# ग्यारहवीं अध्ययन मंडल बैठक की कार्यसूची

## वनस्पति विभाग,

## केंद्रीय विश्वविद्यालय जम्मू

# Minutes of the
# 11th Meeting of the Board of Studies
# of
# Department of Botany
# Central University of Jammu

**Venue : Office of Head, Department of Botany, CUJ, Bagla**

**Date : Thursday, 9th March, 2021**

**Time : 11:00 am**

# Department of Botany
# Central University of Jammu

No.CUJ/BOT/2021/136 7 Date: 9th March 2021

## MINUTES OF THE 11th MEETING OF BOARD OF STUDIES (BOS) OF DEPARTMENT OF BOTANY

**11.1** Minutes of the 11th meeting of the Board of Studies of Department of Botany held on 9th March 2021 at 11.00 am in Office of Head, Department of Botany, Central University of Jammu.

**11.2** The following members attended the meeting:

| | | |
|---|---|---|
| 1. | Prof. B. S. Bhau<br>Head, Department of Botany<br>Central University of Jammu | Chairman |
| 2. | Prof. A. K. Wakhlu (retd.)<br>Department of Botany<br>University of Jammu, Jammu | External Expert Member |
| 3. | Dr. S. Vaishnavi<br>Assistant Professor<br>Department of Botany<br>Central University of Jammu | Member Secretary |
| 4. | Dr. V. Srivastava<br>Assistant Professor<br>Department of Botany<br>Central University of Jammu | Special invitee |
| 5. | Dr. D. Bhardwaj<br>Assistant Professor<br>Department of Botany<br>Central University of Jammu | Special invitee |

Prof. Namrata Sharma and Prof. Veenu Koul, external expert members expressed their inability to attend the meeting because of unavoidable circumstances. Dr. A. Bhat, Assistant Professor, Centre for Molecular Biology, CUJ was on leave.

**11.3 Opening remarks by the Chair**

The Chairman welcomed all the members, and especially thanked Prof. A. K. Wakhlu for making it convenient to attend this meeting and providing invaluable inputs.

**11.4 To consider and approve draft course structure and contents for semester X (AY 2020-21) of the Integrated B.Sc. (Hons.) and M. Sc. in Botany programme.**

The draft course structure and contents were discussed in great detail and finalized. The course structure and contents for semester X (AY 2020 -21 onwards) as approved by the Board are placed as Annexure – 1.

**11.5 To consider and approve the draft course structure and contents for semester II (AY 2020-21) of the Integrated B.Sc. (Hons.) and M. Sc. in Botany programme consequent to adoption of CBCS guidelines.**

The Board considered the draft course structure and contents. Minor modifications made in the course Plants in Human Welfare (approved in 7th meeting of BOS, dt. 29/11/2018) and the contents of proposed new core course Cell Biology were approved by the Board (Annexure – 2).

**11.6 To consider and approve draft contents of proposed course Taxonomy of Angiosperms to be offered in semester IV (AY 2020-21) of the Integrated B.Sc. (Hons.) and M. Sc. in Botany programme.**

The Board considered the fact that components of the course, Taxonomy of Angiosperms and Plants and Human Welfare, being offered in semester IV are already being dealt with in the second semester and approved that a new course, Taxonomy of Angiosperms be offered in lieu of the existing course. The draft contents of course, Taxonomy of Angiosperms, were also discussed. The approved course is placed at annexure – 3.

**11.7 To consider and approve the minutes of meeting of DRC held on 01/02/2021**

The Board approved the minutes of the meeting of the DRC held on 01/02/2021 (Annexure – 4).

5.1 Appointment of Dr. Vikas Srivastava as Ph.D. supervisor of Mr. Aksar Ali Chowdhary (Roll.no. 0151718), Ph.D. scholar 2018 batch.
Approved by the Board.

5.2 Approval of title 'Studies on the contribution of NO and $H_2S$ during abiotic stress in *Solanum lycopersicum*' and synopsis of Ph.D. thesis of Mr. Aksar Ali Chowdhary (Roll.no. 0151718).
Approved by the Board.

5.3 Appointment of supervisors of Ph.D. scholars of 2019 batch

| S. no. | Roll no. | Name | Ph.D. Supervisor |
|---|---|---|---|
| 1. | 0151719 | Barkha Parihar | Prof. B. S. Bhau |

| | | | |
|---|---|---|---|
| 2. | 0251719 | Jyoti Priya | Dr. Deepak Bhardwaj and Dr. Vikas Srivastva |
| 3. | 0351719 | Komal Sharma | Dr. Samantha Vaishnavi |
| 4. | 0451719 | Shreya Proch | Prof. B. S. Bhau |
| 5. | 0551719 | Skalzang Lhamo | Dr. Vikas Srivastava |

Approved by the Board.

5.4 Format of synopsis to be as follows.

i. Cover Page
ii. Table of Content
iii. Abbreviations
iv. Introduction (500-1000 Words)
v. Review of Literature (3000 – 5000 Words)
vi. Hypothesis / Research Question
vii. Justification/ Relevance of Study
viii. Objectives
ix. Plan of Proposed Work
x. Methodology
xi. Expected Outcome of Research
xii. References

Approved by the Board.

5.5 Synopsis presentation to be of 15 minutes with maximum 15 slides. incorporating above mentioned heads

Approved by the Board.

**11.8 Any other agenda item with permission of the Chair.**

**11.8.1** The panel of experts for various courses being offered in the current semester were placed before the Board for consideration. The approved panel is placed at annexure – 5.

**11.8.2** Prof. B. S. Bhau placed a format for submission of monthly progress report of Ph.D. scholars before the Board for its consideration. The same was approved (Annexure – 6).

**11.9 The Meeting ended with a vote of thanks to the Chair.**

Prof. B. S. Bhau

Prof. A. K. Wakhlu

Dr. S. Vaishnavi

Dr. V. Srivastava

Dr. D. Bhardwaj

## SEMESTER X (AY 2020-21)

| Course Code | Paper Title | Credit | Contact hours per week | | |
|---|---|---|---|---|---|
| | **Core Papers** | | **L** | **T** | **P** |
| | Reproductive and Developmental Biology of Plants | 4 | 4 | 0 | 0 |
| | Plant Genetic Engineering and Omics | 4 | 4 | 0 | 0 |
| | Reproductive and Developmental Biology of Plants Lab | 2 | 0 | 0 | 4 |
| | Plant Genetic Engineering and Omics Lab | 2 | 0 | 0 | 4 |
| | Dissertation | 6 | 0 | 2 | 8 |
| | **Electives (choose any 1 paper)** | | | | |
| | Molecular plant-microbe interactions | 2 | 2 | 0 | 0 |
| | Forensic Botany | 2 | 2 | 0 | 0 |
| | Bioentrepreneurship | 2 | 2 | 0 | 0 |
| | Principles of Seed Technology | | | | |
| | | **20** | 10 | 2 | 16 |

**Annexure 1**

**SEMESTER X** (AY 2020-21)

| Course Code | Paper Title | Credit | Contact hours per week | | |
|---|---|---|---|---|---|
| | **Core Papers** | | **L** | **T** | **P** |
| | Reproductive and Developmental Biology of Plants | 4 | 4 | 0 | 0 |
| | Plant Genetic Engineering and Omics | 4 | 4 | 0 | 0 |
| | Reproductive and Developmental Biology of Plants Lab | 2 | 0 | 0 | 4 |
| | Plant Genetic Engineering and Omics Lab | 2 | 0 | 0 | 4 |
| | Dissertation | 6 | 0 | 2 | 8 |
| | **Electives (choose any 1 paper)** | | | | |
| | Molecular plant-microbe interactions | 2 | 2 | 0 | 0 |
| | Forensic Botany | 2 | 2 | 0 | 0 |
| | Bioentrepreneurship | 2 | 2 | 0 | 0 |
| | Principles of Seed Technology | | | | |
| | | **20** | 10 | 2 | 16 |

## Semester – X (AY 2020-21)

## Reproductive and Developmental Biology of Plants

| Assessment | |
|---|---|
| Maximum marks | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives**

To acquaint the students about the mechanisms of development and reproduction in plants. The course will enable students to know about the different reproductive structures of plants and their role in biological processes.

**Unit 1: Development of vegetative parts**

Plant growth kinetics and patterns of growth; Seedling growth - photomorphogenesis and hormonal control.

Shoot development – organization, determinate and indeterminate growth, lineage decisions, tissue differentiation, developmental patterning of shoot apical meristem (SAM); Regulation, and cytological and molecular analysis of cell fate in SAM.

Leaf development - Determination; Phyllotaxy; Control of leaf forms; Differentiation of epidermis - stomatal development and types, trichome development and types, mesophyll development.

Root development – Organization, fate determination, lineage decisions and developmental patterning of root apical meristem (RAM); Vascular tissue differentiation; Development of lateral roots, root hair and quiescent centre.

**Unit 2: Development of floral development**

Floral evocation and development of floral meristem ABC model, Sex determination mechanisms; Regulation of floral architecture and diversification; Physiological, environmental and molecular control of flowering; Floral organs meristem identity genes in *Arabidopsis* and *Antirrhinum* MADS-box genes.

Male gametophyte – Development of androecium and the genes involved; Molecular basis of microsporogenesis and microgametogenesis

Female gametophyte –Development of gynoecium and the genes involved; Molecular basis of megasporogenesis and megagametogenesis.

**Unit 3: Pollination and post-pollination developments**

Plant-pollinator interactions; pollen load; pollinator and pollination efficiency; physicochemical aspects of pollination; pollen: ovule ratio.

Genetic and molecular control of pollen-pistil interaction; Chemical and molecular signalling for pollen tube guidance; Molecular basis of double fertilization.

Molecular mechanism and genes involved in seed development; Molecular basis of embryogenesis in dicots and monocots.

**Unit 4: Developmental perspectives on apomixis**

Origin and maintenance of natural and induced apomixis; Types and significance; Embryological and molecular studies in apomixis; Nucellar and integumentary embryos; Polyembryony – types, significance and developmental patterns.

**Unit 5: Deviations in plant development**

Male sterility - mechanism of action; meiotic abnormalities; pollen viability; Cytological, biochemical and molecular aspects of pollen tube rejection reaction and sexual incompatibility.

*In vitro* fertilization (IVF) - origin; techniques and achievements; fruit and ovule abortion in relation to resource allocation; sibling competition in plants

**Suggested readings:**


1. Maheshwari, P., 2020. An Introduction to the Embryology of Angiosperms. Alpha Editions
2. Barrett, S.C.H., 2008. *Major Evolutionary Transitions in Flowering Plant Reproduction.* University of Chicago Press.
3. Faegri, K. and Van der Pijl, L., 1979. *The Principles of Pollination Ecology*. Pergamon Press, Oxford.
4. Harder, L.D. and Barrett, S.C.H., 2006. *Ecology and Evolution of Flower*. Oxford University Press.
5. O'Neill, S.D. and Roberts, J.A., 2002. *Plant Reproduction*. Sheffield Academic Press.

6. Raghavan, V., 1997. *Molecular Embryology of Flowering Plants*. Cambridge University Press.
7. Raghavan, V., 2000. *Developmental Biology of Flowering Plants*. Springer Verlag, New York.
8. Scott, R.J. and Stead, A.D., 2008. Molecular and Cellular Aspects of Plant Reproduction. *Society for Experimental Biology*, Seminar Series 55.
9. Shivanna, K.R. and Johri, B.M., 1985. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern.
10. Shivanna, K.R., 2003. *Pollen Biology and Biotechnology*. Science Publishers, Enfield, New Hamsphire, U.S.A.
11. Shivanna, K.R. and Rangaswamy, N.S., 1992. *Pollen Biology: A Laboratory Manual*. Springer Verlag, Berlin.
12. Datte, Y., Dumas, C. and Gallais, A., 1992. *Reproductive Biology and Plant Breeding Biologie de la Reproduction et Amélioration des Plantes*. Springer Verlag.
13. Lyndon, R.F., 1990. *Plant Development: The Cellular Basis*. Unnin Hyman, London.
14. Hojsgaard Diego, Hörandl Elvira 2019. The Rise of Apomixis in Natural Plant Populations, Frontiers in Plant Science (10): 358
15. Wheeler, M.J., Franklin-Tong, V.E. and Franklin, F.C.H., 2001. The molecular and genetic basis of pollen–pistil interactions. *New Phytologist*, *151*(3). pp.565-584.
16. Beck, C., 2010. An Introduction to Plant Structure and Development. Cambridge University Press, 465pp.
17. Koltunow, A.M. and Grossniklaus, U., 2003. Apomixis: a developmental perspective. *Annual review of plant biology*, *54*(1). pp.547-574.
18. Steeves, T.A. and Sussex, I.M., 1989. Patterns in plant development. Cambridge University Press, 405pp.
19. Richards, A.J., 2003. Apomixis in flowering plants: an overview. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *358*(1434), pp.1085-1093.
20. Whitelam, G.C. and Halliday, K.J., 2007. Light and Plant Development. Blackwell Publishing Ltd, 350pp.
21. Meyer, P. (Ed.) 2005. Plant Epigenetic. Blackwell Publishing Ltd. 281pp.
22. Leyser, O. and Day, S., 2003. Mechanism in Plant Development. Blackwell Publishing Ltd. 241pp.
23. Timmermans, M., 2010. Plant Development. Academic Press, 480pp.
24. Howell, S.J., 1998. Molecular Genetics of Plant Development. Cambridge University Press, 365pp.
25. Davies, P.J. (ed.) 2010. Plant Hormones: Biosynthesis, Signal Transduction, Action. Springer, Netherlands, 802pp.
26. Karp, J.G., 2007. Cell and Molecular Biology. John Wiley & Sons, USA.

27. Buchanan, B.B., Gruissem, W. and Jones, R.L., 2015. Biochemistry and Molecular Biology of Plants. Wiley Publisher, 1264pp.

28. Research and review articles on relevant topics.

**Course Title: Reproductive and Developmental Biology of Plants Lab**

| Assessment | |
|---|---|
| Max. Marks | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

1. Demonstration of developmental aspects of reproduction using normal and mutant Arabidopsis phenotypes.
2. Demonstration of the stages of pollen and ovule development in the wild and mutant plants using permanent slides; electron micrograph and available phenotypes.
3. Pollen *in vitro* germination methods: Sitting drop culture; suspension culture; surface culture and pollen viability tests.
4. To study the pollen mitosis.
5. Assessment of stigma receptivity by localizing peroxidases, non-specific esterases and phosphatases.
6. Assessment of floral rewards: quantitative and qualitative analysis of nectar and pollen.
7. To localize pollen tubes with aniline blue fluorescence method.
8. To study the different aspects of pollen-pistil interaction and post fertilization stage with the help of permanent slides and electron micrographs.
9. To isolate the embryo sacs and visualization of post-fertilization stages via fluorescence and confocal microscope.
10. To study of use of DNA fluorochromes to localize nuclei during pollen and ovule development.
11. To study the post-fertilization stage with the help of permanent slides and electron micrographs.

12. To induce somatic embryos using a suitable plant material.
13. To study the tissue systems, meristem, vascular and cork cambium.
14. To study the internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
15. To study the origin of lateral roots.

**Annexure 1**

## Course Title: Plant Genetic Engineering and Omics

| Assessment | |
|---|---|
| Maximum marks | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives:** To acquaint the students to the versatile tools and techniques employed in genetic engineering and recombinant DNA technology. The student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science research.

**Theory**

**Unit 1: Advanced tools in plant genetic engineering**

Introduction to plant genetic engineering –restriction enzymes –Protein engineering of restriction enzymes; Vectors - New-generation vectors for transgenic Plants - GATEWAY-Compatible binary Vectors; Destination vectors; GATEWAY-Compatible MicroRNA vectors; Tissue-Specific and Stress-Inducible Binary vectors; Vectors for virus-induced gene silencing; Gene-editing by expression of developmental regulators and *de novo* meristem induction in plants; RNA viruses and mobile guide RNAs for heritable plant gene-editing; Nanoparticles for delivering biomolecules to facilitate plant genome engineering; Cloning vectors for higher organisms; Commercially available plasmids; transcriptional terminators; Vectors for plants; expression vectors;

**Unit 2: Plant genetic transformation**

Plant transformation vectors - T-DNA and viral vectors; plant transformation by Agrobacterium sp; non-Agrobacterium sp; and *in planta* transformation; molecular mechanism of T-DNA transfer; direct gene transfer methods in plants - gene gun and other methods; chloroplast transformation; transgene analysis; silencing and targeting; marker-free and novel selection strategies; multigene engineering; gene knock-down by ribozymes; antisense RNA and RNA interference; Marker-Free Transgenic Plants; Plastid genome

engineering; Plastid bioreactors for molecular farming; Plastid as a biofactory for Industrially Important products

**Unit 3: Applications of plant transgenic technology**

Transgenic crops for resistance against biotic and abiotic stresses; engineering crops for male sterility and modification of flower colour/pattern; fruit ripening and senescence; GM crops for nutritional quality and quantity; RNAi-mediated crop improvement; molecular farming; metabolic engineering and hairy root culture for secondary plant products; global status and biosafety of transgenic plants. Transgenic Crops in Virus Management- Nucleic Acid-Mediated Resistance (NAMR); Artificial MicroRNA (amiR)-Mediated Resistance Key Challenges in Developing Products from Transgenic Plants- Plant Tissues Used for Expression of Recombinant Proteins; Expression Systems; Production of Therapeutic Proteins in Plants

**Unit 4: Computational and Machine learning in botany**

Computational botany-Introduction, morphometrics, morphometric analysis of leaves, flowers and other organs, feature extraction-Leaf shape, texture and margins, image recognition of plant- artificial intelligence, Machine Learning Techniques in Plant Biology machine-learning applications for studies in plants, machine learning methods and modelling techniques, machine learning for plant leaf analysis, limitations of machine learning.

**Unit 5: Plant Omics**

Omics- history and prospects omics; Omics of Model Plants; Next-Generation Sequencing and Assembly of Plant Genomes; Genome Assembly Algorithms; Biological Applications of Next-Generation Sequencing; Cytogenomic Techniques-Chromosome Biology, and Genome Analysis; miRNomics- Plant Gene Regulation by miRNAs; Role of miRNA in Plants; Phenomics: Applications in Plant and Agriculture; Plant Cytomics and applications; Chloroplast and Mitochondrial Omics; Micromorphomics; Microbiomics; Plant Pharmacogenomics Bioinformatics and Nanobiotechnology in agricultural development.

**Suggested readings:**

1. Genes VI: Benjamin Lewin. Oxford University Press, Oxford, 1997.
2. Genes VII: Benjamin Lewin. Oxford University Press, Oxford, 2000.

3. Knowler, J.T., Leader, D.P. and Adams, R.L., 1986. *The Biochemistry of the Nucleic Acids*. Chapman & Hall.

4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson. J.D., 1999. *Molecular Biology of the Cell*, 477–485.

5. DNA cloning 1: A Practical approach: Core techniques, 2nd Edition. IRL Press, 1995.

6. Shaw, C.H. ed., 1988. *Plant Molecular Biology: A Practical Approach*. IRL Press.

7. Barh, D., Khan, M. S., Davies, E., 2015. PlantOmics: The Omics of Plant Science. Springer India

8. Banerjee, R., Kumar, G. V., Jeevan Kumar, S. P., 2019. OMICS-Based Approaches in Plant Biotechnology. Wiley publishers

9. Sathishkumar, R., Sarma, R. K., Jagadeesan, H., Venkidasamy. B., 2019 Advances in Plant Transgenics: Methods and Applications. Springer Nature Singapore Pvt. Ltd.

10. Santos, D. M., 2011. Genetic Engineering -Recent Developments in Applications. Apple Academic Press.

11. Rajagopal, K., 2012. Recombinant DNA Technology and Genetic Engineering. Tata McGraw Hill Education Private Limited.

**Course: Plant Genetic Engineering and Omics Lab.**

| Assessment | |
|---|---|
| Max Marks | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

1. To isolate the nucleic acids from different sources.
2. To analyse the restriction enzyme digestion of DNA and calculation of molecular weight of the digested DNA.
3. To study the DNA amplification by PCR method.
4. To prepare the competent cells in *E. coli*.

5. To study bacteria transformation through $CaCl_2$ and PEG methods.
6. To study the methods of western and southern blotting.
7. To isolate and purify the plasmids DNA of bacteria and yeast.
8. To study the electrophoretic separation of plasmid DNA by agarose gel electrophoresis.
9. To Quantify and assess the quality of DNA by UV spectrophotometry and electrophoresis.
10. To analyse restriction and construction of restriction map of plasmid DNA.
11. To construct of recombinant plasmid.
12. To study the screening of transformed cells for the presence of recombinant plasmid and gene.
13. To study of transformation frequency and cloning efficiency.

# Elective Courses

## Course Title: Molecular plant-microbe interactions

| Assessment | |
|---|---|
| Maximum marks | 50 |
| Continuous Internal Assessment (CIA) | 12.5 |
| Mid Semester Exam (MSE) | 12.5 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

**Course objectives:** At the end of this course, students will be able to explain the physiological and biochemical processes involved in plant-microbe interactions. They can also draw connections between the biology of plant-microbe relationships and the impacts of these relationships on the ecosystem and human society.

**Theory**

**Unit 1: Molecular plant pathology**

An overview of plant-pathogen interaction; molecular biology of disease resistance; phytochemicals involved in resistance; gene-for-gene interaction-resistance genes-avirulence genes; systemic acquired resistance (SAR); SAR –maker proteins; biosynthesis and mode of action of salicylic acid; defense related pathways; octadecanoid pathway; lipoxygenase pathway; shikimic acid pathway; ; hypersensitive reaction; reactive oxygen species and their role in resistance; pathogenesis related (PR) proteins: resistance gene dependent plant defense

**Unit 2: Pathogen and diversity**

Plant pathogens and pathogenesis; bacterial; fungal and viral disease; specific symptoms associated with phytopathogens; virulence mechanisms of viral, bacterial and fungal pathogens; molecular diagnosis: molecular tools for the detection of plant pathogens; introduction molecular probes- different molecular methods (immunological assays and nucleic acid hybridization an amplification techniques) for the identification of pathogens; Use of PCR in the detection and characterization of phytopathogens.

**Unit 3: Management of plant diseases**

Modern biotechnological strategies for disease management: Plant growth- promoting rhizobacteria (PGPR); taxonomy and diversity of fluorescent pesudomonads; mechanisms of plant growth promotion and antagonism; development of disease resistance plants using genetic engineering approaches; different methods of gene transfer; biosafety issues related to GM crops.

**Suggested readings:**


1. Jones, R., Ougham, H., Thomas, H. and Waaland, S., 2012. The *Molecular Life of Plants, first edition*. Wiley-Blackwell publications.
2. Chrispeels, M.J. and Sadava, D.E., 2003. *Plants, Genes, and Crop Biotechnology*. Jones & Bartlett Publishers.
3. Ronald, P.C., 2007. *Plant-Pathogen Interactions: Methods and Protocols*. Humana Press.
4. Gurr, S.J., McPherson, M.J. and Bowles, D.J., 1998. *Molecular Plant Pathology*. Oxford University Press.
5. Prell, H.H. and Day, P., 2001. *Plant-Fungal Pathogen Interactions*. Springer publications, New York.
6. The Plant Cell (Special Edition: Plant Microbe Interaction) Vol. 8, 1996.
7. Singh, U.S. and Singh, R.P., 1995. *Molecular Methods in Plant Pathology*. Lewis Publishers, Boca Raton, Fl.
8. Marshell, G., and Walters, D., 1994. *Molecular Biology in Crop Protection*. Kluwer Academic Publishers.

## Course title: Forensic Botany

| Assessment | |
|---|---|
| Maximum marks | 50 |
| Continuous Internal Assessment (CIA) | 12.5 |
| Mid Semester Exam (MSE) | 12.5 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

**Course objectives**

This course will help students to have a overview of forensic science with an impetus on on forensic botany with primary emphasis on methods other than DNA analysis. Students will be expected to read case studies and other works from the forensic literature. This course will also help students to integrate results of basic science with the forensic sciences in a scientific way.

**Theory**

**Unit 1: Introduction to forensic botany**

Botanical evidence in legal investigations; legal plant definition; types of plants; non-plant groups traditionally studied by botanists; plant habitats and associations; plant characteristics/plant morphology; basic plant characteristics for the forensic investigator; habit; plant dispersal.

**Unit 2: Evidence collection and analytical techniques**

Initial crime scene notation; evidence collection; storage; documentation of botanical evidence; analysis of botanical evidences; types of cases; evidence analysis; laboratory report; transportation of botanical evidence; evidence retention and disposition; step-wise method for the collection of botanical evidence; crime scene data; habitat documentation; scene location; collection information needed for each botanical; types of samples and collection for DNA analyses; uses of genetic data; genotyping methods; microscopes and microscopic botanical structures relevant to forensic botany; importance of reference

collections in microscopic analysis; preparation and documentation of specimen evidence for microscopic examination

**Unit 3: Sources for forensic plant evidence**

Plant taxonomy: plant collection & identification; plant anatomy-Types of plants; plant cell types; plant cells and time of death; plant ecology- Ecological landscapes; climate and weather data palynology: Biological features of pollen; the use of pollen for non-forensic work; application of algal evidence in forensic investigations; collection and processing of algal evidence in forensic investigations

**Suggested readings:**


1. Blum, D., 2011. *The Poisoner's Handbook.* Penguin Books, New York.
2. Bock, J.H., Norris, D.O. and Lane, M.A., 1988. *Identifying Plant Food Cells in Gastric Contents for Use in Forensic Investigations: A Laboratory Manual*. US Department of Justice, National Institute of Justice.
3. Carlier, J., Guitton, J., Romeuf, L., Bévalot, F., Boyer, B., Fanton, L. and Gaillard, Y., 2014. Screening approach by ultra-high performance liquid chromatography–tandem mass spectrometry for the blood quantification of thirty-four toxic principles of plant origin. Application to forensic toxicology. *Journal of Chromatography B*, *975*, pp.65-76.
4. Gallagher, S., August 10, 2004. Andre Noble, Filmmaker Blog, http://www.filmmakermagazine.com/blog/2004/08/andre-noble;php/#;VQtKzWYWFFU.
5. Jhala, C.I. and Jhala, K.N., 2012. The Hippocratic oath: a comparative analysis of the ancient text's relevance to American and Indian modern medicine. *Indian Journal of Pathology & Microbiology*, *55*(3), pp.279-282.
6. Levine, M., Ruha, A.M., Graeme, K., Brooks, D.E., Canning, J. and Curry, S.C., 2011. Toxicology in the ICU: part 3: natural toxins. *Chest*, *140*(5), pp.1357-1370.
7. Lewis, W.H. and Elvin-Lewis, M.P., 2003. *Medical Botany: Plants Affecting Human Health*. John Wiley & Sons, New York.
8. Magner, L.N., 1992. *A History of Medicine*. Marcel Dekker Inc., New York.

## Course Title: Bio-entrepreneurship

| Assessment | |
|---|---|
| Maximum marks | 50 |
| Continuous Internal Assessment (CIA) | 12.5 |
| Mid Semester Exam (MSE) | 12.5 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

**Course objectives**: The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

**Theory**

**Unit 1: Basics of bio-entrepreneurship**

Importance of entrepreneurship; advantages of entrepreneur - freedom to operate; introduction to bio-entrepreneurship – biotechnology in a global scale; scopes in bio-entrepreneurship; types of bio-industries – bio-pharma; bio-agriculture; bio-services and bio-industrial innovations – types; out of box thinking; skills for successful entrepreneur – creativity; leadership; managerial; team building; decision making; opportunities for bio-entrepreneurship development programs of public and private agencies (MSME; DBT; BIRAC; Start-up & Make in India); patent landscape; IP protection and commercialization strategies

**Unit 2: Accounting and finance**

Business plan preparation; business feasibility analysis by SWOT; socio-economic costs benefit analysis; funds/support from government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bio-entrepreneurship; business plan proposal for virtual start-up company; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet; profit and loss statement; double entry 36 book keeping; collaborations and partnerships; information technology for business administration and expansion

**Unit 3: Business strategy and marketing**

Entry and exit strategy; pricing strategy; negotiations with financiers; bankers; government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions; market conditions; segments; prediction of market changes; identifying needs of customers; market linkages; branding issues; developing distribution channels - franchising; policies; promotion; advertising; branding and market linkages for virtual start-up company; knowledge centres e.g, in universities; innovation centres; research institutions (public and private) and business incubators; research and development for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises; regulations for transfer of foreign technologies; quality control; technology transfer agencies; understanding of regulatory compliances and procedures (CDSCO; NBA; GLP; GCP; GMP)

**Suggested readings:**


1. Adams, D.J. and Sparrow, J.C., 2008. *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Scion Publishing, Bloxham.
2. Shimasaki, C. ed., 2014. *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Academic Press.
3. Onetti, A. and Zucchella, A., 2014. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge.
4. Jordan, J.F., 2014. *Innovation, Commercialization, and Start-Ups in Life Sciences*. Crc Press.
5. Desai, V., 2009. *Dynamics of Entrepreneurial Development and Management* (pp. 119-134). Himalaya Publishing House.

## Course Title: Principles of Seed Technology

| Assessment | |
|---|---|
| Maximum marks | 50 |
| Continuous Internal Assessment (CIA) | 12.5 |
| Mid Semester Exam (MSE) | 12.5 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

**Course objectives**: To strengthen understanding of the basic principles of seed production technology. To acquaint the students with fundamental principles seed technology. To provide the basic knowledge of seed production To acquaint the students with knowledge of seed processing, marketing and management.

**Theory**

**UNIT – I Seed production**

Identification of seeds and its classes. Study of biology of different field and vegetable crops, flower structure, mode of pollination & propagation. Concepts of variety release, notification and maintenance of varieties and hybrids of field and vegetable crops. Identification of crop varieties/hybrids on the basis of morphological characters. Factors influencing deterioration and maintenance of genetic purity of crop varieties. Hybrid seed production of field and vegetable crops. Roguing of off type plants in seed production units. Seed act and policies, seed certification standards of field & vegetable crops. WTO, IPR, PPV & FR. Visit to seed production field public and private seed companies.

**UNIT – II Seed Processing, Storage & Marketing**

Principles and importance of seed processing. Standardization of process parameters of seed processing machinery for specific crop/variety. Maintenance of seed processing equipment like: Air screen cleaner, indent cylinder separator, specific gravity separator etc. Determination of seed moisture content before and after drying. Maintenance and calibration of different seed treaters. Study of different types of seed storage structures i.e, Traditional and Modern. Seed marketing and factors influencing it. Visit to seed processing plants and seed stores of various public and private seed companies.

**UNIT – III Seed Testing and Quality Control**

Identification and handling of seed testing equipment. Physical purity analysis and calculation of its components in seed samples. Moisture determination by different methods in various field and vegetable crops. Different germination testing methods of field and vegetable cropsSeed health management. Visit to seed testing laboratory of various public and private seed companies.

**Suggested readings:**


1. Lab Manual of Principles of seed technology
2. Agrawal P.K. 2006. Principles of seed technology. Published by ICAR, Delhi.
3. Copeland L.O. 2012. Principles of seed science and technology. 4th edition. Springer Science and Business media.
4. Geetharani P, Swaminathan V and Ponnuswami V. 2012. Seed technology of horticulture crops, Marendra Publishing House, 1st edition.
5. Kanwar Bhattarai and Mehta. 2010. Seed Technology (Processing, storage. and marketing).

Annexure 2

## Course structure for Semester II

## (AY 2020-2021)

| Course Type | Course Title | Credit | Contact hours per week | | |
|---|---|---|---|---|---|
| | | | L | T | P |
| Core Course | Plants in Human Welfare | 4 | 4 | 0 | 0 |
| Core Course | Cell Biology | 4 | 4 | 0 | 0 |
| Core Course | Plants in Human Welfare Lab | 2 | 0 | 0 | 4 |
| Core Course | Cell Biology Lab | 2 | 0 | 0 | 4 |
| Generic Elective with lab/ Generic Elective with tutorial (please select either of them) | | 6 | 4 | 0 | 2 |
| | | 6 | 4 | 2 | 0 |
| Ability Enhancement Compulsory Course (AECC) | | 2 | 2 | 0 | 0 |
| | | **20** | 18 | 2 | 16 |

**Annexure 2**

## Course title: Plants in Human Welfare

**Course code: ICBOT2C002T** **Credits: 4** [4-0-0]

| Assessment | |
|---|---|
| Max. Mark | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives**

The course aims at making student realize the importance of plants to humankind and introduce them to the history of plant domestication and evolution of agriculture.

**Unit 1: Plants as part of human culture**

Origin and role of agriculture in shaping human history; Centers of origin of plants; Evolution of plants during domestication and production of new varieties.

**Unit 2: Food, spices and beverages**

Origin, morphology and uses of cereals (rice, wheat and maize); pulses (gram and pea); vegetables (potato and tomato); spices (ginger, black pepper and cloves) and beverages (tea and coffee). Processing of tea and coffee.

**Unit 3: Fruits, nuts and medicinal plants**

Origin, morphology and uses of fruits (apple, banana and mango) and nuts (almond and walnut). General features and uses of medicinal plants (*Cinchona*, *Rauwolfia*, *Catharanthus*, *Papaver*, *Cannabis* and *Azadirachta*).

**Unit 4: Timber, fibers, oil, sugar and rubber**

Botanical description and uses of timber (teak and deodar); oils (groundnut, mustard and coconut); essential oils (rose and lemon grass); fibers (cotton, jute and flax); rubber (*Hevea brasilensis* and *Ficus elastica*) and sugar (sugarcane).

**Unit 5: Lower plants & microbes**

Utilization of algae, fungi, lichens, bryophytes and pteridophytes in agriculture, in medicine and as food products. Their role in nitrogen fixation, treatment of waste and as pollution indicators.

**Suggested Readings**


1. Chrispeels M.J. and Sadava D.E. (2003) Plants, Genes and Agriculture. Jones & Bartlett.
2. Clifton A. (1950) Introduction to Bacteria, McGraw – Hill.
3. Gangulee S. C., Das K.S, Dutta C.D. and Kar A.K. (1968) College Botany Vol. I.
4. Kochhar S.L. (2012) Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

5. Kumaresan V. and Annie R. (2013) Taxonomy-Systematic Botany, Economic Botany, Ethnobotany. Saras Publication Nagercoil.
6. Pandey B.P. (2010) College Botany (Vol. I). S. Chand and Company Ltd. New Delhi.
7. Rashid A. (1998). An Introduction to Bryophyta. Vikas Publishing House (P) Ltd., New Delhi.
8. Srivastava H.N. (1998) Gymnosperms. Pradeep Publications, Jalandhar.
9. Vasishta B.R., Sinha A.K. and Kumar A. (2010) Botany for Degree Students - Pteridophyta. S. Chand and Company Ltd., New Delhi.

**Course title: Plants in Human Welfare Lab**

**Course code: ICBOT2C002L** **Credits: 2** [0-0-4]

| Assessment | |
|---|---|
| Max. Mark | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

1. Cereals: Study of habit, L.S./T.S. of grain, starch grains and microchemical tests of rice and wheat.
2. Legumes: Study of habit, fruit, seed structure, micro-chemical tests of pea and groundnut.
3. Sugars: Study of habit of sugarbeet and sugarcane
4. Spices: Study of habit and sections of black pepper, fennel, clove and cumin seeds.
5. Beverages: Study of morphology of tea and coffee plants.
6. Oils and fats: Coconut - T.S. of mature fruit, Mustard – plant and seed morphology, and microchemical tests of crushed seeds.
7. Essential oil yielding plants: Study of morphology of *Rosa*, *Vetiveria, Cymbopogon, Santalum* and *Eucalyptus* (specimens/photographs).
8. Rubber: Study of plant morphology using specimen or photograph, model of tapping, samples of rubber products.
9. Drug-yielding plants: Study of specimens of *Digitalis, Rauwolfia, Papaver* and *Cannabis.*
10. Woods: Study of specimens and section of young stem of *Tectona, Dalbergia sisso* and *Pinus.*
11. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz fibres, whole mount of fibre and test for cellulose), Jute (specimen, test for lignin on transverse section of stem and fibre).

## Course Title: Cell Biology

| Assessment | |
|---|---|
| Maximum marks | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives**

The purpose of this course is to have a firm foundation in the fundamentals of Cell Biology and Cytogenetics. On completion of the course, the students would be able to describe and discuss the structure and functioning of cells, their envelopes and internal components. They would be able to explain the intricacies of cell cycle and division, and discuss the role of numerical and structural aberrations in evolution.

**Unit 1: Introduction to cell and cell envelopes**

Cell as a unit of life – discovery, structure, properties and function; Cell theory; Characteristics of prokaryotic cells (Archaea and Eubacteria); Origin of eukaryotic cell (endosymbiotic theory); Characteristics of eukaryotic cells (plant, animal and fungal); Plant cell types (parenchyma, collenchyma and sclerenchyma); Brief history of studies on plasma membrane structure; Chemical composition of plasma membranes; Function of plasma membrane; Membrane transport – passive (diffusion and facilitated diffusion), active transport (brief account of carriers, channels and pumps), endocytosis and exocytosis; Chemistry, structure and function of plant cell wall

**Unit 2: Double membrane-bound cell organelles**

Nucleus: nuclear envelope, nuclear pore complex, nuclear lamina; Nucleolus – structure and function.

Structural organization and semi-autonomous nature of mitochondria, role in respiration

Structural organization and semi-autonomous nature of chloroplast, chloroplast in lower plants, structure associated with chloroplast, functions of chloroplast.

**Unit 3: Cytoplasmic membrane system and associated organelles**

Endoplasmic reticulum – types (RER and SER) and structure; RER as sites for protein synthesis, targeting and insertion of proteins, protein folding, processing and quality control; Smooth ER and lipid synthesis, export of proteins and lipids, Golgi apparatus – organization, protein glycosylation, protein sorting and export from Golgi apparatus; Structure and function of lysosomes, peroxisomes, glyoxysomes and vacuoles.

Cytoskeleton - structure of microtubules, microfilaments and intermediate filaments

**Unit 4: Cell cycle and cell division**

Cell cycle, interphase (G1, S and G2 phases), Chromosome - gross morphology, fine structure of chromatin in prokaryotes and eukaryotes; Mitosis; Meiosis, synapsis and synaptonemal

complex; Cell cycle regulation; Preliminary view of organogenic callus, plant cell death, apoptosis and cancer.

**Unit 5: Techniques in cell biology**

Microscopy – Principle and applications of light (bright-field, phase-contrast, differential interference contrast), fluorescent, confocal, electron (SEM, TEM).

Sectioning, Microtomy, Stains and dyes; Staining techniques – positive and negative.

Techniques related to cell membrane- Freeze-fracture technique; Centrifugation- types and applications.

Utility of experimental model systems to study cell biology- yeast, *Chalmydomonas*, *Chlorella*, *Arabidopsis thaliana* and *Populus*

**Suggested Readings:**


1. Cooper, G.M. and Hausman, R.E. (2016) The Cell: A Molecular Approach. 7th edition. Sinauer Associates.
2. Albert B et al. (2015) Molecular Biology of the Cell, New York, Garland Sciences, 6th edition.
3. Karp G. and Iwasa J (2015). Cell and Molecular Biology: Concepts and Experiments, John Wiley & Sons, U.S.A. 8th edition.
4. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
5. DeRobertis E.D.P and DeRobertis E.M.F. (2010) Cell and Molecular Biology, 8th edition, Lippincott, Williams & Wilkins.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P.( 2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
7. Gupta PK, Cytology Genetics and Evolution, 8th edition (2017) Rastogi Publications.
8. Cohn, N.S. Elements of Cytology, 2nd edition (1969) Harcourt, Brace and World USA.
9. Darlington, C.D. Recent advances in cytology, 2nd edition (1965).Churchill –London
10. Swanson C.P.T. Merz & W.J. Young, Cytogenetics (1967) Prentice Hall Press


**Cell Biology Lab**

| Assessment | |
|---|---|
| Max Mark | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |

| Passing Marks | 25 |
|---|---|

1. Study of plant cell structure with the help of epidermal peel mount of *Allium/ Rhoeo/ Crinum*.
2. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
3. Measurement of cell size by the technique of micrometry.
4. Counting the cells per unit volume with the help of haemocytometer in Yeast / pollen grains
5. Study of cell and its organelles with the help of electron micrographs.
6. Cytochemical staining of DNA using Feulgen stain
7. Cytochemical staining of cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Staining of nucleus and mitochondria of plant cells using organellar specific stains.
9. Study the effect of organic solvents and temperature on membrane permeability.
10. Study of different stages of mitosis through acetocarmine squash preparation and permanent slides
11. Study of different stages of meiosis through acetocarmine squash and permanent slides

## Taxonomy of Angiosperms

| Assessment | |
|---|---|
| Maximum marks | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives**

The main aim of this course is to provide fundamentals of Angiosperm morphology and classification with special reference to the polygenerid relationship of various taxa.

**Unit 1: Plant taxonomy and systematics**

Historical account of the classification of Angiosperms, Familiarization of the classification of Linnaeus, Hutchinson, Engler and Prantl and Takhtajan. A detailed account of the classification of Bentham & Hooker. Biosystematics, chemotaxonomy, Numerical Taxonomy and cytotaxonomy.

**Unit 2: Botanical nomenclature**

ICBN, Typification, Principles of priority and their limitations, effective and valid publication, citation. Rejection and retention of names. Names of hybrids and cultivars. Keys for identification of plants single access and multi-access, value of computers and databases for identification.

**Unit 3: Process of identification**

Herbarium, herbarium specimens and their preparation, role of herbaria, botanical garden, Important botanical garden of India & world documentation, floras monographs, manuals, journals, online journals abstracts and indices.

**Unit 4: Molecular taxonomy**

Molecular systematic Context and controversies, Collection and storage of tissues. Proteins, amino acid sequence analysis, Serology and Isozyme analysis. Nucleic acid, base ratio, polymerase chain reaction. Analysis of DNA fragments and restriction sites, sequencing applications in molecular systematics.

**Unit 5: Major families of angiosperms**

A detailed study of the following families and their interrelationship and phylogeny. Magnoliaceae, Ranunculaceae, Brassicaceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Asteraceae, Solanaceae, Asclepidaceae, Lamiaceae Nyctaginaceae, Euphorbiaceae, Moraceae, Liliaceae, Orchidaceae and Poaceae.

**Suggested Readings**


1. R.C. Mathur 1990. Systematic Botany Agra book house.
2. N.S.Subramanian 1995. Modern plant taxonomy
3. V.N.Naik 1996 .Principles of Angiosperms Taxonomy.
4. V.V.Sivirarajan 1999. Introduction to principles of Taxonomy of Angiosperms.
5. Sharma O.P. 1995. Plant Taxonomy.
6. G.Singh 2000. Plant systematic theory and Practical's
7. Hill A.F. 1952. Economic Botany.
8. Pullaiah T. 1998. Taxonomy of Angiosperms. Regancy Publication, New Delhi.


## TAXONOMY OF ANGIOSPERMS LAB (0-0-4)

| Assessment | |
|---|---|
| Max Mark | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

Detailed study of the families mentioned in the theory with representative genera from the local area. Familiarity of the binomial nomenclature of the available species from the local flora using Gamble flora. Identification of family, genus, species, and morphology of the useful parts of plants mentioned in the theory.