

UNIVERSITY OF RAJASTHAN

JAIPUR

M. Sc. BOTANY

SEMESTER-II

SYLLABUS SEMESTER SCHEME

2017-18

12.57
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SECOND SEMESTER

S. No.	SUBJECT CODE	Course Title	Course Category	Credit	Contact hours per week			EoSE duration (Hrs.)	
					L	T	P	Theory	P
1	BOT 801	Genetics	CCC	4	4	0	0	3	0
2	BOT 802	Pteridophyta, Gymnosperm and Paleobotany	CCC	4	4	0	0	3	0
3	BOT 803	Plant Morphology & Developmental Anatomy	CCC	4	4	0	0	3	0
4		Theory Elective-1	ECC	4	4	0	0	3	0
5		Theory Elective-2	ECC	4	4	0	0	3	0
6		Theory Elective-3	ECC	4	4	0	0	3	0
7	BOT 811	General Practical Lab. (Based on BOT 801, BOT 802 & BOT 803)	CCC	6	0	0	9	0	6
8		Elective Practical Lab-1	ECC	2	0	0	3	0	4
9		Elective Practical Lab-1	ECC	2	0	0	3	0	4
10		Elective Practical Lab-1	ECC	2	0	0	3	0	4

Note:-

1. Elective core courses lab. can be opted only if the respective Elective theory has been opted by the student. ECC lab. Examination will be based on ECC lab. work of above papers wherever applicable (2 credits each)
2. Department will offer minimum three and maximum six theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.


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Theory Elective Courses:-

Specialization Clusters:-

A- PP: Plant Pathology

B- PM: Plant Morphology

C- PB: Plant Biosystematics

D- MI: Plant Microbiology

E -PPH: Plant Physiology

F -PE: Plant Ecology

H- GEN: General

Theory Elective Courses:-

Elective Course Code	Specialization	Course Title	Prerequisite	Semester in which course will be available
BOT A03	PP	Advanced Plant Pathology	BOT A01	II
BOT A04	PP	Seed Pathology	BOTA02	II
BOT B02	PM	Morphogenesis & Experimental Biology	BOT B01	II
BOT C02	PB	Angiosperm Plant Biosystematics	BOT C01	II
BOT H01	GEN	Principles of Plant Breeding		II
BOT H02	GEN	Bioinformatics and Biostatistics		II

Laboratory Elective Courses:-

Elective Course Code	Specialization	Course Title	Prerequisite	Semester in which course will be available
BOT A13	PP	Advanced Plant Pathology	BOT A11	II
BOT A14	PP	Seed Pathology	BOT A12	II
BOT B12	PM	Morphogenesis & Experimental Biology	BOT B11	II
BOT C12	PB	Angiosperm Plant Biosystematics	BOT C11	II
BOT H11	GEN	Principles of Plant Breeding		II
BOT H12	GEN	Bioinformatics and Biostatistics		II

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BOT 801-Genetics

Inheritance and allelism: Concept and structure of gene, cis-trans test, Mendelian and non Mendelian inheritance, Co-dominance, incomplete dominance, Gene interactions: Complementary genes, Supplementary genes, Epistasis, Duplicate genes, Polygenic inheritance, Pleiotropy, Multiple alleles and human blood group, Extra nuclear inheritance: Inheritance of mitochondrial and chloroplast genes, cytoplasmic male sterility, Sex determination mechanism, sex linked inheritance, sex limited characters and sex reversal, genomic imprinting.

Genetic recombination: Homologous and non-homologous recombination, Independent assortment, crossing over, Molecular mechanism of recombination, Holiday junction, site specific recombination, FLP/FRT and Cre/lox recombination, role of RecA and RecBCD enzymes

Mutations and mutagenesis: Types and nature of mutation: Spontaneous and induced mutations, lethal, conditional, biochemical, loss and gain of function, base substitution, frame shift mutation, germinal verses somatic mutation, physical and chemical mutagens and their effect, Ames test, Mutagenesis: Inspectional mutagenesis by transposons, site directed mutagenesis, in-vitro mutagenesis and deletion technique,

Chromosome mapping: Linkage maps, tetrad analysis, mapping with genetic markers, QTL mapping, construction of molecular maps, restriction mapping, Correlation of genetic and physical maps; mapping by using somatic cell hybrids

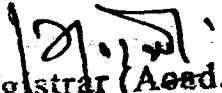
Structural and numerical alteration in chromosome: Origin, meiosis and breeding behavior of duplication, deficiency, inversion and translocation heterozygote. Origin, occurrence, production and meiosis of Haploids, aneuploids and euploids, Induction and characterization of monosomics and trisomics; Origin, production and meiosis of autopolyploids and allopolyploids; Evolution of major crop plants

Molecular cytogenetics: Nuclear DNA content, C value paradox, cot curve and its significance, multigene families and their evolution, in situ hybridization – concept and technique, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in karyotype analysis. An idea about Proteomics, Genomics and Epigenomics

Suggested lab exercise

Practical

1. Problems related to linkage, crossing over and gene interaction
2. Problems related to gene mapping


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3. Construction of restriction map
4. Linear differentiation in Chromosome through banding technique
5. Isolation of chlorophyll mutants following irradiation and treatment with chemical mutagen
6. Quantitative estimation of DNA by diphenylamine method
7. Karyotype analysis
8. Induction of polyploidy
9. To study the application of colchicines treatment.
10. Selfing and crossing technique
11. Demonstration of flow cytometry and confocal microscopy
12. Presentation of chart and models related to syllabus
13. Any other exercise based on theory syllabus

suggested reading

- Benjamin Lewin (2000). **Genes VII**. Oxford university press.
- Gardner E J, Simmons M J, Snustad D P (1991). **Principles of Genetics (III Edn)**. John Wiley and Sons Inc.
- Snustad D P, Simmons M J (2000). **Principles of Genetics (III Edn)**. John Wiley and Sons.
- Strickberger (2005). **Genetics (III Edn)**. Prentice Hall of India Pvt. Ltd.
- William S Klug, Michael R Cummings (1994). **Concepts of Genetics**. Prentice Hall.
- Robert J Brooker (2009). **Genetics: Analysis and principles (III Edn)**. McGraw Hill.
- Daniel L Hartl, Elizabeth W Jones (2009). **Genetics: Analysis of genes and genomes (VII Edn)**. Jones and Bartlett publishers.
- D Peter Snustad, Michael J Simmons (2010). **Principles of genetics (V Edn)**. John Wiley and Sons.
- Acquaah G (2007). **Principles of Plant Genetics and Breeding**. Blackwell Publishing Ltd. USA.
- Hartl DL and Jones EW (2007). **Genetics – Analysis of Genes and Genomes, 7th edition**, Jones and Bartlett publishers.
- Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). **Genetics – From Genes to Genomes, 3rd edition**, McGraw Hill.
- Lewin B (2008). **Genes IX**, Jones and Bartlett Publishers.
- Singh RJ (2002). **Plant Cytogenetics, 2nd edition**, CRC Press.
- Strickberger MW (2008). **Genetics, 3rd Edition**, Pearson (Prentice Hall).
- Weising K, Nybom H, Wolff K and Kahl G (2005) **DNA Fingerprinting in Plants**

BOT 802- Pteridophytes, Gymnosperms and Paleobotany

Pteridophytes: Distribution, classification by International Committee of Botanical Nomenclature (ICBN), Economic importance of Pteridophytes.

General account of fossil Pteridophytes, Psilopsida, Lycopside, Sphenopsida and Pteropsida classes.

Morphology, anatomy, reproduction, classification, life history of: *Thesipteris*, *Lycopodium*, *Gleichenia*, *Isoetes*, *Ophioglossum* and *Azolla*.

Origin and evolution of stele, heterospory and seed habit.

20

Gymnosperms: Distribution, morphology, anatomy, reproduction; classification, life history and evolution. Cycadales (*Zamia*), Ginkgoales (*Ginkgo*), Coniferales (*Pinus*, *Taxus*, *Araucaria* and *Biota*), Welwitschiales (*Welwitschia*), Gnetales (*Gnetum*).

20

Paleobotany: History of paleobotany, formation and types of fossils, techniques of study of fossils, Geological time scale. Brief account of Pteridospermales (*Lygenopteris*, *Medullosa*, *Caytonia* and *Glossopteris*). Brief account of Cycadeoidales (Cycadeoidea), Cordaitales (Cordaite).

Paleobotany and the evolution of vascular plants.

Applied aspects of paleobotany, use in coal and petroleum exploration.

20

Suggested Laboratory Exercises:

Morphological and anatomical study of representative members of Pteridophytes and Gymnosperms in their natural habitat found in your locality with special reference to, *Lycopodium*, *Isoetes*, *Gleichenia*, *Ophioglossum* and *Azolla* in Pteridophytes.

Zamia, *Ginkgo*, *Pinus*, *Taxus*, *Araucaria*, *Biota* and *Gnetum* in Gymnosperms.

Collection and study of fossils.

Suggested Readings:

1. Parihar, N.S. 1996. *Biology & Morphology of Pteridophytes*. Central Book Depot, Allahabad.
2. Sporne, K.K. 1991. *The Morphology of Pteridophytes*. B.I Publishing Pvt. Ltd., Bombay.
3. Stewart, W.N. and Rathwell, G.W. 1993. *Paleobotany and the Evolution of Plants*. Cambridge University Press, UK.
4. Bhatnagar, S.P. and Moitra, A. 1996. *Gymnosperms*. New Age International Pvt. Ltd., New Delhi.
5. Singh, H. 1978, *Embryology of Gymnosperms*, *Encyclopaedia of Plant Anatomy X*. Gebruder Borntraeger, Berlin, Germany.
6. Smith, G.M. 1955. *Cryptogamic Botany Vol II* Tata McGraw Hill Book Co, NY.
7. Pandey, B.P. 1993. *College Botany. Vol. II*. S. Chand and Company Ltd., New Delhi.

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- 8 Arnold, Chester, A. 2000. An Introduction to Paleobotany. Agrobios, (India).
 9 Rashid, A. 2001. An introduction to Pteridophyta (II edition). Vikas publishing house, Pvt. Ltd., New Delhi.
 10 Sunderrajan, S. (2007), Introduction to Pteridophyta, New Age International Publishers, New Delhi.

BOT 803- Plant Morphology and Developmental Anatomy

Introduction: Unique features of plant development, differences between animal and plant development. 4

Seed germination and seedling growth: Metabolism of proteins and mobilization of food reserves, tropisms during seed germination and seedling growth, hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development. 15

Shoot development: Organization of the shoot apical meristem (SAM), cytological and molecular analysis of SAM, control of cell division and cell to cell communication, Stem cell in plants, Primary and Secondary tissue differentiation, control of tissue differentiation, especially xylem and phloem, secretory ducts and laticifers, wood development in relation to environmental factors. 15

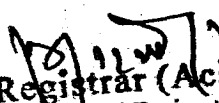
Leaf growth and differentiation: Inception, phyllotaxy, control of leaf form (leaf meristems and other factors), differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll, Kranz anatomy, Leaf traces and leaf gaps, transfer cells. 14

Root development: Organization of root apical meristem (RAM), vascular tissue differentiation, lateral roots, root hairs, root-microbe interactions. 6

Seed coat development: External and internal morphology of seed, seed appendages, ontogeny of seed coat in various families, mature structure, spermoderm patterns. 6

Suggested Readings:

1. Atwell, B.J. Kriedermann, P.E. and Jumbull, C.G.N. (eds). 1999. Plants in Action : Adaption in Nature Performance, in Cultivation, MacMillan Education. Sydney, Australia.
2. Bewley, J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press. New York.
3. Burgess, J. 1985. An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
4. Fahm, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford. New York.
10. Raven, P.H., Evert, R.F. and Eichhorn, S. 1992. Biology of Plants (5th edition). Worth, New York.
11. Salisbury, P.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing, Belmont, California.
12. Steeves, T.A. and Sussex, I.M., 1989. Patterns in Plant Development (2nd edition). Cambridge University Press, Cambridge.


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Suggested Laboratory/Field Exercises

1. Study of living shoot apices by dissections using plants such as *Tabernaemontana*, *Albizia*
2. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
3. Study of alternate and distichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea*, *Mollugo*, *Raphanus*, *Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
4. Microscopic examination of vertical sections of leaves such as *Eucalyptus*, *Ficus*, *Mango*, *Nerium*, maize, grass and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the leaf anatomy C3 and C4 of plants.
5. Study of epidermal peels of leaves such as *Coccinia*, *Tradescantia* etc. to study the development and final structure of stomata and prepare stomatal index.
6. Study of types of stomata in plants belonging to different families.
7. Study of whole roots in monocots and dicots.
8. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives. (use maize, aerial roots of banyan etc.)
9. Study of lateral root development.
10. Study of leguminous roots with different types of nodules.
11. Study of primary and secondary tissue differentiation in roots and shoots.
12. Study of seed coat types- *Pisum*, *Cucurbita*, wheat.
13. Study of vascular tissues by clearing technique


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Theory Elective Courses

Specialization Clusters

Cluster: PP- Plant Pathology

BOTA03: PP: Advanced Plant Pathology

- **Plant Disease epidemiology and plant disease forecasting:** Computer simulation of epidemics ,Methods used in Plant disease forecast ,examples of Plant Disease forecasting System (10)
- **Disease Control :**
 - Immunizing the host
 - Disease control by transgenics
 - Innovative methods of plant disease control –Pollen Management and Integrated Pest Management (15)
- **Breeding for disease resistance**-Types of resistance ,basal resistance,systemic resistance ,acquired resistance ,Gene for Gene concept ,Production of disease resistant plants, Effectors. (15)
- **Molecular Plant Pathology.**
Molecular diagnosis, Identification of genes and specific molecules in disease development, Genetics of host pathogen interaction. Molecular mechanism of resistance and Biotechnological approaches for disease (15)
- **Application of Biotechnology and Information technology in Plant Pathology & Integrated Pest Management.** (5)

Elective Practical Lab BOT A13: Advanced Plant Pathology

Suggested practical Exercises-

- **Biochemistry**-Altered plant physiology due to plant pathogen interaction
- **Histochemistry of altered metabolites**- Protein, lipids, starch, cellulose, peroxidases and polyphenol oxidase
- **Virus detection** through biological (indicator hosts and host range) and serological methods (ELISA, Immunodiffusion)
- **Virus Indexing**
- **Methods of application of fungicides** –seed and foliar application
- **Bio-control of plant pathogens** –dual culture technique
- **Bioassay of fungicides** – poisoned food technique, inhibition zone technique and slide germination technique

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Recommended Books:


1. Agrios, G.N. 2005. **Plant Pathology**, 5th edition. Academic Press, New York, USA.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. **Introductory Mycology**. 4th edition, John Wiley and Sons, Inc., New York, USA
3. Khan, J.A. and J. Dijkstra. 2002. **Plant Virus as Molecular Pathogens**. The Haworth Press Inc. USA.
4. Mehrotra, R.S. and A. Agarwal. 2003. **Plant Pathology**. 2nd Edition. TATA McGraw Hill. Pub. Company Ltd. New Delhi.
5. Singh, R.S. 1982. **Plant Pathogens: The Fungi**. Oxford and IBH Publishing Company, New Delhi, India
6. Singh, R.S. 1989. **Plant Pathogens: The Prokaryotes**. Oxford and IBH Publ. Company, New Delhi, India.
7. Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. **Plant Pathology: Concepts and Laboratory Exercises**. 2nd edition. CRC Press.
8. Vidhyasekram, P. 2004. **Concise Encyclopedia of Plant Pathology**. Food product Press and Haworth Press Inc. Binghamton,

BOT A04 : PP: Seed Pathology

Introduction and importance of Seed Pathology in modern agriculture. History of Seed Pathology. Various methods for testing seed borne fungi, bacteria and viruses (Dry seed examination, seed washing test, incubation methods, cultural, biochemical, serological, nucleic acid based methods). 10

Mechanism of seed infection and its types, environment influencing seed infection, infected/contaminated part of seed, morphology and anatomy of seeds in relation to invasion, location of inoculum of the pathogen in seed- seed coat and pericarp, endosperm and perisperm and embryo. 10

Seed-borne diseases of some important crops with particular reference to the state of Rajasthan and India. Typical case of infection by: fungi (wheat- smuts- and bunts, Sesame-charcoal rot; bacteria (Brassicac- black rot, cluster bean- bacterial blight); viruses (tomato mosaic virus, pea seed borne mosaic virus,) and nematodes (wheat- ear cockle, rice- white tip). 10


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Seed-borne inoculum, inoculum density and assessment of seed borne inoculum in relation to plant infection, epiphytotics due to seed borne inoculum, disease forecast based on infected seed samples, tolerance limits of seed borne pathogens. 10

Transmission of seed borne disease: Systemic and non- systemic seed transmission, types of disease transmission, mode of establishment and course of disease from seed to seedling and plant, factors affecting seed transmission. 10

Management of seed-borne disease, principles of control, seed treatments (physical, chemical and biological), mechanism of action of seed treatments, major seed treatments for important seed borne pathogens and their methods of application. 10


Elective Practical Lab BOT A14 : Seed Pathology

Suggested Practical Exercises:

1. Dry seed examination of seed lots.
2. Isolation and identification of seed-borne mycoflora by standard blotter method.
3. Preparation of culture media (PDA and NA).
4. Plating seeds on PDA/NA for identification of seed borne fungi and bacteria.
5. Other methods of plating e.g. deep freezing, 2,4D- blotter method.
6. Water agar test tube seedling symptom test.
7. Study of any seed-borne nematode disease.
8. Detection of bacterial and viral pathogens in seeds.
9. LOPAT tests for detection of seed-borne bacteria.
10. Nucleic acid based detection of seed borne pathogens.
11. Histopathology of infected seed samples.
12. Physical control of seed-borne pathogens.
13. Antibiotic/fungicidal assay against seed-borne pathogens
14. Biological control of seed borne pathogens.
15. Field visits: Crop fields, FCI, NSC, Seed testing Labs., quarantine station (e.g. NBPGR) etc.

Suggested Readings:

1. Agarwal, P. C., Mortensen, C. N. and Mathur, S. B. (1989). Seed-borne diseases and seed health testing of rice. Technical Bull. No.3, Danish government institute of seed Pathology for Developing Countries (DGISP), Copenhagen and CAB International Mycological Institute, (GMI) UK.
2. Agarwal, V.K. 2006. Seed Health. International Book Distributing Company. Charbagh, Lucknow, India.


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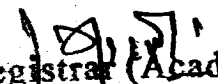
3. Agarwal, V.K. and Sinclair, J.B. (1987). Principles of Seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
4. Agrawal, R.L. 1980. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Agrios, G.N. 2005. Plant Pathology. Academic Press, London., New York
6. Anonymous (1985, 2014). International rules for seed testing. International Seed Testing Association (ISTA). <http://www.seedtest.org/en/home.html>:
<http://www.seedtest.org/en/international-rules-content-1-1083.html>
7. Clifton, A. 1958. Introduction to the Bacteria. McGraw Hill Book Co., New York.
8. Khare, D. and Bhale, M.S. (2014). Seed Technology. Scientific Publishers (India), Jodhpur. Revised 2nd Ed.
9. Mandahar, C.L. 1978. Introduction to plant viruses. S. Chand & Co. Ltd., Delhi.
10. Mathur, S.B. and Cunfer, B.M. 1993. Seed-borne diseases and Seed health Testing of Wheat. Danish Government Institute of Seed Pathology for Developing Countries. Hellerup, Denmark.
11. Neergaard, P. (1977). Seed Pathology. Vol. I & II. The Mac Millan Press Ltd., London.
12. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition). Prentice Hill of India, Pvt. New Delhi.
13. Richardson, M. J. (1990). An annotated list of seed borne diseases 4th edn. Proc. Int Seed Test Assoc. Zurich, Switzerland.
14. Schaad, N. W. (1980). Laboratory guide for identification of plant pathogenic bacteria (ed.). Bacteriology Committee of American Phytopathological Society, St. Paul, Minnesota.
15. Schaad, N. W. (1988). Laboratory guide for identification of plant pathogenic bacteria (2nd eds.). APS Press (The American Phytopathological Society), St. Paul, Minnesota.
16. Singh, D. and Mathur, S. B. (2004). Histopathology of seed-borne infections. CRC Press, Boca Raton, London, New York, Washington DC pp 296.
17. Singh, K.G. and Manalo, P.L. 1986. Plant Quarantine and Phytosanitary Barriers in the Asean. Asean Plant Quarantine Centre and Training Institute, Malays

Cluster: PM- Plant Morphology

BOT B02: PM: Morphogenesis & Experimental Biology

Development and morphogenesis - Shoot apex the apical cell, meristem, the subcellular and biochemical structure of the meristem. the mechanism of primordium initiation, transition to flowering, growth and formation of organs. Experimental work on shoot apical meristem, meristem culture and virus free plants, histochemical studies on apical meristems. 14

The phenomenon of morphogenesis - Correlation, polarity, symmetry, differentiation,


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Morphogenetic factors - Physical, mechanical, chemical and genetic factors. molecular basis of morphogenesis in plants with special reference to work done in *Arabidopsis*.

8

Somatic embryogenesis - Survey of somatic embryogenesis in angiosperms, direct somatic embryogenesis and embryogenesis from callus and protoplasts, cytology, physiology and genesis of somatic embryogenesis, nutritional factors, hormonal factors and embryo rescue in wide hybridization, endosperm and ovary culture, Micropropagation advances and synthetic seeds. Cell plating technique and isolation of mutant cell lines, auxotrophic mutants. Mechanism involved in cell culture mutants. Suspension culture and growth studies.

16

Microtechniques. Collection, killing and fixation (FAA and glutaraldehyde) of plant material, dehydration and embedding in paraffin and GMA, microtomy, (equipments and method), conventional and histochemical staining procedures. Transmission and scanning electron microscopy for internal structure and morphological development of plant organs and tissues.

13

Elective Practical Lab BOT B12: Morphogenesis & Experimental Biology

Suggested Practical/Field Exercises:

1. Study of organization of vegetative shoot apices
2. Study of organization of reproductive shoot apices.
3. Localisation of different metabolites through histochemical techniques.
4. Study of polarity of egg and synergids in embryo sac through permanent slides.
5. *In vitro* tissue and organ culture using different media. Preparation of media,
6. Inoculation and somatic embryogenesis.
7. Micropropagation and endosperm culture.
8. Histological techniques:
 - Collection, killing and fixation
 - Dehydration
 - Infiltration
 - Embedding
 - Microtomy
 - Staining
9. Microtoming equipments:
 - Microtome
 - Spreading table
 - oven
 - Ribbon box
 - Block holder

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Suggested Readings

1. Bhojwani S.S. W, Y. Soh , **Morphogenesis in plant tissue cultures** Springer 1999
2. Lyndon, R.F. 1990. **Plant Development. The Cellular Basis**, Unwin Byman, London.
3. Rogar V. Jean 2009 **A systematic study in palnt morphogenesis , Phylotaxis :** Cambridge University Press
4. Sinnott E.W. 1960. **Plant Morphogenesis**, McGrawhill,Book Co.
6. Sinnott E.W. 1979 **Plant Morphogenesis** McGrawhillBook Co.
7. Steeves, T.A. and Sussex, I.M., 1989. **Patterns in Plant Development (2nd edition).** Cambridge University Press, Cambridge
8. Wardlaw Wiley C.W. 1966. **Trends in plant morphogenesis**
9. Zarsky V. and F. Curckova. **Plant Cell Morphogenesis :Methods and Protocols:2014Springer Protocols, Humana Press www.springer.com**

Cluster: PB- Plant Biosystematics

BOT C02:PB: Angiosperm Plant Biosystematics

Herbarium methods- Plant exploration, plant collection, pressing and drying, mounting, maintenance and importance of herbarium; Important national, international herbaria, concept of digital herbaria. (10)

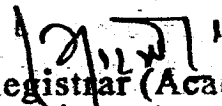
Concept of species- speciation; Gradual and additive mechanism; species classification, concept of characters: analytic versus synthetic character, qualitative verses quantitative characters , good and bad characters. (10 Hours)

Concept of population – its significance, types of variation (developmental, environmental and genetical), variance analysis, isolating mechanism. (10)

Ecotypes- Origin and differentiation, taxonomic significance of ecotypes, vicarians. (6)

Experimental taxonomy and hybridization- Role of hybridization in evolution, amphidiploidy, breeding barriers, epistasis and pleiotropy. (10)

Biochemical systematic- Methods and principles, systematic markers, PCR analysis, chemotaxonomy, seed proteins, technique of protein electrophoresis, chemical protein analysis procedures, genome analysis and nucleic acid hybridization. (14)


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Elective Practical Lab BOT C12: Angiosperm Plant Biosystematics

Suggested Practical Exercises:

1. Flora writing
2. Synonymy
3. Taxometrics and cladistics
4. Molecular taxonomy

Suggested Readings:

1. Cole, A.J. 1989. Numerical Taxonomy, Academic Press, London.
2. Davis, P.H. and Heywood, V.H. 1973, Principles of Angiosperms Taxonomy, Robert E. Kreiger Pub. Co., New York.
3. Grant, V. 1971. Plant Speciation. Columbia University Press, New York.
4. Grant W.E. 1984. Plant Biosystematics Academic Press London.
5. Harrison H.J. 1971. New Concepts in Flowering Plant Taxonomy, Rieman Educational Book Ltd. London.
6. Heslop-Harrison, J. 1967. Plant Taxonomy - English Language Book Soc. & Edward Arnold Pub. Ltd. U.K.
7. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press London.
8. Jones, A.D. and wilbins, a.d. 1971. Variations and Applications in Plant Species. Hiemand & Co. Educational Books Ltd. London.
9. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematic (2nd edition). McGraw-Hill Book co., New York.
10. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematic for 21st century, Portland press Ltd. London.
11. Radford, A.E. 1986. Fundamentals of Plant Systematic. Harper & Row Publications, USA.
12. Singh, H. 1978. Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy X. Gebruder Bortaeager, Berlin.
13. Solbrig, O.T. and Solbrig, D.J. 1979. Population Biology and Evolution, Addison-Wesley Publishing Co. Ind USA.
14. Solbrig, O.T. 1970. Principles and Metods of Plant Biosystematics. The Macmillan Cocollier- Macmillan Ltd. London.
15. Stabbings, G.L. 1974. Flowering Plant- Evolution above Species Level. Edward Arnold Ltd. London.
16. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd edition) Edward Arnold Ltd. London.
17. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
18. Woodland, D.W. 1991. Contemporary Plant Systematic. Prentice Hall. New Jersey.

Cluster: GEN- General

BOT H01:GEN: Principles of Plant Breeding

Overview & Historical perspectives: History of Plant Breeding-the pioneers, their theories and plant breeding techniques. 3

Population and quantitative Genetic principles: Concept of Population ,gene pool, gene frequency and inbreeding and its implications in breeding, Qualitative genetics versus Quantitative genetics, the concept of Population Improvement. 6

Reproductive systems: Importance of Mode of Reproduction , Types of Reproduction, Autogamy, Haploids and double haploids: their application in plant breeding, Allogamy, Inbreeding depression, hybrid vigour, Hybridization, wide crosses, clonal propagation and *In vitro* culture 8

Germplasm for Breeding: Variation-Types, origin and scale, Plant Domestication- Centres & Models ,Plant Genetic resources-Importance & Sources of Germplasm, Concept of Gene pools, Crop vulnerability, Germplasm conservation: *In situ* & *Ex situ*, Types of Germplasm collection, Germplasm storage technologies, Plant explorations & Introductions & their impact on agriculture. 10

Breeding Objectives: Yield and morphological trait- Yield potential, Harvest Index; breeding for lodging resistance, shattering resistance, plant stature & early maturity; Quality traits- breeding for improved protein content, improved fatty acid content, seedlessness in fruits, delayed ripening & novel traits, Breeding for resistance to disease & insect pests – Resistance Breeding strategies; Abiotic Stresses –Breeding for drought resistance, cold tolerance, salt tolerance, heat stress, aluminium toxicity, oxidative stress, resistance to water logging 13

Selection Methods: Breeding -self-pollinated species- Mass selection, pure line selection, Pedigree selection & Bulk population; cross pollinated species -hybrid cultivars and clonally propagated species. 7

Molecular Breeding: Molecular markers- classification, Mapping of Genes- gene maps & QTL mapping, Marker assisted selection, Mutagenesis and Polyploidy in Plant Breeding 7

Marketing and Societal issues in Breeding: Performance and Evaluation for crop cultivar release, Seed certification and commercial seed release, Regulatory and Legal issues, Value driven concepts and social concerns, International Plant breeding Efforts. Plant cultivar protection, legislation, patenting and transgenics. 6

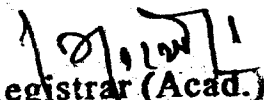
Elective Practical Lab BOT H11: Principles of Plant Breeding

Suggested Practical Exercises:-

1. Vegetative propagation methods of important crops of the locality.
2. Emasculation, selfing and crossing techniques.
3. Floral biology in self pollinated species
4. Floral biology in cross pollinated species
5. Floral biology in self pollinated species
6. Selection methods in segregating populations and evaluation of breeding material
7. Germplasm conservation methods- In situ & Ex situ methods
8. Haploid production.
9. In situ & ex situ conservation methods
10. Analysis of variance (ANOVA).
11. Maintenance of experimental records
12. Field inspection at different growth stages to study various breeding objectives.

Suggested Readings:

1. George Acquah. 2012 Principles of Plant Genetics and Breeding. Wiley-Blackwell.
2. B.D.singh and A.K.Singh 2015 Marker Assisted Plant Breeding .Springer.
3. B.D.singh 2015.Plant Breeding principles & Methods Kalyani Publishers.
4. Jack Brown ,Peter Caligari and Hugo campos.2014.An Introduction to Plant Breeding. Wiley.
5. Brown and Caligari. 2008.An Introduction to Plant Breeding. Blackwell Publishing.
6. Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
7. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
8. Gupta SK. 2005. Practical Plant Breeding. Agribios. Jodhpur
9. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
10. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
11. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
12. Dana, Sukumar. 2001. Plant Breeding. Naya Udyog, Colcutta. 700 006
13. Kucku, Kobabe and Wenzel (1995). Fundamentals of Plant Breeding. Narosa Publishing House.
14. Singh BD. 2006. Plant Breeding. Kalyani.
15. Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
16. Singh P. 2006. Essentials of Plant Breeding. Kalyani.
17. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.
18. Stoskopf, N C, Tomes, D T and Christie. 1993. Plant breeding: theory and Practice. Scientific Publishers (India) Jodhpur.


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BOT H02: GEN: Bioinformatics and Biostatistics

Concepts of Bioinformatics: Introduction and future prospects; Applications in genomics and proteomics; Public databases; Gene bank; Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA; Multiple sequence alignment: CLUSTALW; Detecting functional sites in DNA; Motif and domain prediction and analysis; Identification of open reading frames (ORF); Gene annotation technology. **11**

Databases and online tools: Biological Databases:- Types and applications; Sequence databases:- GenBank, EMBL, DDBJ, PIR-PSD, SWISS-PROT; Structure Databases:- PDB, SCOP, NDB; Derived Databases:- PROSITE, PRINTS, TIGR; Online tools:- Genetool; STRING; I-TASSER; Bioedit; BioGRID; MEGA; Sequin, Bankit **09**

Applications of Bioinformatics: Computational methods for sequence analysis: Dot blot and dynamic programming methods; Phylogenetic analysis; Virtual and electronic cell; Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Application tools- primer designing, molecular mapping and concept and tools of computer aided drug designing **10**

Fundamentals of statistics: Arithmetic mean, median, mode: theory and simple numerical problem; Measures of variation: standard deviation, variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, spearman's correlation, rank correlation; Regression: linear and curvilinear regression (for two variable X and Y only), Regression lines by least square method; regression equations of X on Y and Y on X only; Sample size; Power of study. **13**

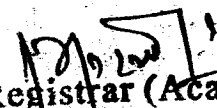
Tests of significance: Null hypothesis; Standard error; Level of significance; Degrees of freedom; Significance of mean for large samples; Significance in means for small samples (students t-test); Significance in ratio of two samples; F test (for difference between variance of two samples); Chi square test; Analysis of variance test (ANOVA) for one and two way classification; Calculation of an unknown variable using regression equation. **13**

Laws of probability, theorem of total probability **4**

Elective Practical Lab BOT H12: Bioinformatics and Biostatistics

Suggested Practical Exercises:-

1. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB etc.
2. Sequence retrieval using BLAST
3. Sequence alignment


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4. Phylogenetic analysis using clustalW
5. Protein structure prediction
6. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction).
7. Prediction of different features of a functional gene
8. Determination of Statistical averages/ central tendencies
 - a) Arithmetic mean b) Median c) Mode
9. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
10. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error
11. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

Suggested Reading

1. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press.
2. Introduction to Bioinformatics, Attwood, Pearson Education.
3. A Textbook of Systems Biology, E. Klipp, W. Liebermeister, C. Wierling, Axel Kowald, H. Lehrach, R. Herwig (2009), Wiley-VCH Verlag GmbH & Co.
4. Bioinformatics: Sequence and Genome Analysis, David W. Mount (2001), Cold Spring Harbor (CSH) Laboratory Press.
5. Plant System Biology, Coruzzi, G.M. (2009), Wiley Publishing House.
6. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevasis.
7. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgins.
8. Bioinformatics - from Genomes to drug. 2 volumes by Lengauer.
9. Bioinformatic Methods and Protocols - Misener.
10. Bioinformatics: Sequence and Genome analysis.
11. Introduction to Bioinformatics by Altwood.
12. Proteome Research: New Frontiers in Functional Genomics: Principles and Practices.
13. Genomics: The Science and Technology behind the human project.
14. Protein Biotechnology. Edited by Felix Franks. Humana Press, Totowa, New Jersey.
15. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
16. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
17. Biostatistics - 7th Edition by Daniel & Fundamental of Biostatistics by Khan
18. Statistics for Biologist by Campbell R.C. (1974) Cambridge University Press
19. Introduction to Biostatistics, Le and Chap (2009), Wiley and Sons.
20. Fundamentals of Biostatistics, B. Rosner (2005), Duxbury Press.
21. Medical Statistics from Scratch, Bowers (2008), Wiley and Sons.