



माँ विन्ध्यवासिनी विश्वविद्यालय, मीरजापुर

Maa Vindhyavasini University, Mirzapur

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BOTANY FOR U.G.-2026-27

PROPOSED STRUCTURE OF SYLLABUS

BOTANY (3+1)

(FACULTY OF SCIENCE)

Semester-wise Titles of the Papers in B.Sc. (Botany)

Semester-wise Titles of the Papers in B.Sc. (Botany)					
Year	Se m.	Course Code	Paper Title	Theory/ Practical	Credits/ Hours
Certificate Course In Microbial Technology & Applied Botany					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4/60
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2/60
	II	B040201T	Archegoniates & Plant Architecture	Theory	4/60
		B040202P	Land Plants Architecture	Practical	2/60
Diploma in Plant Identification, Utilization & Ethnomedicine					
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4/60
		B040302P	Plant Identification Technology	Practical	2/60
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4/60
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2/60
		B040403R	Research Project		3/45
Bachelor of Science					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4//60
		B040502T	Molecular Biology & Bioinformatics	Theory	4/60
		B040503P	Experiments in Physiology, Biochemistry & Molecular biology	Practical	2/60
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4/60
		B040602T	Ecology & Environment		4/60
		B040603P	Cytogenetics, Conservation & Environment Management	Practical	2/60
Bachelor of Science with Honours					
FOURTH YEAR	VII	B040701T	Plant Pathology and Applied Microbiology	Theory	4/60
		B040702T	Environmental Awareness and Social Ethics	Theory	4/60
		B040703T	Plant Tissue Culture and Genetic Engineering	Theory	4/60
		B040704P	Application and Techniques in Microbial and Plant Sciences	Practical	4/60
		B040705T(a)	Plant Resource Utilization	Theory	4/60
		B040705T (b)	Plant Systematics		
	VIII	B040801T	Research Methodology	Theory	4/60
		B040802T	Biostatistics & Data Analysis	Theory	4/60
		B040803T	Techniques and Instrumentation	Theory	4/60
		B040804P	Applied Research Methods	Practical	4/60
		B040805T(a)	Computer Application in biological Sciences	Theory	4/60
		B040805T(b)	Sustainable Biodiversity		

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OR Bachelor of Science with Research (For students who secure 75% marks in the First 6 Semesters)					
FOURTH YEAR	VII	B040701T	Plant Pathology and Applied Microbiology	Theory	4/60
		B040702T	Environmental Awareness and Social Ethics	Theory	4/60
		B040703T	Plant Tissue Culture and Genetic Engineering	Theory	4/60
		B040704P	Application and Techniques in Microbial and Plant Sciences	Practical	4/60
		B040705R	Research Project/ Dissertation/ Internship/ Field work	Project/ Dissertation	4/60
	VIII	B040801T	Research Methodology	Theory	4/60
		B040802T	Biostatistics & Data Analysis	Theory	4/60
		B040803T	Techniques and Instrumentation	Theory	4/60
		B040804P	Applied Research Methods	Practical	4/60
		B040805R	Major Research Project/Dissertation	Project/ Dissertation	4/60

* Total Credits/Hrs / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/ Virtual/ ICT based as per choice of the Institution)

Syllabus Prepared by				
S. N	Name & email	Designation	Department	College/ University
1	Dr. Rashmi Singh rashminknpg@gmail.com	Head & Professor	Department of Botany	Kashi Naresh Govt. P G College, Gyanpur, Bhadohi
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3.	Dr. Maya mayabhue@gmail.com	Head & Professor	Department of Botany	Dr. Shyama Prasad Mukharjee, Govt. Degree College, Bhadohi
4.	Dr. Ranjit Singh ranjeet14nov1975@gmail.com	Assistant Professor	Department of Botany	Kashi Naresh Govt. P G College, Gyanpur, Bhadohi
5.	Dr. Anil Kumar Dwivedi (External Expert)	Professor	Department of Botany	Deen Dayal Upadhyay, Gorakhpur University
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SUBJECT: BOTANY

Subject prerequisites:

1. To study Botany, a student must have had the subject Biology/Biotechnology learnt at 10+2 level.
2. Keen interest in plants and plant-related research, Potential in mathematics, biology and chemistry
3. Skills and aptitude for scientific study and research
4. Creativity and good comprehension while working on scientific procedures and research
5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) 3+1 offer essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using unique combination of core ,elective and vocational papers with significant inter-disciplinary components.

Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany program covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

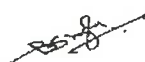
Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO 1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning
PO2	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO 3	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solution, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value systemsystem.
PO 4	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET , UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.
PO 5	Certificate and diploma courses are framed to generate self- entrepreneurship and self-employability, if multiexit option is opted.
PO 6	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

PO7	Field-Based and Entrepreneurial Skills, Develop field survey skills, herbarium techniques, GIS and GPS applications, nursery management, mushroom cultivation, medicinal plant utilization, and other entrepreneurship-oriented skills related to plant sciences.
PO8	Scientific Communication and Ethics, Demonstrate scientific temperament, ethical research practices, effective communication skills, digital literacy, teamwork, and professional responsibility in academic and societal contexts. Contribution to Society and Sustainable Development. Apply botanical knowledge for community development, environmental sustainability, food security, conservation of natural resources, and improvement of human welfare.


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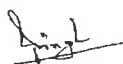






Maa Vindhyavasini University
UG Programme in Botany (3+1)
UG Ordinance NEP (2026)

Programme specific outcomes (PSOs) : <i>B.Sc. I Year / Certificate course in Microbial Technology & Classical Botany</i>
This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects: 1. Diversity of plants and microbes their habitat, morphology, architecture and reproduction. 2. Plant disease causing microbes, symptoms & control. 3. Economic value of plants and their use in Human Welfare.
Programme specific outcomes (PSOs) : <i>B.Sc. II Year/ (Diploma in Plant Identification, Utilization & Ethnomedicine)</i>
This course provides a broad understanding of identifying, growing and using plants .This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromising on academic rigour and our rich wealth of knowledge inherited over generations. 1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity of Plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to Important Families of Flowering Plants, Field Data Collection & Herbarium Techniques. 2. The course is designed to become a commercial crop grower, florist, protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.
Programme specific outcomes (PSOs) : <i>B.Sc. III Year / Bachelor of Science</i>
The learning outcomes of three years graduation course are aligned with program learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach. 1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.






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2.This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.

3.Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.

4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data.

5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values,

6. Strengthen mathematical and computational skills. Enable students to use ICT&AI effectively.

7. Develop good skills in laboratory such as observation and evaluation by the use of modern tools and technology.

**Programme specific outcomes (PSOs) :
B.Sc. IV/ UG Honours Programme in Botany**

After successful completion of the Undergraduate Programme in Botany, the students will be able to:

1.Fundamental Knowledge of Plant Sciences, Acquire comprehensive knowledge of plant diversity, taxonomy, morphology, anatomy, physiology, genetics, ecology, microbiology, plant pathology, biotechnology, and environmental biology.

2.Practical and Laboratory Skills, Develop proficiency in laboratory techniques, microscopy, plant tissue culture, microbial culture techniques, chromatography, molecular biology methods, bioinformatics tools, and scientific instrumentation used in biological sciences.

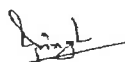
3. Biodiversity Conservation and Environmental Awareness, Understand the importance of biodiversity conservation, sustainable utilization of plant resources, environmental protection, ecological balance, and climate change mitigation for sustainable development.

4. Research and Analytical Competence, Apply scientific methods, biostatistics, research methodology, data analysis, and problem-solving skills for conducting biological research, interpretation of scientific data, and preparation of scientific reports.

5. Plant Health and Disease Management, Identify plant diseases and pathogens, understand host-pathogen interactions, and apply appropriate disease management practices including biological control, integrated pest management, and use of biofertilizers.

6.Application of Biotechnology and Bioinformatics Gain knowledge of genetic engineering, molecular biology, plant tissue culture, transgenic technology, and bioinformatics applications in agriculture, medicine, environmental management, and industry.

PSO 1	Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and environment and the importance of conserving it. Hands on training in various fields will develop practical skills, handling equipments and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.
PSO 2	Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: •Microbiologist, plant pathologist, Taxonomist • Plant Physiologist • Plant Biochemist • Researcher • Mycologist • Ecologist • Weed Scientist • Palaeobotanist • Conservationist • Fruit Grower • Morphologist • Cytologist • Ethnobotanist • Plant geneticists etc.
PSO 3	Inculcate strong fundamentals on modern and classical aspects of Botany, Understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.
PSO 4	Introduction of research project will inculcate research aptitude and passion for higher education and scientific research. Higher Education and Employability prepare for higher studies, research careers, competitive examinations, teaching, agriculture-based industries, environmental consultancy, biotechnology sectors, and allied life science professions.





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Botany Course is One of the Major Subjects for Biology Students and Minor or Elective for students of other faculties

Second Major Subject Can be Zoology/ Chemistry/Biotechnology /Microbiology

Third Subject is Minor or Elective to be selected from any one of other Faculties as per student's own interest One Vocational Course has to be opted from the list given in Syllabus as per NSDC guidelines

One Co-curricular Course is compulsory

Internal Assessment & External Assessment				
Internal Assessment	Marks	External Assessment	Marks	
Class Interaction	5	Viva Voce on Practicals	10	
Quiz	5	Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models	10	
Seminar	7	Table work / Experiments	45	
Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training)	8	Practical Record File	10	
TOTAL * Botanical Excursion/ Lab Visits/Industrial training Is compulsory	25		75	

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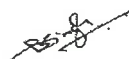
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**DETAIL SYLLABUS FOR
CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL
BOTANY
OR
B.Sc.-I**


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CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I		
Programme: <i>Certificate Course In Microbial Technology & Classical Botany</i>		Year: I Semester: I/Paper-I
Subject: Botany		
Course Code: B040101T	Course Title: Microbiology & Plant Pathology	
Course outcomes: After the completion of the course the students will be able to:		
1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance. 2. Develop conceptual skill about identifying microbes,pathogens,biofertilizers & lichens. 3. Gain knowledge about developing commercial enterprise of microbial products. 4. Learn host –pathogen relationship and disease management. 5. Learn Presentation skills (oral & writing) in life sciences by usage of computer of computer &multimedia 6. Gain Knowledge about uses of microbes in various fields. 7. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens 8. Gain Knowledge about the economic values of this lower group of plant community.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	A. Introduction to Indian ancient ,Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/ assignments / self study mentioned under Continuous Internal Evaluation (CIE). B. Microbial Techniques & instrumentation Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipments of microbiology lab and principle of their working – autoclave, hot air oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.	8
II	Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram negative bacteria, Structure of a bacteria; Bacterial Chemotaxis and Quorum sensing, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria; Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, viroids, Prions & myco& phytoplasma, Actinomycetes & plasmids and their economic uses.	8
III	Phycology Range of thallus organization in Algae, Pigments , Reserve food –Reproduction - Classification and life cycle of – <i>Nostoc</i> ; <i>Chlorella</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> ; <i>Sargassum</i> , <i>Ectocarpus</i> , <i>Polysiphonia</i> .	7

	Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation-Symbiosis ;Commercial products of algae.	
IV	Mycology General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycotina -General characters. Zygomycotina – <i>Rhizopus</i> , Ascomycotina - <i>Saccharomyces</i> , <i>Penicillium</i> , <i>Peziza</i> , Basidiomycotina- <i>Ustilago</i> , <i>Puccinia</i> , <i>Agaricus</i> ; Deuteromycotina – <i>Fusarium</i> , <i>Alternaria</i> , Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality	7
V	Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation. General account of lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.	7
VI	Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic..fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil	7
VII	Diseases and Control Symptoms , Causal organism, Disease cycle and Control measures of – Early & Late blight of Potato, Brown spot of rice, Black stem rust of wheat, Stem rot of Mustard , Red rot of Sugarcane, Wilting of Arhar, mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; citrus canker, little leaf of brinjal; damping off of seedlings, Disease management: - Quarantine, Chemical, Biological, Integrated pest disease management	8
VIII	Applied Microbiology Food fermentations and food produced by microbes, amino acids, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Mass production of bacterial biofertilizers, blue green algae, Azolla and mycorrhiza. Plant growth promoting rhizobacteria & biopesticides— <i>Trichoderma</i> sp. and <i>Pseudomonas</i> , Single cell proteins, Organic framing inputs, Microbiology of water, Biopolymers, Bioindicators, biosensors, Bioremediation, Production of biofuels, biodegradation of pollutants and biodeterioration of materials& Cultural Property	8

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Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. कनस्पति विज्ञान (सम्पूर्ण) शैवाल, कवक, लाइकेन, जीवाणु, विषाणु, ज्ञावांफाडा, टेरिस्ट्रेफाइटा, जिस्टोस्पर्म तथा पुष्प-कनस्पति विज्ञान : लेखक सिंह, पांडे व जैन प्रकाशन, रस्तोगी प्रकाशन, मेरठ
2. सूक्ष्म जैविकी कवक एवं पादप रोग विज्ञान त्रिवेदी शर्मा एवं धनकर तड़क चन्द्रसमीपत 2019
3. परित्यात्मक पादप रोग विज्ञान डॉ. आशीष कुमार त्रिपाठी डॉ. सतत कुमार त्रिपाठी 2018 एग्रोबोस इंडिया पब्लिशर
4. पादप रोग विज्ञान : जिया लात यादव 2012
5. डॉ. आशीष कुमार त्रिपाठी डॉ. सतत कुमार त्रिपाठी 2018 परित्यात्मक पादप रोग विज्ञान एग्रोबोस इंडिया पब्लिशर
6. श्रीता वर्मा 2020, सूक्ष्म जैविकी, कवक एवं पादप रोग विज्ञान
7. प्रजल आर्य 2020, पादप रोग : उत्पत्ति प्रसार एवं नियंत्रण
8. Microbiology Fundamental And Applications (hindi) (pb)
9. ISBN : 9788188826230 Edition : 03 Year : 2016 Author : Dr. Purohit SS , Dr. Deo
PPP Publisher : Student Edition Language : Hindi
10. पादप रोग विज्ञान परिभाषा-कोष : Definitional Dictionary of Plant Pathology. Publisher Commission for Scientific and Technical Terminology.
11. Modern Microbiology (hindi) (hb) ISBN : 9788177543599 Edition : 1 Year : 2018 Author :
Dr. Purohit SS , Dr. Singh T Publisher : Agrobios (India)
- 12.

Unit-I A:

- i. <https://indianculture.gov.in/rarebooks/economic-botany-india>
https://www.infinityfoundation.com/mandala/t/es/t/es_tiwar_botany_frameset.htm
- ii. https://www.researchgate.net/publication/335715457_Ancient_Indian_rishi's_Sages_knowledge_of_botany_and_medicinal_plants_since_Vedic_period_was_much_older_than_the_period_of_Theophrastus_A_case_study-who_was_the_actual_father_of_botany
- iii. <https://www.scribd.com/presentation/81269920/Botany-of-Ancient-India>
- iv. https://insa.nic.in/writereaddata/UploadedFiles/IJHS/Vol17_2_17_PKBhattacharyya.pdf
- v. http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri/wgbis_info/botany_history.pdf

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*vi Ancient Botany (Sciences of Antiquity) Paperback – 1 October 2015 by Gavin Hardy
(Author), Laurence Totelin (Author)*

UNIT-I B.

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Aggarwal, S. K. 2009. Foundation Course in Biology, A one books Pvt. Ltd., New Delhi.
5. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
6. Annie Ragland, 2012. Algae and Bryophytes, Saras Publication, Kanyakumari, India.
7. Basu, A. N. 1993. Essentials of Plant Viruses, Vectors and Plant diseases, New Age International, New Delhi.
8. Chopra. G. L. 1984. A text book of Algae, Rastogi publications, Meerut, India.
9. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
10. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
11. Fritsch, R. E. 1977. Structure and Reproduction of Algae, Cambridge University Press, London.
12. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
13. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
14. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
15. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
16. Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
17. Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
18. Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press.
19. Pandey B.P. 2001. College Botany Volume I, S Chand & Company Pvt. Ltd, New Delhi.
20. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
21. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
22. Rangaswamy, G. 2009, Disease of Crop Plants in India, Prentice Hall of India, New Delhi.
23. Sambamurthy. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
24. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
25. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
26. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
27. Sundar Rajan. S. 2010. College Botany Volume I, Himalaya Publications, Mumbai.
28. Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

This course can be opted as an elective by the students of following subjects: Open to all but special for

B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall

Internal Assessment	Marks
Class Interaction	5
Quiz	5

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Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination//Research Orientation assignment)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://indianculture.gov.in/rarebooks/economic-botany-india> <https://community.plantae.org/tags/mooc>
futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science <https://www.coursera.org/courses?query=plants>
<http://egyankosh.ac.in/handle/123456789/53530>
<https://www.classcentral.com/tag/microbiology>
<https://www.edx.org/learn/microbiology>
<https://www.mooc-list.com/tags/microbiology>
<https://www.udemy.com/topic/microbiology/>
<https://ucmp.berkeley.edu/bacteria/bacteria.html>
<https://www.livescience.com/53272-what-is-a-virus.html>
<https://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdf>
<https://www.slideshare.net/sardar1109/algae-notes-1>
<https://www.onlinebiologynotes.com/algae-general-characteristics-classification/> <https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus> <https://ucmp.berkeley.edu/fungi/fungi.html>
<https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>
<http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293>
<http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction-Pl%20Path%20111.pdf>
http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf
<https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx>
<https://learn.saylor.org/course/view.php?id=23§ionid=6821>
<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy> http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf
<https://lipidnanostructuresgroup.weebly.com/>
<https://zoology4civilservices.wordpress.com/2016/06/18/65/>
<https://microbenotes.com/laminar-flow-hood/>

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CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I		
Programme: <i>Certificate Course In Microbial Technology & Classical Botany</i>	Year: I	Semester: I/Paper-II
Subject: Botany		
Course Code: B040102P	Course Title: Techniques in Microbiology & Plant Pathology	
Course outcomes: After the completion of the course the students will be able:		
1. Understand the instruments, techniques ,lab etiquettes and good lab practices for working in a microbiology laboratory. 2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes. 3. Practical skills in the field and laboratory experiments in Microbiology & Pathology. 4. learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations. 5. Can initiate his own Plant & Seed Diagnostic Clinic 6. Can start own enterprise on microbial products		
Credits:2		Core Compulsory
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2		
Unit	<u>Topic * (Minimum Any three from each unit depending on facilities)</u>	No. of Lectures (60 hrs)
I.	INSTRUMENTS & TECHNIQUES 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments- microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 3. Cleaning and Sterilization of glasswares 4. Preparation of media- Nutrient Agar and Broth 5. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 6. Preparation of agar slant, stab, agar plate 7. Phenol Coefficient method to test the efficacy of disinfectants	7
II	BACTERIAL IDENTIFICATION 1. Isolation of bacteria. 2. Identification of bacteria. 3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 4. Cultural characteristics of bacteria on NA. 5. Pure culture techniques (Types of streaking). 6. Biochemical characterization : IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.	8

III	MYCOLOGICAL STUDY: 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. <i>Rhizopus</i>, <i>Saccharomyces</i>, <i>Penicillium</i>, <i>Peziza</i>, <i>Ustilago</i>, <i>Puccinia</i>; <i>Fusarium</i>, <i>Curvularia</i>, <i>Alternaria</i>. 3. <i>Agaricus</i>: Specimens of button stage and full grown mushroom; Sectioning of gills of <i>Agaricus</i>. 4. Lichens: crustose, foliose and fruticose specimens.	8
IV	PHYCOLOGY: 1. Type study of algae and Cyanobacteria – <i>Spirulina</i>, <i>Nostoc</i>. Chlorophyceae - <i>Chlorella</i>, <i>Volvox</i>, <i>Oedogonium</i>, <i>Cladophora</i>, and <i>Chara</i>; Xanthophyceae – <i>Vaucheria</i>; Bacillariophyceae – <i>Pinnularia</i> Phaeophyceae – <i>Sargassum</i> Rhodophyceae - <i>Polysiphonia</i>	7
V	EXPERIMENTAL PLANT PATHOLOGY 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of <i>Puccinia</i>, Few viral and bacterial plant diseases.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY-1 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic <i>Pseudomonas</i> from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of <i>Azospirillum</i> sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms.	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.	8
VIII	1. Cultivation of <i>Spirulina</i>, & <i>Chlorella</i> in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/IMT, Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation	6

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	procedures	
	4. Mushroom cultivation for Protein	
	5. Alcohol production. from Sugarcane Juice.	
Suggested Readings:		
<i>Course Books published in Hindi may be prescribed by the Universities.</i>		
1. प्रयोगात्मक वनस्पति विज्ञान भाग 1 : तैलक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रत्नगिरी प्रकाशन, भेट 2. प्रायोगिक वनस्पति विज्ञान & 1 Dhankar - Sharma – Trivedi ISBN Code: 978-81-8142-697-0 65, RBD Publishing House Shivaji Nagar Civil Lines, Jaipur - 302006 (Rajasthan) 3. प्रायोगिक वनस्पति विज्ञान बी.एससी एम बी अग्रवाल एंड कंपनी प्रकाशित वर्ष-2018 4. Practical Botany (Part I) ISBN #:81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition:2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual) 5. Modern Mushroom Cultivation And Recipes (hindi) (hb) ISBN : 9788177545180 Edition : 01 Year : 2017 Author : Singh Riti , Singh UC Publisher : Agrobios (India) 6. Biofertilizer Production Manual (hindi) (hb) ISBN : 9788177541274 Edition : 01 Year : 2014 Author : Gehlot D Publisher : Agrobios (India) Language : Hindi		
1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi. 2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi. 3. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York. 4. Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi. 5. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi. 6. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., 7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi. 8. https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf 9. http://nhb.gov.in/pdf/Cultivation.pdf 10. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf 11. Sen, Surjit, Acharya, Krishnendu, Rai, Manjula 2019 IBSN - 978-93-88347-23-5 - Biofertilizers and Biopesticides .Technoworld, kolkatta 12. http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf 13. http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf 14. Hochman, Gal, Zilberman, David 2014 IBSN-1461493285- Algae Farming and Its Bio-Products Springer 18. Gokare A. Ravishankar , Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192 19. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898		
This course can be opted as an elective by the students of following subjects: Open to all but special for		
B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.		

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Assessment	Marks
Internal	
Class Interaction	5
Quiz	
Seminar	7
Minor field work/excursion/lab visit/technology dissemination etc.	8

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Microbiology/biomedical Science.

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Lab Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balances, Fermenter, Anaerobic jar and Spectrophotometer.

Suggested equivalent online courses:

<https://community.plantae.org/tags/mooc>

futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science

<https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html>

<https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf>

<http://allaboutalgae.com/benefits/>

[https://repository.cimmyt.org/xmlui/bitstream/handle/10883/32](https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdf)

[19/64331.pdf https://www.mooc-list.com/tags/microbiology](https://www.mooc-list.com/tags/microbiology)

[http://www.agrifs.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%](http://www.agrifs.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%20%5B8171339239%5D%20%281984%29.pdf)

<D%20%5B8171339239%5D%20%281984%29.pdf>

[https://www.coursera.org/courses?quer](https://www.coursera.org/courses?query=plants)

<y=plants>

[http://egyankosh.ac.in/handle/12345678](http://egyankosh.ac.in/handle/123456789/53530)

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[https://www.classcentral.com/tag/micro](https://www.classcentral.com/tag/microbiology)

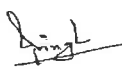
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[https://www.edx.org/learn/microbiolog](https://www.edx.org/learn/microbiology)

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<list.com/tags/microbiology>

<https://www.udemy.com/topic/microbiology/>





Programme /Class: B.Sc.-I/ <i>Certificate Course In Microbial Technology & Classical Botany</i>		Year: I	Semester: II Paper-I
Subject: Botany			
Course Code: B040201T		Course Title: Archegoniates and Plant Architecture	
Course outcomes: After the completion of the course the students will be able to: 1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms 2. Understanding of plant evolution and their transition to land habitat. 3. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants 4. Understand the details of external and internal structures of flowering plants.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	Lectur es (60hrs)	
I	Introduction to Archegoniates & Bryophytes Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Sphagnum</i> . (Developmental details not to be included). economic importance of bryophytes	7	
II	Pteridophytes General characteristics, Early land plants (<i>Rhynia</i>). Classification (up to family)with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	8	
III	Gymnosperms Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance	8	
IV	Palaeobotany General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization &types of fossils and study techniques ; Contribution of Birbal Sahni	8	






V	Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence) Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - <i>Bignonia</i> , <i>Boerhaavia</i> , <i>Dracaena</i> , <i>Nyctanthus</i>	7
VII	Reproductive Botany Plant Embryology, Structure of microsporangium, microsporogenesis, , Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	8
VIII	Palynology: Pollen structure, pollen morphology, pollen allergy , Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. इनस्पेरी विज्ञान (संस्कृत) शैवाल, कवक, ताइफेन, जीवाणु, विषाणु, ब्रायोफाइट, टेरिडोफाइट, जिम्नोस्पर्म तथा पुष्पा वनस्पति विज्ञान : लेखक-सिंह पांडे व जैन प्रकाशन, रस्तोगी प्रकाशन, मेरठ
2. आधुनिकी वनस्पति विज्ञान (टैक्सॉमी, एनाटॉमी, एम्ब्रियोजी तथा इकोनॉमिक बॉटनी) लेखक-सिंह पांडे तथा जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ
3. नवीन धर्मियालक वनस्पति विज्ञान डॉ एम के गुप्ता 2017 केदारनाथ रामनाथ परिवर्तन
4. ए के शर्मा एवं राजेश्वरी शर्मा 2018, वनस्पति विज्ञान बी एस सी प्रथम भाग एस आर साहित्यिक परिवर्तन
 1. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
 2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
 3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
 4. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
 5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
 6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
 7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
 8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
 9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
 10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
 11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
 12. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.
 13. Bhojwani, S.S. and S: P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,.
 14. P.K.K. Nair- A textbook of Palynology.
 15. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
 16. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
 17. E.J.Eames . Morphology of Vascular Plants, Standard University Press.
 18. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
 19. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
 20. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A.

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Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 4 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class ,wifi facility

Other Requisites: : Videos, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.anbg.gov.au/bryophyte/what-is-bryophyte.html>
<https://pteridoportal.org/portal/index.php>
<https://www.conifers.org/zz/gymnosperms.php>
<http://www.mobot.org/MOBOT/research/APweb/>
<https://milneorchid.weebly.com/plant-id-for-beginners.html>
<https://www.botany.org/PlantImages/PlantAnatomy.php>
<http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print> <https://palynology.org/>
<http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html> <https://www.sciencelearn.org.nz/resources/100-plant-reproduction> <https://palaeobotany.org/>

Programme/Class: : <i>Certificate Course In Microbial Technology & Classical Botany</i>	Year: I	Semester: II Paper-II (Practical)
Subject: Botany		
Course Code: B040202P	Course Title: Land Plants Architecture	
Course outcomes: 1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. 2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants. 3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense. 4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants 5. Understand the composition, modifications, internal structure & architecture of flowering plants for becoming a Botanist.		
Credits: 2	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	





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Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2		
Unit	Topic	No. of Lectures
I	Bryophytes: Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). Sphagnum- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8
II	Pteridophytes: <i>Lycopodium</i> : Habit, stem T. S. , strobilus V. S., <i>Selaginella</i> : Habit , rhizophore T. S , stem T. S, axis with strobilus, V. S. of strobilus, Megasporephyll and microsporephyll. <i>Equisetum</i> - Habit, rhizome and stem T. S. and V. S. of strobilus. <i>Azolla</i> – Habitat & its structure	7
III	Gymnosperms 1. Cycas – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S. of ovule.. Pinus - Branch of indefinite growth, spur shoot, T. S of old stem and needle R. L. S and T. L. S. of stem, male and female cone, V. S. of male and female cone.. Ephedra & Thuja -: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed .	8
IV	Palaeobotany & Palynology 1. Morphology of Rhynia and fossils gymnosperms & other groups 2. Visit to Birbal Sahni Institute of Palaeobotany or virtual conference with their scientists to learn fossilization 3. Mark and know about Indian geographical sites rich in plant fossils	6
V	Angiosperm Morphology 1. To study of diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences	8
VI	Plant Anatomy: Normal & Anomalous secondary thickening - <i>Bignonia</i> , <i>Dracaena</i> , <i>Boerhavia diffusa</i> , <i>Nyctanthus</i> Study of primary and secondary growth in root and stem of monocots and dicots by section cutting and permanent slides. Study of internal structure of dicot and monocot leaves. Study of structure of stomata.	8

VII	Reproductive Botany 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule and embryo sac development (through slides). 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants –<i>Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea</i> by microscopic observation. 7. Calculation of pollen viability percentage using in vitro pollen germination techniques.	8
VIII	Commercial Uses and Production technology 1. Azolla production 2. Production technology of Resins 3. Production and propagation of Ornamental Pteris, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and Thuja oil.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

प्रयोगात्मक वनस्पति विज्ञान भाग 1, 11 लेखक : अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन मेरठ प्रयोगात्मक वनस्पति विज्ञान भाग 1, 11, 111 त्रिवेदी शर्मा बोहरा और धनखड़.

प्रयोगात्मक वनस्पति विज्ञान भाग 2 लेखक : अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन मेरठ प्रायोगिक वनस्पति विज्ञान बी.एस.-सी 1, 11

एन बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी

Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I (10th edition). Vikas Publishing House.

Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.

Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.

Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.

Kumar, S and Kashyap. 2003. Manual of Practical Algae. Campus Books International, New Delhi
Bendre and Kumar A text book of Practical Botany. Vol I, II., Rastogi Pub. Meerut.

Suresh Kumar, Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet, New Delhi.
Santra, SC. 2005. College Botany Practical Vol. II. New Central Book Agency (P) Ltd.

This course can be opted as an elective by the students of following subjects:

Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	6
Field work /Virtual/E-learning /Participation in group discussions	7
Industrial or Central laboratory training of two weeks in summer/winter (Compulsory)	12
	25

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Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balance

Suggested equivalent online courses:

<https://www.easybiologyclass.com/topic-botany>

<http://www3.botany.ubc.ca/bryophyte/index.html>

http://ecflora.cavehill.uwi.edu/bio_courses/bl14apl/practical_3.1.htm <http://mydunotes.blogspot.com/p/botany.html>

<http://www.fao.org/3/a-v9236e.pdf>

<https://iinrg.icar.gov.in/library/nrg/nrg.pdf>

[https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model project on Azolla cultivation.pdf](https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model_project_on_Azolla_cultivation.pdf) <http://arnoldia.arboretum.harvard.edu/pdf/articles/1977-37-1-propagation-manual-of-selected-gymnosperms.pdf>

https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730/wo_AgricHandbook727_153_175.pdf

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*Detail Syllabus of
B.Sc.-II Year
or
Diploma in
Plant Identification, Utilization & Ethnomedicine*

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Diploma in Plant Identification, Utilization & Ethnomedicine		
Programme /Class: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II Semester: III Paper-I
Subject: Botany		
Course Code: B040301T	Course Title: Flowering Plants Identification & Aesthetic Characteristics	
Course outcomes: After the completion of the course the students will be able to:		
1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification. 2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants. 3. To compare the different approaches to classification with regard to the analysis of data. 4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family. 5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications. 6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, Set up a farm Or Run a plantation consultancy firm		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60hrs)
I	Systematics & Aesthetic Characteristics of Plants: Principles of classification and nomenclature. Comparative Study of different classification system viz. Artificial (Linnaeus), natural (Bentham and Hooker), phylogenetic (Engler and Prantl and Takhtazan) and angiosperm phylogeny group (APG IV).	8
II	Taxonomic resources: Herbarium and Botanical gardens. Aesthetic characteristics of plants. Some Famous gardens of India, green houses, Indoor garden, Roof garden, Topiary, Bonsai	7
III	Identification of Angiosperms families: Taxonomic study of following families and their economic importance: Dicots: Ranunculaceae, Rutaceae, Malvaceae, Fabaceae, Cucurbitaceae, Lamiaceae, Solanaceae, Asteraceae, Apocynaceae, Rubiaceae, Asclepiadaceae, Monocots: Liliaceae and Poaceae,	8
IV	Angiosperm Morphology: Morphology of roots, Stem and leaf. Plant modifications: Phylloclade, cladode and Phyllodes. Type of inflorescences; flowers, fruits and types of placentation.	7
V	Plant Anatomy: Meristematic and permanent tissues, Anatomy of root, stem and leaf. Root-shoot transition. Apical meristems and theories of apical organization: Apical cell theory, Histogen theory, Tunica Corpus Theory..	8

VI	TOOLS & SOFTWARES IN PLANT IDENTIFICATION- GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy, DDescription Language for TAxonomy – DELTA Internet directory for botany	7
VII	Computer Applications Introduction to Computers – classification, computer generation, low, medium and high level languages, software and hardware, operating systems, compilers and interpreters, personal, mini, main frame and super computers, characteristics and application, computer memory and its types, data representation and storage. Microsoft excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media.	7
VIII	Aesthetic Characteristics of Plants: Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai	8

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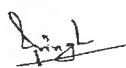
Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. अकृतवीजी वनस्पति विज्ञान (टिक्सामि, एनटोमी, एन्थ्रॉपोजी तथा इकोनॉमिक बोटनी) लेखक : सिंह, प्रह्लाद तथा जैन प्रकाशन : रस्तोमी प्रकाशन
2. भारत की संपदा, विज्ञान संचार भवन कृष्णन मार्ग पूसा कैम्पस
3. Propagation And Nursery Management (hindi) (hb) ISBN : 9788177546200 Edition : 01 Year : 2016 Author : Pandey S.K., Soni N. Publisher : Agrobios (India)
4. Dr. Amar Singh. पादपवर्गिकी- Plant Taxonomy (An Old and Rare Book) from the category Ayurveda in our Books collection. Uttar Pradesh Hindi Sansthan, Lucknow

1. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
2. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
3. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.com>
4. <https://www.naace.co.uk/school-improvement/ict-mark/>
5. <https://www.socitm.gov.uk>, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.
6. K. B. Anjaria, (2015) "Electronic Herbarium and Digital Database Preparation of Common Trees of Anand District, Gujarat" MRP submitted to UGC, WRO, Pune 2015 (unpublished)
7. Lizeron Eremias and R. Subash. (2013) "E-Content Development: A Milestone In The Dynamic Progress Of E-Learning" International Journal of Teacher Educational Research (IJTER) Vol.2 No.1 January, 2013 ISSN: 2319- 4642
8. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd, New Delhi.
9. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
10. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
11. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
12. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
13. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
14. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons.
15. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscape designer. Upper Saddle River, NJ: Pearson Prentice Hall.
16. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group.
17. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed plantings. New York: John Wiley & Sons.
18. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A.







Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination//Research Orientation assignment)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.easybiologyclass.com/topic-botany/>

<http://egyankosh.ac.in/handle/123456789/53530>

<https://www.delta-intkey.com/www/desc.htm>

<https://milneorchid.weebly.com/plant-id-for-beginners.html>

<https://plants.usda.gov/classification.html>

https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf

https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_%20S_%20Nongbri%20III%20Sem%20ppt.pdf

https://www.brainkart.com/article/Bentham-and-Hooker-s-classification-of-plants---Dicotyledonae,-Gymnospermae-and-Monocotyledonae_1000/

<https://libguides.rutgers.edu/c.php?g=336690&p=2267037>

<https://www.delta-intkey.com/>

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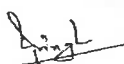
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Programme/Class: : Diploma in Plant Identification, Utilization & Ethnomedicine		Year: II	Semester: III Paper-II (Practical)
Subject: Botany			
Course Code: B040302P		Course Title: Plant Identification technology	
Course outcomes: After the completion of the course the students will be able: 1. To learn how plant specimens are collected, documented, and curated for a permanent record. 2. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology. 3. To gain experience with the various tools and means available to identify plants. 4. To develop observational skills and field experience. 5. To identify a taxonomically diverse array of native plants. 6. To recognize common and major plant families. 7. To Understand aesthetic characters of flowering plants by making-landscapes,gardens,bonsai,miniatures 8. Comprehend the concepts of plant taxonomy and classification of Angiosperms.			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic* *(Perform Any three experiments from each unit as per facility)		No. of Lectur es (60Hrs)
I	Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label the using Standard method g. Organize them and give Index Register Number		7
II	Taxonomic Identification using plant structure a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham Hooker system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.		8
III	Identification during excursions a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.		8
IV	COLLECTION, PRESERVATION AND STORAGE OF ALGAE,FUNGI BRYOPHYTES,PTERIDOPHYTES (Two each)		7

V	Botanical Nomenclature & reporting Method: a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI b. Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal	7
VI	COMPUTERS 1. Learning to use EXCEL Microsoft PowerPoint and Word., WORKING WITH FOLDER AND WINDOWS UTILITY., CREATE AND MANAGE FILES AND FOLDER TREE, 2. Practice browsing of different sites using search engine. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails. 3. Create and Participate in virtual conferencing in an interactive Zoom Meeting	7
VII	Computer Application in taxonomy 1. Use Taxonomic Softwares (Dichotomous Key) 2 . Practicals on Phylogenetic analysis 3. Make line drawing of Plants for description 4. Using of plant identification apps on android phones	8
VIII	1. Create a Bonsai of any plant 2. Develop a miniature garden 3. Draw Layouts of various types of gardens 4. Plant Propagation methods practice	8
Suggested Readings: Course Books published in Hindi may be prescribed by the Universities. प्रयोगात्मक वनस्पति विज्ञान भाग 2 लेखक : अशोक बेन्द्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ प्रयोगात्मक वनस्पति विज्ञान भाग 3 लेखक : अशोक बेन्द्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ प्रायोगिक वनस्पति विज्ञान बी-एससी-1, II, III एस. बी. अग्रवाल बी अग्रवाल प्रकाशन : शिवलाल अग्रवाल एण्ड कम्पनी प्रायोगिक वनस्पति विज्ञान AA II Author Name: - Dhankar - Sharma - Trivedi RBD Publication House 1. Day, S.C. (2003) A Art of Miniature Plant Culture. - Agrobias. Jodhpur, India. 2. Practical Taxonomy of Angiosperms By : R K Sinha ISBN : 9789386768520 I.K International Publishing House Pvt. Ltd.		


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Faculty of Science And Technology
Maa Vinayakdasini University, Mirzapur







1. Day, S.C. (2003) Complete Home Gardening. (2003) Agrobias, Jodhpur, India.
2. Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios, Jodhpur, India.
3. Khan, M.R. (1995) Horticulture and Gardening. - Nirali Prakashan, Pune. India.
4. Pramila Mehra Gardening for every one-. Hind pocket book private limited, New Delhi.
5. Kumarsen V. Horticulture, Saras Publication
6. Ramesh Bangia Learning Computer Fundamentals.,, Khanna Book Publishers
7. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
8. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
9. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
10. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
11. Womersley, J. S. 1981. Plant collecting and herbarium development: A manual.
12. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
13. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.co> <https://www.naace.co.uk/school-improvement/ict-mark/>
14. Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST, N. Delhi
15. Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGraw-Hill Publication Com. Ltd., New Delhi
16. Primak, R. B. (2004) A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers
17. Quicke, Donald, L. J. (1993) Principles and Techniques of Commemorative Taxonomy. Blakie, Academic and Professional, London
18. Singh, G (2004) Plant Systematics: Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
19. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens, Kew (Reprinted 1999).
20. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.
21. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom., Regnum Vegetabile Vol. 39. Utrecht.
22. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printers and Publishers, New Delhi.
23. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials: the Southern African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Botanical Excursion- compulsory	12
Assignment	8
	25

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Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Lab Requisites: Microscopes (Compound, Stereo) Dissection box, stain, Herbarium, Herbarium press, Dryers, Grinder, Reference Flora

Suggested equivalent online courses:

1. <http://egyankosh.ac.in/bitstream/123456789/13096/1/Unit-5.pdf>
2. <https://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp18.pdf>
3. https://www.researchgate.net/publication/267510854_The_Flowering_Plants_Handbook

Any Other :

Botanical Excursions: One teacher along with a batch not more than 7 students be taken for botanical excursion to places of Botanical interest, one in each term. If there are female students in a batch of 7 students, one additional lady teacher is permissible for excursion.

Each excursion will not be more than SEVEN days during college working days. T.A. and D.A. for teachers and non-teaching staff participating in excursions should be paid as per rules. Tour report duly certified by tour in charge teacher and Head of the Department should be submitted at the time of practical examination. For every study tour take the prior permission of the head of the department and Principal.

The marks will be counted under Internal assessment and external assessment both. In external assessment student will have to present his excursion report along with industrial training/central labs visits and BSI or Museum visits. In internal assessment he shall have to label the campus plants with botanical details/develop herbal/floristic garden/conservé plants in botanical garden/contribute specimens via collection .

A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits/
At least three field excursions at hills/Oceans/Deserts including one Compulsory excursion to Botanical Garden, FRI/BSI and Central National Herbarium (CNH). Central Research Institutes/Hot Spots

Programme /Class: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: IV Paper-I
Subject: Botany			
Course Code: B040401T		Course Title: Economic Botany, Ethnomedicine and Phytochemistry	
Course outcomes: After the completion of the course the students will be able to: 1. Understand about the uses of plants –will know one plant-one employment 2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants 3. know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60hrs)	
I	Origin And Domestication of Cultivated Plants & Economic Botany Centres of origin and diversity of crop plants, domestication and introduction of crop plants. Cultivation, production and uses of - wheat, rice, maize and legumes.	8	
II	Plants yielding fatty (mustard, groundnut)/essential oils (mint, rose), spices (Clove, cardamom, Black pepper, Fennel, Bay leaf, Daalchini), beverages (tea, coffee), fiber (cotton, coir, jute, flax); and biofuel (Jatropha) yielding plants. Timber yielding plants (teak, sheesham), gums and resins (Acacia & Commiphora), dye yielding plants (Carthamus, Indigofera).	7	
III	Ethnomedicine: Tribal knowledge of herbal medicine. Study of common medicinal plants used by tribes (Ashwagandha, Sarpgandha, Tulsi, Haldi, Bael, Aamla) Methodologies of Ethnobotanical Research. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani),.	8	
IV	IPR & Traditional Knowledge Traditional Knowledge Digital Library (TKDL), Protection of Traditional Knowledge - IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments. Role of AYUSH, NMPB, CIMAP.	7	
V	Preparation of drugs for commercial market, Organoleptic, Physical and Microscopic evaluation of drugs. Sources of crude drugs- roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds. Active and inert constituents of drugs, drug adulteration.	8	
VI	Organoleptic study of Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea and Zingiber officinale.	7	

VII	Plant natural products, general detection, extraction and characterization procedures. Alkaloids (morphine, quinine, caffeine, ephedrine, strychnine, and Nicotine),	8
VIII	Terpenoids (menthol, camphor, artemisinin, citral, cannabinoid, limonine, carotenoids, linalool), Flavonoids (Quercitine, anthocyanin, flavones and isoflavones, myrcitin, kaempherol), and Essential and volatile oils..	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. आवृत्तबीजी वनस्पति विज्ञान (टैक्सानॉमी, एनाटॉमी, एंब्रियोलॉजी तथा इकोनामिक बॉटनी) लेखक— सिंह, पांडे तथा जैन प्रकाशन : रतोगी प्रकाशन, मेरठ
2. भारत की संपदा, विज्ञान संचार भवन, इ.क.स. कृ.गन मार्ग, पूसा कैम्पस
3. परिस्थितिकी एवं आर्थिक वनस्पति विज्ञान लेखक : धनकर, शर्मा, त्रिवेदी
4. Aushdhiye Poudhe (Hindi) by R.P. Sharma | 1 January 2013 YKING BOOKS
1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.

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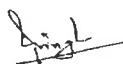
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7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
11. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
12. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
13. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
14. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
15. Jain, S. K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
16. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
17. Joshi, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
18. Kokate, C. and Gokeale- Pharmacognacy- Nirali Prakashan, New Delhi.
19. Lad, V. 1984. Ayurveda – The Science of Self-healing. Motilal Banarasidass, New Delhi.
20. Lewis, W. H. and M. P. F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A a. Wiley Inter science Publication. John Wiley and Sons, New York.
21. Farooqui, A. A. and Sreeraman, B. S. 2001. Cultvation of medicinal and aromatic crops. Universities Press.
22. Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
23. Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai. 1. Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I. Himalaya Publishing house.
24. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
25. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.
26. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
27. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
28. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
29. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
30. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizoms drugs. Bulletin No.1 Ministry of Health, Govt. of India.
31. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
32. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
33. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.
34. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
35. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
36. k. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn Edward Arnold, London.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall









be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination//Research Orientation assignment)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: : Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online resources:

https://www.pnas.org/content/104/suppl_1/8641

<https://www.journals.uchicago.edu/doi/pdfplus/10.1086/659998>

<https://bsi.gov.in/page/en/ethnobotany>

<http://www.legalserviceindia.com/article/198-Intellectual-Property-and-Traditional-knowledge.html>

https://www.brainkart.com/article/Economic-importance-Plants---Food.-Rice.-Oil.-Fibre.-Timber-yielding-plant_1095/

<https://www.loc.gov/rr/scitech/tracer-bullets/economic-botanytb.html>

<http://nsdl.niscair.res.in/bitstream/123456789/127/1/Fibre%20crops%2C%20bamboo%2C%20timber%20-%20Final.pdf>

<https://www2.palomar.edu/users/warmstrong/econpls.htm>

<https://www.longdom.org/proceedings/phytochemistry-and-phytoconstituents-of-herbal-drugs-and-formulations-1668.html>

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Programme : <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: IV Paper-II
Subject: Botany			
Course Code: B040402P		Course Title: Commercial Botany & Phytochemical Analysis	
Course outcomes: After the completion of the course the students will be able to: 1. Know about the commercial products produced from plants. 2. Gain the knowledge about cultivation practices of some economic crops. 3. Understand about the ethnobotanical details of plants. 4. Learn about the chemistry of plants & herbal preparations 5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic (Perform minimum any three experiments from each unit)		No. of Lectures (60hrs)
I	Economic Botany & Microtechniques: Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea- tea leaves, tests for tannin Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance mentioned in Unit I-& II		8
II	Commercial Cultivation Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrient solutions & running models for cultivation of vegetables Development of hydroponics nutrient solutions & running models for cultivation of fodder		8
III	Cultivating Medicinal and aromatic plants & Essential oil extraction a. Lemon grass/ Neem/ Zinger /Rose/Mint		7
IV	Documentation from Traditional Knowledge Digital Library , Mark the Geographic Indications on Map, Understand –Nakshtra Vatika, Navgrah vatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi		7

V	Ethnobotany Study of common plants used by tribes. <i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Cynodon dactylon</i> , Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethno botanical importance in your area . Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital	7
VI	Instrumentation and herbal Preparations Develop Capsules of herbs/ ,Develop Herbal oils/ ,Develop Poulitice/cream Analyse some active ingredients using chromatography /Spectrophotometry	8
VII	Pharmacognosy Organoleptic studies of plants mentioned in the theory : 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test 8. Proteins and lipid test	8
VIII	Phytochemistry: Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.	7
Suggested Readings: <i>Course Books published in Hindi may be prescribed by the Universities.</i> 1. Plant Ecology And Economic Botany by Dhankar - Sharma - Trivedi, RBD Publication 2. फार्माकोप्रॉसी <u>Shiva Kant, Pankaj Kumar Brahmiya</u> : Thakur Publication 3. PHARMACOGNOSY ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANI), RM Publication 4 ^थ प्रयोगात्मक वनस्पति वान मग 2 लेखक – अशोक बेन्द्रे तथा अशोक कुमार प्रकाशन :रस्तोगी प्रकाशन मेरठ 1. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd. 2. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai. 3. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow. 4. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta. 5. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India. 6. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia. 7. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India. 8. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi. 9. Khasim S.M Botanical Microtechniques: Principles and Practice- 10. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. ew Delhi.		

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11. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Arch., BAMS

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

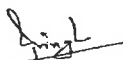
Lab requisites: Repository of economic products, Microscopes/ Botanical /Herbal Garden, TLC, Spectrophotometer.

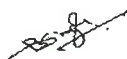
Suggested equivalent online courses:

<https://www.entrepreneurindia.co/Document/Download/pdfanddoc-144615-.pdf> <http://nopr.niscair.res.in/handle/123456789/45825>
https://www.wipo.int/export/sites/www/tk/en/resources/pdf/medicinal_tk.pdf <https://www.bentoli.com/commercial-farming-agriculture/>

**DETAIL SYLLABUS
OF
B.Sc.-III YEAR
or
BACHELOR OF SCIENCE
(BOTANY)**


Dean
Faculty of Science And Technology
Maa Vinaykavasin University, Mirzapur







BACHELOR OF SCIENCE (BOTANY)		
Programme/Class: <i>Bachelor of Science</i>	Year: III	Semester: V Paper-I
Subject: BOTANY		
Course Code: B040501T	Course Title: Plant Physiology, Metabolism & Biochemistry	
Course outcomes: After the completion of the course the students will be able to: 1. Understand the role of Physiological and metabolic processes for plant growth and development. 2. Learn the symptoms of Mineral Deficiency in crops and their management. 3. Assimilate Knowledge about Biochemical constitution of plant diversity. 4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 4-0-0		
Unit	Topic	No. of Lectures(60hrs)
I	Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.	7
II	Carbon Metabolism Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Kerbs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio , cyanide-resistant respiration, factors affecting respiration.	7
III	Nitrogen Metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.	8

IV	Lipid Metabolism & Photosynthesis Lipid Metabolism : Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation. ; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance	7
V	Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence	8
VI	Biomolecules <i>Carbohydrates:</i> Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). <i>Lipids:</i> Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides;	8
VII	Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramchandran plot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Re-naturation, MiRNA	7
VIII	Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes. Phytonutrients, Nutraceuticals, dietary supplements and antioxidants.	8

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. पादप शरीर किया विज्ञान तथा जैव रसायन लेखक— डॉ एच.एस.श्रीवास्तव प्रकाशन : रस्तोगी प्रकाशन, मेरठ
2. पादप शरीर किया विज्ञान एवं जैव रसायन लेखक—सिंह, पांडे तथा जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ
3. पादक कार्यिकी एवं जनन विज्ञान Madan Kumar. 2020.
4. Plant Physiology and Biochemistry ISBN #:81-301-0035-5 Sunil D Purohit, K. Ahmed & Gotam K Kukda Edition: 2013 Pages: 368 + VIII Text Book (Hindi)
5. पादक कार्यिकी एवं जैव रसायन Dhankar - Sharma – Trivedi RBD Publishing
1. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
2. A Handbook On Mineral Nutrition And Diagnostic Techniques For Nutritional Disorders Of Crops (pb) ISBN : 9788177543377 Edition : 01 Year : 2011 Author : Pathmanabhan G , Vanangamudi M , Chandrasekaran CN , Sathyamoorthi K , Babu CR , Babu RC , Boopathi PN Publisher : Agrobios (India)
3. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.

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4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 1992, Wadsworth Publishing Company.
5. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
6. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
7. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pathways 2008, New Central Book Agencies.
8. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
9. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
11. Srivastava, H.N. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
12. Verma, S.K. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
13. Buchanan, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
14. Ramesh Gupta. Efficacy, Safety and Toxicity brings together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
15. Harborne, J.B. 1973. Phytochemical Methods. John Wiley & Sons, New York.
16. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Gardening)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://www.classcentral.com/course/swayam-plant-physiology-and-metabolism-17732>

<https://www.wiziq.com/course/3249-plant-physiology-in-10-live-online-classes>

<https://www.easybiologyclass.com/plant-physiology-free-lecture-notes-online-tutorials-lecture-notes-ppts-mcqs/>

https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

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Programme/Class: Bachelor of Science		Year: III	Semester: V Paper-II
Subject: Botany			
Course Code: B040502T		Course Title: Molecular Biology and Bioinformatics	
Course outcomes: After the completion of the course the students will be able to : 1. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process. 2. Know about Processing and modification of RNA and translation process, function and regulation of expression. 1. Gain working knowledge of the practical and theoretical concepts of bioinformatics.			
Credits: 4		Core Compulsory/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)
I	Historical Perspective: Griffith's And Avery's Transformation Experiments, Hershey-Chase- Bacteriophage Experiment, Types Of Genetic Material. DNA structure, Types of DNA, Types of RNA (mRNA, tRNA, rRNA)		7
II	DNA Replication (Prokaryotes and Eukaryotes) Bidirectional, Semiconservative, θ (Theta) mode of replication. RNA polymerases; Transcription, Genetic Code, Translation, Regulation of Gene Expression in Prokaryotes: Lac Operon.		8
III	Blotting techniques: Northern, Southern and Western Blotting, Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs;		8
IV	DNA Sequencing- Sanger Sequencing, Next Generation Sequencing (Pyrosequencing and Illumina Sequencing) , PCR and Reverse Transcriptase-PCR. Gene editing -CRISPR/Cas systems.		7
V	Recombinant DNA technology: Vectors, Restriction Enzymes, Molecular Probes, Genomic and cDNA libraries, Indirect gene transfer methods (<i>Agrobacterium</i> mediated transfer), Direct Gene transfer methods (Electroporation, Particle Bombardment, Microinjection, PEG, silicon carbide), Transgenic plants (Flavr Savr tomato, Bt cotton, Golden rice, Round Up Ready soybean)		8
VI	Plant Cell, Tissue And Organ Culture: Concept Of Totipotency, Technique Of Plant Tissue Culture, Media Preparation, Callus Cultures, Cell Suspension Cultures, Micropropagation, Somaclonal Variation, Somatic Hybridization, And Synthetic Seeds.		7

VII	Computers in Biology (MS Office, PPT, MS Excel, Number Systems), Scope and applications of bioinformatics, Introduction to biological databases (NCBI,EMBL- EBI, JDBD), Types of Sequence Alignment (Global & Local, Pairwise & Multiple Sequence Alignment)	8
VIII	Methods of Sequence Alignment: Dot-matrix Method, Dynamic Programming, Word or k-tuple Method, Exhaustive Algorithms, Heuristic Algorithm (BLAST & FASTA), Phylogenetic Tree Construction: Types (Rooted, Unrooted, Cladogram & Phylogram),Methods (Distance Vs. Discrete or Character Based), Steps in Construction of Phylogenetic Tree.	7

Suggested Readings:

1. Gardner, E.J., and D.P. Snustad. 1984. *Principles of Genetics*. New York: John Wiley & Sons.
2. Gupta, P.K. 2016. *Biotechnology and Genomics*. 1st ed., 7th reprint. Meerut: Rastogi Publications.
3. Parihar, Dr. [First name not available]. 2018. *A Textbook of Basic and Molecular Genetics*. 1st ed. ISBN: 9788188826193. [Publisher not specified].
4. Primrose, S.B. 1995. *Principles of Genome Analysis*. Oxford, U.K.: Blackwell Science Ltd.
5. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick. 2008. *Molecular Biology of the Gene*. 6th ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press / Pearson.
6. Freifelder, David. *Molecular Biology*.
7. Andreas, D., A.D. Baxeavanis, and B.F. Ouellette. 2004. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd ed. New Jersey, U.S.: John Wiley and Sons.
8. Baxeavanis, A.D., and B.F. Ouellette. 2005. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd ed. New Jersey, U.S.: Wiley & Sons, Inc.
9. Ghosh, Z., and B. Mallick. 2008. *Bioinformatics: Principles and Applications*. 1st ed. NewDelhi: Oxford University Press.. Prentice Hall
10. Pevsner, J. 2009. *Bioinformatics and Functional Genomics*. 2nd ed. New Jersey, U.S.: Wiley Blackwell.
11. Roy, D. 2009. *Bioinformatics*. 1st ed. New Delhi: Narosa Publishing House.
12. Xiong, J. 2006. *Essential Bioinformatics*. 1st ed. Cambridge, U.K.: Cambridge University Press

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5

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Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses: <https://www.edx.org/learn/molecular-biology>
<https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering>
<https://www.classcentral.com/course/swavam-genetic-engineering-theory-and-application-14090>
<https://www.coursera.org/courses?querv=genetics>

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Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: V Paper-III
Subject: Botany			
Course Code: B040503P		Course Title: <i>Experiments In Physiology, Biochemistry & Molecular Biology</i>	
Course outcomes: After the completion of the course the students will be able to: 1. Understand the physiological processes undergoing in plants along with their metabolism 2. Identify Mineral deficiencies based on visual symptoms 3. Understand and develop skill for conducting molecular experiments for genetic engineering			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 0-0-2			
Unit	Topic* <i>*(Perform any three from each unit based on facility)</i>		No. of Lectures(60 hrs)
I	Plant water relation, Mineral Nutrition and translocation in phloem 1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeco / Tradescantia. 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q10. 4. Experiment to demonstrate the transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of stomata (dicot & monocot) 7. Determination of rate of transpiration using cobalt chloride method. 8. Experiment to measure the rate of transpiration by using Farmer's Potometer 9. Experiment to measure the rate of transpiration by using Ganong's potometer 10. Effect of Temperature on membrane permeability by colorimetric method. 11. Study of mineral deficiency symptoms using plant material/photographs.		8
II	Photo Synthesis & Respiration 1. Separation of Plastidial Pigments by Solvent and Paper Chromatography. 2. Estimation of total Chlorophyll content from different chronologically aged leaves (young, mature and senescent) by Arnon method. 3. Effect of H2CO3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). 4. Measurement of oxygen uptake by respiring tissue (per g/hr.) 5. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott's bubbler 6. Determination of the RQ of germinating seeds		8

III	Plant Development, Movements, Dormancy & Responses 1. Geotropism and phototropism — Klinostat 2. Hydrotropism - a. Measurement of growth — Arc and Liver Auxonometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains. 5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on <i>Avena</i> coleoptile elongation (IAA bioassay)	8
IV	Techniques for biochemical analysis 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Qualitative Analysis of carbohydrates, 4. Estimation of reducing sugar by anthrone method, 5. Qualitative Analysis of Lipids 6. Qualitative analysis of Amino acids and Proteins 7. Purification of acid phosphatase from sprouted moong 8. Purification of peroxidase from radish 9. Enzyme kinetics of acid phosphatase/ Enzyme kinetics of peroxidase/ alpha- amylase	8
V	Genetic material 1. Instruments and equipments used in molecular biology. 2. Isolation of Genomic DNA 3. Isolation of DNA from plants 4. Examination of the purity of DNA by Agarose Gel Electrophoresis. 5. Quantification of DNA by UV-Spectrophotometer Estimation of DNA by Diphenylamine method.	7
VI	Plant tissue culture 1. Familiarization of instruments and special equipments used in the Plant Tissue Culture experiments 2. Preparation of Plant Tissue Culture Medium, Sterilization, Preparation of Stock Solutions of nutrients for MS Media. 3. Surface sterilization of plant materials and inoculation in the medium. 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration	7

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VII	Genetic Engineering 1. Construction of restriction map of circular and linear DNA from the data provided. 2. Isolation of Plasmid DNA. 3. Restriction digestion and Gel Electrophoresis of Plasmid DNA (demonstration/ photograph). Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 5. Demonstration of PCR 6. Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by Electroporation, Microinjection, Microprojectile Bombardment. 7. Study of steps of Genetic Engineering for production of Bt cotton, Golden Rice, FlavrSavr Tomato through photographs.	7
VIII	Bioinformatics 1. Exploration of databases- Nucleic acid databases (NCBI, GenBank, EMBL, DDBJ, NDB), Protein databases (PIR, Swiss-Prot, TrEMBL, PDB). 2. Types of Sequence Alignment(Global & Local, Pairwise & Multiple Sequence Alignment) 3. Methods of Alignment (BLAST and FASTA) 4. Phylogenetic Tree Construction: Types (Rooted, Unrooted, Cladogram & Phylogram), Steps in construction of Phylogenetic Tree.	7
Suggested Readings: Course Books published in Hindi may be prescribed by the Universities. 1. रींद्र, अशोक, और अशोक कुमार. 2020. प्रयोक्तिक वनस्पतगत गवज/न: िक्ति 3, मेरठ: रस्तोगी प्रकाशि. 2. Akhtar, Inam. 2012. <i>A Laboratory Manual of Plant Physiology, Biochemistry and Ecology</i>. 1st ed. Jodhpur: Agrobios (India). ISBN: 9788177544589. 3. Dashek, W.V., ed. 1997. <i>Methods in Plant Biochemistry and Molecular Biology</i>. Boca Raton, FL: CRC Press. 4. Henry, R.J. 1997. <i>Practical Application of Plant Molecular Biology</i>. London: Chapman & Hall. 5. Karp, G. 2010. <i>Cell and Molecular Biology: Concepts and Experiments</i>. 6th ed. Hoboken, NJ: John Wiley & Sons, Inc. 6. Padmanaban, G., C.N. Chandrasekaran, A.U. Thangavelu, R. Sivakumar, N. Kalimuthu, P. Boominathan, and P. Anbarasan. 2016. <i>Advanced Methods in Physiology and Biochemistry</i>. 1st ed. Jodhpur: Agrobios. ISBN: 9789381191132. 7. Thimmaiah, S.R. 2004. <i>Standard Methods of Biochemical Analysis</i>. New Delhi: Kalyani Publishers. Wilson, K., and J. Walker. [Year not specified]. <i>Practical Biochemistry: Principles and Techniques</i>. Cambridge, U.K.: Cambridge University Press.		
This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology. Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:		

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Lab requisites: Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:

<https://www.cytology-iac.org/educational-resources/virtual-slide-library>

https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx

<https://www.mooc-list.com/tags/genetics>

<https://www.coursera.org/learn/genetics-evolution>

<https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/>

Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required

BACHELOR OF SCIENCE (BOTANY)

Programme: Bachelor of Science		Year: III	Semester: VI Paper-I
Subject : Botany			
Course Code: B040601T	Course Title : Cytogenetics, Plant Breeding and Nanotechnology		
Course outcomes: After the completion of the course the students will be able to : 1. Acquire knowledge on cell ultrastructure. 2. Understand the structure and chemical composition of chromatin and concept of cell division. 3. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance. 4. Understand the concept of 'one gene one enzyme hypothesis' along with the molecular mechanism of mutation.			
Credits : 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks :	

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Total No. of Lectures-Tutorials- Practical (in hours per week) : 4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Structure of Prokaryotic Cell and Eukaryotic Cells. Function of Cell Wall, Plasma Membrane, Ribosomes, Endoplasmic Reticulum, Golgi Apparatus, Mitochondria, Chloroplast, Lysosomes, Peroxisomes. Organization of Nucleus	7
II	Nomenclature & Structure of Chromosomes (Nucleosome Model). Special types of Chromosomes (Lampbrush Chromosomes and Polytene Chromosomes & B Chromosomes). Karyotype and Ideogram. Cell Cycle & Cell Division (Mitosis, Meiosis). Variation in Chromosome (Numerical and Structural Aberrations).	8
III	Chromosome Theory of Inheritance, Crossing Over and Linkage, Incomplete and Codominance; Interaction of Genes: Incomplete Dominance, Codominance, Lethal Genes; Complementary, Supplementary, Epistasis and Duplicate Gene Interactions.	8
IV	Pleiotropy, Polygenic Inheritance, Multiple Alleles. Extranuclear Inheritance. Patterns of Sex Determination in Plants.	7
V	Plant introduction, Acclimatization, Selection – Mass Selection, Pure Line Selection and Clonal Selection. Hybridization: Intergeneric, Interspecific, Inter Varietal Hybridization with examples. Composite and Synthetic Varieties, Heterosis, Mutation Breeding, Molecular Breeding, Achievements of India in Crop Breeding (Wheat & Rice).	8
VI	Biostatistics: Data and Sampling, Measures of Central Tendency-Arithmetic Mean, Mode and Median; Measurement of Dispersion-Coefficient of Variation, Standard Deviation, Standard Error of Mean; Test of Significance; Chi-Square Test for Goodness of Fit. Computer Application in Biostatistics- MS Excel and SPSS	7
VII	Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).	8
VIII	Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, Nano-Pesticides, Nano-Fertilizers, Nano-Sensors.	7

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. शमाच और निवेदी. 2020. कोशिकी जीवगवज्ञन, आणगवक जीवगवज्ञन एवं जैव प्रौद्योगिकी. अजमेर: आरबीडी पनललकेशनस.
2. गुप्ता, पी.के. 2016. कोशिकी गवज्ञन, आणगवक जीवगवज्ञन, गवकस एवं पसरगस्टुंगतकी. मेरठ: रस्तोगी प्रकाशि.

3. वैज्ञानिक एवं तकनीकी शलदावली आयोग (CSTT). 2015. गवज्ञ7न एवं प्रौद्योगिकी िब्द7व्ी. िई नदल्ली: वैज्ञानिक एवं तकनीकी शलदावली आयोग.

Cell Biology

1. Alberts, B., A. D. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts, and P. Walter. 2014. *Molecular Biology of the Cell*. 6th ed. New York: W.W. Norton & Co.
2. Cooper, G. M. 2015. *The Cell: A Molecular Approach*. 7th ed. Sunderland, MA: Sinauer Associates.
3. Darnell, J., H. Lodish, and D. Baltimore. 1991. *Cell and Molecular Biology*. New York: Lea and Febiger.
4. De Robertis, E. D. P., and E. M. P. De Robertis. 1991. *Cell and Molecular Biology*. New York: Scientific American Books.
5. Gardner, E. J., M. J. Simmons, and D. P. Snustad. 1991. *Principles of Genetics*. 8th ed. New York: John Wiley & Sons.
6. Karp, G. 2010. *Cell Biology: Concepts and Experiments*. 6th ed. Hoboken, NJ: John Wiley & Sons.
7. Lewin, B. 1994. *Genes*. New York: Oxford University Press.
8. Roy, S. C., and K. K. De. 1997. *Cell Biology*. Kolkata: New Central Book Agency.
9. Sandhya Mitra. 1998. *Elements of Molecular Biology*. New Delhi: Macmillan India Ltd.
10. Wilson, K., and J. Walker. [Year not specified]. *Practical Biochemistry: Principles and Techniques*. Cambridge, U.K.: Cambridge University Press

Genetics

11. Dobzhansky, B. 1961. *Genetics and the Origin of Species*. New York: Columbia University Press.
12. Griffiths, A. J. F., S. R. Wessler, S. B. Carroll, and J. Doebley. 2010. *Introduction to Genetic Analysis*. 10th ed. New York: W. H. Freeman.
13. Klug, W. S., M. R. Cummings, and C. A. Spencer. 2009. *Concepts of Genetics*. San Francisco: Benjamin Cummings.
14. Nicholl, T. 2007. *An Introduction to Genetic Engineering*. Cambridge: Cambridge University Press India Pvt. Ltd.
15. Snustad, D. P., and M. J. Simmons. 2010. *Principles of Genetics*. 5th ed. New York: John Wiley & Sons.
16. Swanson, C. P. 1957. *Cytology and Genetics*. Englewood Cliffs, NJ: Prentice-Hall.

Plant Breeding

17. Allard, R. W. 1960. *Principles of Plant Breeding*. New York: John Wiley & Sons.
18. BD Singh. 2003. *Plant Breeding*. Ludhiana: Kalyani Publishers.
19. M. K. Razdan. *An Introduction to Plant Tissue Culture*. New Delhi: Oxford & IBH Publishing.
20. Sharma, J. R. 1994. *Principles and Practices of Plant Breeding*. New Delhi: Tata McGraw-Hill.
21. Sharma, A. K., and A. Sharma. 1980. *Chromosome Technique: Theory and Practice*. New York: Aditya Books.

Biostatistics

1. Gupta, S. C. 2016. *Fundamentals of Statistics*. Mumbai: Himalaya Publishing House.
2. Kapoor, V. K. 2007. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand & Sons.
3. Murty, B. S., P. Shankar, Baldev Raj, B. B. Rath, and James Murday. 2012. *Textbook of Nanoscience and Nanotechnology*. New Delhi: Springer.
4. Nageshwar Rao, G. 2007. *Statistics for Agricultural Sciences*. New Delhi: BS Publications.
5. Nigam, A. K., and V. K. Gupta. 1979. *Handbook on Analysis of Agricultural Experiments*. New Delhi: IASRI Publications.
6. Panse, V. G., and P. V. Sukhatme. 1985. *Statistical Methods for Agricultural Workers*. New Delhi: Indian Council of Agricultural Research.
7. Rangaswami, R. 2009. *A Textbook of Agriculture Statistics*. Hyderabad: New Age International.
8. Sharma, A. K. 2005. *Textbook of Biostatistics I*. New Delhi: Discovery Publishing House.
9. Snedecor, G. W., and W. G. Cochran. 1989. *Statistical Methods*. Iowa: Iowa State University Press.
10. Taylor. 2008. *Biological Sciences*. Cambridge: Cambridge University Press.
11. Das, M. N., and N. C. Giri. 1986. *Design and Analysis of Experiments*. New Delhi: Wiley Eastern Ltd.

Nanotechnology

1. Bass, Joel E., et al. 2009. *Methods for Teaching Science as Inquiry*. Boston: Allyn & Bacon.
2. Chattopadhyay, K. K., and A. N. Banerjee. 2009. *Introduction to Nanoscience and Nanotechnology*. New Delhi: PHI Learning
3. Crespi, R. Stephen. 1991. "Patenting in Biotechnology - Part I." *TIBTECH* 9: 117-22.
4. David, S. Goodshell. 2004. *Bionanotechnology - Lessons from Nature*. Hoboken, NJ: John Wiley & Sons.
5. Kulkarni, Sulabha K. 2014. *Nanotechnology: Principles and Practices*. New Delhi: CP Publishing.
6. Murty, B. S., P. Shankar, Baldev Raj, B. B. Rath, and James Murday. 2012. *Textbook of Nanoscience and Nanotechnology*. New Delhi: Springer.
7. Rajaraman, V. 2012. *Introduction to Information Technology*. New Delhi: Prentice Hall.
8. Xie, Yubing. 2012. *Nanotechnology*. Boca Raton, FL: CRC Press.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology. Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:	
Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25
Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science) Facilities: Smart and Interactive Class Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts	
Suggested equivalent online courses: https://www.cytology-iac.org/educational-resources/virtual-slide-library https://www.asct.com/ASCTWeb/Content/Cytopreparation Online Course.aspx https://www.mooc-list.com/tags/genetics https://www.coursera.org/learn/genetics-evolution https://www.mv-mooc.com/en/mooc/introduction-to-genetics-and-evolution/	
Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required	

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: VI Paper-II
Subject: Botany			
Course Code: B040602T		Course Title: Ecology & Environment	
Course outcomes: After the completion of course the students will be able to 1. understand the complex interrelationship between organisms and environment; 2. to understand the methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. 3. get the knowledge which will be critical in evolving strategies for sustainable natural resource management and biodiversity conservation.			
Credits: 4		Core Compulsory/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60 hrs)	
I	Ecology: Definition of Ecology, Abiotic and Biotic Components, Renewable and Non-Renewable Sources of Energy. Ecological Succession- Primary & Secondary, Hydrosere & Xerosere. Food chains and Food Webs, Ecological Pyramids, Ecological Niche, Ecotypes, Ecological Indicators.	8	
II	Ecosystem: Concepts and Components, Types of Ecosystems: Terrestrial and Aquatic Ecosystems. Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	7	
III	Phytogeographical regions of India and World, Vegetation types of Uttar Pradesh. Agroecological and Floristic zones of India. Natural Vegetation of India, Static and Dynamic plant Geography, Basic Principles governing Geographical Distribution of Plants.	8	
IV	Soil formation, Soil profile, Composition & Properties of soil. Soil types. Soil erosion and soil conservation. Geographical Information System; definitions and components; GIS software packages; Remote sensing and GIS in land use planning, forest resources and agriculture studies.	7	

V	Biodiversity conservation: Definition – Genetic, Species, and Ecosystem Diversity. Value of Biodiversity, Hotspots of Biodiversity, Threats to Biodiversity. Endemic and Endangered Species of Plants in India. Ex-situ and In-situ conservation, Red Data Book, Botanical Gardens, National Parks, Sanctuaries, Ramsar Sites, Bioreserves. Role of Seed Bank and Gene Bank. Role of NBPGR, FAO, BSI.	8
VI	Sustainable Development: Strategies of Sustainable Development, Sustainable Agriculture, India's Environment Action Programme. Carbon Credit: Concept, Exchange of Carbon Credits. Ecological Footprint with emphasis on Carbon Footprint. Concept of Energy and Green Audit.	7
VII	Environmental Pollution, Environmental Protection Laws, Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear	8
Suggested Readings Ecology 1. Ambasht, R.S., and N.K. Ambasht. <i>A Text Book of Plant Ecology</i>. Latest ed. CBS Publication & Distributors. 2. Begon, M., J.L. Herper, and C.R. Townsend. 3rd ed. <i>Ecology: Individuals, Populations and Communities</i>. Oxford: Blackwell Science. 3. Cain, M.L., Bowman, W.D., and Hacker, S.D. 2014. <i>Ecology</i>. 3rd ed. Sinauer Associates. 4. Chapman, J.L., and M.J. Riss. Latest ed. <i>Ecology: Principles and Applications</i>. Cambridge University Press. 5. Gurevitch, J., et al. 2002. <i>The Ecology of Plants</i>. Sinauer Associates. 6. Kumar, H.D. Latest ed. <i>Modern Concept of Ecology</i>. Vikas Publishing House. 7. Kimar, U., and M.J. Asija. 2005. <i>Biodiversity: Principles & Conservation</i>. Student Edition, Agrobios (India). 8. Mackenzie, et al. Latest ed. <i>Ecology</i>. Viva Books. 9. Mani, M.S. Latest ed. <i>Bio-Geography of India</i>. Springer-Verlag. 10. Mitra, D., J.K. Guha, and S.K. Chowdhury. 7th ed. <i>Studies in Botany</i>, Vol. II. Moulik Library. 11. Odum, F.P. Latest ed. <i>Fundamentals of Ecology</i>. Saunders. 12. Sharma, P.D. Latest ed. <i>Elements of Ecology</i>. Rastogi Publications. 13. Shukla, R.S., and P.S. Chandel. Latest ed. <i>Plant Ecology</i>. S. Chandel and Co. 14. Singh, P.S., and U.K. Agarwal. Latest ed. <i>Concept of Ecology</i>. S. Chand & Company. 15. Verma, P.S., and U.K. Agarwal. Latest ed. <i>Concept of Ecology</i>. S. Chand & Company. 16. Vasudevan, N. 2006. <i>Essentials of Environmental Science</i>. Narosa Publishing House. 17. Singh, J.S., S.P. Singh, and S. Gupta. 2006. <i>Ecology, Environment and Resource Conservation</i>. Anamaya Publications. Geographic Information Systems & Remote Sensing 1. Demers, M.N. 2005. <i>Fundamentals of Geographic Information System</i>. Wiley & Sons. 2. Lo, C.P., and A.K.W. Yeung. 2002. <i>Concepts and Techniques of Geographic Information Systems</i>. Prentice-Hall of India. 3. Richards, J.A., and X. Jia. 1999. <i>Remote Sensing and Digital Image Processing</i>. Springer. 4. Sabins, F.F. 1996. <i>Remote Sensing: Principles and Interpretation</i>. W.H. Freeman.		

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Biodiversity and Conservation

1. Krishnamurthy, K.V. 2003. *An Advanced Text Book on Biodiversity*. Oxford & IBH Publishing Co. Ltd.
2. Primack, R.B. 1993. *Essentials of Conservation Biology*. Sinauer Associates.
3. Sodhi, N.S., and P.R. Ehrlich, eds. 2010. *Conservation Biology for All*. Oxford University Press.
4. Sodhi, N.S., L. Gibson, and P.H. Raven. 2013. *Conservation Biology: Voices from the Tropics*. Wiley-Blackwell.
5. Singh, J.S., and S.P. Singh. 1987. "Forest Vegetation of the Himalaya." *The Botanical Review* 53:80-192.
6. Kumar, U., and M.J. Asija. 2005. *Biodiversity: Principles & Conservation*. Agrobios (India).
7. Anonymous. 1997. *National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet)*. National Bureau of Plant Genetic Resources, New York.

Climate Change and Environmental Science

1. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. Martinus Nijhoff Publishers.
 2. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
 3. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
 4. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.
 5. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications.
 6. Mathez, E.A. 2009. *Climate Change: The Science of Global Warming and Our Energy Future*. Columbia University Press.
 7. Mitra, A.P., S. Sharma, S. Bhattacharya, A. Garg, S. Devotta, and K. Sen. 2004. *Climate Change and India*. Universities Press, India.
- Philander, S.G. 2012. *Encyclopedia of Global Warming and Climate Change*. 2nd ed. Sage Publications.

Environmental Pollution and Engineering

1. Abbasi, S.A. 1998. *Environmental Pollution and its Control*. Cogent International, Pondicherry.
2. Abbasi, S.A., and E.V. Ramasamy. 1999. *Biotechnological Methods of Pollution Control*. Universities Press (India) Limited, Hyderabad.
3. Peavy, H.S., D.R. Rowe, and G. Tchobanoglous. 1985. *Environmental Engineering*. McGraw Hill Book Company, Singapore.
4. Rand, M.C., A.E. Greenberg, and M.J. Taras, eds. 1995. *Standard Methods for the Examination of Water and Wastewater: 19th edition*. American Public Health Association (APHA), Washington, D.C.
5. Scragg, A. 1999. *Environmental Biotechnology*. Addison Wesley Longman, Singapore.
6. Tchobanoglous, G. 1988. *Wastewater Engineering: Treatment, Disposal, Reuse*. Tata McGraw Hill, New Delhi.
7. Aarve, V.P., W.A. William, and D.R. Debra. 2002. *Solid Waste Engineering*. Cengage Learning, USA.
8. George, T., H. Hilary, and A.V. Samuel. 1993. *Integrated Solid Waste Management: Engineering Principles and Management Issues*. McGraw Hill.
9. George, T., and F. Frank. 2002. *Handbook of Solid Waste Management*. 2nd ed. McGraw Hill.

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10. Kanthi, L.S. 2000. *Basics of Solids and Hazardous Waste Management Technologies*. Prentice Hall

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B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology

Suggested Continuous Evaluation Methods:

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Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:

<https://community.plantae.org/tags/mooc>

futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science

<https://www.coursera.org/courses?query=plants>

<http://egyankosh.ac.in/handle/123456789/53530>

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: VI Paper-III
Subject: Botany			
Course Code: B040603P		Course Title: Lab on Cytogenetics, Conservation & Environment management	
Course outcomes: After the completion of the course the students will be able:			
1. To perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.			
2. Can be employed in environment impact assessment companies & start his own venture			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic		No. of Lectures(60hrs)
1.	Cell biology 1. Study of plant cell structure with the help of epidermal peal mount of Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.		8
II	Genetics 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: I c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy , emasculation experiment		7
III	Plant Breeding & Biostatistics: 1.Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. Computer application in biostatistics - MS Excel and SPSS		15
	Nanotechnology		

IV	1. Synthesis of metal nanoparticles using plant extracts and characterization. 2. Synthesis and characterization of polymeric nanoparticles for drug delivery. 3. Synthesis and characterization of lipid based nanoparticles for drug delivery. Determination of antimicrobial properties of silver nanoparticles .	15
V	Ecology & Ecosystem 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (<i>Cuscuta</i>), Root parasite (<i>Orobanchae</i>) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. Field visit to familiarize students with ecology of different sites	15
VI	Phytogeography: 1. Marking of vegetation types of India, World & Uttar Pradesh on maps 2. Phytogeographical areas of India 3. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 4. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 5. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 6. Soil Profile study, Soil types of India-Map	15
VII	Biodiversity, Conservation and Sustainable Development 1. Study of plant community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density, abundance and IVI of components species (to be done during excursion/field visit exercise). 2. Green auditing of the College Campus- Demo Conducting Waste audit of your institution.	15
VIII	Pollution & Waste management 1. Study of instruments used to measure Microclimatic Variables: Soil Thermometer, Anemometer, Psychrometer/Hygrometer, Rain Gauge and Lux Meter 2. Estimation of Chloride and Dissolved Oxygen Content in water sample 3. Comparative Anatomical Studies of leaves from polluted and less polluted areas. 4. Measurement of Dissolved Oxygen by Azide Modification of Winkler's Method.	

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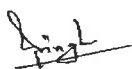
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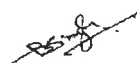
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	5. Determination of Dissolved Oxygen of water samples from polluted and unpolluted sources. 6. Microbiological Assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water Making Compost/Vermicompost from kitchen waste by Enzymes/ Bio decomposer/ Whey with Dung.	15
Suggested Readings: 1. Gupta, P.K. 2017. <i>A Handbook of Soil, Fertilizer and Manure</i>. 2nd ed. Jodhpur: Agrobios (India). 2. Purohit, S.S. 2021. <i>Green Technology: An Approach for Sustainable Environment</i>. Jodhpur Agrobios (India). 3. Theroux, F.R., E.F. Eldridge, and W.L. Mallmann. 2011. <i>Laboratory Manual of Chemical and Bacterial Analysis of Water and Sewage</i>. Jodhpur: Agrobios (India). 4. Gupta, P.K. 2021. <i>Methods in Environmental Analysis: Water, Soil and Air</i>. 2nd ed. Jodhpur: Agrobios (India). 5. Ryan, W.J. 2009. <i>Water Treatment and Purification Technology</i>. Jodhpur: Agrobios (India).		
This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:		
Internal Assessment	Marks	
Class Interaction	5	
Quiz	5	
Seminar	7	
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8	
	25	
Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required		
Facilities: Smart and Interactive Class		
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts		
Lab requisites: Biotech instruments, environmental lab instruments.		
Suggested equivalent online courses: https://www.cytology-iac.org/educational-resources/virtual-slide-library https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx https://www.mooc-list.com/tags/genetics https://www.coursera.org/learn/genetics-evolution https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/		

Detailed Syllabus for UG degree (Honours)
Or
UG degree (Honours with Research)
Or
B.Sc. Fourth Year


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Faculty of Science And Technology
Jyoti Vasini University, Miraj







Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-I
Subject: Botany		
Course Code: B040701T	Course Title: Plant Pathology and Applied Microbiology	
Course Outcome: After the completion of the course the students will be able to: 1. Understand the impact and significance of microbes in maintaining a healthy ecosystem 2. Gain knowledge about microbial formulations used as biopesticides or biofertilizers 3. Learn about the host –pathogen interaction and disease management 4. Gain knowledge about uses of microbes for plant growth promotion and as biocontrol agents 5. Learn about the methods for detection of plant pathogens		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Microbial symbioses and their significance, Plant microbiome and plant health (PGPR and defense priming), Biofertilizers, Microbes in bioremediation	8
II	Microbial fermentations, Role of microbes in production of antibiotics & vaccines	7
III	Impact of crop diseases on global food security, Stages in the development of disease in plants, Bacterial secretion systems, effectors and pathogenesis,	8

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IV	Plant immunity, Biochemistry of host-virus interaction (Hypersensitive response), systematic acquired resistance (SAR), Engineering pathogen resistance in plants	7
V	Purification of plant viruses, Serological and molecular methods for detection and identification of plant viruses and bacteria Modern methods of plant virus control (cross protection, PDR, RNAi, CRISPR-Cas system)	8
VI	Viral and Bacterial diseases: Symptoms, Causal organism, Disease cycle and Control measures of - Mosaic diseases on Tobacco, Yellow vein mosaic of bhindi, Tomato leaf curl, Citrus canker, Soft rot of fruits and vegetables, Scab of potato, Little leaf of brinjal	7
VII	Symptoms, Causal organism, Disease cycle and Control measures of – Damping off of seedlings, White rust of Crucifers, Late blight of Potato, Loose smut of wheat, Black stem rust of wheat, Early blight of potato, Red rot of sugarcane, Wilt of arhar.	8
VIII	Mycorrhizal fungi and their significance, Molecular identification of fungal species, Biological control and IPM, and biopesticides	7

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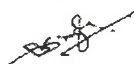
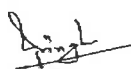
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Suggested Books:

1. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
4. Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
5. Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
6. Rangaswamy, G. 2009, Disease of Crop Plants in India, Prentice Hall of India, New Delhi.
7. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
8. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
9. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.



10. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
11. Sundar Rajan. S. 2010. College Botany Volume I, Himalaya Publications, Mumbai.
12. Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

Suggested Reading:

1. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
2. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
3. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
4. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
5. Madhavi Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi
6. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
7. Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
8. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN: 9780470673898.
9. Trigiano Robert N. 2007. Plant Pathology Concepts and Laboratory Exercises. 2 nd Edition, CRC Press. U.K.

Internet:

<https://www.edx.org/learn/microbiology>

<https://www.mooc-list.com/tags/microbiology>

<https://www.udemy.com/topic/microbiology/>

<https://ucmp.berkeley.edu/bacteria/bacteria.html>

<https://www.livescience.com/53272-what-is-a-virus.html>

<https://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdf>

<https://www.slideshare.net/sardar1109/algae-notes-1>

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<https://www.onlinebiologynotes.com/algae-general-characteristics-classification/>
<https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus>
<https://ucmp.berkeley.edu/fungi/fungi.html>
<https://agrimoon.com/wp-content/uploads/Mushroom-culture.pdf>
<http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293>
<http://www.hillagric.ac.in/edu/coa/ppath/lect/pipath111/Lect.%201%20%20Introduction->
http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf
<https://www.apsnet.org/edcenter/disimpactnngmmt/topc/EpidemiologyTemporal/Pages/ManagementStra>

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-II
Subject: Botany		
Course Code: B040702T	Course Title: ENVIRONMENTAL AWARENESS AND SOCIAL ETHICS	
Course Outcome: After the completion of the course the students will be able to: 1. Understand the relationship of humans and environment and their moral obligation to protect the environment 2. Promote sustainable development of the planet 3. Generate environment consciousness in themselves and the community		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Pollution and Waste management: Types, causes, and effects of pollution. Environmental protection laws, Regulatory framework for pollution monitoring and control. Major pollutants and their impact.	8

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II	Air Quality Index (AQI) and water quality parameters, Waste management strategies and technologies. Bioremediation, Sewage disposal mechanism.	7
III	Types of waste & Circular Economy: Types of waste: solid, liquid, hazardous, e-waste, biomedical collection and disposal, Recycling of solid wastes (hazardous & non-hazardous), collection and segregation, Methods of waste management- sanitary landfill, composting, incineration, pyrolysis,	8
IV	Biogas production, Circular Economy & sustainability. Case studies (e.g., urban smog, river pollution), Ganga Action Plan; Yamuna Action Plan; implementation of CNG.	7
V	Environmental Audit- scope, and significance, Environmental Audit Process (Stages: Pre-audit, on-site audit, post-audit, Checklists, interviews, site inspections, Reporting and follow-up actions), Campus green audit (energy, water, biodiversity, waste).	8
VI	Sustainability: Principles of sustainable development, Sustainable resource management; Environmental Management Systems (EMS): ISO 14001 standard. Indicators and Metrics of Sustainability: Ecological footprint, carbon footprint. India's environment action programme, Policy and Community Engagement.	7
VII	Environmental ethics & Carbon Credits: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways.	8

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VIII	Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.	7
Suggested Reading: 1. Purohit, S. S. 2021. <i>Green Technology: An Approach for Sustainable Environment</i>. 1st ed. Jodhpur: Agrobios (India). 2. Gillespie, A. 2006. <i>Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations</i>. Leiden: Martinus Nijhoff Publishers. Internet: http://vidyamitra.inflibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany http://heecontent.upsdc.gov.in/Home.aspx (http://epathshala.nic.in/ http://epathshala.gov.in/http://heecontent.upsdc.gov.in/Home.aspx		

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-III
Subject: Botany		
Course Code: B040703T	Course Title: Plant Tissue Culture & Genetic Engineering	
Course Outcome: After the completion of the course the students will be able to: • Understand the principles and applications of plant tissue culture. • Gain foundational knowledge of genetic engineering techniques in plants. • Develop practical skills in tissue culture and molecular biology.		
Credits: 4	Core Compulsory	

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Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Plant Tissue Culture: Historical Development, Principles, components and techniques of <i>in vitro</i> plant cultures. Cellular totipotency, Differentiation, and Morphogenesis. Components and preparation of Murashige and Skoog (MS) medium. Role of plant growth regulators in plant tissue culture.	15
II	Sterilization Techniques for plant materials, culture media, culture vessels and tools. Types of explants, Callus and Suspension Cultures, Stages of Micropropagation, Direct and Indirect Organogenesis.	
III	Somaclonal Variation: causes of somaclonal variation and Applications in plant breeding and crop improvement; Meristem Culture for Virus-Free Plants. Production of Haploids; Somatic Embryogenesis and Synthetic Seed Production.	8
IV	Methods of protoplast isolation, Somatic Hybridization and Cybrid Production. Cryopreservation and Germplasm Conservation. Secondary Metabolite Production.	7
V	Isolation of genomic and plasmid DNA, Cloning vectors (plasmids, cosmids, bacteriophages, YAC, BAC), Restriction digestion and ligation, Transformation, Selection of recombinants. Gene libraries, Recombinant vaccines, Recombinant interferon.	8
VI	Polymerase Chain Reaction (PCR & RT-PCR). Gene silencing and RNA interference, CRISPR-Cas9 and genome editing.	7

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VII	Genetic Transformation: Gene Transfer Methods in Plants: <i>Agrobacterium</i> -mediated transformation, Electroporation, Microinjection and biolistic methods. Selectable marker and reporter genes.	8
VIII	Transgenic Plants: Development of genetically modified crops-Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean), Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice), Improved horticultural varieties (Moondust carnations). Role of transgenics in bioremediation. Biosafety regulations and ethical considerations.	7

REFERENCES

Books:

1. Razdan, M.K. (2003). *Introduction to Plant Tissue Culture*. Science Publishers.
2. Bhojwani, S.S., & Razdan, M.K. (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science.
3. Ramawat, K.G. (2008). *Plant Biotechnology*. S. Chand & Co Ltd.
4. Smith, R.H. (2012). *Plant Tissue Culture: Techniques and Experiments* (3rd ed.). Academic Press.
5. Dubey, R.C., 2005 A Textbook of Biotechnology S.Chand & Co, New Delhi.
6. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
7. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi
8. Senger, Gupta and Sharma. 2010. Laboratory manual on Biotechnology. WH Publishers. UK.
9. Singh, B.D. 2008. Biotechnology. Narosa Publishing. New Delhi.
10. A. J. Nair . Basics of Biotechnology- Laxmi Publications, New Delhi.
11. S S Purohit and S K Mathur; Biotechnology-Fundamentals and Application- Agrobotanica, India.
12. A. J. Nair Introduction to Genetic Engineering & Biotechnology. Jones & Bartlett Publishers, Boston,USA.
13. H S Chawla Introduction to Plant Biotechnology-; Oxford & IBH publishing Co.Pvt.Ltd., New

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Delhi.

14. H D Kumar Modern concept of Biotechnology, Vikas Publishing House, Pvt. Ltd., New Delhi.

Suggested Readings:

15. Primrose and Twyman, 2009. Principles of Gene manipulation and Genomics, WileyBlackwell Publishing. UK.
16. Brown T.A. 2007. Genomes 3. Garland Science Publication. USA.
17. Brown T.A. 2011. Gene Cloning and DNA Analysis. Taylor and Francis. UK.
18. Campbell. 2006. Discovering Genomics, Proteomics and Bioinformatics. Pearson Education. USA.
19. Jonathan, P. 2009. Bioinformatics and Functional Genomics. Wiley Blackwell. UK
20. Slater, A., Scott, N.W., & Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants* (2nd ed.). Oxford University Press.

Internet:

<https://www.springer.com/gp/book/9789811391767>

<https://www.springer.com/gp/book/9789811550720>

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Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-IV
Subject: Botany		
Course Code: B040704P	Course Title: Application and Techniques in Microbial And Plant Sciences	
Course Outcome: After the completion of the course the students will be able to: ● Isolate and study plant pathogens in order to correctly identify them ● Learn to devise methods of controlling plant pathogens based on the nature of propagules and mode of transmission ● Practice biological control of pests instead of depending on harmful chemical pesticides ● Learn to mitigate the use of chemical fertilizers, and increase the use of biofertilizer ● Understand techniques that are useful in the study of plant pathogens and biomolecules ● Learn about the host responses to stress, and its quantification		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4		
Unit	Topic	No. of Lectures (60 hrs)
I	Experimental Plant Pathology: ● Study of fermentative diversity of bacteria. ● Isolation and characterization of soil bacteria. ● Morphology and staining of nitrogen fixing bacteria. ● Enumeration of rhizosphere to non rhizosphere population of bacteria. ● Isolation of antagonistic bacterial sp. from the rhizosphere. ● Isolation of Phosphate solubilizing microorganisms. ● Microscopic observations of root colonization by VAM fungi. ● Isolation of phyllosphere microflora.	15

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II	Applied Microbiology: • Study of diseased plant specimens and materials • Preparation of media for isolation of the pathogen: bacteria (NA) and fungi (PDA). • Isolation of pathogens from infected material • Study of the hypersensitive response during virus infection • Insect transmission of plant virus • Purification of plant virus • Serological detection of plant viruses	15
III	Plant Tissue Culture & Genetic Engineering • Preparation of MS medium. • Surface-sterilization of explants, inoculate on MS medium with	15
	2,4-D, observe callus formation over 2–3 weeks. • Excise nodal segments, culture on MS + BAP (and a low auxin), subculture every 3 weeks; count shoots per explant. • Transfer microshoots to half-strength MS with IBA, once roots form (~2 weeks), harden plantlets in greenhouse pots. • Synthetic (Alginate) Seed Production: Encapsulate somatic embryos or microshoots for “synthetic seeds. Mix explants with sodium alginate + CaCl₂ drop-wise, form beads, store briefly and germinate aseptically. • Enzymatic Protoplast isolation • Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by Electroporation, Microinjection, Microprojectile Bombardment. • Study of steps of Genetic Engineering for production of Bt cotton, Golden Rice, FlavrSavr Tomato through photographs.	

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IV	Techniques and Instrumentation: • Chromatographic procedures (gel filtration) for separation of low molecular and high molecular weight leaf extract components. • Thin layer chromatography for detection of amino acids • Isolation of proteins from leaf sap through precipitation and centrifugation. • Separation of proteins by electrophoresis.	15
REFERENCES Books: 1. Matthews Plant Virology, R. Hull, 4th edition, 2003, Elsevier. 2. Prescott's Microbiology, J. Willey, L. Sherwood, 10th edition, 2017, McGraw-Hill Education. 3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 4. Edited by A. Hofmann, S. Clokie, 8th edition, 2018, Cambridge University Press. 5. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier. 6. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and		

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7. Bartlett Learning.
8. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016,
9. Pearson India Education Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press.
10. Text Book of Mycology by A.K. Sarbhoy; ICAR Publications, New Delhi, 2006.

Suggested Reading:

1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. Madhavi Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi
5. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
6. Gokare A. Ravishankar , Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
7. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898.
8. Trigiano Robert N. 2007. Plant Pathology Concepts and Laboratory Exercises. 2 nd Edition, CRC Press. U.K.

Internet:

<https://www.edx.org/learn/microbiology>
<https://www.mooc-list.com/tags/microbiology>
<https://www.udemy.com/topic/microbiology/>
<https://ucmp.berkeley.edu/bacteria/bacteria.html>
<https://www.livescience.com/53272-what-is-a-virus.html>
<https://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdf>
<https://www.slideshare.net/sardar1109/algae-notes-1>
<https://www.onlinebiologynotes.com/algae-general-characteristics-classification/>

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<https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus> <https://ucmp.berkeley.edu/fungi/fungi.html>
<https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>
<http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293>
<http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction->
http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf
<https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementSt ra>

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-V
Subject: Botany		
Course Code: B040705T(a)	Course Title: PLANT RESOURCE UTILIZATION	
Course Outcome: After the completion of the course the students will be able to: 1. Gain knowledge about the introduction, cultivation and domestication of crops. 2. Get an insight into the cultivation practices of some major crops. 3. Learn about the commercial products obtained from plants 4. Gather information on methods of conserving plant diversity		
Credits: 4	Core Elective	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)

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I	Centres of diversity of plants, origin of crop plants, domestication and introduction of crop plants. Cultivation, production and uses of - wheat, rice, maize and legumes	15
II	Plants yielding fatty/essential oils, spices, beverages (tea, coffee, cocoa), fiber (cotton, coconut, jute, flax), medicinal and petro plants.	15
III	Timber yielding plants (teak, sheesham, mango, deodar, sal), gums and resins (<i>Acacia</i> , <i>Commiphora</i> , <i>Pinus</i>), dye yielding plants (<i>Carthamus</i> , <i>Indigofera</i> , <i>Rubia</i> , <i>Haematoxylum</i>)	15
IV	Conservation of plant resources for agriculture and forestry. <i>In situ</i> conservation: sanctuaries, national parks, biosphere reserves, wetlands, mangroves. <i>Ex situ</i> conservation: field gene banks, seed banks, cryobanks.	15

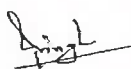
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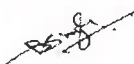
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2. Daniel, WW., Cross, CL., 2014, Biostatistics: Basic Concepts and Methodology for the Health Sciences, Wiley Student Edition.
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6. Trivedi, PC., Sharma, N., 2010, Plant Resource Utilization and Conservation, Pointer Publishers,

Suggested Readings:

1. Chandel K. P. S. Shukla G. and Sharma Neelam. 1996. Biodiversity in Medicinal and Aromatic Plants in India – Conservation and Utilization, Indian Bureau of Plant Genetic Resources, New Delhi,
2. Kaufman Peter B. et al. 1999. Natural Products from Plants, CRC Press. UK.
3. Primack R.B. 2000. A Primer of Conservation Biology, Sinauer Assoc. Publ., Massachusetts. USA.
4. Sahoo S. 2002. Plant Resource Utilization. Allied Publishers. Nagpur.









5. Singh J.S. Singh S.P. and Gupta S.R., 2006, Ecology, Environment and Resource Conservation
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<http://nsdl.niscair.res.in/bitstream/123456789/127/1/Fibre%20crops%2C%20bamboo%2C%20timber%20-%20Final.pdf> <https://www2.palomar.edu/users/warmstrong/econpls.htm>

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VII Paper-V
Subject: Botany		
Course Code: B040705T(b)	Course Title: Plant Systematics	
Course Outcome: After the completion of the course the students will be able to: 1. Learn how plant specimens are collected, documented, and curated for a permanent record 2. Observe, record, and employ plant morphological variation and the accompanying descriptive terminology 3. Gain experience with the various tools and means available to identify plants and trace their phylogeny		

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4. Develop observational skills and field experience 5. Identify a taxonomically diverse array of native plants 6. Recognize common and major plant families 7. Comprehend the concepts of plant taxonomy and classification of Angiosperms according to modern approaches		
Credits: 4		Core Elective
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Principles, Relevance and role of Systematics, Binomial nomenclature, Comparative study of different classification systems along with merits and demerits viz. Bentham and Hooker, Engler and Prantl, Hutchinson, Cronquist, Takhtajan & APG system. Origin and Evolution of Angiosperms. Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups). Pleomorphism and apomorphy.	15
II	Herbarium & Botanical Gardens. ICN (History, Principles and Applications), Protologue and Botanic literature (Monographs, Icons, Floras and Taxonomic literature). Species Concept: Various models, Speciation and Variation. Phytogeography with special reference to discontinuous areas, endemism, hotspots and hottest hotspots, GIS and Phylocode.	15
III	Interesting taxonomic features and interrelationships of following	15

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	Dicot families: Ranunculaceae, Nymphaeaceae, Nelumbonaceae, Malvaceae, Bombacaceae, Rutaceae, Leguminosae (Fabaceae), Rosaceae, Myrtaceae, Cucurbitaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae & Asclepiadaceae.	
IV	Interesting taxonomic features and inter-relationships of following Monocot families: Alismataceae, Arecaceae, Commelinaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae and Zingiberaceae. Special features of Insectivorous/Parasitic and Saprophytic families. Modern tools and evidence of taxonomy viz: Role of Plant Morphology, Anatomy, Embryology and Palynology in plant taxonomy, Cytotaxonomy, Chemotaxonomy, Numerical taxonomy.	15

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2. Eames, A. J. 1961. *Morphology of Angiosperms*. New York: McGraw Hill.
3. Naik, V. N. 1984. *Taxonomy of Angiosperms*. New Delhi: Tata McGraw-Hill Publishing Company.
4. Pandey, B. P. 2007. *Taxonomy of Angiosperms*. New Delhi: S. Chand and Company Limited.
5. Harborne, J. B., B. L. Turner, and D. Boulter. 1971. *Chemotaxonomy of Leguminosae*. London: Academic Press.
6. Duthie, John Firminger. 1903–1911. *Flora of Upper Gangetic Plants*. Vol. I (1903), Vol. II (1911). Dehradun: Shiva Offset Press.
7. Hutchinson, John. 1959. *The Families of Flowering Plants*. Oxford: Clarendon Press.
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9. Randall, Alfred Barton. 1904. *The Classification of Flowering Plants*. Cambridge, MA: Harvard University.
10. Singh, Gurcharan. 1999. *Plant Systematics*. New Delhi: Oxford & IBH Publishing Company Pvt. Ltd.
11. Stuessy, Tod F. 2002. *Plant Taxonomy*. Dehradun: Shiva Offset Press.
12. Sneath, Peter H. A., and Robert R. Sokal. 1973. *Numerical Taxonomy*. Detroit: Wayne State University Press.
13. Pullaiah, T. 1998. *Taxonomy of Angiosperms*. New Delhi: Regency Publications.

Suggested Readings:

1. Sharma, O. P. 2009. *Plant Taxonomy*. Mumbai: Tata McGraw-Hill.
2. Singh, Gurcharan. 2004. *Plant Systematics: Theory and Practice*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
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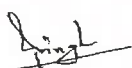
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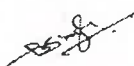
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***For those who opt B.Sc. Honors with Research**

Programme/Class: 4 Year UG degree (Honors with Research)	Year: V	Semester: VII Paper-V
Subject: Botany		
Course Code: : B040705R	Course Title: Research Project/ Dissertation/ Internship/ Field work	
Course Outcome After completion of the course <i>Research Project/ Dissertation/ Internship/ Field Work</i> , students will be able to conduct independent research, analyze and interpret data, apply theoretical knowledge in practical situations, develop problem-solving and communication skills, and prepare scientific reports or dissertation professionally.		
Credits: 04		
Research Project/Dissertation Research Project/ Dissertation/ Internship/ Field Work for Semester VII will be carried out by the students in various recognized/established labs/areas of Botanical interest of Parent/Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, Industry, Government Departments etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).		

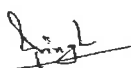






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Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VIII Paper-I
Subject: Botany		
Course Code: B040801T	Course Title: Research Methodology	
Course Outcome: The undergraduate students will develop a research orientation and become acquainted with the fundamentals of research methods. 1. Understand the basic concepts and techniques used in research viz. sampling techniques, research designs and techniques of analysis. 2. Develop understanding of the basic framework of research process. 3. Learn how to review literature and collect data 4. Develop an understanding of the ethical dimensions of conducting applied research. 5. Appreciate the components of scholarly writing and evaluate its quality.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Basic Concepts of Research: Objective and concept of research in biological sciences; Selecting and formulating a research problem. Research methods vs Research methodology; Types of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical	15



II	Research Design and Survey of Literature: Concept and need, Identification of Research problem, defining and delimiting Research problem. Basic principles of research design- objectives, introduction, rationale of work, material and methods, designing experiments. Necessity and importance of review of literature in defining a research problem; Primary and secondary sources of literature reviews, treatise, monographs, web as a source for searching literature. Identifying the gap areas from literature review.	15
III	Data Collection, Analysis and Scientific writing: Observation and collection of data. Data processing, analysis, interpretation and their applications. Format of writing research paper, popular scientific articles for general awareness, review and reports-layout, structure, language, illustrations and tables. Procedure of reference citation. Principles of biostatistics. Computer application: Operating systems, software.	15
IV	Application of Results and Ethics: Environmental impacts, Ethical issues, Ethical committees, Commercialization, Copy right; Royalty, Intellectual property rights and patent law; Trade related aspects of intellectual property rights. Reproduction of published material. Impact factor and citation index. Plagiarisms. Reference citation and acknowledgement. Reproducibility and accountability	15
REFERENCES: Books: 1. Chawla, Deepak, and Neena Sondhi. 2011. <i>Research Methodology: Concepts and Cases</i>. Delhi: Vikas Publishing House Pvt. Ltd. 2. Pawar, B. S. 2009. <i>Theory Building for Hypothesis Specification in Organizational Studies</i>. New Delhi: Response Books. 3. Kothari, C. R. n.d. <i>Research Methodology: Methods and Techniques</i>. New Delhi: New Age Publisher.		

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Suggested Reading:

1. Dawson, C. 2002. *Practical Research Methods*. New Delhi: UBS Publishers.
2. Stapleton, P., A. Yondeowei, J. Mukanyange, and H. Houten. 1995. *Scientific Writing for Agricultural Research Scientists: A Training Reference Manual*.
3. Neuman, W. L. 2008. *Social Research Methods: Qualitative and Quantitative Approaches*. Upper Saddle River, NJ: Pearson Education.
4. Best, John W., and James V. Kahn. *Research Methodology*. New Delhi: PHI Learning Pvt. Ltd.
5. Wilcox, Rand R. *Fundamentals of Modern Statistical Methods*. New York: Springer.
6. Kuehl, Robert O. *Design of Experiments: Statistical Principles of Research Design and Analysis*. Belmont, CA: Brooks/Cole.

Programme/Class: 4 Year UG degree (Honours)		Year: IV	Semester: VIII Paper-II
Subject: Botany			
Course Code: B040802T		Course Title: Biostatistics and Data Analysis	
Course Outcome: 1. Students will learn how to analyze both quantitative and qualitative data using appropriate statistical and qualitative analysis techniques. 2. Applying data preprocessing methods to remove redundancy and incomplete data. 3. Characterizing patterns discovered through association rule mining. 4. Developing data mining applications for analysis using various tools.			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week):4-0-0			
Unit	Topic	No. of Lectures (60 hrs)	
I	Processing Of Data Meaning and Classification of data , Primary vs secondary data. Tabulation, and Graphical Representation, Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Introduction to Statistical Software.	15	

II	Statistical Analysis Of Data Measures of Central Tendency, Measures of Dispersion, Measures of Association/Relationship, Probability distributions: Binomial, Poisson, Uniform, Normal and Exponential, Hypothesis Testing, Confidence Interval, Test of Significance, Comparison of Two Proportions, Comparison of Means (z test, t test, two sample t test, paired-t test), ANOVA, Nonparametric Methods. Computer application in statistics-MS-Excel & SPSS	20
III	Report Writing Types of Reports, Planning of Report Writing, Research Report Format, Principles of Writing, Documentation, Data and Data Analysis, Reporting in a Thesis, Writing of Report, Typing of Report.	10
IV	Web Search Introduction to internet, Use of internet and search engine like Google, Yahoo etc., Use of internet in Research activities, Submission of paper in Archive Electronic Mail System, working knowledge of Sodhganga, EBSCO host and other online journals.	15

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2. Gupta, S. P. 2014. *Statistical Methods*. 44th ed. New Delhi: Sultan Chand & Sons.
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4. Goon, A. M., M. K. Gupta, and B. Dasgupta. 2005. *Fundamentals of Statistics*. Vol. 1. Kolkata: World Press.
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6. Kumar, Ranjit. 2011. *Research Methodology: A Step-by-Step Guide for Beginners*. 3rd ed. New Delhi: Pearson Education India.
7. Field, Andy. 2013. *Discovering Statistics Using IBM SPSS Statistics*. 4th ed. London: Sage Publications.
8. Hair, Joseph F., William C. Black, Barry J. Babin, and Rolph E. Anderson. 2010. *Multivariate Data Analysis*. 7th ed. Upper Saddle River, NJ: Pearson Prentice Hall.
9. Pallant, Julie. 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. 7th ed. London: Routledge.
10. Tabachnick, Barbara G., and Linda S. Fidell. 2019. *Using Multivariate Statistics*. 7th ed.

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Boston: Pearson.

11. Wilcoxon, Rand R. 2010. *Fundamentals of Modern Statistical Methods: Substantially Improving Power and Accuracy*. 2nd ed. New York: Springer.

Suggested Readings:

1. Statistical Methods for Research Workers by Fisher R.A., Cosmo Publications, New Delhi.
2. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VIII Paper-III
Subject: Botany		
Course Code: B040803T	Course Title: Techniques And Instrumentation	
Course Outcome: After the completion of the course the students will be able to: • Introduce fundamental laboratory techniques and instrumentation used in plant science research. • Develop practical skills in microscopy, spectroscopy, chromatography, and molecular biology techniques.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)

I	Histological & Microscopy Techniques Sample preparation: fixation, dehydration, embedding. Sectioning methods: microtomy. Staining and mounting procedures.	15
	Microscopic Types: simple, compound, bright field, dark field, phase contrast, fluorescence, confocal, transmission electron microscopy, scanning electron microscopy. Microscopic measurements and imaging techniques.	
II	Microbiological and Immunological Techniques Sterilization methods and culture techniques. Media preparation and microbial cultivation. Staining methods: simple and differential. Immunoassays: ELISA, Radioimmunoassay, Agglutination tests.	15
III	Chromatography, Spectroscopy & Radioisotopic Techniques Principles and applications of Chromatographic Techniques -Paper chromatography, TLC, GC Flow Cytometry, HPLC. Principles and applications of Colorimetry and Spectroscopic techniques- Ultraviolet-Visible, Chlorophyll Fluorescence, Raman , NMR & MALDI-ToF-MS. Nature of radioactivity, types of decay, units of radioactivity. Applications in plant research and safety protocols.	15






IV	1. Molecular Biology Techniques 2. DNA/RNA isolation and purification. 3. Centrifugation: differential, density gradient, ultracentrifugation. 4. Gel electrophoresis: agarose and SDS-PAGE. 5. Detection of Proteins and Nucleic Acids (Western Transfers , Immuno blots and Southern blot) 6. DNA chip technology and Microarray 7. PCR and its applications.	15
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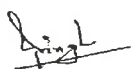
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4. Roe, Simon, ed. 2001. *Protein Purification Techniques: A Practical Approach*. 2nd ed. Oxford University Press.
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6. Hegyi, G. et al. 2013. *Introduction to Practical Biochemistry*. ELTE Faculty of Natural Sciences.
7. Spector, D. L., and R. D. Goldman. 2006. *Basic Methods in Microscopy*. Cold Spring Harbor Laboratory Press.
8. Cazes, J., ed. 2009. *Encyclopedia of Chromatography*. 3rd ed. Taylor & Francis.
9. Ruzin, S. E. 1999. *Plant Microtechnique and Microscopy*. Oxford University Press.
10. Wilson, K., and J. Walker. 2000. *Principles and Techniques of Practical Biochemistry*. 5th ed. Cambridge University Press.
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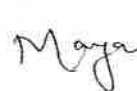
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Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: V III Paper-IV Practical
Subject: Botany		
Course Code: B040804P	Course Title: Applied research methods, statistical analysis and Instrumentation	
Course Outcome: After practical experience the students will be able to • Apply appropriate research methodologies to design, conduct, and evaluate scientific investigations in applied disciplines. • Perform statistical data analysis using tools such as SPSS or Excel to interpret and validate experimental results. • Operate and calibrate essential laboratory instruments (e.g., spectrophotometers, chromatographs) and interpret their outputs effectively. • Develop accurate scientific reports and presentations by integrating research findings, statistical insights, and instrumentation data.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4		
Unit	Topic	No. of Lectures (60 hrs)

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I	Bioinformatics Exercises 1. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy 2. Database search engines: EntrezDBGET 3. Open access bibliographic resources and literature databases a. PubMed b. BioMed Central c. Public Library of Sciences (PloS) d. CiteXplore. 4. Bioinformatics Resources at the species level a. ICTV Database b. AVIS c. Viral genomes at NCBI 5. Sequence databases: a. Nucleic acid sequence databases: GenBank, EMBL, DDBJ; b. Protein sequence databases:	15
	Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; c. Repositories for high throughput genomic sequences: EST, STS, GSS. d. Genome Databases at NCBI, EBI, TIGR, SANGER 6. Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP, DSSP 7. Derived Databases: InterPro, Prosite, Pfam, ProDom 8. Sequence file formats: GenBank, FASTA 9. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, EMBOSS	
II	Genetic Engineering 1. Construction of restriction map of circular and linear DNA from the data provided. 2. Isolation of plasmid DNA. 3. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 4. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	15

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I	Bioinformatics Exercises 1. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy 2. Database search engines: EntrezDBGET 3. Open access bibliographic resources and literature databases a. PubMed b. BioMed Central c. Public Library of Sciences (PloS) d. CiteXplore. 4. Bioinformatics Resources at the species level a. ICTV Database b. AVIS c. Viral genomes at NCBI 5. Sequence databases: a. Nucleic acid sequence databases: GenBank, EMBL, DDBJ; b. Protein sequence databases:	15
	Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; c. Repositories for high throughput genomic sequences: EST, STS, GSS. d. Genome Databases at NCBI, EBI, TIGR, SANGER 6. Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP, DSSP 7. Derived Databases: InterPro, Prosite, Pfam, ProDom 8. Sequence file formats: GenBank, FASTA 9. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, EMBOSS	
II	Genetic Engineering 1. Construction of restriction map of circular and linear DNA from the data provided. 2. Isolation of plasmid DNA. 3. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 4. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	15

III	Biostatistics: 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 4. Computer application in biostatistics - MS Excel and SPSS	15
IV	Biodiversity 1. Study of plant community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density, abundance and Importance Value Index (IVI) of species (to be done during excursion/field visit exercise). 2. Marking of vegetation types of Uttar Pradesh, India & World on map.	15

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2. Kumar, Ranjit. 2011. *Research Methodology: A Step-by-Step Guide for Beginners*. New Delhi: Pearson Education India.

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1. Attwood, Teresa K., and David J. Parry-Smith. 1999. *Introduction to Bioinformatics*. New Delhi: Pearson Education.
2. Baxevanis, Andreas D., and B. F. Francis Ouellette. 2009. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. New Delhi: Wiley India Pvt. Ltd.
3. Mount, David W. 2004. *Bioinformatics: Sequence and Genome Analysis*. 2nd ed. New York: Cold Spring Harbor Laboratory Press.

Programme/Class: 4 Year UG degree (Honours)	Year: IV	Semester: VIII Paper-V
Subject: Botany		
Course Code: B040805Ta	Course Title: : Computer Application in Biological Sciences	
Course Outcome: After the completion of the course the students will be able to: 1. Learn fundamentals of computer application and Bioinformatics 2. Learn about biological databases and their use 3. Learn about phylogenetic analysis and its importance		

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Credits: 4		Core Elective
Max. Marks: 25+75		Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	Computer fundamentals: MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps, programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, and computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	15
II	Biological databases : Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)	15
III	Data Generation and Data Retrieval : Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez).	15
IV	Phylogenetic analysis : Introductory concepts of -Similarity, identity and homology, Alignment – local and global alignment, pairwise	15

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	and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.	
REFERENCES Books: 1. Ghosh, Zhumur, and Bibekanand Mallick. 2012. <i>Bioinformatics: Principles and Applications</i>. New Delhi: Oxford University Press. 2. Rastogi, S. C., Namita Mendiratta, and Parag Rastogi. 2011. <i>Bioinformatics: Concepts, Skills & Applications</i>. New Delhi: CBS Publishers & Distributors Pvt. Ltd. 3. Baxevanis, Andreas D., and B. F. Francis Ouellette. 2009. <i>Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins</i>. New Delhi: Wiley India Pvt. Ltd. 4. Xiong, Jin. 2006. <i>Essential Bioinformatics</i>. New York: Cambridge University Press. Suggested Reading: 1. Mount, David W. 2004. <i>Bioinformatics: Sequence and Genome Analysis</i>. 2nd ed. New York: Cold Spring Harbor Laboratory Press. 2. Attwood, Teresa K., and David J. Parry-Smith. 1999. <i>Introduction to Bioinformatics</i>. New Delhi: Pearson Education. Internet: https://www.springer.com/gp/book/9789811391767 https://www.springer.com/gp/book/9789811550720		

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Programme/Class: 4 Year UG degree (Honours)		Year: IV	Semester: VIII
		Paper-V	
Subject: Botany			
Course Code: B040805Tb		Course Title: Sustainable Biodiversity	
Course Outcome: After the completion of the course the students will be able to: 1. Get an overview of the significance of plant diversity, and an insight into global strategies for developing workable models for its exploration and conservation 2. Develop an understanding of the importance of national parks, biosphere reserves and sanctuaries 3. Understand the role played by government and non-government organizations in conserving biodiversity			
Credits: 4		Core Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-4			
Unit	Topic	No. of Lectures (60 hrs)	
I	Plant diversity concepts, importance of Species diversity in Ecosystems, Ecosystem functions and services. · Levels of Biodiversity - Ecosystem diversity, Species diversity and its measure, Species - richness, evenness, abundance and genetic diversity. · Abiotic and biotic factors affecting biodiversity, causes of biodiversity loss (viz. ecosystem, degradation, land-use change, fragmentation, invasive species, climate change, pollution, overexploitation and co-extinctions).	15	

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II	Need for biodiversity conservation, Types of conservation (preventive, remedial and restoration). · Current status of biodiversity conservation and Red list index. · Conservation status by IUCN red list categorized criteria (DD, LC, NT, VU, EN, CR, EW and EX). · Community based conservation strategies, Indigenous and traditional knowledge in biodiversity.	15
III	In situ conservation - Protected areas and its types, Biosphere reserves, National parks, Wildlife sanctuaries and Sacred groves. · Ex situ conservation- Botanical gardens, Seed banks. · In-vitro storage of germplasm and cryopreservation. · Concept of diversity hot spots, Biodiversity hotspots in India.	15
IV	International and National conservation policies. · Role of government agencies and NGOs in plant conservation. · General account of important authorities and institutions - UNEP, DST, MoEF, BSI, NBPGR, CPCB, NMPB, AYUSH.	15
Suggested Readings: 1. Dutta, Bijan Bihari. <i>A Handbook of Plant Resource Utilization and Conservation</i>. [Place of publication not provided]: [Publisher not provided]. 2. Hawksworth, David L., and Alan T. Bull, editors. [Year not provided]. <i>Plant Conservation and Biodiversity</i>. [Place of publication not provided]: Springer. 3. Hosetti, B. B., and S. Ramkrishna. <i>Biodiversity: Concepts and Conservation</i>. Jaipur: Aavishkar Publishers and Distributors. 4. Sharma, Dushyant Kumar. <i>Biological Diversity and Its Conservation</i>. [Place of publication not provided]: Daya Publishing House.		

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***For those who opt B.Sc. Honors with research**

Programme/Class: 4 Year UG degree (Honours with Research)	Year: IV	Semester: VIII Paper-V
Subject: Botany		
Course Code: B040805R	Course Title: Major Research Project/Dissertation	
Course Outcome The Major Research Project/Dissertation is designed to ensure that the student is able to apply the knowledge gained in the previous semesters in specific areas of interest in a problem solving environment, gaining bench-experience, to serve as a springboard for a professional future.		
Credits: 04		
Research Project/Dissertation Research Project/Dissertation for Semester X will be carried out by the students in various recognized/established labs of Parent/Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, Industry, Government Departments etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).		


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