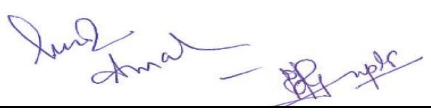
1. Brown, T.A. 1999. Genomes, John Wiley and Sons (Asia) Pvt.Ltd., Singapore.
2. Callow, J.A., Fort-Lloyd, B.V. and Newbury, H.J. 1997.
3. Biotechnology and Plant Genetic Resources : Conservation and Use, CAB International, Oxon, UK.
4. Chrispeels, M.J. and Sadava, 1994, Plants, Genes and Agriculture, Jones & Barlloy Publishers, Boston, USA.
5. Glazer, A.N. and Nikaido, 11, 1995 Microbial Biotechnology. W.H. Freeman & Company, New York, USA.
6. Gustafson, J.P. 2000, Genomes Kluwer Academic Plenum Publishers, New York, USA.
7. Henry, R.J. 1997, Practical Applications of Plant Molecular Biology, Chapman & Hall London, UK/
8. Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Bsel, Switzerland.
9. Old, R.W. and Primrose, S.B. 1989, Principal of Gene Manipulation, Blackwell Scientific Publication, Oxford, UK, Primrose, S.B. 1995, Principles of Genome Analysis, Blackwell Science Ltd., Oxford, UK.
10. Raghavan, V. 1997, Molecular Biology of Flowering Plants, Cambridge University Press, New York, USA.
11. Shantharam, S. and Montgomery, J.F. 1999, Biosafety, and Biodiversity, Oxford and IBH Publishing Co. Pvt.Ltd., New Delhi.

Suggested Laboratory Exercises :

1. Growth characteristics of E. coli using plating and turbidimetric methods.
2. Isolation of plasmid from E. coli by alkaline lysis method and its quantitation spectrophotometrically.
3. Restrictiion digestion of the plasmid and estimation of the size of various DNA fragment.
4. Cloning of DNA fragment in a plasmid vector, transformation of the given bacteria population and selection of recombinants.
   Demonstration of DNA sequencing by Sanger's dideoxy method.

Suggested Reading (for laboratory exercise)

1. Plant molecular biology Manual, 2nd edition, Kluwer Academic Publishers, Dordrecht, The Netherland.
2. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology, CRS press, Boca Raton, Florida.
3. Glover, D.M. and Hames, B.D. (Eds), 1995, DNA Cloning 1: A Practical Approach; Core Techniques, 2nd edition, PAS, IRL Press at Oxford University Press, Oxford.
4. Hackett, P.B., Fuchs, J.W. 1988. An introduction to Recombinant DNA Techniques; Basic Experiments in Gene manipulation. The Benjamin Cummings/ Publishing Co.; Inc Menlo, Calio Park, Callifornin.
5. Shaw, C.H. (Ed.) 1988, Plant Molecule Biology: A Practical Approach, IRL Press, Oxford.



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M.Sc. SEMESTER

- III PAPER - IV

ELECTIVE COURSE-- MOLECULAR PLANT PATHOLOGY-I

MAX.MARKS-80

UNIT-I

1. Introduction and history of plant pathology.
2. General Principles of plant pathology and classification of plant diseases.
3. **Diseases inciting organisms -** Animate Pathogens- fungi, Bacteria, Mycoplasma, Viruses, Nematodes, their general characteristics, heterotrophic behaviour with emphasis on parasitism ability and virulence.

UNIT-II

1. **Disease Syndrome and General Symptoms of plant diseases :** Pathogenic and nonpathogenic; Symptoms caused by fungi, Bacteria, Viruses, Mycoplasma and Nematodes.
2. **Sources of Infection :** Seeds, soil, water and airborne diseases of plants; Significance of phylosphere and rhizosphere studies.
3. **Pathogenesis -** Dissemination of plant pathogens; Mode of infection; Inoculum potential.

UNIT-III

1. **Effect of environment on disease development-** Predisposing factors; Survival of fungi; Germination of spores; Disease initiation and Epidemics.
2. **Host Parasites relationship -** Mechanism and physiology of infection, Path of infection, Role of enzymes, growth regulators and toxins in pathogenesis.
3. **Physiological specialization :** General account; Physiological specialization with special reference to smuts and rusts.

UNIT-IV

1. **Recurrence of disease** with special reference of recurrence of rust disease in India.
2. **Methods of Studying Plant Diseases:** General account, Macroscopic study, Microscopic study, Koch postulates, Culture technique, Preparation of culture tubes, media preparation, Inoculation, Isolation, Pure culture, Parasitism of obligate parasites, Methods in bacteriology, Techniques required in introductory bacteriology

Suggested Laboratory Exercises:

Experiment based on theory syllabus.

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SUGGESTED READINGS :

1. Plant Pathology - J.C. Walkar
2. Fungi and plant diseases - B.B. Mundkar
3. Plant Pathology – G.N. Agrios
4. Plant Pathology - Whecler
5. Plant Pathology (Vol.1-3) – Horsfall & Dimon
6. A text book of Modern Plant Pathology – K.S. Bilgrami and H. S.Dubey
7. Plant Pathology – R.S.singh
8. An introduction to Principles of Plant pathology - R.S.singh
9. Plant Disease of Crop plants in India – N.G. Rangaswamy.
10. Plant Pathology problems and progress- Honfall
11. Essentials of Plant Pathology- V.N. Pathak
12. Plant Pathology – Butter and Jones.
13. Plant Pathology- R.S. Malhotra
14. Crop plant Disease Colender- IARI-India.
15. Physiology of Fungus- – K.S. Bilgrami and H. S.Dubey
16. Micro-organisms in laboratory – G.P. Agarwal and S.K. Hasija.
17. Physiology of fungi – V.G.Lily and H.L.. Barnet.
18. Illustrated Genera of Imperfecti fungi- H.L.. Barnet and.B.B. Hunter.
19. Microbiology and Plant Pathology- P.D.Sharma
20. Plant Pathology- P.D.Sharma
21. Microbiology – P.D.Sharma
22. The Fungi – G. Sumbali
23. Fungicides and crop protection- H.G.Mewitt
24. Fungal diseases of plants- B.M. Duggar
25. Plant Pathology – P.C. Trivedi
26. Plant Pathology – G.P. Gupta
27. Virus and Plant diseases S.R.Mishra
28. Bacterial Diseases- V. Kumar
29. Biotechnology and Plant Pathology- V.K.Jain
30. Laboratory manual of Plant Pathology- D.K.Jha.
31. Modern technology of Plant Pathology- V.Suri.

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M.Sc. SEMESTER – III (Botany)
PAPER – IV
ELECTIVE COURSE-- LIMNOLOGY-I
MAX. MARKS-80

UNIT-1

1.Limnology–Definition, historical development and scope of Limnology.

2.The characteristics of water, Hydrological cycle, Global water balance.

3.Types of fresh water habitats and their ecosystem-

(a) Ponds, Streams and rivers. (b) Lakes– General characteristics of lakes and classification of lakes. Definition depth of lakes. Retention and replacement of water in lakes, origin of lakes.

UNIT-II

1.Morphometry–Use of various morphometric parameters and Zonation. Food Chains, Food webs, Trophic levels and Energy flow in freshwater ecosystems. Eutrophication: Causes, mechanism and significance, Management of freshwater bodies.

UNIT-III

Physical Characteristics of Lake water and their role.

1. Light and Temperature-

(a) Transmission and absorption of Light, Colour and Transparency of light

(b) Distribution of heat in lakes, Temperature Radiation, Stratification and Heat Budget. Comparative analysis of river, reservoir and lakes.

2. Water movements: Flow of water, surface and internal water movements. Turbidity, Salinity and Total Dissolved Solids.

UNIT-IV

3. Chemical characteristics of fresh water with special reference to different parameters-Dissolved gases (Oxygen, Carbon di oxide, Hydrogen Sulphide), Seasonal changes in dissolved gases and pH, Hardness, Alkalinity, Sulphates, Nitrogen, Phosphorus, Iron, Sulphur and Silica cycle, Arsenic, and Fluoride.

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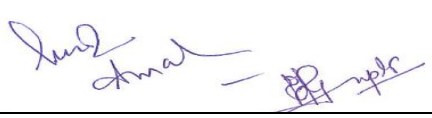
Suggested Readings:

1. Anathakrishnan : Bioresources Ecology
2. Goldman : Limnology
3. Odum : Ecology
4. Pawlosuske : Physico-chemical methods for water Limnology Wetzal : Chemical and biological methods for water pollution studies
5. Trivedi & Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols.I-II
7. Perkins : Ecology
8. Arora : Fundamentals of environmental biology
9. Ghoshe : Toxicology
10. Sood : Toxicology

Suggested Laboratory Exercises

1. Construction of morphometric maps of aquatic systems.
2. Measurement of transparency and temperature.
3. Analysis of different dissolved gases: Dissolved oxygen and Carbon dioxide.
4. Analysis of lake water for bicarbonates, carbonates, total alkalinity, chlorides etc.



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M.Sc.(Botany) III SEMESTER

PAPER –IV

Elective Course –Ethno botany

MAX. MARKS: 80

Unit I

- **Ethno botany** : History, general account and its sub disciplines.
- Interdisciplinary approaches & aim of ethno botany.
- Main world centers of Ethno botanical studies, workers & literature of Ethno botany
- Ethno botany with special reference to Chhattisgarh.
- Ethno botanical Research done in India:
- Ethno botany in relation to national priorities and health care programme.
- Practical application of ethno botany for tribal development programme.

Unit II

- Methods and techniques in ethno botany**.**
- General account of major and minor tribes of Chhattisgarh with special reference to Gond, Kamar, Baiga, Abujhmaria.
- Ethno botanical aspect of Art & literature.
- Abstract ethno botany with special reference to folklore, Taboos, Majico-religious beliefs.

Unit –III

- Ethno botanical importance of Bacteria, Algae, Fungi, Bryophyte, Pteridophyta and Gymnosperm.
- Ethnovaterinary medicines from plants.
- Major & Minor Forest Products (NWFPs)of Chhattisgarh.
- Ethno botany in relation to livelihood security reference to tribes.

Unit- IV

- Ethnobotanical study of following plants with special reference to their medicinal importance 1. *Azadirachta indica* (Neem) 2. *Emblica officinalis* (Amla) 3. *Ricinus conmunis* (Andi) 4. *Madhuca indica* (Mahuaa) 5. *Cassia fistula* (Amaltash) 6. *Ficus religiosa* (Pipal) 7. *Oscimumsanctum* (Tulsi) 8. *Asparagus racemosus* (Satavar) 9. *Aloe vera* (Ghrit kumari) 10. *Andographis paniculata* (Bhui neem).

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Suggested Readings:-

- Baker, H.G. 1978. Plants and Civilization (3 rd edition). C.A. Wadsworth, Belmont.
- Chandel, K.P.S., Shukla, G.& Sharma, N. 1996. Biodiversity in medicinal and Aromatic Plants in India: Conservation & Utilization. National Bureau of Plant Genetic Resources, New Delhi.
- Chrispeels, M.J. & Sadava, D. 1977. Plants , Food & People. W.H Freeman and Co., San Francisco.
- Ambasta S.P. (ed.) (1986). The Useful Plants of India. Publications & Information Direxitorate, CSIR, New Delhi India.
- Anon. (1978). The tribes of Madhya Pradesh. Dept. of Tribal Welfare, Govt. of M.P. Bhopal.
- Arnold. J. E. M. & Ruiz Perez, M, (1998). The role of non-timber forest products in conservation and development. In: Wallenberg, Eva. & Andrew Ingles (Eds.) Income from the Forest, CIFOR 1998, Indonesia, pp-17 to 41.
- Asolkar, L.V. (1992). Second Supplement to Glossary of Medicinal Plants, (CSIR) NISCOM, New Delhi, India.
- Bal, S.N. (1984). Catalogue of Medicinal Plant Exhibits. BSI. Bishne Singh Mahendra Pal Singh, Cannaught Place, Dehra Dun, India.
- Buch, M.N. (1991). Forest of Madhya Pradesh, Madhya Pradesh Madhyam Bhopal.
- Chopra, R.N.; Badhwar, R.L. & Ghosh, S. (1965). Poisonous Plants of India. Vol. I. 2nd Ed. ICAR, New Delhi, India.
- Cotton C.M, (1996). Ethnobotany: Principals and Applications, John Willey & Sons, Chichester. New York.
- Faulks. P.J. (1958) An Introduction to Ethnobotany: Moredale Publications Ltd. London, England.
- Harshberger, J.W. (1896). Purposes of Ethnobotany Bot. Gaz. 21: 146-154.
- Jain S.K. and Phuipps, R.D. (1991). Medicinal Plants of India Rec. Pub.Algonac USA 2Vols. 1-849.
- Jain, S. K. (1991). Dictionary of India folk medicine and Ethnobotany. Deep publications. NEW DELHI, pp. 1-311.
- Jain, S. K. (1995). In Manual of Ethnobotany (edt. S.K. Jain,) Scientific Pubisher, Jodhpur. 128-134.
- Jain, S.K. & Rao, R.R. (1977). A handbook off field and herbarium methods. New Delhi: Today & Tomorrow's Printers and Publishers.
- Jain, S.K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH New Delhi, India.
- Jain, S.K. (1989). Methods and Approaches in Ethnobotany. Society of Ethnobotanist. Lucknow.
- Jain, S.K. and Mudgal, Hand Book of Ethanobotany. Bisen pal Singhm Mahendra Pal Singh Publication.
- Vaishnaw T.K. (2004). Chhattisgarh ki Anusuchit Janjatiyan, Adim Jati Anusandhan Avam Prshikshan Sansthan Raipur. Prakashan kramank 2, pp. 1-120

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- Varghese, E. S. V D. (1996). Applied Ethnobotany - A case study among the Kharias of Central India. New Delhi. Deep Publications
- Jajoria, E, V.K. (1998); "The Kamar [A way of life.] Vanya Prakashan., Tribal Research and Development Institute. 35, Shamla Hills, Bhopal., ethnobot. Res.2:303-3 15.
- Joshi, S.G. (2000). Medicinal Plants, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- Kirtikar, K. R. & Basu, B.D. (1933-1935). Indian Medicinal plants. Vol.I to VIII (4 Vols. text & 4 vols. plates) Reprint 1994, Dehradun U.P.
- Maheshwari, J.K. Ed. (2000). Ethnobotany and Medicinal Plants of Indian Subcontinent. Scientific Publishers, Jodhpur
- Martin, G.J. (1995). Ethnobotany. Chapman and Hall, London.

Suggested Laboratory Exercises:-

1. Description and identification of medicinal plants and its medical properties.
2. Preparation of medicinal plants herbarium and photographs.
3. Herbal preparation:-
    a. Extract of Tulsi leaves.
    b. Ointment from Neem Leaves.
    c. Ayurvedic tooth powder.
    d. Face pack preparation from various herbs.
    e. Preparation of Triphla.
    f. Kwath of Triphla.
    g. Preparation of diabeties controlled powder.
    h. Preparation ofherbal shampoo.
4. To cultivate at least two medicinal plant in earthen pot.
5. Field Study of Forest area or Tribal area.
6. Documentation technique of Ethnobotanical knowledge.
7. To separate active principles from the extract of Medicinal plant.

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M.Sc. SEMESTER - IV

PAPER - I
PLANT REPRODUCTION AND UTILIZATION OF RESOURCES
MAX.MARKS-80

UNIT-I

Reproduction : Vegetative reparation, Methods of propagation. Pollination, Pollination-mechanism and vector, Structure of pistil, Pollen stigma interaction, Sporophytic and gametophytic Self-incompatibility (Cytological, biochemical and molecular aspects), Fertilization, double fertilization, *in-vitro* fertilization.

UNIT-II

Male gametophyte : Structure of anther, Microsporogenesis, Role of tapetum, pollen development, male sterility, sperm dimorphism and hybrid seed production, Pollen germination, Pollen tube growth and guidance, Pollen storage, Pollen allergy, Pollen embryo sac.

Female gametophyte : Ovule development, Organization of embryo sac and Structure of embryo sac cells.

UNIT-III

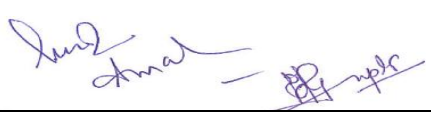
Seed and Fruit development: Endosperm development during early, maturation and desiccation stages. Embryo genesis, Storage proteins of endosperm, Ultra structure and nuclear cytology, Cell lineage during late embryo development, Polyembryony, Apomixes, Embryo culture, Endospermic and non-endospermic seeds, Dynamics of fruit growth, biochemistry and biology of fruit maturation.

UNIT-IV

Utilization of resources: Plant used as avenue trees for shade, Pollution control and aesthetics, Innovation for meeting world food demands Origin of Agriculture. Green revolution; benefits and adverse consequences. Ethanobotanically important plants of Chhattisgarh. World centers of primary diversity of domesticated plants.

SUGGESTED READINGS :

- Bhojwani, SS. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4 revised and enlarged edition) Vikas publication House, New Delhi.
- Fageri, K. and Vander Pijl, L. 1979. The Principles of Pollination Ecology Pergamon Press, Oxford.
- Proctor, And Yeo, P. 1973. The Pollination of Flowers. William Collins, London.
- Raghavan. V. 1997. Molecular Embryology of Flowering Plants. Cambridge University, Press, Cambridge.



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- Raven, P.H. Evert, R.F. and Eichhorn, and S.E. 1992. Biology of plants (5 edition), Worth, New York.
- Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops. Academic Press, London.
- Shivanna, K.R. and Sawhney, V.K. 1997. Pollen Biotechnology for crop Production and Improvement.
- Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Manual. Springer-Verlag, Berlin.
- Shivanna, K.R. and Johri, B.M. 1985. The Angiosperm Pollen : Structure and Function. Wiley Eastern Ltd., New York.
- Chandel, K.P.S., Shukla, G. and Sharma N. 1996. Biodiversity in Medicinal and Aromatic Plants in India; Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
- Chrispeels, M.J. and Sdava, D. 1977. Plants, Food and People. W.H. Freeman and CO., San Francisco.
- Council of Scientific and Industrial Research 1986. The Useful Plants of India. Publications and directorate, CSIR, New Delhi.
- Kochhar, S.L. 1998. Economic botany of the Tropics, 2nd edition. Macmillan India Ltd., Delhi.
- Thakur, R.S., Puri, H.S. and Hussain, A., 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
- Swaminathan, M.S. and Kocchar, S.L.1989. Plants and Society. Macmillan Pub. London.

SUGGESTED LABORATORY / FIELD EXERCISES

- Study of microsporogenesis and gametogenesis in sections of anthers.
- Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (*Maize, Grasses, Cannabis Sativa Crotolaria, Tradiscantia, Brassica, Petunia, Solunum melongena etc.)*
- Tests for [p;;em voabo;otu isomg staoms and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
- Estimating percentage and average pollen tube length *in vitro.*
- Role of transcription translation inhibitors on pollen germination and pollen tube growth.
- Pollen storage, Pollen-pistil interaction, self-incompatibility *in vitro* pollination.
- Study of ovule in cleared preparations, study of monosporic, bisporic and terrasporic types of embryo sac development through examination of permanent, stained serial sections.
- Field study of several types of flower with different pollination mechanisms (wind pollination thrips pollination bee/butterfly pollination, bird pollination.
- Emasculation, bagging and hand pollination to study of pollen germination, seed set and fruit development using self compatible and obligate out crossing system. Study of ceistogamous flowers and. Their adaptations.
- Study of nuclear and cellular endosperm through dissections and staining.

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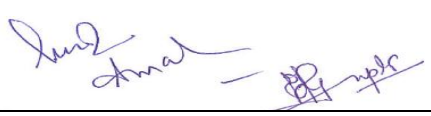
- Isolation of zygotic, globular, heart shaped, torpedo stage and nature embryo from suitable seeds and polyembryony in citrus, jamun (Syzygium cumin) etc. by dissections.
- Study of endospermic and non-endospermic seed.
- Study of seed dormancy and methods to break dormancy.
- Medicinal and Aromatic plants; Depending on the geographical location College/University select five medicinal and aromatic plants each from a garden, crop field or from the wild only if they are abundantly available. Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda ceylanica, Allium sativum, Rauvolffia serpentina, Withania somnifera, Phyllanthus amarus, Andrographis paniculata, Aloe barbadense, Mentha arvesis, Rosa sp. Pogostemon cablins, Origanum vulgare, Vetivera zizanioides, Jasminum grandiflorum, Cymbopoogon sp., Pandanus odoratissimus.
- Study of live or herbarium specimens or other visual materials to become familiar with these resources.
- Vegetable oils; Mustard, Groundnut, Soya bean, Coconut, Sunflower and Castor.
- Gums, Resins, Tannins and Dyes; Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins (Acacia. Terminalia, Mangroves. Tea. Cassia sp. Myrobalans) and dyes (Turmeric, Bixa orellana, Indigo, Butea monosperma, Lawsonia intermis) and perform tests to understand their chemical nature.

SUGGESTED READINGS FOR LABORATORY EXERCISE:

- Adriance, W. and Brison, R. Propagation of horticultural plants. Tata McGraw Hill pub. New Delhi.
- Sen. N. David, 1977. Environmental and seed germination of Indian plants. The chronica botanica co. New Delhi.
- Shivanna, K.R. and Rangaswamy, N.S. 1992 Pollen Biology : A Laboratory Manual. Springer-Verlag, Berlin.
- Shivanna, K.R., Johr, B.M. And Sastri, D.C. 1979. Development and physiology of angiosperm pollen. Today and tomorrows printers and pub. New Delhi.
- Vargheese, T.M. Experimental and applied embryology of angiosperms. Oxforc & IBS pub. Co. New Delhi.



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M.Sc. SEMESTER - IV

PAPER - II
POLLUTION AND BIODIVERSITY CONSERVATION
MAX.MARKS-80

UNIT-I

CLIMATE, SOIL AND VEGETATION PATTERNS OF THE WORLD :
Life zones, major biomes, major vegetation types and soil types of the world, barren land.

UNIT-II
POLLUTION, CLIMATE CHANGE AND ECOSYSTEMS :
Air, water and soil pollution:- kinds, sources, quality parameters, effects on plants and ecosystem. Green house gases (Caron dioxide, methane, nitrous oxide, Chloro florocarbons: sources, trends and role), ozone layer, ozone hole, consequences of climate change) Carbon dioxide fertilization, global warming, seal level rise, UV radiation).

UNIT-III
BIOLOGICAL DIVERSITY :- Concepts and levels, status in India, Utilization and concerns, role of biodiversity in ecosystem functions and stability, speciation and extinction, IUCN categories of threat, distribution and global patterns, terrestrial biodiversity hot spots, inventory.

World centers of primary diversity of domesticated plants; The Indo Burmese center, plant introductions and secondary centers.

UNIT-IV
CONSERVATION STRATEGIES
Principles of conservation, extinctions, environmental status of plants based on International union for conservation of Nature.
In situ conservation, International efforts and Indian initiatives, protected areas in India-sanctuaries, national parks, biosphere reserves, Wetlands, Mangroves and coral reefs for conservation of wild biodiversity.
Ex situ conservation : Principles and practices, botanical gardens, field gene bank, seed banks, in vitro repositories, cryo banks, general account of the activities of Botanical survey of India (BSI), National Bureau of plant genetic resources (NBPGR), Indian council of Agriculture research (ICAR), Council of scientific and Industrial research (CSIR), and the department of Biotechnology (DBT) for conservation and non formal conservation efforts.

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REFERENCE BOOKS :

Threshow, M1985. Air pollution and plant life, Wiley interscience.

Mason C.F. 1991. Biology of fresh water pollution, Longman.

Hill, M.K. 1997. Understanding Environmental pollution, Cambridge University press.

Anonymous, 1987. National gene bank, Indian heritage on plant genetic resources, National bureau of plant genetic resources.

Directory of Indian wet lands, 1993 WWF India and AWB, Kualalumpur.

Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The conservation of Plant biodiversity, Cambridge University press, Cambridge, U.K.

Kothari, A. 1997. Understanding Biodiversity: Life sustainability and Equity, Orient Longman.

Nair, M.N.B. 1998. Sustainable management of non wood forest products, Faculty of forestry, University Putra Malaysia.

Paroda, R.S. and Arora R.K. 1991. Plant resources conservation and management, IPGRIP USA Campus, New Delhi.

Heywood, V.H. and Watson, R.T.1995. Global biodiversity assessment,

Cambridge University press Cambridge, U.K.

Brady, N.C. 1990. The nature and properties of soils, MacMilan.

Chandel, K.P.S., Shukla, G. and Sharma, N., 1996. biodiversity in medicinal and aromatic plants in India, conservation and utilization. National bureau of plant genetic resources, New Delhi.

Falk, D.A. Olwell, M Millan, C. 1996. Restoring biodiversity, Island press, Columbia, USA.

Gaston, K.J. Biodiversity: a biology of numbers and differences, Blackwell science Ltd. Oxford, U.K.

Heywood, V. 1995 Global biodiversity assessment. United nations environment programme, Cambridge University Press, Cambridge, U.K.

Heywood, V.H. and Wyse Jakon, P.S. 1991. Tropical botanical gardens, their role in conservation and development, Academic press San. Diego.

Walter, K.S. and Gillett H.J. 1998. 1997 IUCN Red list of threatened plants.

IUCN The World conservation union, IUCN, Gland, Switzerland and Cambridge, U.K.

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LIST OF PRACTICALS :

1. To prepare ombrothermic diagram for different sites on the basis of given data set and to comment on climate.
2. To determine soil moisture content, porosity and bulk density of soil collected from varying depths at different locations.
3. To determine the water holding capacity of soils collected from different locations.
4. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forests.
5. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
6. To determine gross and net phytoplankton productivity by light and dark bottle method.
7. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification method.
8. To estimate chlorophyll content in sulphur dioxide fumigated and unfumigated plant leaves.
9. To study environmental impact of a given developmental activity using checklist as a EIA method.
10. To determine diversity indices (Shannon Wiener, concentration of dominance, species richness, equability and B diversity.
11. Field survey of a part of town or city to make the students aware of the diversity of plants in urban ecosystems.

REFERENCE BOOKS FOR LABORATORY EXERCISE:

Magurran, A.E. 1988. Ecological diversity and its measurement, Chapman and Hall. London.
APHA-AWWA-WPCF Standard methods for the examination of water and waste water, American public health association, Washington, D.C.
Krebs, C.J. Ecologicl methodology, Harper and Row, New York, USA.
Pielou, E.C. 1984. The interpretation of ecological data, Wiley, New York.
Moore, P.W. and Chapman, S.B.1986. Methods in plant Ecology. Blackwell scientific publications.

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M.Sc. SEMESTER - IV
PAPER – III
BIOTECHNOLOGY-II
PLANT CELL, TISSUE CULTURE AND ORGAN CULTURE

MAX.MARKS-80

UNIT-I

PLANTS CELLS AND TISSUE CULTURE: General introduction, history, scope, concept of cellular differentiation, cellular tot potency.

TISSUE CULTURE MEDIA: Introduction, Media constituents, Media selection, Media preparation.

CELL CULTURE: Introduction isolation of single cells. Suspension cultures, Culture of Single cell, Plant cell reactors, Applications of cell culture.

CLONAL PROPAGATION - Auxiliary bud proliferation, Meristem and shoot tip culture, bud culture.

ORGANOGENESIS AND ADVENTIVE EMBRYOGENESIS : Fundamental aspects of morphogenesis; organogenesis via callus formation, direct adventitive organ formation.

UNIT-II

SOMATIC EMBRYOGENESIS AND ANDROGENESIS : Mechanisms, techniques and utility.

SOMATIC HYBRIDIZATION : Methods of Protoplast isolation, Spontaneous and induced methods of protoplasm fusion, identification and selection of hybrid cells. Regeneration of hybrid plants. Verification and Characterization of somatic hybrids, Cybrids, posibilities, achievements and limitations of protoplast research.

UNIT-III

CRYOPRESERVATION AND GERMPLASM STORAGE : Raising sterile tissue cultures, Addition of cryoprotectants and pretreatment, freezing, storage, thawing, determination of survival viability. Plant growth and generation, verification, encapsulation and dehydration. Slow growth method, Applications.

INTELLECTUAL PROPERTY RIGHTS : Possible ecological risks and ethical concerns.

UNIT-IV

APPLICATION OF PLANT TISSUE CULTURE : Artificial seeds, Production of hybrids and soma clones.

PRODUCTION OF SECONDARY METABILITIES / NATURAL PRODUCTS : Morphological and chemical differentiations, Medium composition for secondary product formation. Growth production patterns, Environmental factors. Selection of cell lines producing high amounts of a useful metabolite, Problems associated with secondary metabolite production Immobilized cell system.

TRANSGENICS IN CROP IMPROVEMENT: Transgenic for Resistance to biotic and abiotic stresses, Transgenes for quality modification, Terminator seed technology. Chloroplast transformation and its utility.

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Suggested Reading:

1. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice revised edition). Elsevier Science Publishers, New York, U.S.A.
2. Bhojwani, S.S. 1990, Plant Tissue Culture; Application and Limitations. Elsevier Science Publishers, New York, USA.
3. Collins, H.A. and Edwards, S., 1998. Plants cell Culture Bio Scientific Publishers, Oxford UK.
4. Jain, S.M. Sopory, S.K. and Veilleux, R.E. 1996. In Vitro Hapliod Productin in Higher Plants, Vois. Fundamental Aspects and Methods Kluwer Academic Publishers. Dordrecht. The Netherlands.
5. Kartha, K.K. 1985. Cryopreservation of Plants Cells and Organs. CRC Press, Boca Raton, Florida, USA.
6. Raghavan, V. 1986. Embryogenesis, in Angiosperms: A Development an Experimental Study Cambridge University Press, New York, USA.
7. Vasil, Ikssshorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer ACADEMIC publishers, The Netherlands.

Suggested Laboratory Exercise:

1. Isolation protoplast from various plant tissues and testing their viability.
2. Effect of physical (e.g. temperature) and chemical (e.g. osmoticum) factors on protoplast yield.
3. Demonstration of protoplast fusion employing PEG.
4. Organogenesis and somatic embryogenesis using appropriates explants and preparations of artificial seed.
5. Demonstration of and oogenesis in Datura.
6. Electroporation of protoplasts and checking of transient expression of the reporter gene.
7. Co-cultivation of the plant material (e.g.leaf discs) with Agrobacterium and study GUS activity histochemically.

Suggested Reading (for laboratory exercise) :

1. Butenko, R.G.2000. Plant Cell Culture, University Press of pacific.
2. Ckollin, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Published, Oxford, UK.
3. Dixon, R.A. (Ed.) 1987. Plant Cell Culture: A Practical Approach. IRL Press, Oxford.
4. George, F.F., 1993, plant propagation by tissue Culture. Part 2. The Technology, 2nd Exegetics Ltd. Edington, UK.
5. Hall, R.D.; (E.D.) 1999. Plant Cell Culture Protocols, Humana Press, Inc., New Jersey, USA.
6. Smith, R.H. 2000, Plant Tissue Culture: Technique and Experiments. Academic Press, New York.

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M.Sc. SEMESTER - IV

PAPER - IV

ELECTIVE PAPER-- MOLECULAR PLANT PATHOLOGY

MAX.MARKS-80

UNIT-I

1. **Epidemiology and disease forecasting:** form of epidemics, factors responsible for the establishment of an epidemic, disease forecasting.
2. **General principles of plant disease control :** General account; Prophylactic. Chemical (including fungicides, systemic fungicides, fumigants, antibiotics, growth regulators etc.) and biological control; Breeding for disease resistance varieties of host plants, Plant quarantine.

UNIT-II

1. **Defense Mechanism-** Defense of host against pathogen, Structural defense; Physiological defense, Biochemical defense-role of phenolic compounds; Phytoalexins Defense through hyper-sensitive reactions.
2. **Resistance and susceptibility:** General account, types of resistance, vertical and horizontal resistance; breeding for disease resistance.

UNIT-III

1. **Wilt diseases:** General account, systems of diseases, Mechanism of wilting.
2. **Diseases due to fungi:** Rusts, smuts, Downy mildews powdery mildew diseases, Wilts, Leaf blight, Ergots, Tikka, necrosis, Rots-red rot of sugarcane, Damping off and warts diseases of economically important plants.
3. **Diseases due to Bacteria:** Bacterial blight of Rice, Tundu disease, citrus canker, Crown galls of stone fruits, Angular leaf spots.

UNIT-IV

1. **Diseases due to Viruses:** Mosaic of tobacco, Potato and tomato, Leaf curl of tomato & papaya, Yellow vein mosaic of Bhindi, Bunchy top of banana, Grassy shoot disease of sugarcane.
2. **Diseases due to Mycoplasma :** Sandal spike, Little leaf of Brinjal, Grassy shoot disease, Sesamum, phyllody, Citrus greening.
3. **Diseases due to Nematodes:** General characteristics of plants nematodes, Root knot, Malaya disease of Barley, wheat, Citrus nematodes, Ear cockle of wheat.

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SUGGEST READINGS:

1. Plant Pathology - J.C. Walkar
2. Fungi and plant diseases - B.B. Mundkar
3. Plant Pathology – G.N. Agrios
4. Plant Pathology - Whecler
5. Plant Pathology (Vol.1-3) – Horsfall & Dimon
6. A text book of Modern Plant Pathology – K.S. Bilgrami and H. S.Dubey
7. Plant Pathology – R.S.singh
8. An introduction to Principles of Plant pathology - R.S.singh
9. Plant Disease of Crop plants in India – N.G. Rangaswamy.
10. Plant Pathology problems and progress- Honfall
11. Essentials of Plant Pathology- V.N. Pathak
12. Plant Pathology – Butter and Jones.
13. Plant Pathology- R.S. Malhotra
14. Crop plant Disease Colender- IARI-India.
15. Physiology of Fungus- – K.S. Bilgrami and H. S.Dubey
16. Micro-organisms in laboratory – G.P. Agarwal and S.K. Hasija.
17. Physiology of fungi – V.G.Lily and H.L.. Barnet.
18. Illustrated Genera of Imperfecti fungi- H.L.. Barnet and.B.B. Hunter.
19. Microbiology and Plant Pathology- P.D.Sharma
20. Plant Pathology- P.D.Sharma
21. Microbiology – P.D.Sharma
22. The Fungi – G. Sumbali
23. Fungicides and crop protection- H.G.Mewitt
24. Fungal diseases of plants- B.M. Duggar
25. Plant Pathology – P.C. Trivedi
26. Plant Pathology – G.P. Gupta
27. Virus and Plant diseases S.R.Mishra
28. Bacterial Diseases- V. Kumar
29. Biotechnology and Plant Pathology- V.K.Jain
30. Laboratory manual of Plant Pathology- D.K.Jha.
31. Modern technology of Plant Pathology- V.Suri.

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M.Sc. SEMESTER – IV (Botany)

PAPER – IV

ELECTIVE PAPER-- LIMNOLOGY-II

MAX.MARKS-80

UNIT-1

1.Study of Biota

(a) Phytoplankton flora-classification of phytoplankton, special distribution of phytoplankton, seasonal distribution and species composition of phytoplankton. Algal blooms effects of salinity and climatic stresses on the distribution of phytoplankton, Phytobenthos-classification.

(b) Phytoplankton and their inter-relationship with Zooplanktons.

(c) Aquatic insects, birds and their environmental significance.

UNIT-II

1. Lake Flora-Higher Plants. Categories of aquatic higher plants, zonation of rooted higher plants, some peculiarities of aquatic higher plants.

2. Lake Bacteria-occurrence, characteristics and importance.

3.Ecological classification of aquatic higher aquatic plants and their significance.

4. Biotic relationship and interaction among organisms. Symbiosis, competition among algae, Parasitism of algae, predation of algae, impact of human being on algae.

UNIT-III

1.Concept of Productivity: Seasonal variation, Primary productivity in freshwater lakes, Estimation of Primary Productivity.

2.Bio indicators-Aquatic flora and fauna in relation to water quality in an aquatic environment.

3. Use and misuse of inland waters.

4. Methods of water quality testing BOD and COD.

UNIT-IV

1.Sewage–Definition, composition and its treatment.

2.Pollution by Domestic and Agriculture sewage, Industrial effluent.

3.Causes of pollution of Aquatic Resources, their management and conservation.

4.Resource Conservation–Aquatic pollution, control, legislation, regulation on discharge of industrial effluents and domestic wastes in rivers and reservoirs.

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Suggested Readings:

Anathakrishnan : Bioresources Ecology Goldman: Limnology
Odum: Ecology
Pawlosuske : Physico-chemical methods for water Limnology Wetzal : Chemical and biological methods for water pollution studies
Trivedi&Goyal : Chemical and biological methods for water pollution studies Welch: LimnologyVols.I-II
Perkins: Ecology
Arora : Fundamentals of environmental biology Ghoshe : Toxicology
Sood : Toxicology

Suggested laboratory Exercise

1. Sampling of phytoplankton and their qualitative and quantitative analysis.
2. Sampling of periphytes and macrophytes, and their qualitative and quantitative analysis.
3. Sampling of Zooplankton and their qualitative and quantitative analysis.
4. Primary production: Experiment-in-situ by light and dark bottle method.
5. Short-term productivity experiments for the understanding of diel variation in aquatic ecosystems.
6. Analysis of sediments for benthic fauna and flora.

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Suggested Reading:

1. Adoni, A.D. et al. 1985. Workbook on Limnology. Pratibha Pub. Sagar 216 p.
2. APHA 1981. Standard Methods for the Examination of Water and Waste water. American Public Health Association, Washington.
3. Arber, A. 1920. Water Plants. Cambridge University Press.
4. Barnes, A.K. and K.H. Mann, 1980. Fundamentals of Aquatic Ecosystems. Blackwell Scientific Publication, Oxford.
5. Brown, A.L. 1971. Ecology of Fresh Water. Heinemann, London, 129 p. nd
6. Cole G.A., 1979. Text book of Limnology. 2
7. De, A.K., 1989. Environmental Chemistry. Wiley Eastern Limited, New Delhi.
8. Goldman, C.R. and A.J. Horne, 1983. Limnology. McGraw Hill Inc. Tokyo, 464 p.
9. Golterman H.L., 1975. Physiological Limnology. Elsevier Scientific Publishing Co., Amsterdam, The Netherlands, 489 p.
10. Hutchinson G.E. 1957. A Treatise on Limnology. Vol. I,II,III, John Wiley & Sons, NY.
11. Mackereth, F.J.H., 1963. Some methods of water Analysis for Limnologists. Fresh Water Biological Association. Scientific Publication, No. 21, Ambleside England.
12. Mackereth, F.J.H., J. Heron and J.F. Talling. 1978. Water Analysis : Some Revised Methods for Limnologists. Freshwater Biological Association, Sci. Pub. No. 36.
13. Moss, B., 1980. Ecology of fresh waters. Blackwell Scientific Publications, Oxford, 417 p. rd
14. Odum, E.P. 1971. Fundamentals of Ecology. 3
15. Ruttner, F., 1963. Fundamentals of Limnology, 3 p.
16. Schwoerbel, I. 1987. Handbook of Limnology. Gustav fisher, Verlag.
17. Strickland J.D.H. and T.R. Parson. 1972. A Practical Handbook of Sea Water Analysis. Fisheries Research Board of Canada, Ottawa.
18. Subramanyam, K. 1962. Aquatic Angiosperms C.S.I.R., New Delhi.
19. Welch, P.S. 1935. Limnology. McGraw Hill Co. N.Y., 472 p.
20. Welch, P.S. 1948. Limnological methods. Philadelphia, Blakiston Co. 381p.
21. Wetzel, R.G. 1975. Limnology0. W.B. Saunders Co., Phildalelphia, 743 p.

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M.Sc. IV SEMESTER

PAPER –IV

ELECTIVE COURSE – ETHNO BOTANY

MAXIMUM MARKS : 80

Unit - I

- Plant Conservation by Tribes & role of Joint Forest Management Programme in Plant Conservation specially People's Protected Area
- Ethnobotany and its role in domestication and conservation of native plant and genetic resources.
- The protection of plant varieties and Intellectual Properties Rights.
- General account of conservation of medicinal plants.
- General role of Aromatic plants.

Unit-II

- General ideas of various system of medicine using plants.
- Basic knowledge of Ayurvedic, Homeopathic, Allopathic system of medicine.
- General idea of active principles of Plants.
- Herbal Cosmetics.
- General account of toxic plants and Harmful effect of plants on human society with special reference to allergic plants of Chhattisgarh.

Unit –III

- Endemic plants of Chhattisgarh.
- Endangered plants of Chhattisgarh.
- Techniques of cultivation and marketing of Aromatic plants –Podina, Lemon grass Kasturibhindi, Palmarosa.
- Techniques of cultivation ,marketing and importance of mushroom
- Techniques of cultivation, extraction of juice and importance of wheat grass.

Unit-IV

- Ethnobotanical study of the following plants with special reference to their medicinal importance-

1. *Allium sativum* (Lahsun) 2. *Aegle marmelos* (Bel) 3. *Terminallia arjuna* (Arjun) 4 *T. bellerica* (Bahera) 5. *T chebula* (Harra) 6. *Calendula officianallis* (Calendula) 7. *Thuja occidentalis* (Vidhya) *8 Dhatura alba* (Dhatura) 9. *Argemone maxicana* (Pili kateli) 10. *Ephedra* sps. (Ephedra).

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Suggested Readings :-

- Baker, H.G. 1978. Plants and Civilization (3 rd edition). C.A. Wadsworth, Belmont.
- Chandel, K.P.S., Shukla, G.& Sharma, N. 1996. Biodiversity in medicinal and Aromatic Plants in India: Conservation & Utilization. National Bureau of Plant Genetic Resources, New Delhi.
- Chrispeels, M.J. & Sadava, D. 1977. Plants, Food & People. W.H Freeman and Co., San Francisco.
- Ambasta S.P. (ed.) (1986). The Useful Plants of India. Publications & Information Direxorate, CSIR, New Delhi India.
- Anon. (1978). The tribes of Madhya Pradesh. Dept. of Tribal Welfare, Govt. of M.P. Bhopal.
- Arnold. J. E. M. & Ruiz Perez, M, (1998). The role of non-timber forest products in conservation and development. In: Wallenberg, Eva. & Andrew Ingles (Eds.) Income from the Forest, CIFOR 1998, Indonesia, pp-17 to 41.
- Asolkar, L.V. (1992). Second Supplement to Glossary of Medicinal Plants, (CSIR) NISCOM, New Delhi, India.
- Bal, S.N. (1984). Catalogue of Medicinal Plant Exhibits. BSI. Bishne Singh Mahendra Pal Singh, Cannaught Place, Dehra Dun, India.
- Buch, M.N. (1991). Forest of Madhya Pradesh, Madhya Pradesh Madhyam Bhopal.
- Chopra, R.N.; Badhwar, R.L. & Ghosh, S. (1965). Poisonous Plants of India. Vol. I. 2nd Ed. ICAR, New Delhi, India.
- Cotton C.M, (1996). Ethnobotany: Principals and Applications, John Willey & Sons, Chichester. New York.
- Faulks. P.J. (1958) An Introduction to Ethnobotany: Moredale Publications Ltd. London, England.
- Harshberger, J.W. (1896). Purposes of Ethnobotany Bot. Gaz. 21: 146-154.
- Jain S.K. and Phuipps, R.D. (1991). Medicinal Plants of India Rec. Pub.Algonac USA 2Vols. 1-849.
- Jain, S. K. (1991). Dictionary of India folk medicine and Ethnobotany. Deep publications. NEW DELHI, pp. 1-311.
- Jain, S. K. (1995). In Manual of Ethnobotany (edt. S.K. Jain,) Scientific Pubisher, Jodhpur. 128-134.
- Jain, S.K. & Rao, R.R. (1977). A handbook off field and herbarium methods. New Delhi: Today & Tomorrow's Printers and Publishers.
- Jain, S.K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH New Delhi, India.
- Jain, S.K. (1989). Methods and Approaches in Ethnobotany. Society of Ethnobotanist. Lucknow.
- Jain, S.K. and Mudgal, Hand Book of Ethanobotany. Bisen pal Singhm Mahendra Pal Singh Publication.
- Vaishnaw T.K. (2004). Chhattisgarh ki Anusuchit Janjatiyan, Adim Jati Anusandhan Avam Prshikshan Sansthan Raipur. Prakashan kramank 2, pp. 1-120
- Varghese, E. S. V D. (1996). Applied Ethnobotany - A case study among the Kharias of Central India. New Delhi. Deep Publications

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- Jajoria, E, V.K. (1998); "The Kamar [A way of life.] Vanya Prakashan., Tribal Research and Development Institute. 35, Shamla Hills, Bhopal., ethnobot. Res.2:303-3 15.
- Joshi, S.G. (2000). Medicinal Plants, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- Kirtikar, K. R. & Basu, B.D. (1933-1935). Indian Medicinal plants. Vol.I to VIII (4 Vols. text & 4 vols. plates) Reprint 1994, Dehradun U.P.
- Maheshwari, J.K. Ed. (2000). Ethnobotany and Medicinal Plants of Indian Subcontinent. Scientific Publishers, Jodhpur
- Martin, G.J. (1995). Ethnobotany. Chapman and Hall, London.

Suggested Laboratory Exercises:-

Ethnobotany

1. Description and identification of medicinal plants and its medical properties.
2. Extraction of phytochemicals from various medicinal plants.
3. Preparation medicinal plants herbarium and photographs.
4. Herbal preparation –
    a. Preparation of digestive powder.
    b. Mouth freshener of Ajwain.
    c. Beverage of Tulsi,Bel,Tikhur,Mango.
    d. Ayurvedic tea preparation.
    e. Tablet of amla vati.
    f. Murabba of Awla/Bel.
    g. Herbal dye
    h. Shitopladi powder.
5. Identification and study of Ethnobotanical importance of some plants of Raipur.
6. To cultivate at least two medicinal plant in earthen pot.

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SYLLABUS M.Sc. BOTANY

Semester	Paper	Title	External marks	Internal marks	Credit
First	I	Cytology	80	20	4
	II	Genetics	80	20	4
	III	Microbiology,Phycology and Micology	80	20	4
	IV	Bryophyte, Pteridophyta and gymnosperm	80	20	4
	LC - I	Lab Course-I (Based on paper I &III)	80	20	4
	LC - II	Lab Course-II (Based on paper I &IV)	80	20	4
Second	I	Taxonomy and diversity of plants	80	20	4
	II	Molecular Biology	80	20	4
	III	Plant physiology	80	20	4
	IV	Plant metabolism	80	20	4
	LC- I	Lab Course-I (Based on paper I &II)	80	20	4
	LC-II	Lab Course-I (Based on paper II &IV)	80	20	4
Third	I	Plant development and plant resources	80	20	4
	II	Plant Ecology– I **(E**cosystem and vegetation ecology)	80	20	4
	III	Biotechnology I (Genetic engineering of plants & microbes)	80	20	4
	IV	**Elective paper-1** Molecular plant pathology-I **OR** **Elective paper-II** Limnology-I **OR** **Elective paper-III** Ethno botany I	80	20	4
	LC-I	Lab Course-I (Based on paper I &II)	80	20	4
	LC-II	Lab Course-II (Based on paper III &IV)	80	20	4

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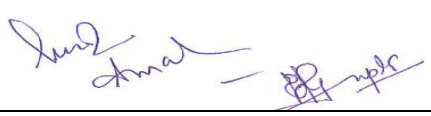
Fourth	I	Plant reproduction and plant resources utilization	80	20	4
	II	Plant Ecology II (Pollution and biodiversity conservation)	80	20	4
	III	Biotechnology II (Plant cell, tissue culture & organ culture)	80	20	4
	IV	**Elective paper-1** Molecular plant pathology-II **OR Elective paper-II** Limnology-II **OR Elective paper-III** Ethno botany II	80	20	4
	LC-I	Lab Course-I (Based on paper I &II)	80	20	4
	LC-II	Lab Course-II (Based on paper III &IV)	80	20	4

Choice Based Credit System: Semester II **Course Forestry seed Technology. Marks 100, Credit Points -03, Total Hours -50**

Choice Based Credit System: Semester III **Course Environmental Science. Marks 100, Credit Points -03, Total Hours -50**

- Each theory paper will have 5 questions of equal marks. First question will encompass all the five units without internal choice, whereas rest questions will be unit wise with internal choice.
- The respective teachers on each paper will ensure the internal evaluation by a class test and a seminar / poster presentation of 20 marks each and submit the foil and counter foil to the HOD by the end of the activity.



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