Agenda for the 10th Meeting of the Board of Studies of Department of Botany Central University of Jammu

Mode of Meeting: Online

Date : Monday, 19th October 2020

Time : 10:30 am

Department of Botany
Central University of Jammu

No.CUJ/BOT/2020/225 Date: 19th October, 2020

MINUTES OF THE 10th MEETING OF BOARD OF STUDIES (BOS) OF DEPARTMENT OF BOTANY

10.1 Minutes of the 10th meeting of the Board of Studies of Department of Botany held on 19th Oct. 2020 at 10.30 am in Committee Room, Temporary Academic Block, Central University of Jammu.

10.2 The following members attended the meeting:

1.	Prof. B. S. Bhau Head, Department of Botany Central University of Jammu	Chairman
2.	Prof. A. K. Wakhlu (retd.) Department of Botany University of Jammu, Jammu	External Expert Member
3.	Prof. Namrata Sharma Head, Department of Botany University of Jammu, Jammu	External Expert Member
4.	Prof. Veenu Kaul Department of Botany University of Jammu, Jammu	External Expert Member
5.	Dr. S. Vaishnavi Assistant Professor Department of Botany Central University of Jammu	Member Secretary
6.	Dr. V. Srivastava Assistant Professor Department of Botany Central University of Jammu	Special invitee
7.	Dr. D. Bhardwaj Assistant Professor Department of Botany Central University of Jammu	Special invitee

Dr. A. Bhat, Assistant Professor, Centre for Molecular Biology, CUJ could not attend the meeting.

10.3 Opening remarks by the Chair

The Chairman welcomed all the members, especially Prof. A. K. Wakhlu, Prof. Namrata Sharma and Prof. Veenu Kaul, for making it convenient to attend the online meeting.

10.4 To ratify the adoption of course structure and contents for semester IX of the Integrated M. Sc. Botany programme.

The Board noted that the Department had to commence classes in online mode because of prevailing Covid conditions and approved the course structure and modified course contents being offered to semester IX of Integrated M. Sc. Botany programme. Approved course structure and contents placed at annexure – 1.

10.5 To consider and approve adoption of CBCS guideline-based course structure from the AY 2020-21 onwards.

The Board considered the draft course structure for the Integrated M. Sc. Botany programme based on the CBCS guidelines issued by UGC and approved offering of the same from the AY 2020-21 onwards. Approved course structure placed at annexure - 2

10.6 To consider and approve the course contents after adoption of CBCS guidelines to be implemented from AY 2020-21 onwards.

The Board considered the draft course contents for the Integrated M. Sc. Botany programme Semester 1 (AY 2020-21) based on the CBCS guidelines issued by UGC, and approved offering of the same from the AY 2020-21 onwards. Approved course contents placed at annexure – 3.

10.7 To consider and approve the subject experts for end-semester examinations of Integrated M. Sc. Botany

The panel of external examiners for each course is was placed before the Board, and the same was approved (annexure – 4).

10.8 To report the end-semester exam results of Ph.D. coursework.

The Board was apprised that the End-semester exams of the five Ph.D. scholars enrolled in September 2019 were conducted online, as per guidelines issued by the University because of the prevailing Covid pandemic. The result of all the five students was placed before the Board, and the same was approved (annexure – 5).

10.9 The meeting ended with a vote of thanks to the Chair.

Prof. B. S. Bhau

Prof. A. K. Wakhlu

Prof. Namrata Sharma

Prof. Veenu Kaul

Dr. S. Vaishnavi

Dr. V. Srivastava

Dr. D. Bhardwaj

Annexure I

Department of Botany
Central University of Jammu

Course structure of integrated M. Sc. Botany-Semester IX

Course Code	Paper Title	Credit	Contact hours / week		
			L	T	P
	Plant Metabolic Regulations	4	4	0	0
	Molecular Plant Pathology	4	4	0	0
	Applied plant *in vitro* technology	4	4	0	0
	Lab based on Plant Metabolic Regulations	2	0	0	4
	Lab Based on Molecular Plant Pathology	2	0	0	4
	Lab Based on Applied plant *in vitro* technology	2	0	0	4
	Discipline specific elective (DSE-1)	2	2	0	0
	Discipline specific elective (DSE-2)	2	2	0	0
	Total	**22**	**16**	**0**	**12**

Semester – IX

Course: Plant Metabolic Regulations

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 course aims at making students competent in understanding different plant metabolic pathways and how they are linked to each other. Knowledge acquisition will enable them to explore new vistas in engineering plant-based products.

Theory

Unit I: Plant metabolism: basics and advancements

Living cell as a unique chemical system, metabolism: introduction, methods employed for its study; transport mechanisms; signal transduction and its mechanisms; bioenergetics biological oxidation. Metabolic pathways, compartmentalization, and bioengineering.

Unit II: Plant metabolic networks and their application

Plant metabolic networks – their organisation; factors affecting their structure and/or performance; relationship between enzyme properties and network fluxes; limitations, enzyme specific responses and adjustments through alternative pathways; practical approaches for identification of appropriate starting enzyme and their engineering.

Unit III: Starch and cellulose metabolism

Starch synthesis and metabolism in algae and plants with special emphasis on green algae and monocotyledonous species; starch synthesis and degradation in general and, specifically, in leaves and tubers; synthesis of bacterial glycogen, amylase and amylopectin; control of starch biosynthesis; starch genes in the rice genome; cellulose biosynthesis in plants, biochemistry and manipulation; *in vitro* synthesis from plant extracts and factors responsible for increasing cellulose synthesis activity; identification of genes encoding cellulose synthases in plants.

Unit IV: Engineering photosynthetic pathways

Naturally occurring diversity in RuBisCO kinetics; engineered improvements of RuBisCO enzymatic properties; obstacles to be resolved for RuBisCO engineering; C4-ization of C3 plants; engineering carbon flow from chloroplasts to sink; protection of the photosynthetic apparatus during abiotic stress; photosynthetic responses under harmful and changing environment, practical aspects in crop research artificial photosynthesis.

Unit V: Bio-products by regulation of plant metabolism

Main classes of bio-products; adaptive advantages for plants; factors affecting their production; significance of RNA sequencing in plant metabolic engineering; CRISPR/Cas9-mediated gene editing tool and metabolic engineering applications in plants; regulation of tropane alkaloid metabolism in plants an plant cell cultures-A case study; some examples of metabolic engineering; methods for the extraction of essential oils and of volatiles; essential oils extraction by hydro-distillation; GC and GC-MS analysis of essential oil plant metabolic responses to specific stresses.

Books:

1. Taiz, L. and Zeiger, E., 2006. Plant Physiology Sinauer Associates. *Inc., Publishers, 764p.*
2. Buchanan, B.B., Gruissem, W. and Jones, R.L. eds., 2015. *Biochemistry and molecular biology of plants*. John Wiley & Sons. Yadav, S.K., Kumar, V. and Singh, S.P. eds., 2018. *Recent Trends and Techniques in Plant Metabolic Engineering*. Springer.
3. Bhatla, S.C. and Lal, M.A., 2018. *Plant physiology, development, and metabolism*. Springer.
4. Park S. Nobel , 2020. Physicochemical and Environmental Plant Physiology. Elsevier Science Publishing Co Inc. San Diego, United States
5. Hans Lambers and Rafael S. Oliveira, 2019. Plant physiological Ecology. Springer Nature Switzerland AG

Plant Metabolic Regulations Lab.

	Assessment
Maximum marks	50

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

Practicals

1. Demonstration of essential oils extraction by hydro-distillation
2. Demonstration of GC and GC-MS analysis of essential oils
3. *In vivo* assay for nitrate reductase in leaf tissues.
4. Comparative assessment of methods for protein quantitation.
5. Extraction of proteins from plant tissue and their quantitative (Bradford's) and qualitative (SDS- PAGE) analysis.
6. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques.
7. PAGE analysis of pigment-protein complexes from chloroplasts.
8. Isolation of genomic DNA by CTAB and SDS method.

Semester – IX

Course Title: Molecular Plant Pathology

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

Course objectives: This course is designed to acquaint the students with the diagnosis of proper management and long-term control of plant disease. Detailed insight will also be given to understand the molecular basis of host pathogen interaction.

Theory

Unit I: Plant disease management

Plant disease control – integrated measures, disease resistance and molecular approach for disease management; history of fungicides; bactericides; nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals; concepts of pathogen immobilization; chemical protection and chemotherapy; foliage, seed and soil application of chemicals; residual effects and safety measures.

Unit II: Plant health diagnostics and management

Plant health clinic – concept, importance and infrastructure; identification of important beneficial insects (predators, pollinators and others of economic importance); pest management – principles, injury caused by different type of insects to the plants by feeding, oviposition and sheltering; screening of damaged material for identifying of casual agents (insect, microbe, nematode, mites, rodents, vertebrates); important plant parasitic nematodes - their symptoms produced on major crops; molecular approaches for viral; bacterial and fungal diseases with regards to diagnostics and management; identification of problematic weeds and their management.

Unit III: Disease resistance in plants

Disease resistance – historical prospective, dynamics of pathogenicity; process of infection; variability in plant pathogens; gene centres as sources of resistance; identification of physiological and genetic races of pathogens; disease progression in relation to resistance;

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stabilizing selection pressure in plant pathogens; gene-for-gene concept; protein-for-protein and immunization basis; management of resistance genes; strategies for gene deployment.

Unit IV: Biological control of plant diseases

Biological control – concept, history and importance; principles biological control – merits and demerits; types of biological interactions-competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance; factors governing biological control – role of physical environment; agroecosystem and cultural practices; biocontrol agents; comparative approaches to biological control of plant pathogens by resident and introduced antagonists; control of soil-borne and foliar diseases; compatibility of different bio agents; commercial production of antagonists; their delivery systems; application and monitoring; biological control in IDM; IPM and organic farming system; biopesticides available in market.

Unit V: Molecular basis of host-pathogen interaction

Host pathogen relationship - basic concepts and principles; molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system; induction of defense responses – pathogenesis related proteins; hypersensitive response (HR); reactive oxygen species; phytoalexins and systemic acquired resistance; miRNA mediated disease resistance; mediated programmed cell death; viral induced gene silencing; molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling; mapping and cloning of resistance genes and marker-aided selection; pyramiding of R genes.

Books:

1. Fry, W.E., 2012. *Principles of plant disease management*. Academic Press.
2. Maria Lodovica Gullino and Peter J.M. Bonants., 2104 Detection and Diagnostics of Plant Pathogens, Springer Dordrecht Heidelberg New York London
3. Mehrotra RS and Aggarwal A, 2017, Plant Pathology IIIrd Edition. McGraw Hill Education (India) Private Limited
4. Stephen Burchett and Sarah Burchett., 2018., Plant Pathology. Taylor & Francis
5. Ulrich Gisi, Ilan Chet and M. Lodovica Gullino (Eds)., 2010. Recent Developments in Management of Plant Diseases. Springer Dordrecht Heidelberg London New York
6. Nene, Y.L. and Thapliyal, P.N., 1993. *Fungicides in plant disease control* (No. Ed. 3). International Science Publisher.

7. Palti, J., 2012. *Cultural practices and infectious crop diseases* (Vol. 9). Springer Science & Business Media.

8. Vyas, S.C., 1993. *Handbook of Systemic Fungicides*. Vols. I-III; Tata McGraw Hill. New Delhi.

9. Ciancio, A. and Mukerji, K.G. eds., 2008. *Integrated management of diseases caused by fungi, phytoplasma and bacteria* (Vol. 3). Springer Science & Business Media.

10. Trigiano, R.N. ed., 2007. *Plant pathology concepts and laboratory exercises*. CRC press.

Molecular Plant Pathology Lab.

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

Practicals

1. Identification of symptoms caused by important insect pests.
2. Preparation of pesticide stock solution and safe handling of some of the available agrochemicals in local market.
3. Disease diagnostic kit and related basic facilities.
4. Identification and isolation of causative agents of common diseases.
5. To study the types of plant parasitic nematodes, demonstration of pathogenicity of root knot nematode on tomato and vegetables, root knot index calculation.
6. To study the symptoms of root knot disease in *Capsicum* and ear-cockle disease of wheat.
7. To study the management methods to control nematode diseases in crop.

Semester – IX

Course Title: Applied plant *in vitro* technology

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

Course objectives: This course seeks to provide students deeper insight to the principles of plant tissue culture and its applications.

Theory

Unit I: Introduction to plant tissue culture

Basic techniques and types of cultures; culture basal media (MS, Gamborg, woody plant medium, medium for orchids); role of individual constituents in these media and mechanisms therein; macro and micronutrient nutrition of plants in greenhouses; hydroponic systems; standardization tissue culture media on the basis of plant elemental analysis and composition of hydroponic substrates.

Unit II: Micropropagation & somatic embryogenesis

Micropropagation – concepts, methods and technical problems; production of virus free plants by meristem and shoot-tip culture; factors affecting micropropagation and somatic embryogenesis (explants, media composition, subculturing,); maturation of somatic embryogenesis: advances on genetic (molecular mechanism) and physiological Basis of Callus formation, organogenesis & somatic embryo formation; somatic embryogenesis in broad-leaf woody plants; advances in conifer somatic embryogenesis; somatic embryogenesis case studies in selected plants *Crocus sativus* L and *Oryza sativa*.

Unit III: *In vitro* crop improvement techniques

Embryo rescue technique; somaclonal variation; protoplast fusion technology – somatic hybridization and cybridization; haploid plants- Introduction; methods and approaches; androgenesis; gynogenesis; sperm isolation and culture; egg isolation and culture; diploidization; *in vitro* fertilization; synthetic seed production and success stories; endosperm culture; triploid production; important case studies in triploid production.

Unit IV: Bioreactors

Bioreactors - concept and types; simple bioreactors for mass propagation of plants their practical; bioreactor design for propagation of somatic embryos; temporary immersion system: a new concept for use of liquid medium in mass propagation; mass propagation of conifer trees in liquid cultures – progress towards commercialization; potentials for cost reduction.

Unit V: Automation in plant tissue culture

General introduction and overview of automation in plant tissue culture; economic analysis of automated micropropagation and somatic embryogenesis; engineering aspects of plant propagation in bioreactors; mechanical engineering approaches to plant biotechnology; image analysis for plant cell culture and micropropagation and embryogenesis; automated systems for organogenesis; a new approach for automation: sorting and sowing dehydrated somatic embryos of *Daucus* and *Coffea* using seed technologies.

Books:

1. Bhojwani, S.S., Razdan, M.K., 2005. *Plant tissue culture*. Elsevier. New Delhi.
2. Aitken-Christie, J., Kozai, T. and Smith, M.A.L. eds., 2013. *Automation and environmental control in plant tissue culture*. Springer Science & Business Media.
3. Andersen, S.B., Christiansen, I. and Farestveit, B., 1990. Carrot (Daucus carota L.): In Vitro Production of Haploids and Field Trials. In *Haploids in Crop Improvement I* (pp. 393-402). Springer, Berlin, Heidelberg.
4. Cervelli, R. and Senaratna, T., 1995. Economic aspects of somatic embryogenesis. In *Automation and environmental control in plant tissue culture* (pp. 29-64). Springer, Dordrecht.
5. Smith, R.H., 2012. *Plant tissue culture: techniques and experiments*. Academic Press.

Applied plant *in vitro* technology Lab.

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

Practicals

1. Preparation of tissue culture medium (MS or B5).
2. To study the sterilization methods of explants (seed, leaf, internode and roots).
3. To establish the callus cultures from different explants using different hormonal concentrations.
4. To study the different stages of somatic embryogenesis.
5. To establish the cell suspension cultures.
6. Isolation and characterization of protoplast.
7. To study the production of synthetic seed.
8. To demonstrate the green house functioning.

Elective Courses

Course Title: Bioinformatics, Computational Biology and Biostatistics

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

Course objective: This course will introduce students to the fundamental concepts in biostatistics, data science in biology, and how to apply these concepts using the R statistical programming language. Additionally, the course will cover data visualization and presentation using R.

Theory

Unit I: Bioinformatics

Genome sequencing technologies and analysis methods; Utilization of bioinformatics tools to analyze genomics and transcriptomics/microarray data; analysis of gene expression data; gene set enrichment and pathway analyses; transcription factor regulation and motif analysis; in silico analysis of protein sequence: domain and motif search; conserved domain analysis, protein modelling; epigenetics and its role in transcription regulation; integrative approaches to analyse genome-wide data; network biology; genome-wide association studies of plants; genome editing tools and applications to plant improvement; single-cell genomics and cellular heterogeneity; spatial-temporal variation of gene expression.

Unit II: Computational biology

Machine learning techniques; protein secondary structure prediction based on a neural network; hidden Markov models for gene finding; decision trees; support vector machines; microarray analysis; DNA computing; assembling the genome; STS content mapping for clone contigs; functional annotation; peptide mass fingerprinting; visualization (graph types in biology: bar graphs, line graphs, area graphs, scatter plot, pie and 3-dimensional graphs); Octave or Mat lab; advanced use of computers like scientific libraries; scripting; scope of cellular dynamics; basics of PERL programming for bioinformatics; datatypes (scalars and

collections); operators; program control flow constructs; library functions (string specific functions); user defined functions; file handling.

Unit III: Biostatistics

Biostatistics: Conceptual understanding of Statistic and Statistics; Parameters; Variable; Population, Finite and Infinite Populations; Sample; Discrete and Continuous Variations; Samples: Simple random sample, Stratified sample, Clustered samples, Judgment sample, Countable and Uncountable sample; Variables and Attributes; Arithmetic Mean, Median, Mode, Merits and demerits of Mean, Median and Mode; Range; Roles of t – statistic; Independent t – statistic, Paired t – statistic, Two samples t – statistic, One sample t – statistic; F – statistic; Chi-square test and its uses; "testing" in statistics; Hypothesis, Null hypothesis, Two-sided hypothesis, One-sided hypothesis; Critical region; Level of significance; P – value; Standard deviation; Variance.

Bbooks:

1. Rubin, A. and Riznichenko, G.Y., 2014. *Mathematical biophysics* (Vol. 15, p. 273). New York: Springer.
2. Das, N. G., 2009. *Statistical Methods.* Vol: I and II, The McGraw-Hill Companies.
3. Rosner, B., 2006. Fundamentals of biostatistics. Belmont. *CA: Thomson-Brooks/Cole*.
4. Lesk, A., 2019. *Introduction to bioinformatics*. Oxford university press.
5. *obabilistic models of proteins and nucleic acids*. Cambridge university press.
6. DW, M., 2004. Bioinformatics: Sequence and Genome Analysis.
7. Rice, P., 2002. Beginning Perl for Bioinformatics: An Introduction to Perl for Biologists.
8. Lee, E.T. and Wang, J., 2003. *Statistical methods for survival data analysis* (Vol. 476). John Wiley & Sons.
9. Biswas, S., 2007. *Applied Stochastic Processes*. New Central Book Agency.
10. Kleinbaum, D.G. and Klein, M., 2010. *Survival analysis*. Springer.
11. Indrayan, A. 2008. Medical Biostatistics, 2 nd Edition Chapman and Hall/CRC.

Course Title: Synthetic Biology

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

Course objectives: This course aims to enable students to obtain knowledge and an understanding of synthetic biology. Students will learn about key technologies such as recombinant DNA technologies, genomics, and proteomics, and how these technologies are used for specific applications. Additionally, emphasis will be given on entrepreneurial aspects using synthetic biology.

Theory

Unit I: Fundamentals of Synthetic Biology

Introduction to synthetic biology; standardisation in conventional biology; standardisation in synthetic biology; gene expression; signal carriers for measuring gene output; reporter proteins; synthetic biology standards for protein measurement; classical gene circuits; bacterial synthetic gene networks; creating artificial life; designed organisms and their potential impacts on the ecosystem; biosecurity; bioterrorism; biowarfare.

Unit II: Metabolic engineering: Introduction and Significance

Introduction to cell metabolism; methods of flux analysis including flux balance analysis (FBA); computational tools for whole genome metabolic model reconstruction and integrated frameworks for design of metabolic pathways such as retrosynthesis; design and engineering of ribosome binding sites (RBS); promoters; repressors; activators and transcription terminator sequences; combinatorial and synthetic promoters; concept of biological logic gates; circuits and devices; design principles for transcriptional networks with targeted behaviour; debugging and directed evolution of biological devices and systems. Targeted plant pathways- Primary and Secondary Pathway: Metaboliic engineering approaches: pathway engineering, TF engineering, Pathway and TF engineering, Gene Silencing; Application of metabolic engineering in nutraceutical, pharmaceutic and flavour and fragrance; Engineering of plant pathways in microbes and its commercial significance.

Unit III: Synthetic Biology: Culture and Bioethical Considerations

Applications of synthetic biology: Environmental, Agricultural; Chemical; Pharmaceutical etc.; National and International policies for its implementation; Prospects and challenges; general biosafety concerns; ecosystem-level impacts; gene flow; emergence of unpredictable properties and way forward; strategies for containment; physical biological and social aspects of containment; prevention of transboundary harm to the environment; synthetic biology and the "utilization of genetic resources."

Books/references:

1. Brown, T.A., 2016. *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
2. Mann, R. 2006. Mann Genetic Engineering: Concepts, Tools and Techniques, Syrawood Publishing House.
3. Primrose, S.B. and Twyman, R., 2013. *Principles of gene manipulation and genomics*. John Wiley & Sons.
4. Winnacker, E.L., 1987. *From genes to clones: introduction to gene technology*. VCH Verlagsgesellschaft.
5. Cooper, G.M. and Hausman, R.E., 2016. The Cell: A Molecular Approach. edited by C. Holabird.
6. Turksen, K. ed., 2016. *Genome Editing*. USA: Springer.
7. Yamamoto, T., 2015. *Targeted Genome Editing Using Site-Specific Nucleases*. Tokyo: Springer.
8. https://www.horizondiscovery.com/gene editing
9. http://bioinformatics.ac.cn/synbiolgdb/
10. Krömer, J.O., Nielsen, L.K. and Blank, L.M., 2014. Metabolic Flux Analysis. *Methods in Molecular Biology. New York, NY.*
11. Freemont, P.S. and Kitney, R.I., 2015. *Synthetic Biology-a Primer (revised Edition)*. World Scientific.

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Course Title: Basic and Applied Mycorrhiza

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

Course objectives: The aim of this course is to acquaint the students with mycorrhizal symbiosis with host plants. It will also inform the students about symbionts and distribution of all mycorrhiza types.

Theory

Unit I: Physiology **and Production of Mycorrhiza**

Introduction to mycorhiza: types and ecological significance morphological ecology and physiology of ectomycorrhizae; methods of inoculation; plant response to inoculation; mechanism of improved plant growth; production of the vesicular-arbuscular mycorrhizae inoculum and its application; vesicular-arbuscular mycorrhizae taxonomy; morphology and histology; quantification in plant roots and in soil; isolation, axenic and pot culture; procedures for inoculation; plant response to colonization; physiology and ecology of the vesicular-arbuscular mycorrhizae symbiosis; biological interactions with other soil flora and fauna; mass multiplication techniques; exploitation of mycorrhizae in agriculture, horticulture, and forestry.

Unit II: Biology of Mycorrhiza

Genetics of ectomycorrhizal fungi; sexual reproduction; mating types; post-meiotic nuclear behaviour and spore development; host range; improvement of ectomycorrhizal strains by breeding; polypeptide analysis; isozyme analysis; immunochemical approach; genetic diversity in mycorrhiza; identification of ectomycorrhizal fungi using molecular techniques; molecular phyllotaxonomic diversity; genetic transformation; protoplast generation; functional symbiosis; polypeptide analysis; future perspectives.

Unit III: Application of Mycrorrhiza

Stress and mycorrhizal plant; interaction of rhizobacteria with arbuscular mycorrhizal fungi (AMF); role of AMF in stress alleviation in agriculture; phytoremediation; enhancing crop

production; heavy metal tolerance in plants; physiological and molecular mechanisms of stress alleviation; arbuscular mycorrhizal mediated control of plant pathogens, biocontrol agents for parasitic nematodes in plants, tool for restoration of degraded land; signalling systems between a plant and its associated beneficial microbes in relation to plant growth and development.

Books:

1. Koltai, H. and Kapulnik, Y. eds., 2010. *Arbuscular mycorrhizas: physiology and function*. Springer Science & Business Media.
2. Mukerji, K.G., Manoharachary, C. and Chamola, B.P. eds., 2002. *Techniques in mycorrhizal studies*. Springer Science & Business Media.
3. Declerck, S., Strullu, D.G. and Fortin, A., 2005. *In vitro culture of mycorrhizas* (Vol. 4). Springer Science & Business Media.
4. Souza, T., 2015. *Handbook of arbuscular mycorrhizal fungi*. Cham: Springer.

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Course Title: Plant Nanobiotechnology

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

Course objectives: This course addresses the advanced subjects of biotechnology. It involves the use and applications of various computational tools and software in the field of plant biotechnology.

Theory

Unit I: Introduction to Nanoparticles

Fundamentals of nanomaterials; nanoscale dimension and paradigm; definitions; historical evolution and current practice; nanomaterials (types and classifications); nanocrystal; nanoparticle; quantum dot; quantum wire and quantum well; polymer; carbon; inorganic; organic; biomaterials (structures and characteristics);; overview of synthetic methods; surfactants; polymers; emulsions; micelles/reverse micelles and colloids; top-down and bottom-up approaches; biological methods; growth and stabilization; self-assembly.

Unit II: Nanoparticles and plants

Uptake; translocation; accumulation; transformation; generational transmission of nanoparticles in plants; effects of different nanoparticles in plant system (Gold, Silver, TiO_2, ZnO, SiO_2, Al_2O_3, CeO_2, and CuO); effects of magnetite nanoparticles; effects of carbon-based nanomaterials; effects of nanoparticles on germination growth and development; physiology and development; role of nanoparticles in photosynthesis; molecular mechanism of plant–nanoparticle interactions; nanotoxico genomics; nanotoxico proteomics; prospects of transgenerational transmission of nanoparticles.

Unit III: Nanotechnology in crop improvement

Role of nanotechnology in crop improvement; enhancement of plant biomass and yield; enhancement of secondary metabolites; delivery of genetic material; availability of nutrients; smart delivery of fertilizers (nanofertilizers, slow/controlled-release of nanofertilizers,

nanocomposites); ecotoxicological impacts of NM in soil; applications of nanoparticles in plant protection; biosafety and environmental compliance.

Books:

1. Mirkin, C.A. and Niemeyer, C.M. eds., 2007. *Nanobiotechnology II: more concepts and applications*. John Wiley & Sons.
2. Vo-Dinh, T. ed., 2017. *Nanotechnology in biology and medicine: methods, devices, and applications*. CRC Press.
3. Hornyak, G.L., Dutta, J., Tibbals, H.F. and Rao, A., 2008. *Introduction to nanoscience*. CRC press.
4. Kuno, M., 2012. Introductory nanoscience: Physical and chemical concepts. *MRS Bulletin*, *37*(2), pp.169-170.

Course Title: Ethnobotany

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

Course objective: This course will give a broad overview of the science related to use of plants in different cultures and societies with emphasis on current research and issues.

Theory

Unit I: Ethnobotany concept, scope and objectives

Ethnobotany and folk medicines; ethnobotany as an interdisciplinary science; ethnobotany in national and global perspectives: relevance of ethnobotany in the present context; economical and medicinal assessment; major and minor ethnic groups or tribals of India; methods to study ethnobotany; applications of ethnobotany: national interacts; palaeo-ethnobotany; folk medicines of ethnobotany; ethnomedicine; ethnoecology.

Unit II: Methodology, legal aspects and application of ethnobotanical studies

Ancient literature; archaeological findings; temples and sacred places; ethnobotany as a tool to protect interests of ethnic groups; sharing of wealth concept with a few examples from India; biopiracy; intellectual property rights and traditional knowledge.

Unit III: Role of ethnobotany in modern medicine

Medico-ethnobotanical sources in India; significance of the following plants in ethnobotanical practices along with their habitat and morphology (*Azadiractha, Ocimum, Vitex, Gloriosa, Tribulus, Pongamia, Cassia. Indigofera tinctorial)*; role of ethnobotany in modern medicine with special examples (*Rauvolfia, Trichopus, Artemisia, Withania)*; role of ethnic groups in conservation of plant genetic resources; endangered taxa and forest.

Books:

1. Jain, S.K. and Goel, A.K., 1995, A manual of ethnobotany. Jodhpur.
2. Jain, S.K., 1981, Glimpses of Indian ethnobotany. Oxford and I B H; New Delhi – 1981

3. Jain, S.K., 1989. Methods and approaches in Ethno-botany. Society of Ethnobotanists. *CDRI, Lucknow*, pp.127-128.

4. Jain, SK., 1990. Contributions of Indian ethnobotany; Scientific publishers. Jodhpur.

5. Colton, C.M., 1997. Ethnobotany – Principles and applications. John Wiley and sons. Chichester.

6. Rama Rao, N. and Henry, A.N., 1996. ethnobotany of Eastern Ghats in Andhra Pradesh, India.

7. Sinha, R.K., 1996. *Ethnobotany: The renaissance of traditional herbal medicine*. INA Shree Publishers.

Course Title: Plant Breeding

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

Course objectives: This course will help the students understand the theoretical knowledge and practical skills about plant breeding, modes of reproduction as well as the genetic consequences and breeding methods for crop improvement.

Theory

Unit I: Plant breeding and its application

History of plant breeding; botany of the crop; cytogenetics; agronomy; physiology; pathology; entomology; biochemistry; bacteriology; statistics; plant biotechnology; objectives of plant breeding (high yield, improved quality, disease and pest resistance); early maturity; photosensitivity; varieties for new seasons; resistant varieties; activities in plant breeding (creation of new varieties, selection, evaluation, multiplication and distribution); centres of origin (different centres and their significance); germplasm conservation; *in situ* seed banks (plant banks, shoot tip banks, cell and organ banks, DNA banks); germplasm evaluation, cataloguing, multiplication, and distribution.

Unit II: Plant reproduction and sexual incompatibility

Plant introduction; history of plant introduction (primary and secondary); plant introduction agencies; procedure of plant introduction (quarantine, cataloguing, evaluation, multiplication distribution, acclimatization); purpose of plant introduction (achievements, merits and demerits); mode of reproduction (vegetative reproduction, grafting, layering, apomixis); sexual incompatibility; self-incompatibility (homomorphic, heteromorphic, gametophytic and sporophytic incompatibility); mechanism of self-incompatibility; pollen-stigma interaction; pollen tube-style interaction; pollen tube-ovary interaction; significance of self-incompatibility; methods to overcome self-incompatibility (bud pollination, surgical methods, off season pollination, high temperature, irradiation); sterility (male sterility, genetic male sterility, cytoplasmic male sterility, cytoplasmic genetic male sterility); application of male sterility in crop improvement.

Unit III: Methods of selection and hybridization

Selection (history of selection, pure line selection, mass selection, pedigree selection, bulk method of selection); merits and demerits; achievements of each type; backcross method of selection (introduction, requirements, applications of back cross methods, genetic consequences of repeated back crossing, procedure of back cross method, transfer of a dominant gene, transfer of a recessive gene, number of plants necessary in backcross generation, selection of the characters being transferred, transfer of quantitative characters, modification of back cross method); production of F2 and F3 generation; use of different recurrent parents; application of back cross method in cross pollinated crops (merits and demerits, achievements); hybridization (history, objectives, techniques, and consequences); types of hybridization (interspecific, intergeneric, distant hybridization); procedure of hybridization; choice of parents; evaluation of parents; emasculation; bagging; tagging; pollination; harvesting and storing of the F1 seeds and selfing; consequences of hybridization.

Suggested readings:

1. Allard, R.W. 1960. *Principles of Plant Breeding*. John Wiley & Sons. Inc. New York, Backcock.
2. Chopra,V. L. 2000. *Plant Breeding Theory and Practicals* (2nd edition), Oxford & IBH Publ. Co. Pvt. Ltd. New Delhi.
3. Frankel, R. and Galun, E., 2012. *Pollination mechanisms, reproduction and plant breeding* (Vol. 2). Springer Science & Business Media.
4. Kharkwal, M.C. and Jain, H.K. eds., 2004. *Plant breeding: Mendelian to molecular approaches*. Narosa Publishing; House; New Delhi.
5. Poehlman, J.M. and Borthakur, D., 1969. Breeding Asian field crops, with special reference to crops of India. Oxford & IBH Publishing Co. New Delhi.
6. Russel, G.E. 1985. *Progress in Plant Breeding* (Ed;) Butter Worth & Co. Publ. Ltd. Calcutta.
7. Sharma, J.R., 1994. *Principles and practice of plant breeding*. Tata McGraw-Hill Pub.

Annexure II

Proposed Scheme for Choice Based Credit System in Integrated M. Sc. Botany [Session 2020-21 onwards]

Semester	Core Course	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	Discipline Specific Elective (DSE)	Generic Elective (GE)
I	C1 – Plant Kingdom: Diversity in Form, Structure and Reproduction	English communication			GE 1
	C2 - Plant Kingdom: Diversity in Form, Structure and Reproduction Lab				
	C3 – Introduction to Biochemistry and Biomolecules				
	C4 - Introduction to Biochemistry and Biomolecules Lab				
II	C5 – Plants in Human Welfare	Environmental Sciences			GE 2
	C6 – Plants in Human Welfare Lab				
	C7 – Anatomy and Embryology				
	C8 – Anatomy and Embryology Lab				
III	C9 - Bryology and Pteridology		SECC 1		GE 3
	C10 - Bryology and Pteridology Lab				
	C11 - Mycology and Plant Pathology				
	C12 - Mycology and Phytopathology Lab				
	C13 - Phycology and Microbiology				
	C14 - Phycology and Microbiology Lab				
IV	C15 - Taxonomy of Angiosperms & Plants and Human Welfare		SECC 2		GE 4
	C16 - Taxonomy of Angiosperms & Plants and Human Welfare Lab				
	C17 - Gymnosperms and Palaeobotany				
	C18 - Gymnosperms and Palaeobotany Lab				

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	C19 - Environmental Biology				
	C20 - Environmental Biology Lab				
V	C21 - Biochemistry and Plant Physiology			DSE 1	
	C22 - Molecular Biology and Plant Biotechnology			DSE 2	
	C23 - Biochemistry and Plant Physiology Lab				
	C24 - Molecular Biology and Plant Biotechnology Lab				
VI	C25 - Genetics			DSE 3	
	C26 - Genetics lab			DSE 4/ Project work	
	C27 - Cell Biology and Cytogenetics				
	C28 - Cell Biology and Cytogenetics Lab				
VII	Applied Phycology and Bryology				
	Applied Phycology and Bryology Lab				
	Applied Mycology and Microbiology				
	Applied Mycology and Microbiology Lab				
	Molecular Cell Biology				
	Molecular Cell Biology Lab				
	Systematics and Evolution				
	Systematics and Evolution Lab				
VII	Applied Ecology				
	Genetics and Cytogenetics				

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	Molecular Plant Physiology				
	Applied Pteridology and Gymnospermology				
	Applied Ecology Lab				
	Genetics and Cytogenetics Lab				
	Molecular Plant Physiology Lab				
	Applied Pteridology and Gymnospermology Lab				
IX	Plant Metabolic Regulations			DSE 5	
	Plant Metabolic Regulations Lab			DSE 6	
	Molecular Plant Pathology				
	Molecular Plant Pathology Lab				
	Applied plant in vitro technology				
	Applied plant in vitro technology Lab				
X				DSE 7	
				DSE 8/ Dissertation	

Annexure II

Semester	Course Type opted	Course Title	Credits
I	Core Course 1	Plant Kingdom: Diversity in Form, Structure and Reproduction	4
	Core Course 2	C2 - Plant Kingdom: Diversity in Form, Structure and Reproduction Lab	2
	Core Course 3	C3 – Introduction to Biochemistry and Biomolecules	4
	Core Course 4	C4 - Introduction to Biochemistry and Biomolecules Lab	2
	Ability Enhancement Compulsory Course (AECC) 1	English communication	2
	Generic Elective 1	GE 1	4
	Generic Elective 1 Lab/ Tutorial	GE 1 Lab/ Tutorial	2
			20
II	Core Course 5	C5 – Plants in Human Welfare	4
	Core Course 6	C6 – Plants in Human Welfare Lab	2
	Core Course 7	C7 – Anatomy and Embryology	4
	Core Course 8	C8 – Anatomy and Embryology Lab	2
	Ability Enhancement Compulsory Course (AECC) 2	Environmental Sciences	2
	Generic Elective 2	GE 2	4
	Generic Elective 2 Lab/ Tutorial	GE 2 Lab/ Tutorial	2
			20
III	Core Course 9	C9 - Bryology and Pteridology	4
	Core Course 10	C10 - Bryology and Pteridology Lab	2
	Core Course 11	C11 - Mycology and Plant Pathology	4
	Core Course 12	C12 - Mycology and Phytopathology Lab	2
	Core Course 13	C13 - Phycology and Microbiology	4
	Core Course 14	C14 - Phycology and Microbiology Lab	2
	Skill Enhancement Compulsory Course (SECC) 1	SECC - 1	2
	Generic Elective 3	GE 3	4
	Generic Elective 3 Lab/ Tutorial	GE 3 Lab/Tutorial	2
			26

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IV	Core Course 15	C15 - Taxonomy of Angiosperms & Plants and Human Welfare	4
	Core Course 16	C16 - Taxonomy of Angiosperms & Plants and Human Welfare Lab	2
	Core Course 17	C17 - Gymnosperms and Palaeobotany	4
	Core Course 18	C18 - Gymnosperms and Palaeobotany Lab	2
	Core Course 19	C19 - Environmental Biology	4
	Core Course 20	C20 - Environmental Biology Lab	2
	Skill Enhancement Compulsory Course (SECC) 2	SECC – 2	2
	Generic Elective 4	GE 4	4
	Generic Elective 4 Lab/ Tutorial	GE 4 Lab/Tutorial	2
			26
V	Core Course 21	C21 - Biochemistry and Plant Physiology	4
	Core Course 22	C22 - Biochemistry and Plant Physiology Lab	2
	Core Course 23	C23 - Molecular Biology and Plant Biotechnology	4
	Core Course 24	C24 - Molecular Biology and Plant Biotechnology Lab	2
	Discipline Specific Elective (DSE) 1	DSE 1	4
	Discipline Specific Elective (DSE) 1 Lab	DSE 1 Lab	2
	Discipline Specific Elective (DSE) 2	DSE 2	4
	Discipline Specific Elective (DSE) 2 Lab	DSE 2 Lab	2
			24
VI	Core Course 25	C25 - Genetics	4
	Core Course 26	C26 - Genetics lab	2
	Core Course 27	C27 - Cell Biology and Cytogenetics	4
	Core Course 28	C28 - Cell Biology and Cytogenetics Lab	2
	Discipline Specific Elective (DSE) 3	DSE 3	4
	Discipline Specific Elective (DSE) 3 Lab	DSE 3 Lab	2
	Discipline Specific Elective (DSE) 4	DSE 4	4
	Discipline Specific Elective (DSE) 4 Lab	DSE 4 Lab	2
			24

VII	Core Course 29	Applied Phycology and Bryology	4
	Core Course 30	Applied Phycology and Bryology Lab	2
	Core Course 31	Applied Mycology and Microbology	4
	Core Course 32	Applied Mycology and Microbology Lab	2
	Core Course 33	Molecular Cell Biology	4
	Core Course 34	Molecular Cell Biology Lab	2
	Core Course 35	Systematics and Evolution	4
	Core Course 36	Systematics and Evolution Lab	2
			24
VIII	Core Course 37	Applied Ecology	4
	Core Course 38	Applied Ecology Lab	2
	Core Course 39	Genetics and Cytogenetics	4
	Core Course 40	Genetics and Cytogenetics Lab	2
	Core Course 41	Molecular Plant Physiology	4
	Core Course 42	Molecular Plant Physiology Lab	2
	Core Course 43	Applied Pteridology and Gymnospermology	4
	Core Course 44	Applied Pteridology and Gymnospermology Lab	2
			24
IX	Core Course 45	Plant Metabolic Regulations	4
	Core Course 46	Plant Metabolic Regulations Lab	2
	Core Course 47	Molecular Plant Pathology	4
	Core Course 48	Molecular Plant Pathology Lab	2
	Core Course 49	Applied plant in vitro technology	4
	Core Course 50	Applied plant in vitro technology Lab	2

	Discipline Specific Elective (DSE) 5	DSE 5	2
	Discipline Specific Elective (DSE) 6	DSE 6	2
			22
X			
Total Credits			

Annexure III

Department of Botany
Central University of Jammu

Course structure of Integrated M. Sc. Botany - Semester I (AY 2020-21)

Course Code	Paper Title	Credit	Contact hours / week		
			L	T	P
Core Course					
	Plant Kingdom: Diversity in Form. Structure and Reproduction	4	4	0	0
	Plant Kingdom: Diversity in Form. Structure and Reproduction Lab	2	0	0	4
	Basics of Biochemistry and Biomolecules	4	4	0	0
	Basics of Biochemistry and Biomolecules Lab	2	0	0	4
Ability Enhancement Compulsory Course					
	Communicative Skills in English	2	2	0	0
Generic Elective Course					
	Animal Diversity-1	4	4	0	0
	Animal Diversity-1 Lab	2	0	0	4
Total		20	14	0	12

Semester – I

Course: Basics of Biochemistry and Biomolecules

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

Course Objective: The course will provide basic understanding of fundamental of biochemistry and introduce to the student to important biomolecules of life.

Unit I: Foundation of Biochemistry

Cellular foundations; Chemical foundations; Physical foundations, Genetic foundations, Chemical foundations; Water.

Unit II: Carbohydrate and Glycobiology

Monosaccharides ad Disaccharides; Polysaccharides; Glycoconjugates: Proteoglycan, Glycoproteins and Glycolipids; Carbohydrate as Information molecules, Working with carbohydrates.

Unit III: Amino Acids and Proteins

Amino acids- Structure, Classification and Properties; Peptide and Proteins; Structure (3D) of Proteins; Protein Functions, Working with Proteins: Separation and Purification.

Unit IV: Nucleotide and Nucleic Acids

Nucleotides: Bases, Pentoses and Phosphodiester bonds; Structure and Classification of Nucleic acids; Nucleic acid Chemistry, Other functions of nucleotides; Working with Nucleic acids: Separation and Purification.

Unit V: Lipid

Fatty acids and triacylglycerols; Storage lipids; Structural lipids in membrane; Lipids as Signals and Cofactors; Working with Lipids: Extraction and Separation

Suggested Readings

1. Moore, T.F. (1989). Biochemistry and Physiology of Plants Hormones. 2ndEdn. Springer-Verlag.

2. Nelson, D.L. and Cox, M.M. (2013). Lehninger-Principles of Biochemistry. Worth Publishers Inc. New York, USA.

3. ,Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Course: Basics of Biochemistry and Biomolecules Lab

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

Observation and demonstration-based experiments related to carbohydrate, proteins, lipids and nucleic acids.