

News

School of Studies in Botany
Vikram University, Ujjain

VU Botany CBCS 2016

Scheme and Syllabus

M.Sc. Botany

2016

Choice Based Credit System (C.B.C.S.) based

From Academic Session 2016-17 onwards

Re-Submitted
News
22/7/17

M.K. SESODIYA
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Choice Based Credit System (C.B.C.S.) based Scheme and Syllabus M.Sc. (Botany)
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Table-2: The Core and other Papers

S. No.	Core –Papers (60 Credits)	Discipline Centric Elective (DCE Choice based-any one) (6 Credit)	Generic Elective (GE Choice based-anyone) (6 Credit)	Soft Skills: Skill enhancement and development, Practical, Viva voce (6+18+6=30 Credit)	Project Work (18 Credits)
1	Biology and Diversity of Algae and Bryophytes	a. Plant Pathology	a. Biostatistics and Computer Application*	Seminars-2 (3 X2 =6)	Project Work in an institution or in the UTD 18 Credit
2	Biology and Diversity of Pteridophytes and Gymnosperms	b. Utilization and Conservation of Plant Resources	b. Plant Cytogenetics	Practical, Viva voce (In Semester- 1,2 &3) (6 X3=18)	
3	Taxonomy and Morphology of Angiosperms	c. Ethnobotany	c. Pollution Ecology	Viva voce on the Project work (6)	
4	Plant Development and Reproduction	d. Environmental Science*	d. Weed Science		
5	Cytogenetics and Genetics	e. Industrial Microbiology	e. Bioinformatics		
6	Cell and Molecular Biology	f. Forest Ecology	f. Water Management and treatment		
7	Ecology	g. Plant Tissue Culture	g. Floriculture		
8	Plant Physiology and Biochemistry	h. Soil Biology and Conservation	h. Plant Breeding		
9	Basic Biotechnology	i. Plant Metabolism	i. Basic Instrumentation		
10	Genetic Engineering and Genomics	j. Environmental Microbiology	j. Remote Sensing and GIS		
Total Credits – 120					

*DCE and GE papers are available for the students of other departments/ faculties.

M.Sc. (Botany) - I Semester

Courses, Teaching scheme and Credits

Course	Course Code	Theory/ Practical	Teaching Scheme (hrs/ credit/ week)			Credits
			TH (1hr = 1 Credit)	PR (2hr = 1 Credit)	Total	
CORE:1	BOT PG 101	Biology and Diversity of Algae and Bryophytes	4	2	6	6
CORE:2	BOT PG 102	Biology and Diversity of Pteridophytes and Gymnosperms	4	2	6	6
CORE:3	BOT PG 103	Taxonomy and Morphology of Angiosperms	4	2	6	6
CORE:4	BOT PG 104	Plant Development and Reproduction	4	2	6	6
CORE: 1-4 based	BOT PG 105	Practical, Viva voce- Based on the BOT PG 101, 102, 103 & 104 courses	-	6	6	6
Total			16	14	30	30

M.Sc. (Botany) - II Semester

Courses, Teaching scheme and Credits

Course	Course Code	Theory/ Practical	Teaching Scheme (hrs/ credit/week)			Credits
			TH (1hr = 1 Credit)	PR (2hr = 1 Credit)	Total	
CORE:5	BOT PG 201	Cytogenetics and Genetics	4	2	6	6
CORE:6	BOT PG 202	Cell and Molecular Biology	4	2	6	6
CORE:7	BOT PG 203	Ecology	4	2	6	6
CORE:8	BOT PG 204	Plant Physiology and Biochemistry	4	2	6	6
CORE: 5-8 & DCE based	BOT PG 205	Practical , Viva voce– Based on the BOT PG 201,202,203 & 204 courses	-	6	6	6
	Total		16	14	30	30

M.Sc. (Botany) - III Semester

Courses, Teaching scheme and Credits

Course	Course Code	Theory/ Practical	Teaching Scheme (hrs/ credit/week)			Credits
			TH (1hr = 1 Credit)	PR (2hr = 1 Credit)	Total	
CORE:9	BOT PG 301	Basic Biotechnology	4	2	6	6
CORE:10	BOT PG 302	Genetic Engineering and Genomics	4	2	6	6
DCE	BOT PG 303	Discipline Centric Elective (DCE) (Choice based)	4	2	6	6
GE	BOT PG 304	Generic Elective (GE- Choice based)	4	2	6	6
CORE: 9-10, DCE & GE based	BOT PG 305	Practical, Viva voce- Based on the BOT PG 301, 302, 303 & 304 courses	-	6	6	6
Total			16	14	30	30

M.Sc. (Botany) - IV Semester

Courses, Teaching scheme and Credits

Course	Course Code	Theory/ Practical/ Project Work	Teaching Scheme (hrs/ credit/week)			Credits
			TH (1hr = 1 Credit)	PR (2hr = 1 Credit)	Total	
Project Work	BOT PG 401	Project Work in an institution or in the department (UTD)	-	-	-	18
Project Work- Viva	BOT PG 402	Viva voce on the Project work	-	-	-	6
Soft Skills	BOT PG 403	Seminars- (2) (Skill enhancement and development)	-	-	-	6
	Total		-	-	-	30

GRAND TOTAL OF CREDITS (of all 4 Semesters) (I- Sem-30, II- Sem-30, III- Sem- 30, IV- Sem- 30)	-	-	-	120
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Vikram University, Ujjain
CBCS based Syllabus for M.Sc. (Botany) - I Semester

Paper- BOT PG 101: Biology and Diversity of Algae and Bryophytes

Unit-1: General classification of living organisms. Structure- Thallus organisation, diversified habitats, cell structure and reproduction of Algae. Criteria for classification of Algae. Pigments, Reserve foods, Flagella. Different classifications of Algae.

Unit-2: Salient features and study of- Cyanophyta: *Nostoc*, *Anabaena*, *Oscillatoria*, Charophyta: *Chara* and *Nitella*, Chlorophyta; *Chlorella*, *Ulothrix*, *Fritschiaella* and *Oodogonium*. Xanthophyta: *Vaucheria*, *Botrydium*, Bacillariophyta: *Pinnularia*, Phaeophyta: *Ectocarpus*, *Fucus*, *Sargassum*, Rhodophyta: *Porphyra*, *Batrachospermum*, *Polysiphonia*, Algal blooms, Algal fertilizers. Economic importance of Algae.

Unit-3: Introduction and classification of Bryophyta. Morphology, structure, reproduction and Life history of Bryophytes. Occurrence and distribution of Bryophytes.

Unit-4: Detail study of Marchantiales: *Riccia*, *Marchantia*, *Sphaerocarpus*, Jungermanniales: *Pellia* and *Porella*, Anthocerotales: *Anthoceros* and *Nothothyllas*.

Unit-5: Detail study of Sphagnales: *Sphagnum*, Funariales: *Funaria* and Polytrichales: *Polytricum*. Evolutionary trends in Bryophytes. Economic importance of Bryophytes.

Suggested Readings

- Brower, F.O. 1956. Primitive Land Plants. Cambridge University Press.
- Chopra & Kumar, 1988. Biology of Bryophyta. Wiley Eastern Ltd.
- Fritsch, F.E. 1959. (Vol- I). The Structure and Reproduction of the Algae. Cambridge University Press.
- Fritsch, F.E. 1959. (Vol- II). The Structure and Reproduction of the Algae. Cambridge University Press.
- Kashyap. 1972. Liver Worts of Western Himalayas and Punjab. Research Co. Publication, Delhi.
- Kumar, H.D. 1988. Introductory Phycology. Affiliated East-west press Ltd. New Delhi.
- Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
- Puri, P. 1980. Bryophyta. Morphology, Growth and Differentiation. Atma Ram & Sons, Delhi.
- Ram Udar, 1970. An Introduction to Bryophyta. Shashidhar Malviya Prakashan, Lucknow
- Smith G.M. 1955. Cryptogamic Botany VOL-II (2nd edition) Tata MCGraw-Hill Publishing Company Ltd. Bombay- New Delhi.
- Smith, G.M. 1955. Cryptogamic Botany VOL-I (2nd edition), Tata MCGraw-Hill Publishing Company Ltd. Bombay- New Delhi.
- Watson, 1968. Structure and life of Bryophyta. Hutchinson & Co. Ltd.

Paper- BOT PG 102: Biology and Diversity of Pteridophytes and Gymnosperms

Unit-1: Salient features and affinities of Pteridophytes. Classification, origin and evolution of Pteridophytes. Vascular elements and evolution of vascular (Stele) system. Heterospory: Apospory and apogamy.. Distribution and Life history of pteridophytes in India.

Unit-2: General features, morphology, internal structures and reproductive organs of Psilophitales, Psilotales, Sphenophyllales, Equisetales, Lycopodiales, Ophioglossales, Osmundales, Pteridales, Marsileales and Salviniiales. External morphology and development of sporophyte of Filicales.

Unit-3: Salient features, affinities and classifications of Gymnosperms. Economic importance and distribution of Gymnosperms in India. Progymnosperms and origin of gymnosperms. General account of Pteridospermales and Bennettitales.

Unit-4: Main features, distribution, external morphology; the sporophyte- vegetative and reproductive, embryology, internal structures of vegetative and sex organs; male and female gametophytes development, interrelationships of Cycadales- *Cycas*, Ginkgoales- *Ginkgo* and Coniferales- *Pinus*, *Picea*, *Cryptomeria*, *Biota*, *Podocarpus* and *Taxus*.

Unit-5: Main features, distribution, external morphology; the sporophyte- vegetative and reproductive, embryology; Internal structures of vegetative and sex organs; male and female gametophytes development, interrelationships of Ephedrales- *Ephedra*, Welwitschiales- *Welwitschia* and Gnetales- *Gnetum*.

Suggested Readings:

- Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.
- Biswas, C. and Johri. B. 1997. The Gymnosperms. Narosa Publication House, New Delhi.
- Bower, F.O. 1959. Primitive Land Plants. Hafner Publishing Co., New York.
- Chamberlin, C. J. 1998. Gymnosperms- Structure and Evolution. CBS Publishing and Distributors, New Delhi.
- Eames, A.J. Morphology of Vascular Plants- Lower Groups. Tata McGraw- Hill Publishing Company Ltd, New Delhi.
- Foster, A. S. and Gifford, E.M. Comparative Morphology of Vascular Plant. Vakils, Feffer & Simons Pvt. Ltd., Bombay.
- Kashyap, 1972, Liverworts of Western Himalayas and Punjab. Research Co. Publication, Delhi.
- Parihar, N. S. 1965. Pteridophytes, Central Book Depot, Allahabad.

- Parihar, N. S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.
- Rashid, A. 1999. An Introduction to Pteridophytes. Vikas Publishing House Pvt. Ltd.
- Shukla, A.C. and Mishra, S.P. 1975. Essential of Paleobotany. Vikas Publishing House Pvt. Ltd., Delhi
- Singh, H. 1978. Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X. Gebruder Borntraeger, Berlin.
- Smith, G.M: Cryptogamic Botany Vol- I. 1972. (Second Edition), Tata McGraw- Hill Publishing Company Ltd, Bombay- New Delhi.
- Smith, G.M: Cryptogamic Botany Vol- II. 1972. (Second Edition), Tata McGraw- Hill Publishing Company Ltd, Bombay- New Delhi.
- Sporne, K. R. 1991. The Morphology of Gymnosperms. Hutchinson University Library, London.
- Sporne, K. R. 1991. The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Bombay.
- Stewart, W. N. and Rathwell, G.W. 1993. Paleobotany and Evolution of Plants. Cambridge University Press.
- Trivedi and Singh. 1966. An Introduction to Gymnosperms. Shashidhar Malviya Prakashan, Lucknow
- Vashishtha, P.C. 2005. Gymnosperms. S. Chand & Company, New Delhi.

Paper- BOT PG 103: Taxonomy and Morphology of Angiosperms

Unit-1: Introduction, aims, objectives and principals of taxonomy. Systems of angiosperm classification, phenetic versus phylogenetic systems. Cladistics in taxonomy, relative merits and demerits of major systems of classification. Salient features of International Code of Botanical Nomenclature.

Unit-2: The species concept, taxonomic hierarchy- species, genus, family and other categories. Principles used in assessing relationship, delimitation of taxa and attribution of rank. Taxonomic evidence- and Relevance of Taxonomy to Conservation.

Unit-3: Taxonomic tools- herbarium, Floras, Histological, Cytological, Phytochemical, Serological, Biochemical and Molecular techniques, Computers and GIS. Local Plant Diversity and its socio-economic importance. Endemism, Hotspots, Hottest Hotspots, Plant Explorations, Invasions and Introductions.

Unit-4 Morphological and anatomical structure of vegetative parts of the plants: Root, Stem and Leaf- their types, modifications and functions. The vegetative shoots. Phyllotaxis and leaf meristems. Types of wood ray and bark types.

Unit-5: Morphological and anatomical structure of flower and their parts: Stamens, types of pollen tetras. Carpels, types of Ovaries and ovules. Placentation- types and their origin. Structure, types and morphology of fruits and seeds.

Suggested Readings

- Banson, L. B. 1957: Plant Classification, Health & Co. Boston.
- Davis P.R. & Heywood V.H. 1973: Principles of Angiosperms and Taxonomy. Robert E. Kreiger Pub. Co. New York, USA.
- Eames, A. J. 1961: Morphology of Angiosperms, Mc-Graw Hill, New York.
- Heywood & Moore, D. M. 1984: CW Tent concept in Plant taxonomy Academic Press.
- Jeffery, C. 1968: An Introduction to Plant Taxonomy. J. & H. Churchill Limited
- Lawrence, G.H.M. 1951: Taxonomy of Vascular Plants. Macmillan, New York.
- Massey J.R. and Ben. C.R. 1974. Vol-II. Pant Systematics, Harper & Row, New York
- Naik, V. N. 1992: Taxonomy of Angiosperms. Tata Mc-Graw Hill Pub. Co. Ltd. New Delhi
- Singh, V.P. & Khare, V.S. 1996 Flora of Ujjain district. PEBA Publishers New Delhi
- Singh, V.P. 2014 Flora of Madhya Pradesh (Western Part) Scientific Publishers Jodhpur
- Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford & IBH Pub. Co. New Delhi
- Sporne, K. R. 1974. The Morphology of Angiosperms. Hutchinson University Library, London
- Verma, D.M., Balkrishnan, N.P. & Dixit, R.D. 1993 Flora of M.P. 5 volumes. B.S.I., Calcutta

Paper- BOT PG 104: Plant Development and Reproduction

Unit-1: Unique features of plant development. Differences between development of different plant groups. Organization of shoot apical meristem (SAM). Control of tissue differentiation specially Xylem, Phloem, Secretary ducts and Laticifers. Wood development in relation to environmental factors.

Unit-2: Organization of root apical meristem (RAM). Cell fates and lineages, Vascular tissue differentiation, Lateral roots, Root hairs. Root-microbe interaction. Leaf growth and differentiation.

Unit-3: Flower development, genetics of floral organ differentiation. Sex determination, homeotic mutants in *Arabidopsis* and *Antirrhinum*. Vegetative options and sexual reproduction. Structure of Anthers, microsporogenesis, role of tapetum, pollen development and gene expression.

Unit-4: Pollen germination, pollen tube growth and guidance. Pollen storage, pollen allergy and pollen dispersal. Male sterility. Ovule development, megasporogenesis, organisation of embryo sac, Structure of embryo sac cells.

Unit-5: Floral characteristics, pollination, breeding systems, pollen stigma interactions, sporophytic and gametophytic self-incompatibility, double fertilization, endosperm development, embryogenesis, polyembryony, apomixes, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation.

Suggested Readings

- Atwell, B.J. Kriedermann, P.E. and Jurnbull, C.G.N. (eds). 1999. Plants in Action: Adaptation in Nature, Performance in Cultivation. MacMillan Education, Sydney, Australia.
- B.M. Johri (Ed.) 1984 Embryology of Angiosperms. Springer-Verlag
- Bhojwani, S.S. & Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Edition). Vikas Publishing House Delhi.
- Bhojwani, S.S. & Bhatnagar, S.P. 1976 Embryology of Angiosperms. 2 Ed Vikas Publishing House Pvt. Ltd.
- Burgess, J. 1985. An Introduction to Plant cell Development. Cambridge University Press, Cambridge.
- Fageri, K. & Van der Pijl 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford
- Fahn, A. 1982. Plant Anatomy. 3rd Edition. Pergamon Press, Oxford.
- Fosket, D. E. 1994. Plant Growth and Development. A Molecular Approach. Academic Press San Diego.
- Howell, S.H. 1998. Molecular Genetics of Plant Development. Cambridge University Press Cambridge.
- Leins, P., Tucker, S.C. & Endress, P.K. 1988. Aspects of Floral Development. J. Cran Germany.
- Lyndon, R.F. 1990. Plant Development. The Cellular Basis. UniHyman. London.

- Maheshwari, P. 1950 An Introduction to Embryology of Angiosperma. Mc Graw-Hill Book Co. Inc. NY
- Murphy, T.M. & Thompson, W.E. 1988. Molecular Plant Development. Prentice Hall, New Jersey.
- Proctor, M. & Yeo, P. 1973. The Pollination of Flowers. William Collins Sons; London.
- Raghvan, V. 1986. Embryogenesis in Angiosperms. The Press Syndicate of Cambridge University, NY
- Raghvan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
- Raghvan, V. 1999. Developmental Biology of Flowering Plants. Springer-Verlag.

Paper- BOT PG 105: Practical**Suggested Laboratories exercise of paper 101: Biology and Diversity of Algae and Bryophytes**

1. Morphological study of representative members of division Cyanophyta, Charophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rodophyta, etc.
2. Study of permanent slides and specimens of various representative members of division Thallophyta.
3. Collection of Algal material from nearest locality.
4. Morphological and anatomical study of representative members of division Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales etc. (Section cutting and preparing permanent slide)
5. Study of permanent slides and specimens of various representative members of Bryophyta.
6. Collection of Bryophytes material from nearest locality.

Suggested Laboratory exercises 102: Biology and Diversity of Pteridophyta and Gymnosperms

1. Comparative study of the anatomy of vegetative and reproductive parts of Pteridophytes: *Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Pteris, Ophioglossum and Isoetes*.
2. Study of Morphology, Anatomy and reproductive structures of Pteridophytes from prepared slides and specimens.
3. Comparative study of the anatomy of vegetative and reproductive parts of *Cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cyptomeria, Taxodium, Pinus, Biota, Podocarpus, Agathis, Taxus, Ephedra and Gnetum*.
4. Study of important fossil gymnosperms and living gymnosperms from prepared slides and specimens.

Suggested Reading for the Laboratory exercises

- Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.
- Chamberlin, C. J. 1998. Gymnosperms- Structure and Function. CBS Publishing and Distributors, New Delhi.
- Foster, A. S. and Gifford, E.M. Comparative Morphology of Vascular Plant. Vakils, Feffer & Sissons Pvt. Ltd., Bombay.
- Parihar, N. S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.
- Shukla, A.C. and Mishra, S.P. Essential of Paleobotany. Vikas Publishing House Pvt. Ltd., Delhi
- Singh, H. 1978. Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
- Sporne, K. R. 1991. The Morphology of Gymnosperms. Hutchinson University Library, London.
- Stewart, W. N. and Rathwell, G.W. 1993. Paleobotany and Evolution of Plants. Cambridge University Press.

- Suggested Laboratories exercise of paper 103: Taxonomy and Morphology of Angiosperms**
1. Description of a specimen from representative, locally available representative families (about 25).
 2. Description of a species based on various specimens to study intraspecific variation: a collective exercise.
 3. Description of various species of a genus; location of key characters and preparation of keys at generic level.
 4. Location of key characters and use of keys at family level.
 5. Field trips within and around the campus, compilation of field note and preparation of such plants, wild or cultivated, as are abundant.
 6. Training of using flora and herbaria for identification of specimens in the class.
 7. Comparison of different species of genus and different genera of a family to calculate similarities coefficient and preparation of dendrograms.
 8. Preparation of a herbarium based on morphological and anatomical study of vegetative and reproductive.
 9. Study of various types of placentations, inflorescence, ovules and fruits.

Suggested Laboratories exercise of paper 104: Plant Development and Reproduction

1. Study of primary and secondary anatomical structure of root and stem in selected dicots and monocots.
2. Microscopic examination of monocot and dicot leaves to understand the internal structure of leaf tissue and trichomes, glands etc. Also study the C₃ and C₄ leaf anatomy of plants.
3. Examination of modes of anther dehiscence and collection of pollen grains of microscopic examination.
4. Test of pollen viability using stain in-vitro germination. Estimating percentage and average pollen tube length in vitro.
5. Field study of several flowers with different pollination, mechanism.
6. Emasculation, bagging and hand pollination to study pollen germination.
7. Study of permanent slides and specimen and comments upon them.

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CBCS based Syllabus for Class- M.Sc. (Botany) - II Semester

Paper- BOT PG 201: Cytogenetics and Genetics

Unit:1

Brief history of Genetics. Chromosome structure and functions. Karyotype and its evolution. Organization of chromatin, euchromatin and heterochromatin, packaging of DNA, nucleosome. Chromosome banding. Special types of chromosomes. Cell cycle: control mechanisms, role of cyclins and cyclin dependent kinases. Cell divisions: Mitosis and Meiosis, cytokinesis and cell plate formation, mechanisms of Programmed cell death.

Unit: 2

Cytogenetics of Numerical and Structural changes of chromosomes: origin, Meiosis and breeding behavior of duplication, deficiency, Inversion and Translocation heterozygotes; Origin, occurrence, production and meiosis of haploids, euploids and aneuplois; origin, types and production of autopolyploids and allopolyploids; their significance and uses.

Unit: 3

Organization of genetic material: Nuclear DNA content, C- Value paradox and repetitive DNA sequences, Cot curve and its significance. Molecular cytogenetics: Restriction mapping, in situ hybridization- concepts and techniques, physical mapping of gene on chromosomes FISH, GISH. Virtual and spectral karyotypes.

Unit: 4

Mendel's laws of Inheritance, lethality and Interaction of genes, Quantitative Inheritance, Multiple alleles. Physical basis of Heredity: The chromosome theory of Inheritance. Linkage and crossing over and chromosome mapping in eukaryotes. Extra chromosomal Inheritance: inheritance of Mitochondrial and Chloroplast genes.

Unit: 5

Mutations: Types (lethal, conditional, biochemical, molecular etc.), causes and methods of detection. Germinal versus somatic mutants. Induced mutagenesis; physical and chemical mutagens. Transposable elements in prokaryotes and eukaryotes. Genetic recombination in prokaryotes (transformation, conjugation and transduction) and in eukaryotes.

Suggested Readings

- A.Kornberg & T.A.Baker 1992 DNA Replication. W.H.Freeman
- Aherly, A.G. Girton, J.R. & Mc Donald, J.E. 1999. The Science of Genetics. SaPosts College Publishing, Fort Worth, U.S.A.
- Benjamin Lewin 2010 Gene X. Pearson Prentice Hall
- Brown, T. A. 2006 Gene Cloning & DNA Analysis, 5th Edition (Supplier ; N R Distributor , Delhi)
- Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
- Busch, H. & Rothblum, L. 1982. Volume X. The Cell Nucleus rDNA Part A. Academic Press.
- Clark, David 2005 Molecular Biology (Supplier ; N R Distributor , Delhi)
- F. Jacob 1973. The Logic of Life : A History of Heredity. Pantheon Book, N.Y.
- Fairbanks & Anderson 1999 Genetics the continuity of life. Cole Pub. Co
- Hartl, D.L. & Jones, E.W. 2006. Genetics: Principles and Analysis (5th edition). Jones & Bartlett Publishers, Massachusetts, U.S.A.
- Jurgen Schulz-Schaeffer 1980 Cytogenetics Plants, Animals, Humans. Springer-Verlag
- Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
- Lewis, R. 1997. Human Genetics: Concepts and Applications. (2nd edition). WCB McGraw Hill, U.S.A.
- Matt Ridly 2000 Genome : The autobiography of a species in 23 chapters. Fourth Estate
- P. K. Gupta 2004 Biotechnology and Genomics Rastogi Publisher, Meerut
- P. K. Gupta 2010 Cytogenetics Rastogi Publisher, Meerut
- P. K. Gupta 2010 Genetics Rastogi Publisher, Meerut
- R. C. King & W. D. Stansfield 2002 A Dictionary of Genetics. Oxford University Press
- R. Dulbecco 1987 The Design of Life Yale University Press, New Haven
- R. J. Singh 1996 Cytogenetics. CRC Press
- R. Morris et al. 1998 Cytogenetics : Classical & Molecular Kluwer Academic Publisher
- R. S. Verma 1995 Human Chromosomes : Manual of Basic Techniques Mc Graw Hill
- Russel, P.J. 1998. Genetics (5th edition) The Benjamin/Cummings Publishing Company Inc., U.S.A.
- Snustad, D.P. & Simmons, M.J. 2006. Principles of Genetics (3rd edition). John Wiley & Sons Inc., U.S.A.
- Wagner, R.P. , Maguire, M.P. & Stalling, R.L. 1993 Chromosomes. Wiley - Liss, NY
- Watson, Baker, Bell, Gann, Levine, Losick 2004 Molecular Biology of the Gene V Edition Pearson Education, Inc.
- Willium Klug & Michael Cummings 2002 Concepts of Genetics. Prentice Hall

Paper- BOT PG 202: Cell and Molecular Biology**Unit: 1**

Structural organization of the cell: specialized plant cell types, structure and function of cell wall, biogenesis, growth. Cytoskeleton: organization and role of Microtubules and Microfilaments, motor movements. Plasma membrane: structure, models and functions, sites for ATPases, structure of Plasmodesmata and role in the movement of molecules.

Unit: 2

Chloroplast: structure, genome organization and expression, functions, nucleo-chloroplastic interactions. Mitochondria: structure, genome organization, biogenesis, functions. Plant Vacuoles: as storage organelle, Tonoplast membrane, ATPases, as transporters. Golgi apparatus. Lysosomes, Endoplasmic Reticulum.

Unit: 3

Structure and functions of Nucleus: The nuclear envelope, structure of the Nuclear pore complex (NPC) and its role in Nucleo - cytoplasmic exchange. The concept of a gene as a unit of inheritance. The chemical nature of the gene, Structure of DNA: A, B, and Z forms, Watson- Crick model, DNA supercoiling, Organization of the genome.

Unit: 4

Functions of Nucleic Acids: DNA Replication in prokaryotes and eukaryotes: basic features of DNA replication *in vivo* and *in vitro*, role of DNA polymerases and other enzymes, the complex replication apparatus. Gene expression: Transcription in prokaryotes and eukaryotes. RNA Processing in eukaryotes, RNA splicing. Promoters and transcription factors. Types of RNA molecules. Interrupted genes in eukaryotes: exons and introns.

Unit: 5

Translation and the Genetic code: synthesis of protein, mechanism of translation- initiation, elongation and termination. Genetic code- properties, codon assignment and Wobble hypothesis. Structure and role of tRNA, Protein sorting, targeting of proteins to organelles. Regulation of gene expression in prokaryotes (operon and other models) and in eukaryotes.

Suggested Readings

- Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. & Watson J.D. 1999. Molecular biology of the Cell. Garland Publishing Inc., New York, U.S.A.
- Benjamin Lewin 2010 Gene X. Pearson Prentice Hall
- Buchanan, B.B. Gruissem, W. & Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologist, Maryland, U.S.A.
- De, D.N. 2000. Plant Cell Vacuoles: An Introduction. CSIRO Publication, Coollingwood, Australia.
- Karp, G. 1999. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons Inc., U.S.A.
- Kleinsmith, L.J. & Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd edition). Harper Collins College Publishers, New York, U.S.A.
- Kumar, H. D. 2000. Molecular Biology. Vikas Publishing House. Pvt. Ltd.
- Lodish, H. Bert, A. Zipursky, S.L. *et al.*, 2000. Molecular Cell Biology. W.H. Freeman and Co., New York, U.S.A.
- Malacinski, G.M. and Freifelder, D. 1998. Essentials of Molecular Biology (3rd edition). Jones and Barlett Publishers, Inc. U.S.A.
- P. K. Gupta 2010 Genetics Rastogi Publisher, Meerut
- Pollard, T.S. & Eajnshaw, W.C. 2002. Cell Biology. SaPosts, Philadelphia, U.S.A.
- Rost, T. *et al.*, 1989. Plant Biology. Wadsworth Publishing Co., California, U.S.A.
- Sheeler, P. and Bianchi, D. E. 2006. Cell and Molecular Biology. John Wiley & Sons.
- Snustad, D.P. & Simmons, M.J. 2006. Principles of Genetics (3rd edition). John Wiley & Sons Inc., U.S.A.
- Twyman, R. M. 2003. Advanced Molecular Biology. Viva Books Private Ltd. New Delhi.
- Watson, Baker, Bell, Gann, Levine, Losick 2004 Molecular Biology of the Gene V Edition Pearson Education, Inc.
- Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, U.S.A.

Paper- BOT PG 203: Ecology

Unit-1: Ecology and Ecosystem: Definition, types, history and scope, Organization and components. Structure, functions and types of ecosystems, trophic organization, food chains, food webs, Energy flow pathways; Productivity and net energy. Ecosystem cybernetics and ecological footprints

Unit-2: Population Ecology- Growth and Regulation: Ecological population, Densities, distribution, natality, mortality, survival curves, growth, age structures and pyramids. Fecundity schedules, Life Tables; Exponential and logistic curves; Intra specific competition and self regulation; r - and k -Strategies. Population Genetics.

Unit- 3: Community Ecology, Ecosystem development and biodiversity: Concepts, types and analysis of community, ecological niche, ecades, ecotypes; Interspecific association; Evolution and differentiation of species; Keystone & dominant species; Concept of biodiversity; Causes of biodiversity loss; Hot spots. Succession- processes, types and mechanisms. Concept of climax persistence, resilience and resistance. Ecological perturbations and ecosystem restoration.

Unit- 4: Nutrient pathways, Biogeochemical cycles and soil: Nutrient exchange and cycling; Relationship between energy flow and recycling pathways. Global biogeochemical cycles of C, N, P, S and hydrological cycle. Biological magnification of toxic substances. Soil profile; Physical, chemical and biological properties of soil.

Unit- 5: Environmental Pollution, climate change and conservation: Kinds, sources and effects of air, water, soil, noise and radioactive Pollution. Green House gases- trends, role and effect on climate; Acid rain; Global ozone problem and global warming. Different methods for soil and water conservations. Plant resource - Forest. Natural forest management v/s joint forest management.

Suggested Readings:

- Andrews, W.R., Jackson & Julie, M. Jackson. 1996. Environmental Science- The Natural Environment and Human Impact. Addison Wesley Longman Ltd.
- Barbour, M.G., Burk, J.H. and Pitts, W.O. 1987. Terrestrial Plant Ecology. Cummings Pub. Co., California.
- Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science. Cambridge. U.K.
- Brady, N. C. 1990. The Nature and Properties of Soils. MacMillan.
- Chapman, J.L. and Reiss, M.J. 1988. Ecology- Principles and Applications. Cambridge University Press, Cambridge, U.K.
- Heywood, V.H. and Watson, R. T. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.
- Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press, Cambridge, U.K.
- Kohli, R., Arya, K. S., Singh, P. H. and Dillon, H. S. 1994. Tree Directory of Chandigarh. Lovedale Educational, New Delhi.

- Kormondy, E. J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
- Kothari, A. 1997. Understanding biodiversity- Life sustainability and Equity. Orient Longman.
- Ludwig, J. and Renold, J.F. 1988. Statistical Ecology. John Wiley & Sons., New York.
- Mason, C. F. 1991. Biology of Freshwater Pollution. Orient Longman.
- Moldan, B. and Billharz, S. 1997. Sustainability Indicators. John Wiley & Sons., New York.
- Muller- Dombols, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology. Willey, New York.
- Nair, M. N. B. et al. (Eds.). 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry. Universiti Putra, Malaysia.-434004, P.M. Serdang, Selangor, Malaysia.
- Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
- Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.
- Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Brooks/ Cole, EWP Pvt. Ltd., New Delhi.
- Santra, S.C. 2008. Environmental Science. New Central book Agency Pvt. Ltd., Kolkota.
- Sharma, P.D. 2000. Ecology and Environment. Rastogi Publications, Meeruth.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publisher, New Delhi.
- Smith, R.L. 1996. Ecology and Field biology. Harper Collins, New York.
- Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
- Wilson, E.O. 1988. Biodiversity. National Academic Press, Washington, D.C.

Paper- BOT PG 204: Plant Physiology and Biochemistry**Unit-1**

The structure and properties of water, plant water relations, mechanism of water transport through xylem, root-microbe interactions in facilitating nutrient uptake. Membrane transport process and proteins.

Unit-2

Phloem transport; phloem loading and unloading, passive and active solute transport. Signal transduction; overview, receptors and proteins, phospholipids signalling, role of cyclic nucleotides, calcium-calmodulin cascade. Specific signalling mechanisms in bacteria and plants.

Unit-3

Plant growth regulators and elicitors: physiological effects and mechanism of action of plant hormones. Photoperiodism, endogenous clock, floral induction and development, phytochromes and cryptochromes, role of vernalization. Stress physiology: biotic and abiotic stress, water deficit and drought resistance.

Unit-4

Structure and function of biomolecules: carbohydrates, lipids proteins, nucleic acids. Fundamentals of enzymology: allosteric mechanism, enzyme kinetics, regulation, mechanism of enzyme action, isozymes, enzyme immobilization Respiration: Overview, glycolysis, TCA cycle, electron transport and ATP synthesis. Oxidative pentose phosphate pathway, alternative oxidase system.

Unit-5

Photosynthesis and Photochemistry: General concepts, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes. Photooxidation of water, mechanism of electron and proton transport. Carbon assimilation: Calvin cycle, photorespiration and its significance, C4-cycle, CAM pathway, physiological and ecological considerations.

Suggested readings

- Asana, R. D. and Nanda, K. K. 1965. Growth and Development of Plants. Today and Tomorrow's Book Agency. New Delhi.
- Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. Biochemistry and molecular Biology of plants. American Society of Plants Physiologist, Maryland USA.
- Dennis, D. T. and Terpin, D. H., Lefevre, D. D. and Layzell, D. V. 1997 Plant Metabolism II Ed. Longman England.

- Goodwin, T. W. and Mercer, E. I. 1985. Introduction to Plant Biochemistry. Pergamon Press New York.
- Heldt, H.W. 2005. Plant Biochemistry. Elsevier Academic Press. Amsterdam
- Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
- Jones, H.G., Flowers, T.J. and Jones, M.B. 1993. Plants Under Stress: Biochemistry, Physiology and Ecology and their Applications to Plant Improvement. Cambridge University Press, NY.
- Kumar, H.D. and Singh, H. N. 1976. Plant metabolism East-West Press Pvt. Ltd. New Delhi.
- Lodish, H., Berk, A. Zipursky, S. L., Matsudaria, P., Baltimore, D. and Darnell, J. 2000. Molecular cell Biology (fourth edition). W.H. Freeman and company, New York USA.
- M. Ashraf, M., Ozturk, M., Athar, H.R. (Editors). 2009. Salinity and Water Stress: Improving Crop Efficiency. Springer Science + Business Media B.V.
- Moore, T. C. 1989. Biochemistry and Physiology of Plant Hormones (second edition). Springer-Verlag, New York. USA.
- Nelson, D.L. and Coax, M.M. (2000). Lehlingers- Principles of Biochemistry III Ed. MacMillan Worth Publishers.
- Nobel, P. S. 1999. Physiochemical and environmental Plant Physiology (second edition). Academic Press, San Diego, USA.
- Paleg, L.G. and Aspinall, D. 1981. The Physiology and biochemistry of drought resistance in plants. Academic Press, University of California, USA.
- Pandey S.N. and Sinha, B.K. 2009. Plant Physiology. Vikas Publication Pvt. Ltd. New Delhi. Publications, Meerut
- Purohit, S.S. 1984. Hormonal regulation of plant growth and development -I. Agro-Botanical Publishers. Bikaner.
- Salisbury, F. B. and Ross, C. W. 1991 Plant Physiology IV Edition Wdsworth Publishing co. California USA.
- Shrivastava, H.S. 2005 Plant Physiology and Biochemistry. Rastogi Publications, Meerut
- Shrivastava, H.S. 2009 Plant Physiology, Biochemistry and Biotechnology. Rastogi
- Stryer, L. 1988. Biochemistry. Freeman and company. New York.
- Taiz, I. and Zeiger, E. 1998 Plant Physiology II Edition. Sinauer Associates Inc. Publisher MS.
- Taiz, L. and Zeiger, E. 2014. Plant Physiology and Development. Sinauer Associates. Incorporated
- Verma, S. K. and Verma, M. 2008. A Textbook of Plant Physiology, Biochemistry And Biotechnology. S. Chand Limited, New Delhi.

Paper- BOT PG 205: Practical

Suggested Laboratory exercises: 201: Cytogenetics and Genetics

1. Study of mitotic stages and metaphase chromosomes in suitable materials.
2. Study of meiotic stages in suitable materials.
3. Preparation of karyotype.
4. Working out the Mendel's laws of inheritance and interaction of genes using seed mixture.
5. Working out the effect of mono and tri-somy on plant phenotype, fertility and meiotic behaviour.
6. Induction of polyploidy using colchicine; different methods of the application of colchicine.
7. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
8. Effect of translocation heterozygosity on plant phenotype, chromosome pairing and chromosome disjunction and pollen and seed fertility.
9. Meiosis of complex translocation heterozygotes.
10. Isolation of chlorophyll mutants of following irradiation and treatment with chemical mutagens.

Suggested Laboratory exercises: 202: Cell & Molecular Biology

1. Isolation of genomic DNA from plant tissue using CTAB (cetyltri methyl ammonium bromide) or any animal tissue.
2. Isolation of DNA & its quantitation by a spectrophotometric method.
3. Restriction digestion of plant DNA, its separation by Agrose gel electrophoresis and visualization by ethidium bromide staining.
4. Isolation of RNA and quantitation by a spectrophotometric method.
5. Separation of RNA by Agrose gel electrophoresis and visualization by Et.Br.staining.
6. Immunological techniques : Ouchterlony method, ELISA & western blotting.
7. Isolation of chloroplasts and SDS-PAGE. Profile of proteins to demarcate the two subunits of Rubisco.

Suggested Laboratory exercises: 203: Ecology

1. To determine minimum size and number of quadrats required for a liable estimate of biomass in Grasslands.
2. To find out association between important grassland species using Chi-square test.
3. To compare protected and unprotected grassland stands using community coefficients (Similarity indices).
4. To analyze plant communities using Bra- Curtis ordination method.
5. To determine diversity indices (Shannon-Wiener, concentration of dominance, species richness, Equitability and unprotected grassland stands.
6. To estimate [V] of the species in a woodland using point centered quarter method.

7. To determine gross and net phytoplankton productivity by light and dark bottle method.
8. To determine soil moisture content, porosity and bulk density of solid collected from varying depths at different location.
9. To determine the water holding capacity of soils collected from different locations.
10. To determine percent organic carbon and organic matter in the soil or cropland, grassland and forest.
11. To estimate to dissolved oxygen content in eutrophic and oligotrophic water sample by Azide modification of winkler's method.
12. To estimate chlorophyll content in SO₂ fumigated and unfumigated plant leaves.
13. To estimate rate of carbon dioxide evolution from different soil using soda lime or Alkyl absorption method.

Suggested Reading for the Laboratory exercises

- APHA- 2000. Standard Methods for the Examination of Water and Waste Water, American Public Health Association, Washington, D.C.
- Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop plants in India NBPGR Science Monograph No. 7.
- Baker, H.G. 1978. Plants civilization (3rd ed.). C.A Wadsworth, Belmont.
- Bole P.V. and vaghani, Y. 1986. Field Guide to common Indian Trees. Oxford University Press, Mumbai.
- Chandel, K.P.S Shukla, G. and sharma, N. 1966 Biodiversity in Medicinal and Aromatic Plants in India: Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
- Krebs. G.J.: 1989. Ecological Methodology, Harper and Row, New York, USA.
- Ludwig. J.A. and Reynolds, J.F.: 1988. Statistical Ecology. Wile, Newyork.
- Magurran, A.E.: 1988 Ecological Diversity and its Measurement. Chapman & Kall, Lndon.
- Misra, R. : 1968 Ecology Work, Book. Wxford& IBH, New Delhi.
- Moore. P.W. and Chapman, S.B.: 1986 Method in Plant Ecology, Blackwell Scientific Publications.
- Muller-Demobois. D. Ad Ellenberg, H. : 1974 Aims and Methods of Vegetation Ecology, Wile, New York.
- Plelou. E.C.: 1984. The Interpretation of Ecological Data. Wiley, New York.
- Smith, R.L: 1996 Ecology and Field Biology, Harper Collins, New York.
- Sokal, R.R and Rohlf, F.J: 1995. Biometry. W.H. Freeman& Blackwell Scientific Publications.

Suggested Laboratory Exercises: 204: Plant Physiology and Biochemistry

1. Effect of time and enzyme concentration on the rate of reaction of enzyme. e.g. acid phosphatase, nitrate reductase.
2. Effect of substrate concentration on activity of any enzyme and determination of its K_m value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
5. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
6. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
7. To determine the chlorophyll a/ chlorophyll b ratio in C3 and C4 plants.
8. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
9. To demonstrate photophosphorylation in intact chloroplast, resolve the phosphoproteins by SDS- PAGE and perform autoradiography.
10. Extraction of seed proteins depending upon the solubility.
11. Desalting of proteins by gel filtration chromatography employing Sephadex G25.
12. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's or Bradford's method.
13. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex G200.
14. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Brilliant Blue or silver nitrate.

CBCS based Syllabus for Class- M.Sc. (Botany) - III Semester

Paper- BOT PG 301: Basic Biotechnology

Unit-1

Biotechnology: history, origin and definition. Basic concepts, principles and scope. Different aspects of biotechnology: genetic engineering, plant and animal tissue culture, microbial biotechnology, environmental biotechnology, enzyme and.

Unit-2

Plant Biotechnology: General introduction and history. Laboratory organization, culture media and sterilization. Techniques of plant cell, tissue and organ culture. Cytodifferentiation and organogenic differentiation; organogenesis, embryogenesis, types of culture. Micropropagation / Clonal propagation.

Unit-3

Protoplast isolation, culture, somatic hybridization, hybrid selection and regeneration, artificial seeds, production of haploids, somaclones and somaclonal variations, production of secondary metabolites. Cell immobilization. Cryopreservation.

Unit-4

Animal Biotechnology: Animal cell and tissue culture, In vitro fertilization (IVF) and Embryo transfer in humans and livestock. Cloning. Transfection methods. Enzyme biotechnology: enzyme engineering, protein engineering, immunotoxins, drug designing. Microbial biotechnology: isolation and culturing of micro-organisms; microbial fermentation, microbial transformation; nitrogen fixation; biofertilizers.

Unit-5

Applications: transgenic plants, DNA fingerprinting, molecular maps, pollution control, production of organic compounds and enzymes Environmental biotechnology: water pollution, BOD sensor, waste water treatment, renewable sources of energy, energy and fuel using micro-organisms; Air pollution: pesticides and herbicides pollution, degradation.
Intellectual Property Rights- possible ecological risks and ethical concerns.

Suggested readings

- Brown T. A. 1999. Genomes. John Wiley & sons, Singapore.
- Butenko, R.G. 2000. Plant Cell Culture. University Press of Pacific.
- Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetics. Resources: Conservation and Use. CAB International, Oxon, UK.
- Collin, H. A. And Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
- Dixon, R. A. (Ed.) 1987. Plant Cell culture: A Practical Approach. IRL Press, Oxford.
- Gelwin, S. B. and Schilperoot, R. A. (Eds), 1994. Plant Molecular Biology Manual, 2nd edition, Kluwer Academic Publishers, Dordrecht, the Netherlands.
- George, E. F. 1993. Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd. Edington, UK.
- George, E. F. 1993. Plant Propagation by Tissue Culture. Part 2. In practice, 2nd edition. Exegetics Ltd. Edington, UK.
- Glick, B. R. and Thompson, J. E. 1993. Methods in Plant Molecular Biology and Biotechnology. GRC Press, Boca Raton, Florida.
- 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.
- Gupta P. K. 2004 Biotechnology and Genomics, Rastogi Publisher, Meerut
- Gupta P.K., 2010 Genetics, Rastogi Publication.
- Jolles, O. And Jornvall, H. (Eds.) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK.

Paper- BOT PG 302: Genetic Engineering and Genomics

Unit-1

Genetic Engineering: basic concepts, principal and scope; Tools and techniques – isolation of DNA from bacteria, animal and plant cell. Restriction enzymes: endonucleases, ligases, kinases.

Unit-2

Cloning vectors: plasmids, bacteriophage, cosmids, phagemids, transposone, shuttle vectors. Techniques of restriction mapping- gel electrophoresis, blotting techniques, Gene cloning: construction of chimeric DNA, molecular probes, construction and screening of genomic and cDNA libraries. PCR- principle, technique and types.

Unit-3

Gene transfer in plants: vector dependent (*Agrobacterium*) mediated gene transfer. Direct DNA transfer (microinjection, electroporation, particle gun etc.). Strategies for development of transgenics. Transposon mediated gene tagging; Chloroplast engineering: transformation and its utility.

Unit-4

Gene transfer in animals. Transfection methods using fertilized or unfertilized eggs and cultured mammalian cells. Transgenic animals- mice, sheep, pig etc. Genetically modified bacteria and their uses in agriculture and control of pollution.

Unit-5

Genomics and Proteomics; genetics and physical mapping of genes; molecular markers for introgression of useful traits; artificial chromosomes; high throughput sequencing; genome project; bioinformatics; functional genomics; microarrays; protein profiling and its significance.

Suggested readings

- Brown T. A. 1999. Genomes. John Wiley & sons, Singapore.
- Brown, T. A. 2006 Gene Cloning & DNA Analysis, 5th Edition, (Supplier ; N R Distributor , Delhi)
- Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetics. Resources: Conservation and Use. CAB International, Oxon, UK.
- Edward Alchamo 2001 DNA Technology. The Awesome skill Harcourt- Academic Press
- Edward Alchamo 2001 DNA Technology. The Awesome skill. Harcourt- Academic Press
- Gelvin, S. B. and Schilperoort, R. A. (Eds), 1994. Plant Molecular Biology Manual, 2nd edition, Kluwer Academic Publishers, Dordrecht, the Netherlands.
- Glick, B. R. and Thompson, J. E. 1993. Methods in Plant Molecular Biology and Biotechnology. GRC Press, Boca Raton, Florida.

- 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.
- Jolles, O. And Jornvall, H. (Eds.) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
- Lodish, H. Bert, A. Zipursky, S.L. *et al.*, 2000. Molecular Cell Biology. W.H. Freeman and Co., New York, U.S.A.
- P. K. Gupta 2004 Biotechnology and Genomics, Rastogi Publisher, Meerut
- P. K. Gupta 2010 Genetics Rastogi Publisher, Meerut
- Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK.

**Paper- BOT PG 303: List of Discipline Centric Elective
(DCE Choice based- any one) Papers**

- a. Plant Pathology
- b. Utilization and Conservation of Plant Resources
- c. Ethnobotany
- d. Environmental Science
- e. Industrial Microbiology
- f. Forest Ecology
- g. Plant Tissue Culture
- h. Soil Biology and Conservation
- i. Plant Metabolism
- j. Environmental Microbiology

**Paper- BOT PG 303: List of Discipline Centric Elective
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- a. **Plant Pathology**
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- c. **Ethnobotany**
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- g. **Plant Tissue Culture**
- h. **Soil Biology and Conservation**
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- j. **Environmental Microbiology**

Vikram University, Ujjain

CBCS based Syllabus for Class- M.Sc. (Botany) - III Semester

Paper- BOT PG 303: Discipline Centric Elective

a. Plant Pathology

Unit 1. General Principles

- 1.1 History of plant pathology and its modern trends. Plant pathology in India and role of plant pathology in Indian Agriculture.
- 1.2 Nature, concept, importance and classification of plant diseases. Symptomatology and identification of plant diseases.
- 1.3 Methods of investigating plant diseases, Koch's postulate, establishment of pathogenicity. Dissemination of plant pathogens. Disease forecasting.
- 1.4 The phenomenon of infection, host-pathogen relationships, Pathogenesis and disease development.

Unit 2. Mechanism of Disease Development and Resistance

- 2.1 Seed as carrier of plant disease, seed surface micro-flora, seed pathology.
- 2.2 Concept of genetics of resistance and susceptibility, horizontal and vertical resistance. Breeding of resistant varieties.
- 2.3 Mechanisms of plant defense against pathogens.

Unit 3. Diseases caused by viruses, Mycoplasma and Bacteria

- 3.1 Diseases caused by viruses: mosaic, necrosis and leaf curl of potato, bunchy top of banana, leaf curl of papaya.
- 3.2 Diseases caused by mycoplasma: little leaf of brinjal, greening disease of citrus, grassy shoot of sugarcane.
- 3.3 Diseases caused by bacteria: citrus canker, tundu disease of wheat, soft rot of potato, blight of rice, angular leaf spot of cotton.

Unit 4. Diseases caused by Lower Fungi, Ascomycetes and Basidiomycetes

- 4.1 Diseases caused by myxomycetes: club root diseases of crucifer.
- 4.2 Diseases caused by phycomycetes: wart of potato, white rust of crucifers; downy mildew of peas, green ear disease of bajra.
- 4.3 Diseases caused by Ascomycetes: stem gall of coriander, peach leaf curl, powdery mildew of wheat, ergot of bajra.
- 4.4 Diseases caused by Basidiomycetes; loose smut of wheat, covered smut of barley, rust of wheat, wheat rust problem in India.

Unit 5. Diseases caused by Deuteromycetes and Principles of Plant Disease Control

- 5.1 Disease caused by Deuteromycetes: wilt of cotton, root rot of cotton, canker of potato, takka disease of groundnut, and blast disease of rice, red rot of sugarcane.
- 5.2 Principles and practice of plant disease control: Physical and regulatory methods, physical agents, chemotherapy, biological control.

Suggested Readings

- Agrios, G.N. 1978. Plant Pathology. Academic Press. New York.
- Blackwell Scientific Publication, Oxford.
- Dickinson. H. and Lucas. 1977. Plant Pathology and Plant Pathogens.
- Manners, J.G. 1982. Principles of Plant Pathology. Cambridge University Press. Cambridge.
- Mehrotra. R.S, and Agrawal, A. 2002. Plant Pathology. Tata McGraw-Hill Publishing company, New Delhi.
- Plank, J.E. Van Den. 1975. Principles of Plant Infection. Academic Press, New York.
- Rangaswamy, G. 1962. Bacterial Plant Diseases in India. Asia Publishing House, Bombay.
- Rangaswamy, G. 1975. Diseases of Crop Plants in India. Prentice Hall of India Private Limited. New Delhi.
- Raychawdhary, S.P. and Nariani, T.K. 1977. Virus and Mycoplasma Diseases in India. Oxford & IBH Publishing Co. New Delhi.
- Singh, R.S 1968. Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Co., New Delhi.
- Walker, J.C. 1972 Plant Pathology. Tata McGraw Hill Publishing Company, New Delhi.
- Wheeler, B.E.J. 1969. An Introduction to Plant Diseases. The English Language Book society and John Wiley and Sons. Ltd. London.
- Wheeler, H. 1975. Plant Pathogenesis. Springer- Verlag, Berlin.
- Wood, R.K.S. and Jellis, G.J.1984. Plant Diseases. Blackwell Scientific Publications, Oxford.

Suggested Field/Laboratory Exercises

1. Estimation of loss due to disease.
2. Fungi, bacteria as causal agents in plant diseases.
3. Isolation of pathogen from diseased material.
4. Isolation and identification of seed-borne microorganisms.
5. Production of wilt syndrome and toxin in *Fusarium* wilt of tomato.
6. Appresorium formations in root rot of bean caused by *Rhizoctonia solani*.
7. Transmission of viral diseases.
8. Production and measurements of activity of cellulase enzymes by pathogenic fungi.
9. Effect of *Fusarium* wilt on water transport in tomato.

Study of the following disease with the help of preserved material, museum mounts, microscopic slides and living material to bring out symptoms, pathogen, host-pathogen relationships and disease cycle.

1. Diseases caused by viruses, mycoplasma and bacteria.
2. Clubroot disease of crucifer, Wart disease, leaf and foot rot of pan.
3. White rust of crucifers, downy mildew diseases, Powdery mildew diseases.
4. Smut, Rust and Wilt diseases of important crops.
5. Tikka disease of ground nut, Root rot caused by *Rhizoctonia* spp., White rot of onion.
6. Effect of antibiotics on bacteria and fungi.

Paper- BOT PG 303: Discipline Centric Elective

(b) Utilization and Conservation of Plant Resources

Unit-1: Plant Biodiversity: Major Biomes of the world; Tropical rain and seasonal forests, Temperate rain and seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic biomes; Wetlands, Lakes, Ponds, Streams, Rivers, Marine, Estuarine habitats and Coral reefs.

Unit-2: Sustainable Development: Resource utilization; Status and utilization of Biodiversity; Sustainable development and utilization of resources from forest, grassland and aquatic habitats; Food forage, fodder, timber and non wood forest products; Threaten to quality and quantity of resources due to overexploitation.

Unit-3: Strategies for conservation of resources: Classification of Resources; Principle of conservations: *in-situ* Conservation, Sanctuaries, National Parks, Biospheres reserve for wild life conservations: Habitat conservation practices of conservation for Forest, Ranges, Soil and Water: *ex-situ* Conservation; Botanical gardens, Field gene banks, Seed banks, *in-vitro* Repositories, Cryo-banks.

Unit-4: Pollution and climate change: Air, Water and Soil Pollution; Kinds, Sources, Quality parameters; Effect on structure and function of ecosystem; Management of Pollution, Bioremediation: Climate change source; Trend and role of Green-house gases, Effect of Global warming on Climate, Ecosystem process and Biodiversity: Ozone layer and Ozone Hole.

Unit-5: Resources Monitoring: Remote sensing concepts and tools; Types of Remote Sensing: Satellite & Radar remote sensing; Basic sensors, Visual and Digital interpretation; EMR bands and their applications; Indian Remote Sensing Program; Thematic mapping of resources; Applications of Remote sensing in Ecology, Forestry, Agriculture and Water bodies.

Suggested Readings:

- Andrews, W.R., Jackson & Julie, M. Jackson. 1996. Environmental Science- The Natural Environment and Human Impact. Addison Wesley Longman Ltd.
- Barbour, M.G., Burk, J.H. and Pitts, W.O. 1987. Terrestrial Plant Ecology. Cummings Pub. Co., California.
- Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science. Cambridge. U.K.
- Brady, N. C. 1990. The Nature and Properties of Soils. MacMillan.
- Chapman, J.L. and Reiss, M.J. 1988. Ecology- Principles and Applications. Cambridge University Press, Cambridge, U.K.
- Heywood, V.H. and Watson, R. T. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.

- Hill, M.K. 1997. *Understanding Environmental Pollution*. Cambridge University Press, Cambridge, U.K.
- Jenson, J.R. 2003. *Remote Sensing of the Environment- An Earth Resource Perspective*. Pearson Education (Singapore) Pte. Ltd. Delhi
- Kohli, R., Arya, K. S., Singh, P. H. and Dillon, H. S. 1994. *Tree Directory of Chandigarh*. Lovedale Educational, New Delhi.
- Kormondy, E. J. 1996. *Concepts of Ecology*. Prentice-Hall of India Pvt. Ltd., New Delhi.
- Korte, G.B. 2001. *The GIS Book*. 5th Edition. Onward Press- Thomson Learning, Singapore.
- Kothari, A. 1997. *Understanding biodiversity- Life sustainability and Equity*. Orient Longman.
- Ludwig, J. and Renold, J.F. 1988. *Statistical Ecology*. John Wiley & Sons., New York.
- Mason, C. F. 1991. *Biology of Freshwater Pollution*. Orient Longman.
- Moldan, B. and Billharz, S. 1997. *Sustainability Indicators*. John Wiley & Sons., New York.
- Muller- Dombols, D. and Ellenberg, H. 1974. *Aims and Methods of Vegetation Ecology*. Willey, New York.
- Nair, M. N. B. et al. (Eds.). 1998. *Sustainable Management of Non-wood Forest Products*. Faculty of Forestry. Universiti Putra, Malaysia.-434004, P.M. Serdang, Selangor, Malaysia.
- Odum, E.P. 1971. *Fundamentals of Ecology*. Saunders, Philadelphia.
- Odum, E.P. 1983. *Basic Ecology*. Saunders, Philadelphia.
- Odum, E.P. and Barrett, G.W. 2005. *Fundamentals of Ecology*. Thomson Brooks/ Cole, EWP Pvt. Ltd., New Delhi.
- Santra, S.C. 2008. *Environmental Science*. New Central book Agency Pvt. Ltd., Kolkata.
- Sharma, P.D. 2000. *Ecology and Environment*. Kastogi Publications, Meeruth.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publisher, New Delhi.
- Smith, R.L. 1996. *Ecology and Field biology*. Harper Collins, New York.
- Treshow, M. 1985. *Air Pollution and Plant Life*. Wiley Interscience.
- Wilson, E.O. 1988. *Biodiversity*. National Academic Press, Washington, D.C.

(c) Ethnobotany

Unit-1: Definition and scope of Ethnobotany. Historical review and outline idea of archaeoethnobotany, Ethnocoology, Ethnomedicines, Ethnonarcotics, Ethnopharmacology, Ethnotaxonomy, Ethnocosmetics, Ethnolinguistics, Ethnoorthopadics, Ethnopadiarics.

Unit-2: Preservation of genetic diversity, plants used in various system of medicine- Ayurvedic, Unani and homeopathic system, Allopathic system. Plant used by villagers and tribal people. Role of Ethnobotany in the development of society.

Unit-3: Plants in mythology, Taboos and Totems in relation to plants, folklore and folktales. Wild life protection in tribal, Plant domestication by the tribal, Plants in similes in metaphors.

Unit-4: Ethnobotanical importance of – *Aconitum napellus*, *Allium cepa*, *Allium sativum*, *Aloe vera*, *Atropa belladonna*, *Azadirachta indica*, *Butea monosperma*, *Cassia fistula*, *Cannabis sativa*. *Emballica officinalis*, *Enginea jambolana*, *Hollarhena antidysertrica*, *Lawsonia inefis*, *Mantha arvensis*, *Nux vomica*, *Ocimum sanctum*, *Piper nigrum*, *Tarocarpus Marsupium*. *Ricinus communis*, *Santalum album*, *Terminallea bellerica*, *Terminallea chebula*, *Terminallea arjuna*, *Withania somanifera*.

Unit-5: Detailed study of the common plants and their parts used in the treatment of following disease- Expulsion of worms, Skin disease – Bronchial inflammation and asthma flamation, Tuberculosis, Urinogenital problems, Amoebic dysentery, Malaria, Rheumatism, Leprosy, Jaundice, Heart diseases, piles, leukoderma

Suggested readings:

- Cotton, C.M. 1996. Ethnobotany- Principles and applications, John Wiley & Sons, NY.
- Jain, S. K. & Mudgal V. 1999. A hand book of Ethnobotany. Bishan Singh & Mahendra pal Singh, Dehradun.
- Jain, S. K. & Rao R. R. 1976. Field and Herbarium methods. Today's & tomorrow Pub., New Delhi.
- Jain, S. K. & Shrivastava S. 1999. Dictionary of Ethnobotany- Veterinary Plants of India Deep Pub, New Delhi.
- Jain, S. K. 1987. Manual of Ethnobotany. Scientific Pub, Jodhpur.
- Jain, S. K. 1991. Dictionary of Indian Folk Medicine and Ethnobotany. Deep Pub, New Delhi.
- Jain, S. K. 1997. Contribution to Indian Ethnobotany -III Ed. Scientific Pub, Jodhpur.
- Jain, S. K. 2001. Bibliography of Indian Ethnobotany. Scientific Pub, Jodhpur.
- Jain, S. K. 1989. Methods and approaches in Ethnobotany. Society of Ethnobotany, Lucknow.
- Martin J. 1995. Ethnobotany. Chapman & Hall, London.

- Sakalami A. & Jain S. K. 1994. Cross Cultural Ethnobotany of N-E India. Deep Pub, New Delhi.
- Vargese E. 1996. Applied Ethnobotany- A case study of among the Kharia of Central India. Deep Pub, New Delhi.

Suggested Laboratories exercise of elective paper of Ethnobotany

1. Preparation of certain herbal drugs-

- 1- Triphla churn 2. Sitapodi churn 3. Satva 4. Triphla kwath 5. Sanjeevani vati 6. Vasa – kalk
7. Mirchiadi vati 8. Certain herbal drugs made by single or double herbal compound, mixtures.

2. Collection and study of germplasm (seeds) and prepare a seed-bank medicinal & ethnobotanically important plants.

3. Preparation of a herbarium, medicinal parts of plants. (Leaf, stem, bark, root-powder, decoction, Bark powder also.)

4. Detailed study of certain diseases and collect plants which are used in treating these diseases like - Skin diseases – Expulsion of worms, Bronchial inflammation and asthma, Tuberculosis, urogenital problems, amoebic dysentery, malaria, rheumatism, leprosy, Jaundice, Hear diseases, piles and Leucoderma,

5. Collection of locally available plants their parts which are credible to medicinal purposes.

(d) Environmental Science

Unit- 1: Ecology and Environment: History and scope of Ecology, Autecology, Synecology, Population, Community, Biome. Distinguishing characters of forests, grasslands, arid lands and wetlands, community organization- concept of habitat, key stone species, dominant species. Species diversity and measurement of diversity. Biological communities and Ecosystem, Bioclement cycling.

Unit- 2: Natural Environmental Resources and Conservation: Forest Resources- Forest types of India, Deforestation and its effects. Water Resources- Indian Water Resources, Hydrological cycle, Surface Water, Ground Water, World Water Resources, and distribution, Food Resources, Conservation of Natural Resources and Environmental Management.

Unit- 3: Current Environmental Issues: Climate Change- Global Warming, Green House Effect and Global Ozone Problems, Acid Rains, Atmosphere Turbidity and Nuclear Winter, Global Carbon dioxide rise and impact on Biosphere. Air, Water and Noise Pollution, Radiation hazards and environmental degradation.

Unit- 4: Energy Production and Management: Introduction, Energy Production and Consumption, Sources of Energy, Non- Conventional and Biological Energy. Use of wastes and energy use pattern in India. Future Energy Scenario of the World. Nuclear Energy and the Risks.

Unit- 5: Environmental Biotechnology: Basic techniques in Genetic Engineering: Nucleic Acid Hybridization and Polymerase chain reaction as sensitive detection methods. Use of microorganisms like- Thermophiles, Alkalophiles, Acidophiles, Halophiles and Psychrophils in waste treatment and methane production. Production of Enzymes like- Cellulase, Proteases, Amylases; Alcohol and Acetic Acid Production.

Suggested Readings:

- Andrews, W.R., Jackson & Julie, M. Jackson. 1996. Environmental Science- The Natural Environment and Human Impact. Addison Wesley Longman Ltd.
- Anjaneyulu, Y. 2004. Introduction to Environmental Science. B.S. Publications, Hyderabad, India.
- Brady, N. C. 1990. The Nature and Properties of Soils. MacMillan.
- Chapman, J.L. and Reiss, M.J. 1988. Ecology- Principles and Applications. Cambridge University Press, Cambridge, U.K.
- Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press, Cambridge, U.K.
- Kaur, H. 2006. Environmental Studies. Pragati Prakashan.
- Kormondy, E. J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.

- Ludwig, J. and Renold, J.F. 1988. Statistical Ecology. John Wiley & Sons., New York.
- Mason, C. F. 1991. Biology of Freshwater Pollution. Orient Longman.
- Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia. USA
- Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.
- Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Brooks/ Cole, EWP Pvt. Ltd., New Delhi.
- Santra, S.C. 2008. Environmental Science. New Central book Agency Pvt. Ltd., Kolkata.
- Sharma, P.D. 2000. Ecology and Environment. Rastogi Publications, Meeruth.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publisher, New Delhi.
- Smith, R.L. 1996. Ecology and Field biology. Harper Collins, New York.
- Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
- Wanger, K.D. 1998. Environmental Management. W.B. Saunders, Philadelphia. USA.
- Wilson, E.O. 1988. Biodiversity. National Academic Press, Washington, D.C.
- Wright, R.T. 2007. Environmental Chemistry. Pearson Education Inc., South Asia.

Suggested Laboratory exercises:

1. Good Laboratory Practices: Preparation and Standardization of experimental solution calibration of glasswares.
2. Physical Characteristics of waste/ water: Hardness, color, turbidity, Total solids; TDS, Total Alkalinity, Acidity.
3. Estimation of Dissolve Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand.
4. Study of some endangered plant species.
5. Study of morphological and structural adaptation of locally available Hydrophytes, Mesophytes and Epiphytes and correlate to their particular habitats.

(c) Industrial Microbiology

Unit 1. Industrial Strains

- 1.1 Isolation, Preservation and Improvement of strains.
- 1.2 Microbial growth kinetics, Aeration and agitation, Sterilization.
- 1.3 Media for industrial fermentations.

Unit 2. Fermenter Design and Function

- 2.1 Design of Fermenter, Stirred tank fermenter, Basic components, Sterilization of Fermenter, Air supply, Sampling, Foam control, Transfer of inoculum. Air lift.
- 2.2 Types of fermenter.

Unit 3. Fermentation Processes

- 3.1 Media for industrial fermentations, Development of inoculum.
- 3.2 Downstream processing, Filtration, Centrifugation, Cell disruption, Liquid-liquid Extraction, Chromatography.

Unit 4. Microbial Productions I

- 4.1 SCP, Protein for animal feed, Mass production of baker's yeast.
- 4.2 Microbial transformations of acetic acid and gluconic acid.
- 4.3 Oriental food and Mushroom cultivation.

Unit 5. Microbial Productions II

- 5.1 Organic acids and Vitamins.
- 5.2 Antibiotics and Vaccines.
- 5.3 Alcoholic beverages, Industrial alcohol and solvents.

Suggested Readings

- Anke, T. 1997. Fungal biotechnology. Chapman and Hall. London.
- Bullock, J. and Kristiansen, B. 1987. Basic Biotechnology. Academic Press, New York.
- Casida, Jr. L.E. 1968. Industrial Microbiology. New Age International (P) Ltd Publishers, New Delhi.
- Crueger, W. and Crueger, A 2000. Biotechnology: A Text Book of Industrial Microbiology. Panima Publishing Corporation, New Delhi.
- Pepler, H.J. 1997. Microbial Technology. Robert E. Krieger Publishing Company. New York.
- Prescott, C.S and Duim. G.C. 1959. Industrial Microbiology. McGraw-Hill Book Company, New York.
- Reed, G. 1987 Prescott and Dunn's Industrial Microbiology. CBS Publishers and Distributors, New Delhi.
- Riviere. J. 1975. Industrial Applications of Microbiology. John Wiley & sons, New York.
- Smith, J.E., Berry, D.R., and Kristiansen, B. 1983. Filamentous Fungi Vol. IV, Fungal Technology, Edward Arnold, London.
- Stanbury, P.F., Whitaker, A. and Hall, S.J. 1995. Principles of Fermentation Technology, Pregemen Press, Oxford.

Suggested Field/Laboratory Exercises

1. Isolation of microorganisms- Selection of culture media, Isolation of colony, screening.
2. Growth pattern in shake culture and fermenter, Utilization of carbohydrate/production of biomass, Control of parameters: nutrition, agitation, aeration, temperature, oxygen.
3. Biomass production of baker's yeast and *Bacillus thuringiensis*.
4. Utilization of cellulose/methanol for biomass production-*Trichoderma reesei*/*Candida utilis*, *Methylbacterium*.
5. Production of:
 - i. Organic acids - Citric acid (*Aspergillus niger*), Gluconic acid (*A. niger*), lactic acid (*A. oryzae*) and Acetic acid (*Acetobacter*).
 - ii. Amino acids-Glutamic acid (*Corynebacterium*).
 - iii. Solvents - Alcohol (*Saccharomyces cerevisiae*).
 - iv. Vitamins and Hormones- Riboflavin (*Ashbya gossypii*), Gibberellin (*Gibberella fujikuroi*) and Ergosterol (*Cleviceps tropicalis*).
 - v. Enzymes- Amylase (*S. occidentalis*, *B. megaterium*) diastase (*A. oryzae*), pectinase (*A. aureus*).

(f) Forest Ecology**Unit 1. Forest and Environment**

- 1.1 Forest Ecology - State of world forests and resources, state of Indian forests and resources.
- 1.2 Forest Environment - Solar radiation, temperature, precipitation, humidity, fire and soil.

Unit 2. Forest Types and Forest Composition

- 2.1 Principal types of forest in India, their geographic distribution. Basics of classification.
- 2.2 Ecology of tropical deciduous forest, tropical rain forest, mangrove forest, temperate coniferous forest, savannah vegetation.
- 2.3 Forest types in Madhya Pradesh, their composition, diversity, ecology.

Unit 3. Forest Mensuration and Mapping

- 3.1 Forest Mensuration - Measurement of tree height, girth, volume and age. Estimate of growth. Stem analysis. Volume table. Yield table.
- 3.2 Forest utilization and forest-based industries.
- 3.3 Remote sensing in forest mapping.

Unit 4. Forest Restoration

- 4.1 Factors affecting deforestation.
- 4.2 Concept of Restoration ecology, natural vs. man-made restoration.

Unit 5. Forest Management

- 5.1 Wildlife management, various protection acts. National Wildlife Action Plan.
- 5.2 Joint forest management.

Suggested Readings

- Ahlgren, C.E. 1960. Fire and Ecosystem. Academic Press. Inc.
- Borman E.H. and Likens G.E.. 1987. Pattern and Process in a Forested Ecosystem. Springer Verlag.
- Burton, B. V. Donald, Z. R., Shirley, D.R. and Stephen, S.H.1998. Forest Ecology. John Wiley & Sons.
- Cairns, J. 1992. Rehabilitation of Disturbed Ecosystems. CRC Press, Boca Raton. Florida, U.S.A.
- Champion, H.G. and Seth, S.K. 1968. Forest Types of India. Government of India.
- Champion, H.G. and Seth, S.K. 1968. General Silviculture of India. Government of India.
- Dwivedi, A.P. 1993. Forestry in India. Surya Publication.

- Lal, A. B. 1965. Indian Silviculture. Jugal Kishore & Company.
- Sagreiya, P.K. 1967. Forest and Ecology. National Book Trust of India, New Delhi.
- Troup, R.S. 1921. The Silviculture of Indian Trees. Volume 1, 2 & 3, Clarendon Press, Oxford.

Suggested Field/ Laboratory Exercises

1. Forest composition by plotless method.
2. Relationship between girth and height.
3. Relationship between girth and canopy spread.
4. Measurement of tree height.
5. Measurement of diameter and girth classes.
6. Measurement of bark thickness.
7. Measurement of volume of trees.
8. Measurement of moisture in wood biomass.
9. Ordination of forest species.
10. Litter production on area basis.
11. Organic matter estimation on land area basis.
12. Nitrogen in soil on land area basis.
13. Phosphorus in soil on land area basis.
14. Microbial biomass, C, on land area basis.
15. Microbial biomass, N, on land area basis.
16. Buried seed population.
17. Determination of chlorophyll content in leaves of forest trees situated at varying horizons.
18. Determination of chlorophyll and carotenoid contents in leaves of forest trees in light and shade conditions.
19. Measurement of rates of transpiration of two forest species by cobalt chloride method.
20. To determine the relative turgidity of forest leaves by weight method.
21. Determination of protein content in leaves.
22. Determination of NPP in various forest species by leaf disc method.
23. Preparation of absorption spectra of Chlorophyll a and Chlorophyll b.
24. Spectral properties under gap and crown canopy in forest.

Paper- BOT PG 303: Discipline Centric Elective

(g) Plant Tissue Culture

Unit-1: Plant Cell and Tissue Culture: General Introduction, History, Scope, Concept of cellular differentiation and totipotency.

Unit-2: Techniques of Tissue culture. Organ culture- meristem, anther, embryo. *In vitro* fertilization.

Unit-3: Organogenesis and adventives embryogenesis; fundamental aspects of morphogenesis, somatic embryogenesis and androgenesis. Mechanism, techniques and utility.

Unit-4: Somatic hybridization, protoplast isolation, fusion and culture, hybrid selection and regeneration; possibilities and achievements and limitation of protoplast research.

Unit-5: Application of plant tissue culture; clonal propagation; artificial seeds; production of hybrids; somaclones and somaclonal variations; production of secondary metabolites/natural products; cryopreservation and germplasm storage.

Suggested readings

- Bojwani, S. S. and Razdan, M.K. 2004. Plant Tissue Culture. Panima Publishing Corporation. New Delhi.
- Brown T. A. 1999. Genomes. John Wiley & sons, Singapore.
- Butenko, R.G. 2000. Plant Cell Culture. University Press of Pacific.
- Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetics. Resources: Conservation and Use. CAB International, Oxon, UK.
- Chawla, H.S. 2003 Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
- Collin, H. A. And Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
- Dixon, R. A. (Ed.) 1987. Plant Cell culture: A Practical Approach. IRL Press, Oxford.
- Gelvin, S. B. and Schilperoort, R. A. (Eds), 1994. Plant Molecular Biology Manual, 2nd edition, Kluwer Academic Publishers, Dordrecht, the Netherlands.
- George, E. F. 1993. Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd. Edington, UK.
- George, E. F. 1993. Plant Propagation by Tissue Culture. Part 2. In practice, 2nd edition. Exegetics Ltd. Edington, UK.
- Glick, B. R. and Thompson, J. E. 1993. Methods in Plant Molecular Biology and Biotechnology. GRC Press, Boca Raton, Florida.
- Glover, D. M. and Hames, B. D. (Eds) 1995. DNA Clonning 1 : A Practical Approach; Core Techniques, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
- Gupta, P. K. 2004 Elements of Biotechnology. Rastogi Publication. Meerut.
- Jolles, O. And Jornvall, H. (Eds.) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basal, Swizerland.

- Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK.
- Purohit, S. S. 2004. Plant Biotechnology. Agrobios Jhodhpur.
- Ramawat, K.G. 2000. Plant Biotechnology. S.Chand & Co. Ltd. New Delhi
- Razdan, M. K. 2003. Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Suggested Laboratory exercises: 303: (g) Plant Tissue Culture:

1. Sterilization techniques.
2. Preparation of Culture media
3. Sterilization of media
4. To prepare tissue culture lab
5. Sterilization of glasswares
6. Preparation of tissue culture media
7. Sterilization of ex plants
8. Study effect of plant growth hormones (PGR) on tissue culture
9. To perform the techniques of micro propagation/ somatic embryogenesis/ androgenesis
10. To perform the techniques of organogenesis
11. Study of applications of tissue culture.

Paper- BOT PG 304: List of Generic Elective

(GE Choice based-any one) Papers

- a. **Biostatistics and Computer Application**
- b. **Plant Cytogenetics**
- c. **Pollution Ecology**
- d. **Weed Science**
- e. **Bioinformatics**
- f. **Water Management and treatment**
- g. **Floriculture**
- h. **Plant Breeding**
- i. **Basic Instrumentation**
- j. **Remote Sensing and GIS**

Paper- BOT PG 304: Generic Elective**(a) Biostatistics and Computer Applications****Unit-1**

1. An Introduction to Biostatistics: Definition, Scope, role of statistics in biological sciences
2. Sample and sampling methods
3. Frequency distribution: Graphical representation, measures of central value and dispersion.

Unit-2

1. Probability: Discrete and continuous distributions
2. Sampling methods, Standard Deviation and standard errors.
3. Testing for Goodness of Fit, Analysis of Variance, 'F' test, Student's' test, χ^2 test.

Unit-3

1. Correlation and Regressions: Linear & Multiple, Polynomial Regression.
2. Experimental designs- Completely Randomized, Randomized Complete Block and Factorial.
3. Biological applications of Statistics.

Unit-4

1. Introduction, Structure and Functional Aspects of Computers.
2. Common using computer programs: MS-DOS, MS- WORD, MS- EXCEL, POWER POINT, CORAL, WINDOW 2007.
3. Applications of computer in Biostatistical problems.
4. Detail study of Internet

Unit-5

1. Networking of Computer need and advantages
2. Commonly used Programs, packages and Internet.
3. Computer in biology: Sequence data base; sequence analysis of protein and nucleic acid, structure prediction, simple molecular modeling, sample graph plotting
4. Some commonly used softwares related to Plant Science, Biodiversity, conservation, molecular taxonomy and vegetation mapping.

Suggested Readings

- Finne, D.J. 1971. *Statistical Methods in Biological Assay* (2nd Ed.). Griffin London.
- Fisher, R.A. and Yates, F. 1970. *Statistical Tables for Biological, agricultural and medical research* (6th Ed.). Oliver and Boyd Edinburg Tweeddabe Court.
- Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedures for agricultural research*. (2nd Ed.). John Wiley & Sons. Inc. New York.
- Johnson, R.C.E.T. 1971. *Probability Methods and Statistical Methods in Genetics*. John Wiley & Sons. Inc. New York.
- Prasad, S. *Elements of Biostatistics*. 2013. Rastogi Publications. Meerut.
- Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods* (8th Ed.). East West Press., New Delhi.

Suggested Field/Laboratory Exercises:

Suggested Field/Laboratory Exercises corresponding to theory courses, covering all units.

Paper- BOT PG 304: Generic Elective**(b) Plant Cytogenetics****Unit 1. Chromosomes**

- 1.1 Chromosomes and their structure, modern methods.
- 1.2 Genetic map, cytogenetic maps and physical maps
- 1.3 Molecular cytogenetics: Genome organization, restriction mapping, molecular markers in mapping.

Unit 2. Cytogenetics of Duplications and Deficiencies

- 2.1 Duplications: Origin, occurrence, meiotic behavior, phenotypic effect and uses.
- 2.2 Duplications in plant breeding and evolution.
- 2.3 Deficiencies: Origin, occurrence, meiotic behavior, phenotypic effect and uses.
- 2.4 Genetics of deficiencies.

Unit 3. Cytogenetics of Inversion and Translocation

- 3.1 Inversions: Types, origin, occurrence and production, meiotic behavior, complex types.
- 3.2 Role of inversion in evolution and karyotype reconstruction.
- 3.3 Translocations: Origin, induction and meiotic behavior.
- 3.4 Breeding behavior of translocations. Complex types.

Unit 4. Cytogenetics of Haploids and Polyploids

- 4.1 Haploidy: Origin, induction, meiotic behavior and uses of haploids.
- 4.2 Autopolyploidy: Origin, induction, meiotic behavior, genetics.
- 4.3 Allopolyploidy: Natural and induced, genome analysis of allopolyploids, synthetic allopolyploids.

Unit 5. Cytogenetics of Aneuploids and other systems

- 5.1 Classification of Aneuploids. Trisomics in diploid and polyploids, their cytology, genetics and uses. Trisomy in humans. Tetrasomy.
- 5.2 Monosomics and Nullisomics: Origin, meiotic behavior, inheritance and uses.
- 5.3 Alien gene transfer through chromosomal manipulation.
- 5.4 Human cytogenetics.

Suggested Readings

- Burnham, C.R. 1962. Discussions in Cytogenetics. Burgess, Minneapolis.
- Gupta, P.K. 1995. Cytogenetics: Rastogi & Co., Meerut.
- Gupta, P.K. and Tsuchiya, T. (Eds.) 1991. Chromosome Engineering in Plants: Genetics, Breeding, Evolution. Elsevier, Amsterdam.
- Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York.
- Lewis, R. 1999. Human Genetics. WCB McGraw-Hill.
- Schulz-Schaeffer, J. 1980 Cytogenetics Animals, Plants, Humans. Springer- Verlag.
- Singh, R.J. 1996. Cytogenetics. CRC Press.
- Swaminathan, M.S., Gupta, P.K. and Sinha, U. (Eds.). 1983. Cytogenetics of Crop Plants. Macmillan India Ltd., New Delhi.
- Swanson, C.P. 1972. Cytology and Cytogenetics. Macmillan India Ltd. New Delhi.
- Sybenga, J. 1972. General cytogenetics. American Elsevier Publ. Co., New York.

Suggested Field/Laboratory Exercises

1. Preparation of various stains and other reagents used in chromosome studies.
2. Study of mitotic complement and karyotype in *Vicia*, *Phlox*, *Allium*, *Aloe* and other available materials.
3. Meiotic analysis in *Vicia Phlox*, *Allium*, *Aloe* and other available materials.
4. Meiotic studies in translocation heterozygotes, complex types like *Rhoeo*.
5. Induction of polyploidy in plants.
6. Comparative study of meiosis in diploids and autotetraploids.
7. Study of polytene chromosomes in *Drosophila*.
8. Study of radiation induced chromosomal aberrations at mitosis and meiosis.
9. Test of pollen viability.
10. Study of inversion heterozygote.
11. Study of Aneuploids and other aberrant systems.

Paper- BOT PG 304: Generic Elective**(c) Pollution Ecology****Unit 1. Pollution: Status and Concerns**

- 1.1 Classification of contaminants and pollutants.
- 1.2 Brief account of major environmental disasters of the past.
- 1.3 Indicator concept- biological indicators of pollution.

Unit 2. Air Pollution

- 2.1 Sources and causes of air Pollution.
- 2.2 Effects of air pollution on flora and fauna, materials and structures, soil atmosphere, water, bodies and on human health.
- 2.3 Transport and dispersion of pollutants.

Unit 3. Water Pollution

- 3.1 Sources and causes of water pollution.
- 3.2 Status of water pollution in India and M.P.
- 3.3 Water harvesting and recharging of water resources -concerns and remedies.

Unit 4. Soil pollution and other pollution types

- 4.1 Causes and sources of soil pollution.
- 4.2 Pesticidal and heavy metal pollution- sources, causes and effects.
- 4.3 Nuclear, thermal and noise pollution- causes, sources and effects.

Unit 5. Pollution: Monitoring and Control

- 5.1 Monitoring systems and analytical methods for air, water and soil pollution.
- 5.2 Control and abatement measures for air, water and soil pollution.
- 5.3 Brief account of legislation and environmental protection acts in India.

Suggested Readings

- Ali, S.M., Legal Aspects of Environmental Pollution and its Management. CBS Publication and distribution, New Delhi.
- Butler, J.D., Air Pollution Chemistry, Academic Press, New York.
- Coughtrey, P.J., Martin, M.H. and Unsworth, M.H., Pollutant Transport and Fate in Ecosystems. Blackwell Scientific Publication, Canada.
- Goel, P.K., Water Pollution -Causes, Effects and Control. New Age International Publisher, New Delhi.
- Harrison R.M. and Perry R. Handbook of Air Pollution.
- Harrison, R.M., Pollution Causes, Effects and Control.

- Khan, S.U., Pesticides in the Soil Environment, Elsevier Scientific Publication Co.,
- Laws, E.A., Aquatic Pollution. A Wiley Inter Science Publication, New York.
- Lenihen and Fletcher, Measuring and Monitoring the Environment. New York.
- Stern, A.C., Air Pollution Vol. I - IV. Academic Press, New York.

Suggested Field/ Laboratory Exercises

1. Survey of industrial and polluted zones in the region/locality: Symptom studies on vegetation.
2. Generation of SO_2 and its effect on chlorophyll content using open/close top chambers.
3. Determination of ambient SO_2 and NO_2 levels using High volume sampler.
4. Determination of suspended particulate matter in ambient air.
5. Determination of dust collecting potential of different plants (Foliage capacity).
6. Estimation of BOD loads in industrial effluents/sewage.
7. Determination of pH, conductivity of different effluents and waste water.
8. Determination of Total Suspended Solids (TSS), Total Dissolved Solids (TDS) and Total Solids (TS) in different fresh and waste water samples.
9. Movements of pesticides in soil- bioassay, quantitative (using soil columns).
10. Volatility of pesticides - effect on seed germination, growth of seedlings.
11. Effects of pesticides on plants- foliar application, soil application.
12. Effects of toxic metals in biosynthesis of chlorophyll.
13. Determination of D.O. in a given sample.

Paper- BOT PG 304: Generic Elective**(d) Weed Science****Unit 1. Introduction to Weed Science**

- 1.1 Definition, Origin and classification of weeds.
- 1.2 Format for the study of biology and ecology of weeds.
- 1.3 Biological adaptations of weeds.
- 1.4 Positive and negative aspects of weeds as vectors for other pests.

Unit 2. Weed Biology and Ecology

- 2.1 Weed seed dormancy and germination, vegetative propagation.
- 2.2 Crop-weed interference; competition for light, water, nutrient and space.
- 2.3 Phyto- allelopathy- Role in crop-weed interaction.

Unit 3. Herbicides

- 3.1 Herbicides, their classification and general mode of action.
- 3.2 Herbicide absorption, translocation and transformations in plants.
- 3.3 Degradation and persistence of herbicides in soil.
- 3.4 Bioassay and analytical techniques for detection and quantification of herbicides.

Unit 4. Weed Control

- 4.1 Weed control by manual, mechanical and cultivation methods.
- 4.2 Biological control of weeds.
- 4.3 Chemical weed control in important crops kharif and rabi.

Unit 5. Weed Science prospects

- 5.1 Weed Science in India- Past, Present and Future.
- 5.2 Weed Research Centers in India and World.
- 5.3 Quarantine for weeds and its importance.
- 5.4 Effects of weed control on Agriculture and Environment.

Suggested Readings

- Aston, F.M. and Crafts A.S. 1991 Mode of Action of Herbicides. Wiley- Interscience Publication, New York.
- Fedtke C. 1982 Biochemistry and Physiology of Herbicide Action. Springer-Verlag, New York.
- Freyer J.D. And Evans, S.A., 1968 Weed Control Handbook Vol. I/II Blackwell Scientific Publications.
- Gupta, O.P. 1978 Scientific Weed Management in Tropics and Sub tropics. Today and Tomorrow's. Printers and Publishers, New Delhi.

- Joshi, N.C. 1974 Manual of Weed control. Research Publication, Delhi.
- Kearney, P.C. and Kaufman, D.D. 1975 Herbicides- Chemistry, Degradation and Mode of Action Vol. I, II, III Merceel Dekker Incorporation.
- Klingman, G.C., Aston F.M. and Noordhoof, L.J. 1975 Weed Science: Principles and Practises. A Wile Interscience Publication, New York.
- Muzik, T.J. 1970 Weed Biology and Control. Mc Graw-Hill Books Corporation.
- Sen, D.N. 1981 Ecological Approaches to Indian Weeds. Geobios International, Jodhpur.

Suggested Field / Laboratory Exercises

1. Survey of weeds associated with different kharif and rabi crops.
2. Determination of density, frequency and distribution of weeds in crop fields.
3. Determination of herbage covers of various weeds.
4. Comparative study of weeds with the help of polygraphs.
5. Survey of aquatic and semi- aquatic weeds in and around nearby water bodies.
6. Weed seed collection and identification.
7. Effect of herbicides on rate of photosynthesis.
8. Effect of herbicides on rate of respiration.
9. Determination of EC-50 of a given herbicide with reference to respiration.
10. EC-50 of a given herbicide with reference to photosynthesis.
11. Effect of a given herbicide on rate of transpiration.
12. EC-50 of a given herbicide with reference to transpiration.
13. Bioassay of triazine/ phenoxy herbicides.
14. Seed viability test (TTC) for crops/weeds.
15. Effect of herbicides on chlorophyll content.
16. Chemical tests for herbicide groups-Urea and Phenoxy.
17. Degradation of a given herbicide and its residual toxicity.
18. Effect of a given antidote on herbicide toxicity.
19. Effect of a given herbicide on seed germination and seedling growth in crops/weeds.

(e) Bioinformatics**Unit -1**

Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ. Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB. Genome Databases at NCBI, EBI, TIGR, SANGER. Other Databases of Patterns/Motifs/System Biology.

Unit- 2

Introduction to various Machine Learning techniques and their applications in Bioinformatics. Genetic algorithms, Support Vector Machine, Neural Networks and their practical applications towards the development of new models, methods and tools for Bioinformatics.

Unit -3

Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method].

Unit- 4

System Biology: Introduction and macromolecular interactions: Protein – Protein, Protein – Nucleic acids, Protein – carbohydrates etc. Gene and protein networks. Top down and bottom up approaches in systems biology. Computational methods, tools, and databases in systems biology, their description, analysis and applications to the biological community. Sequence and structure based methods for predicting protein-protein interactions.

Unit- V

Prediction of protein structure Secondary structure: algorithms of Chou Fasman, GOR method. Tertiary Structure: basic principles and protocols, Methods to study 3D structure. Protein structure comparison and classification: classes, folds; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI. Principles and methods of protein folding. Visualization of structures using softwares. Basic concepts in molecular modeling and different types of computer representations of molecules.

Suggested Readings

- Cynthia Gibas and Per Jambek. 2001. *Developing Bioinformatics Computer Skills*. O'Reilly.
- David M Webster. 2000. *Protein Structure Prediction: Methods and Protocols*. Springer Science & Business Media.
- David W. Mount. 2004. *Bioinformatics second edition*. Cold Spring Harbor Laboratory Press.
- Jin Xiong. 2006. *Essential Bioinformatics*. Cambridge University Press.
- S. C. Rastogi. 2008. *Bioinformatics Concepts, Skills & Applications, 2c (PB)*. CBS Publishers & Distributors

Suggested Field/Laboratory Exercises:

Suggested Field/Laboratory Exercises corresponding to theory courses, covering all units.

Suggested Laboratory Exercises: 301: Basic Biotechnology

1. Growth characteristics of *E. coli* using plating and turbidimetric methods.
2. Sterilization techniques.
3. Preparation of culture medium.
4. Sterilization of medium.
5. To prepare tissue culture lab.
6. Sterilization of glass ware.
7. Preparation of tissue culture medium.
8. Sterilization of explants.
9. Study effect of plant growth hormones (PGR.) on tissue culture.
10. To perform the techniques of micro-propagation/somatic embryogenesis/ androgenesis.
11. To perform the techniques of organogenesis.
12. Study of application of tissue culture.
13. Isolation of protoplasts from various plant tissues and testing their viability.
14. Effect of physical (e.g. temperature) and chemical (e.g. osmoticum) factors on protoplast yield.
15. Demonstration of protoplast fusion employing PEG.
16. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
17. Demonstration of androgenesis in *Datura*.
18. Electroporation of protoplasts and checking of transient expression of the reporter gene.

Suggested Laboratory Exercises: 302: Genetic Engineering and Genomics

1. To demonstrate growth characteristics of *E. coli* using plating methods.
2. To demonstrate growth characteristics of *E. coli* by turbidimetric methods.
3. Demonstration of DNA sequencing by Sanger's dideoxy method.
4. Isolation of DNA and preparation of 'Cot' curve.
5. Isolation of DNA and quantitation by spectrophotometric methods.
6. Isolation of genomic DNA from plant or animal tissue using CTAB method.
7. Isolation of chloroplasts & SDS-PAGE. Profile of demarcate the two subunits of Rubisco.
8. To study the effect of antibiotics on growth of microorganism.
9. To study fermentation techniques.
10. Study of nitrogen fixer and its applications.
11. Demonstration of Gel electrophoresis.
12. Demonstration of molecular markers.

13. Isolation of plasmid from *E.coli* by alkaline lysis method and its quantitation spectrophotometrically.
14. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
15. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.
16. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.

CBCS based Syllabus for Class- M.Sc. (Botany) - IV Semester

Course	Course Code	Theory/ Practical/ Project Work
Project Work	BOT PG 401	Project Work in an institution or in the department (UTD)
Project Work- Viva	BOT PG 402	Viva voce on the Project work
Soft Skills	BOT PG 403	Seminars (2) (Skill enhancement and development)

Prepared by

Prof. R. C. Verma
Dr. Jagadish K. Sharma
Dr. (Smt) C. L. Kadel
Ms. Pratibha Shrivastava