Agenda and Minutes of the 16th Meeting of the Board of Studies of Department of Botany Central University of Jammu

Venue : Office of Head, Department of Botany, CUJ, Bagla
Date : , 15th February 2024

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13.	To review and approve the inclusion of MOOC courses within the curriculum for the II and IV semesters, as per the guidelines of the New Education Policy, and for the IV semester under the Choice Based Credit System (CBCS) for the Integrated B.Sc. (Honours) and M.Sc. Botany program.
14.	Any other item with the permission of the Chair.
15.	Vote of Thanks.

5. **To report the course structure for semester VI (January – May 2024) of batch 2021-22 students of the Integrated B.Sc. (Honours) and M.Sc. Botany program as part of the Choice Based Credit System and inclusion of Biostatistics as a Discipline Specific Elective course within the curriculum.**

CBCS-based course structure placed at annexure –3b was approved and adopted for Integrated B.Sc. (Hons.) and M.Sc. Botany from the AY 2020-21 onwards in the 10th Meeting of the BOS dt. 19/10/2020. Accordingly, the students of batch 2021-22, currently in their semester VI (January – May 2024) are following the course structure placed at annexure –4. Biostatistics was approved in the 6th meeting of the BOS held on 10-07-2018 to be offered as a discipline specific elective course in the semester V of the Integrated B.Sc. (Honours) and M.Sc. Botany program. This course is currently being offered as DSE to the semester VI students of batch 2021-22 (Course content placed at annexure – 5). Further, the contents of the core courses being offered are as per approval of the 7th meeting of the BOS held on 29-11-2018 (Annexure - 5).

6. **To report the course structure for semester V (July – December 2022 and July – December 2023) students of batches 2020-21 and 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

CBCS-based course structure was approved and adopted for Integrated B.Sc. (Hons.) and M.Sc. Botany from the AY 2020-21 onwards in the 10th Meeting of the BOS dt. 19/10/2020. Accordingly, students of batches 2020-21 and 2021-22 completed semester V (July – December 2022 and July – December 2023, respectively) with the course structures as placed at annexure – 6. It is further submitted that the course contents of both core and elective courses have been approved in the 6th meeting of the BOS held on 10/07/2018.

7. **To consider and approve the modified course structure for semester IV (January – May 2021) of students of batch 2020-21 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

CBCS based course structure placed at annexure – 7a was approved and adopted for Integrated B.Sc. (Hons.) and M.Sc. Botany from the AY 2020-21 onwards in the 13th Meeting of the BOS dt. 27/05/2022. Accordingly, batch 2020-21 students were required to study one Generic elective course of 6 credits and a Skill Enhancement Compulsory Course (SECC) of 2 credits. Due to the faculty shortage at the time, the students had to take these courses through MOOC. The selected courses comprised 3 credits for the Generic elective and 2 credits for the Skill Enhancement Compulsory Course (SECC). As a result, students substituted these with three MOOC courses, consisting of two 3-credit courses and one 2-credit course, fulfilling the requirements for both a Generic elective and a SECC. The modified course structure for semester IV (January – May, 2021) of students of batch 2020-21 is placed at annexure – 7b. The Board is requested to consider and accord post-facto approval to the modified course

structure (placed at annexure-7b) for the semester IV (January – May 2021) of batch 2020-21 students.

8. **To consider and approve the modified course structure for semester IV (January – May 2022) of students of batch 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

CBCS based course structure placed at annexure – 8a was approved and adopted for Integrated B.Sc. (Hons.) and M.Sc. Botany from the AY 2020-21 onwards in the 13th Meeting of the BOS dt. 27/05/2022. Accordingly, batch 2020-21 students were required to study one Generic elective course of 6 credits and a Skill Enhancement Compulsory Course (SECC) of 2 credits Due to the faculty shortage at the time, the students had to take these courses through MOOC. The courses available and opted for were of 4 credits each. Thus, instead of 6 credits of Generic elective and 2 credits of Skill Enhancement Compulsory Course (SECC), the students studied two MOOC courses of 4 credits each. These courses fulfilled the general requirements of completing a Generic elective and an SECC. The Board is requested to consider and accord post-facto approval to the modified course structure (placed at annexure-8b) for the semester IV (January – May 2022) of batch 2021-22 students.

9. **To consider and approve the 'Environmental Sciences' course content as an AEC and grant retrospective approval for its offering to the batch of 2022-23 students in semester III (July – December 2023) of the Integrated B.Sc. (Hons.) and M. Sc. in Botany program.**

NEP-based course structure was approved and adopted for Integrated B.Sc. (Hons.) and M.Sc. Botany from the AY 2022-23 onwards in the 13th Meeting of the BOS dt. 27/05/2022. As per the approved structure, the students are required to study an Ability Enhancement Course (AEC) of 2 credits in their third semester. Since a course on Environmental Sciences is a pre-requisite at the UG level, the Department of Environmental Sciences was requested to offer the same to batch 2022-23 students in their 3rd semester (July – December 2023). The course was designed and offered to our students by the EVS Department, and an examination was also conducted. However, later, it came to the notice that their BOS did not approve the particular course and that the EVS Department, as a policy, is not approving courses to be offered at the UG level. Consequently, the result for the 3rd semester (July – December 2023) was withheld since the same requires approval of the course by BOS, which is not possible through the EVS Department. To resolve the situation, the matter was discussed by the faculty of the Department of Botany and Dean, School of Life Sciences, and it was observed that the contents of the said course designed by the EVS Department, being generic in nature, could be offered by the Department of Botany as well. Accordingly, the Board is requested to consider and accord post-facto approval to the course having been offered to batch 2022-23 in their third semester (July-December 2023). Course contents are placed at annexure – 9

10. To consider and approve course content of Environmental Studies as an Open Elective to be offered at UG level.

The Department of Botany has developed the curriculum for a four-credit Environmental Studies course, which will be available to undergraduate students enrolled in various Departments of the University. This course aims to educate students on the significance of environmentally sustainable development for the future of humanity. Through this course, students will explore topics including pollution, proper solid waste management, environmental degradation, the intersection of economic productivity and national security, global warming, ozone layer depletion, and biodiversity loss. The Board is requested to consider and approve the draft course contents placed at annexure-10.

11. To report the value-added courses (VAC) offered to II and IV semesters of Integrated B.Sc. (Honours) and M.Sc. Botany

This is to apprise the members of the BOS that two courses vis, NCC (II semester) and Religion Communication (IV semester), have been offered as Value Added Courses (VAC) at the university level under the New Education Policy. The courses are 2-credit each and have been opted for by the students of the 2022-23 batch of Integrated B.Sc. (Honours) and M.Sc. Botany in their second (Jan- May 2023) and fourth (Jan-May 2024) semesters.

12. To review and approve the inclusion of MOOC courses within the curriculum for the II and IV semesters, as per the guidelines of the New Education Policy, and for the IV semester under the Choice Based Credit System (CBCS) for the Integrated B.Sc. (Honours) and M.Sc. Botany program.

The Botany Department is seeking the approval of BOS members to integrate 4-credit courses, such as Agriculture Geography, Introduction to Psychology, and General Microbiology, as open elective courses in accordance with the guidelines of the New Education Policy. These courses are to be included in the curriculum for II (2023 batch) and IV (2022 batch) semester students enrolled in the Integrated B.Sc. (Honours) and M.Sc. Botany program. Additionally, the department is seeking approval to incorporate Pollutants and Water Supply, Genome Editing and Engineering, Microbiology, and Environmental Sciences as Discipline Specific Elective Courses, following the guidelines of the CBCS. These courses are intended for VI (2021 batch) semester students enrolled in the Integrated B.Sc. (Honours) and M.Sc. Botany program. All courses are proposed to be offered through the Swayam portal, facilitating Massive Open Online Courses (MOOCs).

13. Any other item with the permission of the Chair.

14. Vote of Thanks

Department of Botany
Central University of Jammu

No. CUJ/BOT/2022/ Date: 20th February 2024

MINUTES OF THE 16th MEETING OF BOARD OF STUDIES (BOS) OF DEPARTMENT OF BOTANY

Minutes of the 16th meeting of the Board of Studies of Department of Botany held on 20th February, 2024 at 11.00 am in Office of Head, Department of Botany, Central University of Jammu.

The following members attended the meeting:

Name	Affiliation	Designation
Prof. BrijMohan Singh Bhau,	Head, Department of Botany, CUJ	Chairman
Prof. Namrata Sharma	Department of Botany, University of Jammu, Jammu	External Expert Member
Dr. Yogesh Kumar	Associate Professor, Department of Botany, CUJ	Member Secretary
Dr. Ashok Kumar	Assistant Professor, Department of Botany, CUJ	Member Secretary
Dr. Shweta Yadav	Assistant Prof. EVS department	Member

1) **Opening remarks by the Chair.**

The Chairman extended a warm welcome to all the members, expressing gratitude for their attendance and the valuable input they have contributed.

2) **To consider and approve draft course contents for core courses under the New Education Policy for the 4th semester of Integrated B.Sc. (Honours) and M.Sc. Botany program.**

The Board considered and approved the course contents for core courses under the New Education Policy for the 4th semester of Integrated B.Sc. (Honours) and M.Sc. Botany program. The approved courses are placed at annexure-1.

3) **To consider and approve draft course contents for Gardening and Landscaping as a Skill Enhancement Course under the New Education Policy for Integrated B.Sc. (Honours) and M.Sc. Botany program.**

The Board considered and approved the course content for Gardening and Landscaping as a Skill Enhancement Course under the New Education Policy for Integrated B.Sc. (Honours) and M.Sc. Botany program. The approved courses are placed at annexure-2

4) **To consider and approve the modified course structure for semester VI (January – May 2023) of students of batch 2020-21 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

The Board considered and approved the modified course structure for semester VI (January – May 2023) of students of batch 2020-21 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme. The modified course structure and course contents of core and elective courses are placed under annexure-3a, 3b and 3c.

5) **To report the course structure for semester VI (January – May 2024) of batch 2021-22 students of the Integrated B.Sc. (Honours) and M.Sc. Botany program as part of the Choice Based Credit System and inclusion of Biostatistics as a Discipline Specific Elective course within the curriculum.**

The Board noted and approved the course structure and courses offered therein for semester VI (January – May 2024) of batch 2021-22 students of the Integrated B.Sc. (Honours) and M.Sc. Botany program as part of the Choice Based Credit System. It was noted and approved that since a course on Cell Biology was offered in the 2nd semester therefore in its

place Anatomy and Embryology theory and Lab. was offered as a core course in the modified structure. The inclusion of Biostatistics as a Discipline Specific Elective course was also noted and approved. The approved course structure and course contents of core and Elective courses are placed in the annexure- 3b, 4 and 5.

6) **To report the course structure for semester V (July – December 2022 and July – December 2023) students of batches 2020-21 and 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

The Board and approved the course structure for semester V (July – December 2022 and July – December 2023) students of batches 2020-21 and 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme. The modified course structure and course contents are placed under annexure- 6.

7) **To consider and approve the modified course structure for semester IV (January – May 2021) of students of batch 2020-21 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

The Board has considered and approved the modified course structure for semester IV (January – May 2022) of students of batch 2020-21 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme. The modified course structure and course contents of core and elective courses are placed under annexure 7a and 7b.

8) **To consider and approve the modified course structure for semester IV (January – May 2022) of students of batch 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme.**

The Board has considered and approved the modified course structure for semester IV (January – May 2022) of students of batch 2021-22 of the Integrated B. Sc. (Hons.) M. Sc. Botany programme. The modified course structure and course contents of core and elective courses are placed under annexure 8a and 8b.

9) **To consider and approve the course content of 'Environmental Sciences' as an AEC and to grant Post Facto approval to the course having been offered as an AEC to the batch 2022-23 students in their semester III (July – December 2023) of the Integrated B.Sc. (Hons.) and M. Sc. in Botany programme.**

The Board has considered and approved the course content of 'Environmental Sciences' as an AEC and granted Post Facto approval to the course having been offered as an AEC to the batch 2022-23 students in their semester III (July – December 2023) of the Integrated

B.Sc. (Hons.) and M. Sc. in Botany programme. The course contents of EVS course is placed under annexure-9.

10) To consider and approve course content of Environmental Studies as an Open Elective to be offered at UG level.

The Board considered and approved the course contents for an open elective course under the New Education Policy for all the Departments of the University. The approved courses are placed at annexure-10.

11) To report the value-added courses (VAC) offered to II and IV semesters of Integrated B.Sc. (Honours) and M.Sc. Botany

The Board acknowledged the matter, deliberated upon it, and subsequently approved the value-added courses (VAC) offered to II and IV semesters of Integrated B.Sc. (Honours) and M.Sc. Botany. VAC course for II and IV semesters are NCC and Religion Communication respectively.

13) To review and approve the inclusion of MOOC courses within the curriculum for the II and IV semesters, as per the guidelines of the New Education Policy, and for the IV semester under the Choice Based Credit System (CBCS) for the Integrated B.Sc. (Honours) and M.Sc. Botany program.

The Board reviewed the matter and approved the inclusion of MOOC courses within the curriculum for the II and IV semesters, as per the guidelines of the New Education Policy, and for the IV semester under the Choice Based Credit System (CBCS) for the Integrated B.Sc. (Honours) and M.Sc. Botany program.

14) The Meeting ended with a vote of thanks to the Chair

Signatories

Professor BS Bhau

Dr. Shweta Yadav

Dr. Yogesh Kumar

Dr. Ashok Kumar

Professor Namrata Sharma

Integrated B. Sc. (Honours) and M.Sc. Botany
Semester – IV [January – May, 2024]

Course Structure approved as per NEP pattern

Course code	Course title	L-T-P	Credits
Core Courses			
	Plant Anatomy and Embryology of Phanerogams	3-0-2	5
	Taxonomy and Systematics	3-0-2	5
Open Elective courses			
	General Microbiology	4-0-0	4
	Religion communication	4-0-0	4
Skill Enhancement Compulsory Course			
	Gardening and Landscaping	2-0-0	2
Value Added Course			
	Religion Communication	2-0-0	2
Total		**18-0-4 = 22**	**22**

11 An-1

Course title: Plant Anatomy and Embryology of Phanerogams

Learning Objectives:

1. Gain a foundational understanding of plant cell structure and the processes involved in the development, growth, and organization of the plant body.
2. Explore the scope of reproductive biology, delving into the development and structure of both male and female reproductive units in flowers, as well as the organization of male and female gametophytes. Additionally, examine pre-fertilization, fertilization, and post-fertilization events.
3. Comprehend the processes and significance of interactions between pollen and pistil, as well as the phenomena of apomixis and polyembryony.
4. Recognize the importance of seeds as dispersal units (diaspores) in the context of plant reproduction

Learning Outcomes:

Upon successfully completing the course, students will:

1. Acquire familiarity with the structure and functions of various components within plant cells.
2. Develop an understanding of the processes governing cell growth and its regulatory mechanisms.
3. Comprehend the structure and functions of tissues organizing diverse plant organs.
4. Gain knowledge about the reproductive processes integral to the life cycle of angiosperms.
5. Appreciate the intricate interactions among developmental pathways leading to plant body differentiation.
6. Recognize the importance of plant developmental biology for plant improvement and conservation.
7. Understand the significance and scope of reproductive biological studies in crop production and conservation.
8. Explore the structure and function of anther and ovule, as well as male and female gametophytes.
9. Examine the importance of associations such as MGU (male gametophytic unit), FGU (female gametophytic unit), and double fertilization; along with embryo and endosperm development, and genomic imprinting.
10. Investigate pollination and seed dispersal mechanisms, apomixis, and polyembryony as alternate pathways of angiosperm reproduction.
11. Engage in experiential learning through field trips, scientific photography, videography, and documentary preparation.
12. Develop the skills to write scientific reports and effectively present scientific data.

Theory

Plant Anatomy

Unit 1: Tissue Systems and Anatomy of plant parts

Origin of vascular plants, Structural adaptation: origin of multicellularity; Classification of tissues: Simple, complex and secretory. Tissue systems: Epidermal, ground and vascular. Encrustation and incrustation: Ergastic substances.

Stem: Organization of shoot apex; Anatomy of dicot and monocot stem; Types of vascular bundles. Leaf: Anatomy of dicot and monocot leaf; Kranz anatomy. Root: Anatomy of root apex; Structure of dicot and monocot root; Origin of lateral root.

Unit 2: Secondary Growth and Adaptations

Vascular cambium: Structure, function, and seasonal activity. Secondary growth in root and stem. Wood anatomy: Axial and radial elements; types of rays and axial parenchyma. Periderm: Development and composition. Adaptive and protective systems: Cuticle, epicuticular waxes, trichomes, stomata. Adaptive features in plants: Hydrophytes, xerophytes, alpine plants, epiphytes, insectivorous plants and halophytes.

Plant Embryology

Unit 3: Pre-fertilization Events

Anther wall: Structure and functions, microsporogenesis, micro gametogenesis. Pollen wall: Structure and functions, NPC, pollen viability and storage, MGU. General structure and types of pistil and ovules, Megasporogenesis and mega gametogenesis, Organization and ultrastructure of mature embryo sac, Female Germ Unit: Structure and significance.

Unit 4: Pollination and Post-fertilization Events

Types of pollination: Self, cross, geitonogamy, xenogamy, Structure of stigma and style Pollen-pistil interactions, Path of pollen tube in the pistil, Double fertilization, Self-Incompatibility: Basic concepts, methods to overcome. Endosperm: Types, development, structure, and functions. Embryo: General pattern and comparison of dicot and monocot embryo development. Suspensor: Structure and functions, embryo-endosperm relationship, Nutrition of embryo, haustorial systems. Seed: Structure and importance of seed as diaspore and storage organ, Germination and seedling formation. Polyembryony and Apomixis Introduction, types, causes, and applications.

Practicals

1. Prepare temporary whole mounts or sections to examine the organization of the apical meristem in roots, shoots, and vascular cambium.
2. Investigate the distribution and types of parenchyma, collenchyma, and sclerenchyma using temporary preparations, digital resources, or permanent slides.
3. Create temporary stained mounts (maceration, sections) to observe xylem components such as tracheids, vessel elements, thickenings, perforation plates, and xylem fibers.

4. Explore different types of wood, including ring-porous, diffuse-porous, tyloses, heartwood, and sapwood, using specimens, permanent slides, and digital resources.
5. Prepare temporary whole mounts or sections to observe phloem components, including sieve tubes, sieve plates, companion cells, and phloem fibers.
6. Study the epidermal system, including cell types, stomata types, and trichomes (non-glandular and glandular) through temporary whole mounts, peels, or enamel use.
7. Investigate the organization of roots in monocots, dicots, and secondary growth through temporary whole mounts or sections.
8. Examine the organization of monocot and dicot primary and secondary growth, phloem wedges in *Bignonia*, included phloem in *Leptadenia*/*Salvadora*, periderm, and lenticels using temporary whole mounts or sections.
9. Study the organization of leaves, including isobilateral, dorsiventral, and Kranz anatomy, using temporary whole mounts or sections.
10. Explore adaptive anatomy in xerophytes and hydrophytes (two each) through temporary preparations, digital resources, or permanent slides.
11. Investigate secretory tissues such as cavities, lithocysts, and laticifers using permanent slides or digital resources.
12. Project submission: Permanent slides.

Plant Embryology

1. Examine the wall and ontogeny of anthers, tapetum (amoeboid and glandular), microspore mother cells, spore tetrads, uninucleate, bicelled, and dehisced anthers using temporary stained mounts of T.S. anther.
2. Study pollen morphology, pseudomonads, polyads, and pollinia through slides, digital resources, or fresh material; investigate the ultrastructure of the pollen wall (micrograph); assess pollen viability using tetrazolium test/FDA; calculate percentage germination in different media using hanging drop/sitting method.
3. Analyze temporary mounts of pollen grains cleared with 1N HCl/KOH to study germ pores and the ultrastructure of the male germ unit (MGU) through micrographs.
4. Explore ovule types (anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic) and special structures (endothelium, obturator, hypostase, caruncle, and aril) using permanent slides, specimens, or digital resources. Study the developmental sequence of monosporic embryo sac and the ultrastructure of the Female Germ Unit.
5. Dissect developing seeds for endosperm with free-nuclear haustoria. Study embryogenesis by examining the development of dicot embryos through permanent slides and dissecting developing seeds for embryos at various stages. Investigate the suspensor through electron micrographs.
6. Explore seed dispersal mechanisms through adaptations observed in live specimens or digital images.

Suggested Readings:

1. Fahn A. (1974) Plant Anatomy. Pergmon Press, USA.
2. Mauseth J.D. (1988) Plant Anatomy. The Benjamin/Cummings Publisher, USA.
3. Esau K. (1977) Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
4. Evert R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development, Third Edition. John Wiley & Sons, Inc.
5. Beck, C.B. (2010). Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK, New York, USA.
6. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA. 3.
7. Bhojwani S.S. and Bhatnagar S.P. (2011) The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
8. Ragliavan V. (2000) Developmental Biology of Flowering plants, Springer, Netherlands.
9. Raghvan V. (2006) Double Fertilization, Embryo and Endosperm Development in Flowering Plants, Springer-Verlag, Netherlands.
10. Raghvan V. (1997) Molecular Embryology of Flowering Plants, Cambridge University Press.
11. Bhojwani S.S., Bhatnagar S.P. & Dantu P.K. (2015). The Embryology of Angiosperms, 6th Edition. By VIKAS PUBLISHING HOUSE. ISBN: 978-93259- 8129-
12. P. Maheshwari, (2004). An introduction to the embryology of Angiosperms. Tata McGraw-Hill Edition, ISBN: 0-07-099434-X.
13. Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag. ISBN: 13:978-3-642-69304-5
14. Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer. ISBN: 978-1-4612-7054-6.
15. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
16. Mangla,Y., Khanduri, P., Gupta, C.K. 2022. Reproductive Biology of Angiosperms: Concepts and Methods. Cambridge University Press ISBN 978-1-009-16040-7.
17. Tandon R, Shivanna KR, Koul M Reproductive Ecology of Flowering Plants: Patterns and Processes 1st ed. 2020 Edition ISBN 978-9811542091.Springer Verlag.
18. Kapoor, R., Kaur, I. Koul M.2016. Plant Reproductive Biology and Conservation IK International Publishing House Ltd. India ISBN: 9789382332909.

Additional Resources:

1. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement.
2. Crang, R., Lyons-Sobaski, S., Wise, R. (2018) Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants 1st ed. Springer.
3. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA.
4. Evert, R.F. (2017) Esau's Plant Anatomy; Meristems, Cells and Tissues Of The Plant Body- Their Structure, Function And Development. 3rd Edn Wiley India.

5. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.
6. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London.
7. Shivanna, K.R., Tandon, R. (2020). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
8. Shivanna, K. R., & Rangaswamy, N. S. (2012). Pollen biology: a laboratory manual. Springer Science & Business Media.

Course Title: Taxonomy and Systematics

Learning Objectives:

Upon completion of this course, students should be able to:

1. Understand the historical development of Angiosperms classification.
2. Demonstrate practical skills in field inventory, Herbarium Techniques, and use of Virtual Herbarium and E-flora.
3. Explore significant herbaria and botanical gardens globally and in India.
4. Gain knowledge of Biosystematics, Chemotaxonomy, Numerical taxonomy, and cytotaxonomy.
5. Apply the International Code of Botanical Nomenclature (I.C.B.N) and understand principles of priority.
6. Discuss Effective and valid publication, Citation norms, and Rejection/retention of names.
7. Evaluate the significance of computers and databases in plant identification.
8. Analyze Molecular Systematics, including proteins, nucleic acids, and sequencing.
9. Understand taxonomic hierarchy, species concept, and Cladistics methodology.
10. Examine major contributions in plant classification history and familiarize with key classification systems, including the APG IV Classification.

Learning Outcomes:

Upon successfully completing the course, students will be able:

1. Demonstrate a deep understanding of the historical narrative of Angiosperms classification, including key developments and influential figures.
2. Acquire practical skills in field inventory, Herbarium Techniques, and the utilization of Virtual Herbarium and E-flora for plant identification.
3. Explore and evaluate significant herbaria and botanical gardens globally and in India, gaining insights into their functions and importance.
4. Develop expertise in Biosystematics, Chemotaxonomy, Numerical taxonomy, and cytotaxonomy for systematic plant classification.
5. Apply the International Code of Botanical Nomenclature (I.C.B.N), understand principles of priority, and effectively publish and cite botanical names.
6. Evaluate the significance of computers and databases in plant identification, demonstrating proficiency in utilizing digital resources for taxonomy.
7. Gain expertise in Molecular Systematics, including the analysis of proteins, nucleic acids, and sequencing techniques for molecular data compilation.
8. Define taxa (family, genus, species) and comprehend the taxonomic hierarchy, including the species concept and Cladistics methodology.
9. Critically examine major contributions in plant classification history, understanding key classification systems such as Bentham and Hooker, Engler and Prantl, and the APG IV Classification.
10. Apply their acquired knowledge to assess and classify plants systematically, demonstrating competence in practical plant identification and classification.

Theory

Unit 1: History of Plant Classification and Identification

Exploration into the historical narrative of Angiosperms classification; Examination of the major contributions of prominent figures in plant classification history, including Parasara, Charaka, Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Cronquist, Bremer, and MW Chase. Comprehensive coverage of the classification systems of Benthan and Hooker (up to series) and Engler and Prantl (up to series). Inclusion of the Angiosperm Phylogeny Group (APG IV) Classification, highlighting major clades.

Practical aspects of field inventory, Herbarium Techniques, Functions of Herbarium, and exploration of significant herbaria and botanical gardens globally and in India. Emphasis on Virtual Herbarium, E-flora, including Flora, Monographs, Journals. Comprehensive study of Biosystematics, Chemotaxonomy, Numerical taxonomy, and cytotaxonomy.

Unit 2: Nomenclature and Documentation

Examination of I.C.B.N, Typification, Principles of priority, and their limitations. Detailed discussions on Effective and valid publication, Citation norms, Rejection, and retention of names. Special focus on Names of hybrids and cultivars, Concepts of biocode, and the application of Keys for plant identification, both single access and multi-access. Evaluation of the significance of computers and databases in plant identification.

Unit 3: Molecular Systematics

Exploration of Molecular Systematics, delving into context and controversies. Analysis of Proteins, Amino acid sequence, Storage Protein, Serology, and isozyme. Examination of Nucleic acids, Base ratio, Polymerase chain reaction, Fragment analysis, restriction sites, and the application of sequencing in molecular systematics. Evidence compilation from cytology, phytochemistry (Alkaloids, Phenolics, Glycosides in brief), and molecular data (cp DNA, mt DNA, nuclear DNA, PCR amplification, sequence data analysis).

Unit 4: Taxonomic Hierarchy and Basic Terms and Concepts of Phylogeny

Conceptualization of taxa (family, genus, species) and exploration of Categories and taxonomic hierarchy. In-depth exploration of Species concept (taxonomic, biological & evolutionary). Introduction to Cladistics, encompassing terms and concepts such as primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, and grades. Methodology of Cladistics and various methods of illustrating evolutionary relationships, such as phylogenetic tree and cladogram.

Practicals

1. Conduct an in-depth examination of the families outlined in the theoretical framework and categorize them based on Bentham and Hooker's classification, utilizing representative species indigenous to the local region. Please focus on a minimum of twelve families from the provided list, ensuring the study includes at least two specimens (or one, if constraints exist). The suggested families include *Apiaceae,

*Asteraceae, *Brassicaceae, *Euphorbiaceae, *Fabaceae, *Lamiaceae, *Malvaceae, *Poaceae, *Ranunculaceae, *Solanaceae, Acanthaceae, Rubiaceae, Apocynaceae, and Moraceae and Orchidaceae.

2. Acquire proficiency in the binomial nomenclature of the indigenous plant species using the Gamble flora as a reference.
3. Identify the family, genus, species, and morphological characteristics of plant parts deemed valuable according to the theoretical framework.
4. Create a minimum of two herbarium specimens, employing available resources such as literature, herbaria, e-resources, and taxonomic keys for identification. Classify the specimens up to the family level, adhering to Bentham and Hooker's classification.

Suggestive Readings:

1. Simpson, M. G. (2019). Plant systematics. 3rd Edition, Academic press.

2. Singh, G. (2019). Plant Systematics- An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.

3. Pandey, A. K., Kasana, S. (2021). Plant Systematics. 2nd Edition. CRC Press Taylor and Francis Group 4. http://www.mobot.org/MOBOT/research/APweb/

5. Maheshwari, J. K. (1963). The flora of Delhi. Council of Scientific & Industrial Research.

6. Maheshwari, J. K. (1966). Illustrations to the Flora of Delhi. Council of Scientific & Industrial Research.

7. Harris, J. G., Harris, M. W. (2001). Plant Identification Terminology: An Illustrated Glossary. Spring Lake, Utah: Spring Lake Pub. Spring Lake, Utah.

Additional Resources:

1. The Angiosperm Phylogeny Group, Chase, M.W., Christenhusz, M.J.M, Fay M.F., Byng, J.W., Judd, W.S., Soltis, D.E., Mabberley, D.J., Sennikov, A.N., Soltis, P.S., Stevens, P.F. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical journal of the Linnean Society 181 (1): 1-20.

2. https://www.mobot.org/MOBOT/research/APweb/treeapweb2s.gif

3. https://www.digitalatlasofancientlife.org

4. http://apps.kew.org/herbcat/navigator.do

5. https://efloraofindia.com/

6. https://powo.science.kew.org/

7. Page, R.D.M., Holmes, E.C. (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell Publishing Ltd. Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

Ann. L

Course title: Gardening and Landscaping

Learning Objectives:

Upon completion of this course, students should be able to:

1. Analyze how meteorological instruments and plant morphology influence gardening and landscaping practices.
2. Evaluate the importance of weather and climate elements in agricultural activities.
3. Demonstrate understanding of agro-climatic regions, their characteristics, and the influence on crop seasons.
4. Identify and explain special weather phenomena and hazard events and their implications for gardening and landscaping.
5. Recognize the importance of weather forecasting and its practical applications in horticulture.
6. Describe the morphology, physiology, and foundational knowledge of horticultural plants.
7. Evaluate soil properties, interpret soil test reports, and classify soils based on texture and agro-climatic zones.
8. Discuss soil correction techniques for acid, alkaline, and saline soils.
9. Explain the role of soil organic matter in influencing soil properties and fertility.
10. Apply horticultural principles in nursery and seed production, including soil, media, fertilizers, and environmental factors.

Learning outcomes:

Upon completion of this course, students will be able to:

1. Evaluate the impact of meteorological instruments and plant morphology on gardening and landscaping.
2. Demonstrate understanding of agro-climatic regions and their influence on crop seasons.
3. Identify and explain special weather phenomena and hazard events affecting gardening and landscaping.
4. Apply principles of weather forecasting in horticulture practices.
5. Describe the morphology, physiology, and foundational knowledge of horticultural plants.
6. Evaluate soil properties and interpret soil test reports.
7. Classify soils based on texture and agro-climatic zones.
8. Discuss acid, alkaline, and saline soil characteristics, and implement correction techniques.
9. Explain the role of soil organic matter in influencing soil properties and fertility.
10. Apply integrated nutrient management principles to maintain soil fertility.

Theory

Unit 1: Foundations of Gardening

Significance of Weather and Climate Elements in Agriculture: Impact of rainfall, temperature, humidity, sunshine, wind speed, and direction. Agro-climatic Regions and their Distinct Characteristics, Weather Patterns in Crop Seasons (Winter, Summer, Monsoon). Significance of Weather Forecasting. Morphology, Physiology, and foundational knowledge of horticultural plants.

Soil and Growth Medium, Fertilizers and Bio-fertilizers, Irrigation Techniques. Cultivation Techniques: Protected Cultivation, Garden Implements. Plant Health and Maintenance: Disease and Pest Control, Disease Control in gardening, Recognition of Ailments and Pesticide Application.

Methods of Propagation: Time and Techniques of Propagation. Specialized Cultivation: Nursery and Seed Production, Bulb and Corm Production, Pot Plants and Lawn Grasses, Ornamental Plants, Landscape Plants and Bonsai. Flower Crop Cultivation: Strategies for Flower Induction. Use of Growth Regulators: Cultivation in Protected Environments (Poly and Net Houses), Specific Crop Focus: Chrysanthemum, Carnation, Rose, Orchids.

Unit 2: Soil Science and Management

Various aspects of soil, including its physical and chemical properties. Interpretation of soil test reports, Soil texture classification, Important features: porosity, bulk density, particle density, and structure, Water holding capacity, pH, electrical conductivity (EC), cation exchange capacity (CEC), Soil solution and classification based on agro-climatic zones.

Types of soils: acid, alkaline, saline: Correction techniques for acid, alkaline, and saline soils; Soil organic matter and its role in influencing soil properties and fertility; Practices for recycling organic matter in the field; Soil fertility, productivity, Various manures, bio-fertilizers, essential plant nutrient elements, deficiency symptoms, Chemical fertilizers and factors affecting soil fertility depletion and its maintenance

Unit 3: Green Spaces Survey and Indoor Gardening Exploration

Significance and Extent. Historical Development and Varieties of Gardens, Notable Garden Characteristics and Constituents of Gardens. Residential Gardens and Garden Structures. Enhancing Elements and Optimal Lighting. Soil, Water, and Energy Conservation through Landscaping. Plant Selection for Aesthetic and Functional Landscape Values. Garden and Lawn Maintenance. Boulevard Trees. Interior Gardens, Rooftop Gardens, Window Gardens, Container Gardens, Aquariums, Hanging Baskets, Mini Landscapes, Rock Gardens. Choosing and Organizing Indoor Potted Plants, their Care, and Sustainable Practices. Preparation for Garden Competitions and Flower Shows. Crafting Floral Ornaments – Garlands, Bangles, Crowns, Veni, Rangoli; Baskets and Bouquets; Boutonnieres and Corsages.

Suggested Readings:

1. Floriculture in India by G.S. Randhava and Amitabha Mukhopadhyay Allied Publishers, PVT. Ltd. 1986. Plant Propagation Principles and Practices by Hartman

H.T. Prentice-Hall International: London, 1959. Encyclopedia of Gardening by Christopher Brukell. Dorling Kindersley, Ltd. 2007.

2. Propagation Hand Book; basic Techniques for Gardeners Mechanicsburg, Pas; stackpok Books, 1995.
3. Horticulture, Principles and Practices by George Acquaah. 4th edition, Pearson Publisher, Prentice Hall, 2009.
4. Gardening in India by Bose, T.K and Mukerjee, D. New Delhi Oxford & IBH Pub. Co. Pvt. Ltd, 1977.
5. Textbook of Horticulture by Mani Bhushan Rao. Macmillan India Ltd. 2005 (2nd edition).
6. Introduction to Horticulture by Kumar, N. 7th edition, Oxford & IBH Publishing Company Pvt. Ltd. 2010.
7. Introduction to ornamental Horticulture by J.S. Arora, 1999.
8. Kalyani Publishers, Ludhiana, India. Plant propagation by Sandhu M.K. New Age International Publishers Ltd. 1989.
9. Ornamental plants and Garden design in Tropics and Subtropics (Vol 1 & 2) by T.K. Bose, L.J. Singh, M.K. Sandhu and T.K Maity. Publisher: Daya Publishing House; A division of Astral International PVt. Ltd. 2015.

Ann - 3.

3a

Integrated B. Sc. (Honours) and M.Sc. Botany

Semester – VI Course Structure approved for batches 2016-17 to 2019-20

Course code	Course title	Credits	Contact hours per week		
			L	T	P
ICBOT3C001T	Genetics	4	4	0	0
ICBOT6C002T	Anatomy and Embryology	4	4	0	0
ICBOT6C003T	Introduction to Bioinformatics	2	2	0	0
ICBOT6C001L	Genetics Lab	2	0	0	4
ICBOT6C002L	Anatomy and Embryology Lab	2	0	0	4
ICBOT6C003L	Introduction to Bioinformatics Lab	2	0	0	4
ICBOT6C001D	Project	6	0	2	8
	Total	**22**	**10**	**2**	**20**

3b

Integrated B. Sc. (Honours) and M.Sc. Botany

Semester – VI Course Structure approved as per CBCS for batches 2020-21 and 2021-22

Course title	Credits	Contact hours per week		
		L	T	P
Core courses				
Genetics	4	4	0	0
Cell Biology and Cytogenetics	4	4	0	0
Genetics lab	2	0	0	4
Cell Biology and Cytogenetics Lab	2	0	0	4
Two Discipline-Specific Elective (theory and lab) courses OR One DSE (theory and lab) course and Project course				
DSE 1	4	4	0	0
DSE 1 Lab	2	0	0	4
DSE 2	4	4	0	0
DSE 2 Lab	2	0	0	4
Project	6	0	2	8
Total	**24**	**16 (12)**	**0 (2)**	**16 (20)**

3c.

Integrated B. Sc. (Honours) and M.Sc. Botany

Course structure followed by batch 2020-21 in Semester – VI (January – May, 2023)

Course code	Course title	Credits	Contact hours per week		
			L	T	P
ICBOT3C001T	Genetics	4	4	0	0
ICBOT6C002T	Anatomy and Embryology	4	4	0	0
ICBOT6C003T	Introduction to Bioinformatics	2	2	0	0
ICBOT6C001L	Genetics Lab	2	0	0	4
ICBOT6C002L	Anatomy and Embryology Lab	2	0	0	4
ICBOT6C003L	Introduction to Bioinformatics Lab	2	0	0	4
ICBOT6C001D	Project	6	0	2	8
	Total	**22**	**10**	**2**	**20**

Ann - 4

Integrated B. Sc. (Honours) and M.Sc. Botany

Course structure followed by batch 2021-22 in Semester – VI (January – May, 2024)

Course code	Course title	Credits	Contact hours per week		
			L	T	P
ICBOT3C001T	Genetics	4	4	0	0
ICBOT6C002T	Anatomy and Embryology	4	4	0	0
ICBOT6C001L	Genetics Lab	2	0	0	4
ICBOT6C002L	Anatomy and Embryology Lab	2	0	0	4
	Biostatistics	4	4	0	0
	Biostatistics Lab	2	0	0	4
ICBOT6C001D	Project	6	0	2	8
	Total	24	12	2	20

Course code: ICBOT6C001T **Course title: Genetics**

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

17 - 2 A

Course objectives

The prime aim of the course of the course is to understand the basis of similarities and/or differences between parents and offspring.

Unit 1: Mendelian genetics and its extension

Mendelism - History; Principles of inheritance; Chromosomal theory of inheritance; Probability and pedigree analysis; Codominance and incomplete dominance; Lethal alleles; Multiple alleles; Epistasis; Pleiotropy; Penetrance and expressivity (numericals); Polygenic inheritance.

Unit 2: Linkage, crossing over and chromosome mapping

Linkage and crossing over; Cytological basis of crossing-over; Molecular mechanism of crossing-over; Recombination frequency; Chromosome mapping - two factor and three factor crosses; Interference and coincidence; Autosomes and sex chromosomes; sex-linked inheritance.

Unit 3: Extrachromosomal inheritance

Chloroplast mutation - Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects - shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*; Cytoplasmic male sterility in plants.

Unit 4: Fine structure of gene and mutation

Classical *vs* molecular concept of gene; Cis-trans test for functional allelism; Structure of phage T4 rII locus; Gene mutations - Types, Molecular basis of mutations; Mutagens – physical (ionizing and UV radiations) and chemical (base analogs, deaminating, alkylating and intercalating agents); Detection of mutations - ClB method; DNA repair mechanisms, Introduction to transposons and role of transposons in mutations.

Unit 5: Population and evolutionary genetics

Population genetics - concept and importance; Hardy-Weinberg Law; Allele frequencies- effects of mutation, migration, selection and genetic drift; Genotype frequencies - probability and pedigree analysis; Genetic variation and speciation.

Course title: Genetics Lab

Credits: 2 [0-0-4]

Course code: ICBOT6C001L

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

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
5. Study of incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4)
6. Blood Typing: ABO groups & Rh factor.
7. Identification of translocation ring, laggards and inversion bridge using photographs/permanent slides
8. Study of human genetic traits using photographs - Sickle cell anaemia, xeroderma pigmentosum, albinism, red-green colour blindness, widow's peak, rolling of tongue, hitchhiker's thumb and attached ear lobes.

Suggested Readings:

1. Gardner E. J., Simmons M. J. and Snustad, D. P. (2005) Principles of Genetics, 8th edition, John Wiley and Sons Inc., U.S.A.
2. Klug W.S., Cummings M.R., Spencer C.A. and Palladino A. (2015) Concepts of Genetics, 11th edition, Pearson Education
3. Russell P. J. (2013) iGenetics: A Molecular Approach, 3rd edition, Pearson Education
4. Brooker R. (2018) Genetics: Analysis and Principles, 6th Edition, McGraw-Hill Education
5. Brown T. A. (2011) Introduction to Genetics: A Molecular Approach, 1st edition, Garland Science
6. Griffiths A. J. F., Wessler S. R., Carroll S. B. and Doebley J. Introduction to Genetic Analysis, 11th edition, Freeman W. H. and Company, New York
7. Gupta P. K. (2010) Genetics, 4th edition, Rastogi Publications, Meerut.
8. Gupta P. K. (2017) Cytology, Genetics and Evolution, 8th edition, Rastogi Publications, Meerut.
9. Strickberger M. W. (2008) Genetics, 3rd edition, PHI Learning

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Course title: Plant Anatomy and Embryology

Course code: ICBOT6C002T **Credits: 4 [4-0-0]**

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

Course objectives

The objective of the first half of paper is to apprise the students about anatomical details of plants and the second half gives an overview of the pre- and post-fertilization events.

Plant Anatomy

Unit 1: Tissues and tissue system

Classification of tissues - Simple and complex tissues; Tracheary and sieve elements; Pits and plasmodesmata; transfer cells; Adcrustation and incrustation; Ergastic substances.

Unit 2: Anatomy of different organs:

Stem - Organization of shoot apex (apical cell, histogen, tunica corpus theories and cytohistological zonation); Anatomy of dicot and monocot stem; Types of vascular bundles.

Leaf - Anatomy of dicot and monocot leaf; Kranz anatomy.

Root - Anatomy of root apex (apical cell, histogen and Korper-Kappe theories); quiescent center; root cap; structure of dicot and monocot root; endodermis; exodermis; origin of lateral root.

Unit 3: Secondary Growth and anatomical adaptations

Vascular cambium - Structure, function and seasonal activity of cambium; secondary growth in root and stem- normal and anomalous; Wood - Axially and radially oriented elements; Types of rays and axial parenchyma; reaction wood, sapwood and heartwood; ring and diffuse porous wood; early and late wood; tyloses; dendrochronology.

Periderm - Development and composition of periderm, rhytidome and lenticels.

Adaptive and protective systems - Cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular); stomata (structure and types); anatomical adaptations of xerophytes and hydrophytes; Secretory system - Hydathodes, cavities, lithocysts and laticifers.

Plant Embryology

Unit 4: Pre-fertilization events

Anther - Wall layers, microsporogenesis and microgametogenesis; Male sterility; Pollen - Storage, viability and germination.

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Ovules - Structure and types; Megasporogenesis and megagametogenesis; Structure of an organized embryo sac (Polygonum type); Concept of double fertilization (syngamy and triple fusion) and self-incompatibility.

Unit 5: Post-fertilization events

Development and structure of dicot and monocot embryo (*Capsella* and *Sagittaria*); Endosperm types; Development and structure of maize endosperm; Storage products of embryo and endosperm; Concept of polyembryony, apomixes, parthenocarpy and parthenogenesis.

Course title: Plant Anatomy and Embryology Lab

Course code: ICBOT6C002L **Credits: 2 [0-0-4]**

Assessment	
Maximum Marks	50 marks
Continuous Internal Assessment (CIA)	25 marks
End Semester Exam (ESE)	25 marks
Passing Marks	25 marks

Plant Anatomy

1. Types of tissues - parenchyma, collenchyma and sclerenchyma.
2. Epidermal system - cell types, stomata types, trichomes (glandular and non-glandular).
3. T.S. of root – monocot and dicot; secondary growth.
4. T.S. of stem – monocot and dicot - primary and secondary growth, periderm, lenticels.
5. V.S. of leaf - monocot and dicot, isobilateral, dorsiventral, C4 leaves (Kranz anatomy).

Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples. Apical meristem of root, shoot and vascular cambium.

Plant embryology

6. Anther - Wall and its ontogeny, tapetum (amoeboid and glandular), MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit.
7. Diversity in pollen and stigma.
8. Female gametophyte - Types, ultrastructure of mature egg apparatus (using permanent slides/ photographs)
9. Study of microsporogenesis through acetocarmine squash techniques (using Allium)
10. Pollen viability - Tetrazolium test, Pollen germination using different concentrations of sucrose

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Ann-S

Discipline - specific elective for pri

Course title: Biostatistics

Course code:	Credit: 4-0-0
Max. Marks: 100 marks	Total Teaching hours: 60
Continuous Internal Assessment (CIA)- 25	Time Allowed: 3 Hours
Mid Semester Exam (MSE): 25 marks	
End Semester Exam (ESE): 50 marks	
Pass Marks: 50% in Theory and Practical Separately	

Course objectives

Biostatistics is the application of statistical tools in solving the biological problem. This course aims to impart students with the knowledge of data collection, analysis and interpretation, and its importance in plant improvement.

Theory

Unit 1: Data collection and sampling:

Importance, scope, and limitation of biostatistics, statistical methods - basic principle. Variables – types, measurements and functions. Types of data: Primary and secondary, methods of data collection, merits and demerits. Classification - tabulation and presentation of data, sampling methods.

Unit 2: Descriptive statistics:

Measures of central tendency - mean, median, mode, geometric mean, merits and demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation, merits and demerits, Co- efficient of variation.

Unit 3: Frequency and probability distributions

Frequency distribution- Types and importance, concept and uses of probability distribution and differences from frequency distribution.

Unit 4: Data analysis

Correlation- Types and methods, Regression-Types, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression, applications.

Unit 5: Test of significance

Statistical inference – hypothesis, simple hypothesis, computation and importance of student 't' test, chi-square test, F-test and one-way ANOVA.

Practical's

Max. Marks: 50 marks	Total Teaching hours:
Continuous Internal Assessment (CIA): 25 marks	Time Allowed: 4 Hours

33.

End Semester Exam (ESE): 25 marks	
Pass Marks: 50% in Theory and Practical Separately	

1) Calculation of mean, standard deviation and standard error and c.v.
2) Calculation of correlation coefficient values and finding out the probability
3) Calculation of 'F' value and finding out the probability value for the F value.
4) Calculation of mode and median.
5) Calculation of quartiles
6) Construction of frequency distribution tables
7) Chi square and T-test

Suggested Readings:

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

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Integrated B. Sc. (Honours) and M.Sc. Botany

Semester – V Course Structure approved as per CBCS for batches 2020-21 and 2021-22

Course code	Course title	L-T-P	Credits
Core Courses			
	Biochemistry and Plant Physiology	4-0-0	4
	Biochemistry and Plant Physiology Lab	0-0-4	2
	Molecular Biology and Plant Biotechnology	4-0-0	4
	Molecular Biology and Plant Biotechnology Lab	0-0-4	2
Discipline Specific Electives			
	Discipline Specific Elective - 1	4-0-0	4
	Discipline Specific Elective – 1 Lab	4-0-0	4
	Discipline Specific Elective – 2	0-0-4	2
	Discipline Specific Elective – 2 Lab	0-0-4	2
Total		16-0-16 = 32	24

Integrated B. Sc. (Honours) and M.Sc. Botany

Course structure followed by batch 2020-21 in Semester – V (July – December, 2022)

Course code	Course title	L-T-P	Credits
Core Courses			
	Biochemistry and Plant Physiology	4-0-0	4
	Biochemistry and Plant Physiology Lab	0-0-4	2
	Molecular Biology and Plant Biotechnology	4-0-0	4
	Molecular Biology and Plant Biotechnology Lab	0-0-4	2
Discipline Specific Electives (Any 2 theory and their associated labs)			
	Biostatistics	4-0-0	4
	Conservation Biology	4-0-0	4
	Tools and Techniques in Plant Sciences	4-0-0	4
	Biostatistics Lab	0-0-4	2
	Conservation Biology Lab	0-0-4	2
	Tools and Techniques in Plant Sciences Lab	0-0-4	2
Skill Enhancement Course (1)			
	Mushroom cultivation	2-0-0	2
	Total	18-0-16 = 34	26

Integrated B. Sc. (Honours) and M.Sc. Botany

Course structure followed by batch 2021-22 in Semester – V (July – December, 2023)

Course code	Course title	L-T-P	Credits
Core Courses			
	Biochemistry and Plant Physiology	4-0-0	4
	Biochemistry and Plant Physiology Lab	0-0-4	2
	Molecular Biology and Plant Biotechnology	4-0-0	4
	Molecular Biology and Plant Biotechnology Lab	0-0-4	2
Discipline Specific Electives (Any 2 theory and their associated labs)			
	Biostatistics	4-0-0	4
	Conservation Biology	4-0-0	4
	Tools and Techniques in Plant Sciences	4-0-0	4
	Biostatistics Lab	0-0-4	2
	Conservation Biology Lab	0-0-4	2
	Tools and Techniques in Plant Sciences Lab	0-0-4	2
	Total	16-0-16 = 32	24

Integrated B. Sc. (Honours) and M.Sc. Botany
Semester – IV [January – May, 2021]

7(a)

Course Structure approved as per CBCS pattern

Course code	Course title	L-T-P	Credits
Core Courses			
ICBOT4C001T	Taxonomy of Angiosperms & Plants and Human Welfare	4-0-0	4
ICBOT4C001L	Taxonomy of Angiosperms & Plants and Human Welfare Lab	0-0-4	2
ICBOT4C002T	Gymnosperms and Palaeobotany	4-0-0	4
ICBOT4C002L	Gymnosperms and Palaeobotany Lab	0-0-4	2
ICBOT4C003T	Environmental Biology	4-0-0	4
ICBOT4C003L	Environmental Biology Lab	0-0-4	2
Generic Elective		4-0-0	4
Generic Elective Lab		0-0-4	2
Skill Enhancement Compulsory Course		2-0-0	2
Total		**18-0-16 = 34**	**26**

Integrated B. Sc. (Honours) and M.Sc. Botany
Semester – IV [January – May, 2022]

7(b)

Course Structure followed

Course code	Course title	L-T-P	Credits
Core Courses			
ICBOT4C001T	Taxonomy of Angiosperms & Plants and Human Welfare	4-0-0	4
ICBOT4C001L	Taxonomy of Angiosperms & Plants and Human Welfare Lab	0-0-4	2
ICBOT4C002T	Gymnosperms and Palaeobotany	4-0-0	4
ICBOT4C002L	Gymnosperms and Palaeobotany Lab	0-0-4	2
ICBOT4C003T	Environmental Biology	4-0-0	4
ICBOT4C003L	Environmental Biology Lab	0-0-4	2
MOOC (Both courses)			
Biochemistry		3-0-0	3
Experimental Biochemistry		3-0-0	3
Any one of the following MOOC courses			

Forest and their Management	3-0-0	3
Data analysis for Biologist	2-0-0	2
Geomorphic Processes: Landforms & Landscapes	2-0-0	2
Introduction to Psychology	2-0-0	2
Cell Biology: Celluar organization, Divison and Processes	2-0-0	2
Speaking Effectively	2-0-0	2
Biostatistics and Design of Experiments	2-0-0	2
Basics in Biology	2-0-0	2
Bioengineering: An Interface with Biology and Medicine.	2-0-0	2
Total	**20-0-12 = 32**	**26**

Ann B

Integrated B. Sc. (Honours) and M.Sc. Botany
Semester – IV [January – May, 2022]

8(a)

Course Structure approved as per CBCS pattern

Course code	Course title	L-T-P	Credits
Core Courses			
ICBOT4C001T	Taxonomy of Angiosperms & Plants and Human Welfare	4-0-0	4
ICBOT4C001L	Taxonomy of Angiosperms & Plants and Human Welfare Lab	0-0-4	2
ICBOT4C002T	Gymnosperms and Palaeobotany	4-0-0	4
ICBOT4C002L	Gymnosperms and Palaeobotany Lab	0-0-4	2
ICBOT4C003T	Environmental Biology	4-0-0	4
ICBOT4C003L	Environmental Biology Lab	0-0-4	2
Generic Elective		4-0-0	4
Generic Elective Lab		0-0-4	2
Skill Enhancement Compulsory Course		2-0-0	2
Total		**18-0-16 = 34**	**26**

Integrated B. Sc. (Honours) and M.Sc. Botany
Semester – IV [January – May, 2022]

8(b)

Course Structure followed

Course code	Course title	L-T-P	Credits
Core Courses			
ICBOT4C001T	Taxonomy of Angiosperms & Plants and Human Welfare	4-0-0	4
ICBOT4C001L	Taxonomy of Angiosperms & Plants and Human Welfare Lab	0-0-4	2
ICBOT4C002T	Gymnosperms and Palaeobotany	4-0-0	4
ICBOT4C002L	Gymnosperms and Palaeobotany Lab	0-0-4	2
ICBOT4C003T	Environmental Biology	4-0-0	4
ICBOT4C003L	Environmental Biology Lab	0-0-4	2
MOOC courses	(any two of the following.)		
Genome Editing and Engineering		4-0-0	4
Pollutants and water Supply		4-0-0	4
Environmental Sciences		4-0-0	4
General Microbiology		4-0-0	4
	Total	**20-0-12 = 32**	**26**

Any

AM- 9
2023 : 201

2 credits

Environmental Sciences

Unit-1 The Environment and Ecosystem

1.1. Environment and Environmental studies: Definition, concept, components and importance

1.2. Ecosystem: Structure and function of ecosystem

1.3. Food chain, food web and ecological pyramid

1.4. Biogeochemical cycles in ecosystem (Carbon cycle, nitrogen cycle, phosphorus cycle and sulphur cycle)

1.5. Ecological succession: Definition, type, concept and process (hydrosere and xerosere)

Unit-2 Biodiversity and its Conservation

2.1. Definition, concept, levels and values of biodiversity

2.2. Biodiversity of India, India as a mega diversity nation, biodiversity hotspots

2.3. Threats of biodiversity: habitat loss, poaching of wildlife and man wildlife conflict, invasive species, increased pollution climate change

2.4. Conservation of biodiversity: In-situ conservation; ex-situ conservation

2.5. Ecotourism, concept of protected areas, some famous protected areas of India.

Unit-3 Natural Resources and their Conservation

3.1. Forest Resources: uses and overexploitation of forests and consequences of deforestation

3.2. Water Resources: use and consequences of over-utilization, concept of rain water harvesting and watershed management, water conflicts.

3.3. Food Resources: Sources of food, Impacts of modern agriculture on environment (Fertilizer-pesticide problem, water logging and salinity), organic farming.

3.4. Energy Resources: renewable and non-renewable energy sources, growing energy needs and alternate energy sources.

3.5. Land Resources: global land use patterns, soil erosion, desertification, wasteland reclamation.

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AW-10

Course title: Environmental Studies

Learning Objectives:

1) Define the multidisciplinary nature of environmental studies and its scope, emphasizing the importance of public awareness.
2) Describe the structure and function of ecosystems, including energy flow, ecological succession, and the roles of producers, consumers, and decomposers.
3) Identify various natural resources and ecosystems, explaining their significance and the importance of sustainable management practices.
4) Understand the concept of biodiversity, including its value, threats, and conservation strategies such as in-situ and ex-situ conservation.
5) Classify different types of environmental pollution and analyze their causes, effects, and management strategies, including pollution prevention methods.
6) Analyze social and legal aspects of environmental protection, including sustainable development principles, urban environmental issues, environmental ethics, and the role of environmental protection laws and public awareness in enforcement.

Learning Outcomes:

1) Students will articulate the definition and scope of environmental studies and recognize its multidisciplinary nature.
2) Students will demonstrate understanding of ecosystem structure, function, and dynamics, including energy flow and ecological succession.
3) Students will be able to identify and evaluate various natural resources and ecosystems, and propose sustainable management practices.
4) Students will recognize the value of biodiversity, identify threats to it, and propose conservation strategies.
5) Students will classify and analyze different types of environmental pollution, propose management strategies, and understand pollution prevention methods.
6) Students will analyze social and legal aspects of environmental protection, including sustainable development principles, urban environmental issues, environmental ethics, and the role of environmental protection laws and public awareness in enforcement.

Unit 1: Foundations of Environmental Studies

Multidisciplinary nature of environmental studies: Definition, scope, and importance, Need for public awareness, Structure and function of an ecosystem: Producers, consumers, and decomposers, Energy flow, Ecological succession, Food chains, food webs, and ecological pyramids.

Unit 2: Natural Resources and Ecosystems

Overview of natural resources, Forest, water, mineral, food, and energy resources, Introduction to ecosystem types: Forest, grassland, desert, and aquatic ecosystems.

Unit 3: Biodiversity and Conservation

Introduction to biodiversity, Biogeographical classification of India, Value of biodiversity, Threats to biodiversity, Endangered and endemic species, Conservation strategies (in-situ and ex-situ).

Unit 4: Environmental Pollution and Management

Overview of environmental pollution, Air, water, soil, marine, noise, thermal, and nuclear pollution, Solid waste management, Individual roles in pollution prevention, Pollution case studies, Disaster management.

Unit 5: Social and Legal Aspects of Environmental Protection

Sustainable development, Urban problems and energy issues, Water conservation and management, Resettlement and rehabilitation, Environmental ethics, Climate change and global issues, Environment protection laws, Enforcement and public awareness.

Project Based Dissertation

Course Code: ICBOT6C003L **6 credits** [0-2-8]

Assessment		
Maximum Marks		150 marks
Continuous Internal Assessment (CIA)		45marks
Mid Semester Review		45marks
End Semester Exam (ESE)	Dissertation (30)	60 marks
	Presentation (20)	
	Viva voce (10)	
Passing Marks		75 masks

For the project based course, students shall consult respective faculty members and based on area of interest shall opt for faculty guides. Guide allotment for project will be based on choice-cum- merit. At the end of the semester, the student shall be required to submit a dissertation on the project undertaken and give a presentation of the work done.

More than one student can work on the same project. In such a case, the students shall submit a joint dissertation; however, the presentation and *viva voce* shall be conducted individually.

Note:

1. Student shall submit two hard copies and one soft copy (with duly signed scanned copies of declarations) of the dissertation in prescribed format with all declarations and signatures.
2. The dissertation shall comprise of the following components:
    a. Declaration and certificate
    b. Acknowledgement
    c. Content
    d. Introduction
    e. Review of literature
    f. Material and methods
    g. Observations/Results
    h. Discussion
    i. References (style: Bhau BS, Medhi K, Sarkar T and Saikia SP (2009) PCR based molecular … pitcher plant. *Genetic resources and crop evolution*, 56(8):1183-86).

Mid semester review shall be conducted by a committee constituted for the purpose, comprising of two faculty members of the Department and the guide. The end semester evaluation shall be based on the dissertation submitted, presentation by the student followed by a *viva-voce* conducted by an external examiner.