

DR. BHIM RAO AMBEDKAR UNIVERSITY AGRA



NATIONAL EDUCATION POLICY-2020 STRUCTURE AND SYLLABUS OF BOTANY

For

**Under Graduate (UG) Programme
Four Year Undergraduate Programme (FYUP)
Post Graduate (PG) Programme**

Effective From Academic Session 2025-26

DR. BHIM RAO AMBEDKAR UNIVERSITY, AGRA

BOARD OF STUDIES – BOTANY MINUTES OF MEETING

Meeting of Board of Studies of Botany was held on **24-03-2025**, at S. R. Rangnathan Central Library, Paliwal Park, Dr.B.R.Ambedkar University Agra, on the agenda: "Alignment of Botany Syllabus for Five Years of Higher Education with Four Year Undergraduate Programme (FYUP)". Following members attended the meeting –

S. No.	NAME	DESIGNATION	AFFILIATION
MEMBERS OF BOARD OF STUDIES			
1.	Dr. Arvind Yadav	Convener of BOS	Department of Botany, Shri Chitragupta P.G. College, Mainpuri
2.	Dr. Ajey Karan Chaudhari	Assistant Professor	Department of Botany, Paliwal P.G. College, Shikohabad
3.	Dr. Ramesh Chandra Dubey	Assistant Professor	Department of Botany, Paliwal P.G. College, Shikohabad
4.	Dr. Mridula Yadav	Assistant Professor	Department of Botany, N. D. College, Shikohabad
5.	Dr. Manoj S. Paul	Professor	Department of Botany, St. John's College, Agra
6.	Prof. Vashist Narayan Pandey	Professor	Department of Botany, Faculty of Science, DDU Gorakhpur University, Gorakhpur

All the above members recommended the following:

1. In the First Three Years of Higher Education, the currently running Common Minimum Syllabus of Botany for all U.P. State Universities and Colleges will remain applicable.
2. Indian Knowledge System (IKS), introduced in the first unit of theory paper (B040101T) of Semester I of First Year of Higher Education, has been amplified.
3. Research Project of Credit 3, in Semester V & VI of Third Year of Higher Education has been removed.
4. Research Project of Credit 3, in Semester IV of Second Year of Higher Education has been introduced.
5. In the Fourth & Fifth Year of Higher Education, the currently running M.Sc. Botany Syllabus will remain applicable with certain modifications in its Structure and Syllabus so as to align it with FYUP.
6. There will be no Continuous Internal Evaluation (CIE) in Practical Papers and Research Projects / Dissertations under FYUP.
7. **All the above amendments will be applicable only to the students admitted in the Academic Session 2025-26 in Semester I of First Year of Higher Education. All other students will complete their courses as per the previous rules.**
8. Papers related to the Syllabus of Botany, that can be opted through Swayam Portal were also discussed.



DEPARTMENT OF HIGHER EDUCATION U.P. GOVERNMENT, LUCKNOW

**Common Minimum Syllabus for all U.P. State Universities and Colleges
for the first three years of
Higher Education (UG)**



**PROPOSED STRUCTURE OF SYLLABUS
BOTANY
(*FACULTY OF SCIENCE*)**

UNDER GRADUATE PROGRAMME

(First Six Semesters)

Eligibility for Admission in B.Sc. First Year (First Semester):

A candidate who has passed 12th standard with Biology as one of the subjects from Madhyamic Shiksha Parishad, Uttar Pradesh or any Indian University duly incorporated by any law enforce for the time being or any other examination recognized by the university as equivalent there to shall be permitted to take admission in B.Sc. First Semester with Botany as one of his/her subjects.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of attendance register for candidates who have registered for the course. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not any circumstance be granted for attendance below 65%.

or

**Examination pattern as decided by
Examination Committee of the University**

or

Any other Regulatory Body

PAPER CODING AND CREDIT DISTRIBUTION B.Sc. (BOTANY)

	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
Certificate Course In Microbial Technology & Applied Botany					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4
		B040202P	Land Plants Architecture	Practical	2
Diploma in Plant Identification, Utilization & Ethnomedicine					
SECOND YEAR	III	B040301T	Flowering Plants Identification &Aesthetic Characteristics	Theory	4
		B040302P	Plant Identification technology	Practical	2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2
		B040403R	Research Project in Botany	Research	3
Bachelor of Science					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4
		B040502T	Molecular Biology & Bioinformatics	Theory	4
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		B040602T	Ecology & Environment	Theory	4
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2

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	
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 solutions, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system.
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 multi exit option is opted.
PO 6	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.
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

5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a 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 Programme 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.

people's participation in environmental conservation without compromising on academic rigor 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.
3. Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

Programme specific outcomes (PSOs):

B.Sc. III Year / Bachelor of Science

The learning outcomes of a three years graduation course are aligned with programme 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 a 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.
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 a 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 the laboratory such as observation and evaluation by the use of modern tools and technology.

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 the environment and the importance of conserving it. Hands-on training in various fields will develop practical skills, handling equipment 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.

- **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	15
Quiz & Seminar	12	Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models	15
		Table work / Experiments	50
Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training)	8	Practical Record File	20
TOTAL * Botanical Excursion/ Lab Visits/Industrial training Is compulsory	25		100

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

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 & 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, electron microscopy, Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Spectrophotometry, fermenters.	8
II	Microbial world Structure of prokaryotic and eukaryotic cells, Gram positive and Gram-negative bacteria, Bacterial Chemotaxis, Bacterial Growth curve, factors affecting growth of microbes; Reproduction and recombination in bacteria. Viruses, general characteristics, Structure of virus, Bacteriophage, T4 & λ-phage; Lytic and Lysogenic cycles, viroid, mycoplasma & phytoplasma.	8
III	Phycology Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – <i>Nostoc</i>, <i>Volvox</i>, <i>Hydrodictyon</i>, <i>Oedogonium</i>, <i>Chara</i>; <i>Sargassum</i>, <i>Polysiphonia</i>. Economic importance of algae.	7
IV	Mycology General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Myxomycota: General characters of Mastigomycotina, Zygomycota: <i>Rhizopus</i>, Ascomycota: <i>Saccharomyces</i>, <i>Penicillium</i>, Basidiomycotina: <i>Ustilago</i>, <i>Puccinia</i>, <i>Agaricus</i>; Deuteromycotina: <i>Fusarium</i>, Heterothallism, Heterokaryosis & Parasexuality.	7
V	Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation. General account of lichens, reproduction and significance; <i>Mycorrhiza</i> and their significance.	7
VI	Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection. Defense mechanism, Resistance, Systemic fungicides.	7
VII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late Blight of Potato, Black Stem Rust of Wheat, <i>Alternaria</i> and White rust of Crucifers, Red Rot of Sugarcane, Mosaic diseases on tobacco, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal, Integrated pest disease management.	8

VIII	Applied Microbiology Amino acids, Production of antibiotics, alcoholic beverages, biofertilizers, Biopesticides, Single cell proteins, Microbiology of water, Biopolymers, Bioindicators, biosensors, Bioremediation, Biofuels.	8
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Suggested Readings:

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

1. Microbiology Fundamental and Applications (hindi) (pb)
2. ISBN: 9788188826230 Edition: 03Year : 2016Author : Dr. Purohit SS , Dr. Deo Publisher : Student Edition
Language : Hindi
3. for Scientific and Technical Terminology.
4. Modern Microbiology (hindi) (hb) ISBN: 9788177543599 Edition : 1Year : 2018Author : Dr. Purohit SS ,
Dr. Singh T Publisher : Agrobios (India)
5. Suggested books “Plant pathology by R.S. Mehrotra, Tata McGraw-Hill Education” are included in reading resources list

Unit-I A:

- i. <https://indianculture.gov.in/rarebooks/economic-botany-india>
https://www.infinityfoundation.com/mandala/t_es/t_es_tiwari_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
vi Ancient Botany (Sciences of Antiquity) Paperback – 1 October 2015 by Gavin Hardy (Author), Laurence Totelin (Author)

vii. <https://www.plantsdiseases.com/p/symptoms.html>

viii. <https://www.plantsdiseases.com/p/pathogenic-diseases-in-plants.html>

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 1, 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, Prientice Hall of India, New Delhi.
23. Sambamurty. 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 and Seminar	12
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/ 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&sectionid=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/		
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: 100	Min. Passing Marks: 33	

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2		
Unit	Topic * (Minimum Any three from each unit depending on facilities)	No. of Lectures (60 hrs)
I.	INSTRUMENTS & TECHNIQUES - Laboratory safety and good laboratory practices - Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. - Buffer preparation & titration - Cleaning and Sterilization of glasswares - Preparation of media- Nutrient Agar and Broth - Inoculation and culturing of bacteria in Nutrient agar and nutrient broth - Preparation of agar slant, stab, agar plate - Phenol Coefficient method to test the efficacy of disinfectants	7
II	BACTERIAL IDENTIFICATION - Isolation of bacteria. - Identification of bacteria. - Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. - Cultural characteristics of bacteria on NA. - Pure culture techniques (Types of streaking). - 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: - Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. - 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>. <i>Agaricus</i>: Specimens of button stage and full grown mushroom; Sectioning of gills of <i>Agaricus</i>. - Lichens: crustose, foliose and fruticose specimens.	8
IV	PHYCOLOGY: 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 - Preparation of fungal media (PDA) & Sterilization process. - 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 - Isolation of nitrogen fixing bacteria from root nodules of legumes. - Enumeration of rhizosphere to non rhizosphere population of bacteria. - Isolation of antagonistic <i>Pseudomonas</i> from soil. - Microscopic observations of root colonization by VAM fungi. - Isolation of <i>Azospirillum</i> sp. from the roots of grasses. - Isolation of phyllosphere microflora. - Isolation of P solubilizing microorganisms.	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 - Wine production. - Isolation of lactic acid bacteria from curd. - Isolation of lipolytic organisms from butter or cheese. - Immobilized bacterial cells for production of hydrolytic enzymes. - Enzyme production and assay – cellulase, protease and amylase. - Immobilization of yeast. - Isolation of cellulolytic and anaerobic sulphate reducing bacteria. - Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.	8

VIII	1. Cultivation of Spirulina, & Chlorella in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/ IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures 4. Mushroom cultivation for Protein	6
	5. Alcohol production. from Sugarcane Juice.	

Suggested Readings:

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

- 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)
 - Modern Mushroom Cultivation And Recipes (hindi) (hb)ISBN : 9788177545180Edition : 01Year : 2017Author : Singh Riti , Singh UC Publisher : Agrobios (India)
 - Biofertilizer Production Manual (hindi) (hb) ISBN : 9788177541274Edition : 01Year : 2014Author : 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.
 5. Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
 6. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
 7. Sambamurty. A.V.S.S. 2006, A Textbook of Algae, I. K. International Publishing House, Pvt. Ltd.,
 8. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
 9. <https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>
 10. <http://nhb.gov.in/pdf/Cultivation.pdf>
 11. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
 12. Sen, Surjit, Acharya, Krishnendu, Rai, Manjula 2019 IBSN - 978-93-88347-23-5 - Biofertilizers and Biopesticides .Technoworld, Kolkata
 13. <http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf>
 14. <http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf>
 15. 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.

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/10883/3219/64331.pdf>

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

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

<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/>

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	Lectures (60 hours)
I	Introduction to Archegoniates & Bryophytes: Bryophytes: General characteristics, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <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, Fossilization & types of fossils, 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.	7
VI	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization. Secondary growth - Root and stem, Anomalous secondary growth - <i>Bignonia</i> , <i>Boerhaavia</i> , <i>Dracaena</i> , <i>Nyctanthes</i> .	7
VII	Reproductive Botany I: Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, Megasporeogenesis, Structure and types of female gametophyte.	8
VIII	Reproductive Botany II: Pollination and its types, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony. Palynology and its applications	7

Suggested Readings:**Course Books published in Hindi may be prescribed by the Universities.**

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-Verlag, 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. 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 and Seminar	12
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
Total	25

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: Certificate Course In Microbial Technology & Classical Botany		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: 100		Min. Passing Marks: 33	
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). <i>Sphagnum</i> - 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. stobilus V. S., <i>Selaginella</i> : Habit, rhizophore T. S, stem T. S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. <i>Equisetum</i> - Habit, rhizome and stem T.S. and V. S. of strobilus. <i>Azolla</i> – Habitat & its structure	7	
III	Gymnosperms 1. <i>Cycas</i> – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule. <i>Pinus</i> - 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. 2. <i>Ephedra</i> & <i>Thuja</i> : 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 <i>Rhynia</i> and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences 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 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>Boerhaavia diffusa</i> , <i>Nyctanthes</i> Study of primary and secondary growth in the 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</i> , <i>Vinca</i> , <i>Balsam</i> , <i>Ixora</i> , <i>Crotalaria</i> , <i>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. <i>Azolla</i> production 2. Production technology of Resins 3. Production and propagation of Ornamental <i>Pteris</i> , Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and <i>Thuja</i> oil.	7
Suggested Readings: Course Books published in Hindi may be prescribed by the Universities. 1. Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I(10th edition). Vikas Publishing House. 2. Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House. 3. Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House. 4. 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. 5. Suresh Kumar, Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet, New Delhi. 6. 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.		

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

<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

***Detail Syllabus of
B.Sc.-II Year
or
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	Taxonomic Resources & Nomenclature Taxonomic resources: Herbarium, Important herbaria, Botanical gardens, Flora, Keys. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication).		7
II	Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Angiosperm Phylogeny Group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Protein and Nucleic acid homology.		8
III	Identification of Angiospermic families -I: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker’s system), Brassicaceae, Malvaceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Asteraceae, Apocynaceae.		8
IV	Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker’s system) Asclepiadaceae, Solanaceae, Lamiaceae, Euphorbiaceae, , Liliaceae, Poaceae.		7
V	Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy).		8

VI	TOOLS & SOFTWARES IN PLANT IDENTIFICATION- GIS 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA	7
VII	Computer usage & Android Applications MS Office: PPT, Microsoft Excel, graphs, formulas and functions, GPS tagging, Plant Identification Apps.	7
VIII	Aesthetic Characteristics of Plants: English, Italian, Mughal and Japanese gardens; Features of a garden (Fencing, Hedge, Lawn, shrubs, climbers, rockery, Flower beds, Water garden). Some Famous gardens of India. Green houses, Vertical garden, Topiary, Bonsai.	8
Suggested Readings: <i>Course Books published in Hindi may be prescribed by the Universities.</i> 1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House. 2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay. 3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun. 4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. http://delta-intkey.com 5. https://www.naace.co.uk/school-improvement/ict-mark/ 6. https://www.socitm.gov.uk, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm. 7. 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) 8. 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 9. 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. 10. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London. 11. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi. 12. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press. 13. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London. 14. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London. 15. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons. 16. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscape designer. Upper Saddle River, NJ: Pearson Prentice Hall. 17. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group. 18. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed plantings. New York: John Wiley & Sons. 19. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.		
This course can be opted as an elective by the students of the 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: <table border="1"> <thead> <tr> <th>Internal Assessment</th><th>Marks</th></tr> </thead> <tbody> <tr> <td>Class Interaction</td><td>5</td></tr> <tr> <td>Quiz and Seminar</td><td>12</td></tr> <tr> <td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td><td>8</td></tr> <tr> <td>Total</td><td>25</td></tr> </tbody> </table>	Internal Assessment	Marks	Class Interaction	5	Quiz and Seminar	12	Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8	Total	25
Internal Assessment	Marks										
Class Interaction	5										
Quiz and Seminar	12										
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8										
Total	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.senecaohs.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/										

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: 100		Min. Passing Marks: 33	
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 Lecture (60 hours)
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 them 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 and Hooker natura system of classification in the following families: Malvaceae, Euphorbiaceae, Rutaceae, Fabaceae, Solanaceae, Apocynaceae, Acanthaceae, Lamiaceae, Rubiaceae, Liliaceae.		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 AND 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,		7

		2. Practice browsing different sites using search engines. 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	
	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: <i>Course Books published in Hindi may be prescribed by the Universities.</i> - Day, S.C. (2003) A Art of Miniature Plant Culture. - Agrobios. Jodhpur, India. - Practical Taxonomy of Angiosperms By : R K Sinha ISBN : 9789386768520 I.K International Publishing House Pvt. Ltd. - Day, S.C. (2003) Complete Home Gardening. (2003) Agrobios, Jodhpur, India. - Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios, Jodhpur, India. - Khan, M.R. (1995) Horticulture and Gardening.- NiraliPrakashan, Pune. India. - Pramila Mehra Gardening for everyone-. Hind pocket book private limited, New Dehli. - Kumarsen V. Horticulture ,Saras Publication - Ramesh Bangia Learning Computer Fundamentals.,, Khanna Book Publishers - Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH PublishingCo., New Delhi. - Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras. - Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers. - Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay. - Womersley, J. S. 1981. Plant collecting and herbarium development: A manual. - Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; DehraDu - Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. http://delta-intkey.com https://www.naace.co.uk/school-improvement/ict-mark/ - Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST,N. Delhi - Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi - Primak, R. B. (2004) A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers - Quicke, Donald, L. J. (1993) Principles and Techniques of Commemorative Taxonomy. Blakie, Academic and Professional, London - 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 Printer 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 the following subjects: Open to all but special for B.S Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS
	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 <u>Any Other :</u> 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/conservate 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: Diploma in Plant Identification, Utilization & Ethnomedicine		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: Centers of diversity of plants, origin Domestication and introduction of crop plants. Cultivation, production and uses of Cereals, legumes, Spices & beverages.		7
II	Botany of oils, Fibers, timber yielding plants & dyes: Study of the plants with Botanical names, Family, part used, yielding Edible & essential oils; Sugar, Fibers, Paper, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.		7
III	Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise): Commercial greenhouse cultivation of rose, Gladiolus, tomato, strawberry & Exotic leafy vegetables using Hydroponics.		7
IV	IPR & Traditional Knowledge: IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.		8
V	Ethnobotany: Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea, Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI. Tribal knowledge of medicinal plants.		8
VI	Medicinal aspects: Study of common plants used by tribes (<i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Cynodon dactylon</i> , <i>Ocimum sanctum</i>) Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics. Plants in primary health care: common medicinal plants: <i>Tinospora</i> , <i>Turmeric</i> and <i>Aloe</i> .		8

VII	Pharmacognosy Preparation of drugs for commercial market, Evaluation of drugs, Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs – roots, rhizome, leaves, stems, flowers, fruits and seeds. organoleptic study of <i>Adhatoda vasica</i> , <i>Azadirachta indica</i> , <i>Coriandrum sativum</i> , <i>Embolica officinalis</i> , <i>Ocimum sanctum</i> , <i>Ricinus communis</i> , <i>Vinca rosea</i> and <i>Zingiber officinale</i> .	8
VIII	Herbal Preparations & Phytochemistry Collection of wild herbs, Hydrotherapy or Herbal bath, Herbal oils, Liquid extracts, Poultices, Salves. Teas, Alkaloids, Phenolic compounds, Terpenoids, Glycosides and Volatile oils - therapeutic applications.	7

Suggested Readings:

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

- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
- Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
- Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
- Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
- Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
- Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
- Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
- Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
- N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
- Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
- Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
- Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
- Jain, S. K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
- Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
- Joshi, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
- Kokate, C. and Gokeale- Pharmacognacy- Nirali Prakashan, New Delhi.
- Lad, V. 1984. Ayurveda – The Science of Self-healing. Motilal Banarasidass, New Delhi.
- Lewis, W. H. and M. P. F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Inter science Publication. John Wiley and Sons, New York.
- Farooqui, A. A. and Sreeraman, B. S. 2001. Cultivation of medicinal and aromatic crops. Universities Press.
- Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
- Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai. I. Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I. Himalaya Publishing house.
- Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
- 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 and Seminar	12
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
Total	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/tr/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.htm>

Programme: Diploma in Plant Identification, Utilization & Ethnomedicine		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: 100		Min. Passing Marks: 33	
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 & Microtechnique: 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 ethnobotanical 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. Wallis, T. E. 1946. Textbook 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. New Delhi. 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 the 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		

	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/medical_tk.pdf https://www.bentoli.com/commercial-farming-agriculture/

Programme/Class: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: IV Paper-III
Subject: BOTANY			
Course Code: - B040403R		Course Title: Research Project in Botany	
Course outcomes: ● Project work will supplement field experimental learning and deviations from classroom and laboratory transactions. ● project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes. ● It will promote creativity and the spirit of enquiry in learners. ● They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing. ● It will enhance their abilities, enthusiasm, and interest.			
Credits: 03		Core: Compulsory	
Max. Marks: 100		Min. Passing Marks: 33	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.			
	Suggestive List Of PROJECTS		
	1. Rural Areas: Flora of a city/ village, Biodiversity of Village, Soil & seed testing service provision to farmers, 2. Industrial waste management 3. water pollution status of rural water & promotion of WASH in villages 4. Plant Disease identification in farms, nurseries and orchards. 5. Digital portal for plants: Campus, city or particular area 6. Rare and endangered plants & their conservation & domestication 7. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area 8. Science Communication by Creating science documentaries of innovators , Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.) 9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public. 10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties 11. Study of pollen grains in different flowers 12. Study of stomata in different plants 13. Study of various types of secretory and special tissues in plants. 14. Prepare beds for growing nursery for herbs, shrubs and trees, Develop Green house facility in college and grow plants,		

	Develop hydroponics facility in college and grow plants. 15. Develop botanical garden in the college with labelling Vertical gardens, roof gardens. 16. Culture & art of making bonsai. 17. Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing) 18. Phytochemical Analysis of Medicinal plants, Biocomposting and Vermicomposting. 19. Performing Aromatherapy by essential Oils
Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.	
This course can be opted as an elective by the students of following subjects: Open to all	
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: All listed under all papers of the course.

Suggested equivalent online courses:

<https://ndl.iitkgp.ac.in/>

https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

<http://www.dli.ernet.in/>

<http://www.ulib.org/> <http://www.tkdlib.res.in/>

<http://www.vigyanprasar.gov.in/digilib>

Directory of Open Access Repositories (DOAR)<http://www.openoar.org> Registry

of Open Access Repositories (ROAR)<http://roar.eprints.org/>

http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf

<https://ndl.iitkgp.ac.in/>

<http://heecontent.upsdc.gov.in/Home.aspx>

<http://epathshala.nic.in/>, <http://epathshala.gov.in/>

nptel.iitm.ac.in

https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

<http://www.dli.ernet.in/>, <http://www.ulib.org/>

<http://www.tkdlib.res.in/>, <http://www.vigyanprasar.gov.in/digilib>

Directory of Open Access Repositories (DOAR)<http://www.openoar.org> Registry of

Open Access Repositories (ROAR)<http://roar.eprints.org/>

http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf

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

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 Water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Role of essential elements; Symptoms of mineral deficiency.	7
II	Carbon Oxidation Krebs cycle, Glycolysis, aerobic and anaerobic respiration, fermentation, oxidative pentose phosphate pathway, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, factors affecting respiration.	7
III	Nitrogen Metabolism Nitrate assimilation, Biological Nitrogen fixation, Ammonia assimilation (GS-GOGAT), Reductive amination and transamination, Amino acid synthesis.	8
IV	Lipid Metabolism & Photosynthesis Synthesis and breakdown of triglycerides, Gluconeogenesis, Photosynthesis: Pigments, Action spectra, ETS, Photophosphorylation, C3 & C4 photosynthesis, CAM Pathway.	7
V	Plant Development, Movements, Dormancy & Responses Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Photoperiodism, Phytochrome, red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence.	8
VI	Biomolecules <i>Carbohydrates:</i> Nomenclature and classification; Monosaccharides (glucose, fructose, sugar alcohols – mannitol); Disaccharides (sucrose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, pectin, storage – starch) <i>Lipids:</i> Storage lipids: Fatty acids structure and functions, Structural lipids, Lipid functions.	8

VII	Proteins: Structure of amino acids; Peptide bonds; Protein structure, Ramchandran plot, Isoelectric point. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids, MiRNA	7
VIII	Enzymes: Structure of enzyme, Mechanism of action (activation energy, lock and key hypothesis, induced- fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes.	8

Suggested Readings:

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

1. 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)
2. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
3. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
4. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
5. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
6. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book. Agencies.
7. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
8. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
9. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
10. Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
11. Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
12. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
13. Ramesh Gupta. Efficacy, Safety and Toxicity brings together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
14. Harborne, J.B. 1973 .Phytochemical Methods. John Wiley & Sons, New York.
15. 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.
16. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017

This course can be opted as an elective by the students of following subjects: Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech,

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

Internal Assessment	Marks
Class Interaction	5
Quiz and Seminar	12
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
Total	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

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: V Paper-II
Subject: BOTANY			
Course Code: B040502T		Course Title: Molecular Biology & 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. 3. Gain working knowledge of the practical and theoretical concepts of bioinformatics			
Credits: 4		CC / 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(60hrs)
I	Genetic material Historic perspective, Experiments of Griffith, Avery Macleod & McCarty and Hershey-Chase, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): Semi-conservative. DNA replication (Prokaryotes and eukaryotes, Replication enzymes.		7

II	Transcription, Translation & Regulation of gene expression Transcription, Types of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), Genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon.	7
III	Principles & Techniques of genetic engineering Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; DNA markers i.e. RAPD, RFLP, SNPs; PCR and Reverse Transcriptase-PCR. Monoclonal antibodies, ELISA	8
IV	Applications of Genetic engineering Pest resistant (Bt-cotton); herbicide resistant plants, Transgenic crops (Flavr Savr tomato, Golden rice); Transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Biosafety concerns.	7
V	Bioinformatics & its applications Computer fundamentals, Role of supercomputers in biology. Scope of bioinformatics- Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand-based approaches), Limitations of bioinformatics.	8
VI	Biological databases Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL), protein databases (Swiss- Prot, PDB), metabolic pathway database (KEGG), small molecule databases (PubChem).	8
VII	Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (FASTA, EMBL); Sequence annotation; Data retrieval systems (SRS, Entrez)	7
VIII	Phylogenetic analysis Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments. Methods of Alignment (Dot matrix, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, Dendrograms	8

Suggested Readings:

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

1. Dr Pooja Rai, Bhopal
2. Sharma - Trivedi Molecular Biology And Biotechnology
by RBD Publisher
3. Plant Physiology and Biochemistry ISBN #: 81-301-0035-5 Author: Sunil D Purohit, K. Ahmed & Gotam K Kukda Edition: 2013 Pages: 368 + VIII Type: Text Book (Hindi)
4. Molecular Biology Biotechnology ISBN #: 81-301-0033-9 Author: Sunil D Purohit & Gotam K Kukda Edition: 2013 Pages: 366 + X Type: Text Book (Hindi) Apex Publishing House, Udaipur, Rajasthan
5. Bioinformatics Paperback – 1 January 2015 by Dr Archana Pandeya (Author), Santosh Choubey (Editor), & 2 More Hindi AISECT Ltd.
6. BIOTECHNOLOGY AND GENETIC ENGINEERING (Hindi, Hardcover, Dr. Archana Nigam)

1. Primrose, SB. 1995. Principles of Genome Analysis. Blackwell Science Ltd. Oxford, UK..
2. E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, New York.
3. 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.
4. Freifelder - Molecular Biology.
5. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017.
6. Ghosh, Z., Mallick, B. (2008). Bioinformatics – Principles and Applications, 1st edition. New Delhi, Delhi: Oxford University Press.
7. Baxevanis, A.D. and Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
8. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
9. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
10. Pevsner J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
11. Xiong J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press
12. A Textbook Of Basic And Molecular Genetics (pb) ISBN : 9788188826193 Edition : 01 Year : 2018 Author : Dr. Parihar

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

Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture.

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 and Seminar	12
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
Total	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)

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/swayam-genetic-engineering-theory-and-application-14090>

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

<https://www.coursera.org/courses?query=molecular%20biology>

<https://www.edx.org/learn/genetic-engineering>

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

<https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907>

<https://nptel.ac.in/courses/102/103/102103013/>

Programme/Class: Bachelor of Science		Year: III	Semester: V Paper-III
Subject: Botany			
Course Code: B040503P		Course Title: Experiments in physiology, Biochemistry & molecular biology	
Course outcomes: After the completion of the course the students will be able to: 1. Know and authentic 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: 100		Min. Passing Marks: 33	
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 Rhoeo / 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	Nitrogen Metabolism, Photo Synthesis & Respiration 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO3 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). 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott’ bubble		8
III	Plant Development, Movements, Dormancy & Responses 1. Geotropism and phototropism — Klinostāt 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.		8

	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)	
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. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items.	8
V	Genetic material 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating E.coli on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method.	7
VI	Preparation of models/ charts: 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous ; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA 4. Study of structures of: tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs	7
VII	Genetic Engineering 1. Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	7

	6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR	
VIII	Applications of Genetic engineering 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.	7

Suggested Readings:

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

1. A Laboratory Manual Of Plant, Physiology, Biochemistry And Ecology ISBN : 9788177544589 Edition : 01 Year : 2012 Author : Akhtar Inam Publisher : Agrobios (India)
2. Advanced Methods In Physiology And Biochemistry (pb) ISBN : 9789381191132 Edition : 01 Year : 2016 Author : Padmanaban G , Chandrasekaran CN , Thangavelu AU , Dr. Sivakumar R , Kalimuthu N , Dr. Boominathan P , Dr. Anbarasan P, Agrobios.
3. Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
4. Wilson and Walker .Practical Biochemistry: Principles and Techniques. Cambridge University Press.U.K.
5. Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
6. Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London

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

Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture.

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

Lab requisites: Electrophoresis units, Gelrocker, UV-transilluminator, Vortex Mixer, Shaker, CVT,

Suggested equivalent online courses:

<https://www.edx.org/learn/molecular-biology>

<https://krishikosh.egranth.ac.in/handle/1/5810039999>

<https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090>

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

<https://www.coursera.org/courses?query=molecular%20biology>

<https://www.edx.org/learn/genetic-engineering>

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

<https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907>

Programme/Class: Bachelor of Science		Year: III	Semester: VI Paper-I
Subject: Botany			
Course Code: B040601T		Course Title: Cytogenetics, Plant Breeding & Nanotechnology	
Course outcomes: After the completion of the course the students will be able:			
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:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic		No. of Lectures (60hrs)
I	Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes; Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal structure and organization, Lampbrush chromosomes and polytene chromosomes. Cell cycle, Mitosis, Meiosis. Chromosomal aberrations (Numerical and structural).		8
II	Genetics Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Sex chromosomes; Sex determination in plants		7
III	Plant breeding Plant introduction-process. Agencies of plant introduction in India; Selection - mass selection, pure line selection and clonal selection. Hybridization: Inter generic, Inter-specific, Inter-varietal hybridization with examples, Male sterility, Heterosis and its exploitation in plant breeding, Mutation.		8
IV	Biostatistics: Statistical methods, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution-definition only, 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.		7
V	Plant Tissue Culture: Principles, components and techniques of <i>in vitro</i> plant cultures, Callus cultures, Cell culture, Embryogenesis and Organogenesis, Protoplast isolation and culturing of protoplast, protoplast fusion and somatic hybridization, Somaclonal variation,		8
VI	Nanotechnology Fundamentals of nanoscale self-assembly process involved in DNA and RNA, Proteins, Enzymes. Nanoscale assembly of cell membrane. Nanoscale assembly of microorganisms (virus). Nano-particle synthesis, Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.		7
VII	Artificial Intelligence in Plant Sciences Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Artificial Neural Networks and Genetic algorithms, Predictive Analytics, IoT Sensors, Applications of Artificial Neural Networks in Plant Science.		8

VIII	Introduction to use of Digital technologies – AI, IoT & ICT in Botany Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository- google scholar, science direct. resource management, weather forecasting. IoT Database management, IoT platforms, IoT Graphical user interface • IoT application, ICT Applications for different crops and horticulture.	7
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Suggested Readings:

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

1. PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct Publishing ISBN: ISBN: 9781698665283 Authors: H. R. Dagla Jai Narain Vyas University
 2. Biotechnology: Fundamentals And Application (hindi) (hb) ISBN : 9788177544732 Edition : 03 Year : 2018 Author : Dr. Purohit SS , Mathur S
 3. Biotechnology (Hindi) (Hindi, Paperback, B.D.Singh) Hindi Publisher: Kalyani Publishers ISBN: 9789327246070, 9327246071
 4. Cytogenetics, Plant Breeding, Evolution and Biostatistics ISBN #: 978-81-301-0066-1 Sunil D Purohit & Gotam K Kukda, Apex Publishing House
 5. Genetics and Biotechnology Sunil D Purohit, K. Ahmed & Gotam K Kukda Apex Publishing House
 6. Padap Prajnan (Hindi) Hardcover – 1 January 2016 by Chandra Prakash Shukl (Author) Pointer Publishers, Jaipur
 7. PLANT BREEDING : PRINCIPLE AND METHODS B D SINGH - IN HINDI
1. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
 2. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. 6th Edition. WW. Norton & Co.
 3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
 4. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
 5. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H. Freeman.
 6. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company

7. Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*, 5th Ed., W.H. Freeman and Company.
8. Karp, G. (2010). *Cell Biology*, John Wiley & Sons, U.S.A. 6th edition.
9. Hardin, J., Becker, G., Skliensmith, L.J. (2012). *Becker's World of the Cell*. 8th edition. Pearson Education Inc. U.S.A.)
10. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). *Principles of Genetics*, John Wiley & sons, India. 8th e
11. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, John Wiley & Sons Inc., India. 5th edition.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics*. Benjamin Cummings, U.S.A..
13. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). *Introduction to Genetic Analysis*. W. H. Freeman and Co., U.S.A. 10th edition.
14. M K Raxdan *An Introduction to Plant Tissue Culture* –; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
15. Aggarwal SK (2009) *Foundation Course in Biology*, 2nd Edition, Ane Books Pvt. Ltd
16. Allard RW (1960) *Principles of Plant Breeding*. John Wiley and Sons. Inc. New York
17. BD Singh (2003) *Plant Breeding*. Kalyani Publishers
18. Cohn, N.S. (1964) *Elements of Cytology*. Brace and World Inc, New Delhi
19. Darnel, J. Lodish, Hand Baltimore, D. (1991) *Cell and molecular biology*. Lea and Fibiger, Washington.
20. De Robertis, E.D.P and Robertis, E.M.P (1991) *Cell and molecular biology* Scientific American books.
21. Dobzhansky, B (1961) *Genetic and origin of species*, Columbia university Press New York
22. Durbin (2007) *Biological Sequence Analysis*. Cambridge University Press India Pvt. Ltd
23. Gerald Karp (1985) *Cell biology*, Mc Graw Hill company..
24. Lewin, B, (1994) *Genes*, Oxford University Press, New York.
25. Lewis, W.H (1980) *Polyploidy*. Plenum Press, New York.
26. Nicholl T (2007) *An Introduction to Genetic Engineering*, Cambridge University Press India Pvt. Ltd
27. Roy S.C. and Kalayan kumar De (1997) *Cell biology*. New central Boos Calcutta
28. Sandhya Mitra, (1998) *Elements of molecular biology*. Macmillan, India Ltd.
29. Sharma JR (1994) *Principles and Practices of Plant Breeding*. Tata McGraw-Hill Pub. Co. New Delhi
30. Sharma, A.K and Sharma A (1980) *Chromosome technique Theory and practice*, Aditya Books, New York
31. Swanson, C.P (1957) *Cytology and Genetics*. Englewood cliffs, New York.
32. Taylor (2008) *Biological Sciences*. Cambridge University Press India Pvt. Ltd
33. Twyman, R.M. (1998) *Advanced molecular biology* Viva books New Delhi.
34. Veer Bala Rastogi (2008), *Fundamentals of Molecular Biology* Ane Books Pvt. Ltd
35. A. J. Nair . *Basics of Biotechnology*- Laxmi Publications, New Delhi.
36. S S Purohit and S K Mathur; *Biotechnology-Fundamentals and Application- Agrobotanica*, India.
37. A. J. Nair *Introduction to Genetic Engineering & Biotechnology*. Jones & Bartlett Publishers, Boston, USA.
38. H S Chawla *Introduction to Plant Biotechnology*;-; Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
39. H D Kumar *Modern concept of Biotechnology*, Vikas Publishing House, Pvt. Ltd., New Delhi.
40. P C Trivedi , *Plant biotechnology*, Recent Advances Panima Publishing Corporation, New Delhi.
41. Du, C., and S. A. Jackson. 2019. Machine learning and complex biological data. *Genome Biology* 20: 76. <https://doi.org/10.1186/s13059-019-1689-0>
42. Alexis and Mathew Leon., *Fundamentals of Information Technology* Leon Vikas
43. Plant R. E., Stone N. D. (1991). *Knowledge-based systems in agriculture*. McGraw-Hill, Inc. 1221 Avenue of the Americas, New York, NY 10020.
44. Han S., Steward B.L., Tang L. (2016). Intelligent agricultural machinery and field robots. In Zhang Q. *Precision agriculture technology for crop farming* (pp.133-176). CRC Press, Taylor&Francis Group, New York.
45. Lucci S., Kopec D. (2013). *Artificial intelligence in the 21st century*. 22841 Quicksilver Drive Dulles, VA 20166.
46. V. Rajaraman *Introduction to Information Technology*.., Prentice Hill.
47. Ramesh Bangia *Learning Computer Fundamentals*., Khanna Book Publishers
48. Bass, Joel, E and et. al., Allyn & Bacon, 2009 . *Methods for Teaching Science as Inquiry, The truth of science*, Newton R.G.,
49. R. Rangaswami (2009) *A Text book of Agriculture Statistics* .New Age International (P) Limited, Hyderabad.
50. Nageshwar Rao G. (2007) *Statistics for Agriculture Sciences* BS Publications. New Delhi
51. Nigam A.K. and Gupta, V.K. (1979) *Hand book on Analysis of Agricultural Experiments*.. IASRI Publication, New Delhi.

52. Panse V.G. Sukhatme P.V. (1985) Statistical methods for Agricultural workers . Indian Council of Agricultural Research, New Delhi
53. Snedecor G.W. & Cochran W.G. (1989) Statistical Methods . Iowa State University Press.
54. Design and Analysis of Experiments by Das M.N. and Giri N.C.(1986). Wiley Eastern Ltd., New Delhi.
55. Gomez, A.A. and Gomez, A.A.(1984) Statistical Procedures for Agricultural Research .John Wiley and Sons. New York.
56. Gupta, S.C. (2016) Fundamentals of Statistics .Himalaya Publishing House Mumbai - 400004, Maharashtra, India.
57. V.K. Kapoor (2007) Fundamentals of Applied statistics by Sultan Chand and Sons, New Delhi- 110 002
58. Yubing Xie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
59. Sulabha K. Kulkarni. 2014 Nanotechnology : Principles and Practices. CP publishing, New Delhi.
60. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer
61. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
62. Sharma A.K. 2005. Text Book Of Biostatistics I, Discovery Publishing House.
63. Annadurai, B. 2007. Text Book of Biostatistics. New Age International.
64. Gurumani, N. 2010. An Introduction to Biostatistics (2nd Edn). MJP Publishers.
65. David S. Goodshell. 2004. Bionanotechnology-Lessons from nature. John Wiley Publications.
66. R. Stephen Crespi, Tibtech, Patenting in Biotechnology - Part I, Vol. 9, 117-122, 1991.
67. Pattnaik, P.K., Kumar, R., Pal, S., Panda, S.N. (Eds.)IoT and Analytics for Agriculture,2020
68. <https://www.springer.com/gp/book/9789811391767>
69. <https://www.springer.com/gp/book/9789811550720>
70. Petersen Roger G. (1994) Agricultural Field Experiments Design and Analysis by Marcel Dekker, NewYork.

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 and Seminar	12
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	8
Total	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

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

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: VI Paper-II
Subject: Botany			
Course Code: B040602T		Course Title: Ecology & Environment	
Course outcomes: 1. acquaint the students with complex interrelationship between organisms and environment; 2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. 3. This knowledge is 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	Natural resources & Sustainable utilization: Soil degradation and management, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Energy: Renewable and non-renewable sources, EIA, GIS, Ecological Footprint with emphasis on carbon footprint.		7
II	Ecology & Ecosystem Ecosystem: Structure and function. Energy flow. Ecological Succession (Hydrosere and Xerosere). Food chains and food webs, Ecological pyramids, production and productivity; Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.		8
III	Soil Formation, Properties & Conservation Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological–Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Watershed Management, Soil reclamation.		7
IV	Biodiversity and its conservation: Definition -Genetic, Species and Ecosystem diversity. Biodiversity-value and threats; hotspots of Biodiversity, Endemic and endangered species of plants in India. Ecological niche, ecological indicators. Ex-situ and in-situ conservation, Red data book, Botanical gardens, National parks, Sanctuaries and Bioreserves. Role of Seed Banks and Gene Banks, Ecotourism, Role of NBPGR, FAO, BSI.		7
V	Phytogeography: Biogeographic regions of India & world, Natural vegetation of India, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.		7

VI	Environmental audit & Sustainability Concept of environmental audit; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Concept of energy and green audit, Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.	8
VII	Pollution, Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Regulatory framework for pollution monitoring and control; Case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG; Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) collection and segregation , Incineration, Pyrolysis and gasification , Sanitary landfilling; Composting, Biogas production ,Circular Economy & sustainability.	8
VIII	Environmental ethics, Carbon Credits & Role of GIS Carbon credit: concept, exchange of carbon credits, Carbon sequestration, Global warming, acid rain, ozone layer depletion, nuclear accidents, Wasteland reclamation. Geographical Information Systems: spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications of remote sensing and GIS in land use planning, forest resources & agriculture studies.	8
Suggested Readings: <i>Course Books published in Hindi may be prescribed by the Universities.</i> 1. Environmental Studies (Hindi) ISBN 81-301-0004-5B. L. Chaudhary & Jitendra Pandey Edition: 2013 Pages: 340 + XII Apex Publishing House 2. Soil and Water Conservation ISBN #: 978-81-301-0071-5S. C. Mahnot & P. K. Singh Apex Publishing 3. House 4. Paryavaran Evam Paristhitiki 5e (Hindi) Paperback – 20 February 2020 Majid Husain 5. Environmental Biology and Phytogeography ISBN #: 978-81-301-0064-7B. L. Chaudhary, Gotam K Kukda & Jitendra Kumar Joshi 6. Ugc Unified: Environmental Sciences (hindi) (pb) ISBN: 9788177545814 Edition : 01 Year : 2015 Author : Dr. Purohit SS , Dr. Deo PP , Dr. Agrawal Ashok K Publisher : Agrobios (India) 1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press 2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co. 3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House 4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science 5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company		

6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
10. Mackenzie et al. Ecology, Latest Ed., Viva Books.
11. Gurevitch, J. (et al.), The Ecology of plants, 2002, Sinauer Associates.
12. Kimar, U. & Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.
16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.
17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates
18. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
19. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
20. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
21. Abbasi, S. A. (1998). Environmental Pollution and its Control. Cogent International, Pondicherry.
22. Abbasi, S. A. and Ramasamy, E. V. (1999). Biotechnological Methods of Pollution Control. Universities Press (India) Limited, Hyderabad.
23. Peavy, H. S., Rowe, D. R. and Tchobanoglaus, G. (1985). Environmental Engineering, Mc Graw Hill Book Company, Singapore.
24. Rand, M. C., Greenberg, A. E. and Taras, M. J. (Ed.) (1995). Standard methods for the examination of water and wastewater: 19th edition, American Public Health association (APHA), Washington, D.C.
25. Scragg, A. (1999). Environmental Biotechnology, Addison Wesley Longman, Singapore.
26. Tchobanoglaus, G. (1988). Wastewater Engineering: Treatment, Disposal, Reuse. Tata Mc Graw Hill, New Delhi.
27. Aarve, V. P., William, A. W. and Debra, R. R. (2002). Solid waste engineering. Cengage reading, USA.
28. George, T., Hilary, T. and Samuel, A. V. (1993). Integrated solid Waste Management, Engineering Principles and Management Issues, Mc Graw Hills.
29. George, T. and Frank, K. (2002). Handbook of solid waste management: (Second edition). Mc Graw Hills.
30. Kanthi, L. S. (2000). Basics of Solids and hazardous waste management Technologies. Prentice Hall.
31. Anonymous. 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New York.
32. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries
33. with Policy and Science Considerations. Martinus Nijhoff Publishers.
34. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
35. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
36. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
37. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
38. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
39. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India.
40. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.
41. Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
42. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
43. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.
44. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London,
45. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. The Botanical Review 53:80-192.
46. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. Conservation Biology for All. Oxford University Press.
47. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.

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 and Seminar	12
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/ 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: 100			Min. Passing Marks: 33
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic		No. of Lectures(60hrs)
I	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.		7

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: 1 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.	8
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 Mendellian 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.	7
IV	Plant tissue culture 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration	8
V	Ecology & Environment 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 (Cuscuta), Root parasite (Orobanchae) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites	8
VI	Soil Formation, Properties & Conservation 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map	8
VII	Biodiversity and Phytogeography: 1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps	7

	3. Phytogeographical areas of India	
VIII	Pollution & Waste management 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum 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 O₂ by azide modification of Winkler's method. 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 7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. Climate Change, Carbon Credits & Role of GIS 1. Conducting Waste Audit of your Institution -Demo 2. Green auditing of the College/University -Demo	7
Suggested Readings: as in papers above: <i>Course Books published in Hindi may be prescribed by the Universities.</i> 1. Practical Botany (Part III) Author: Sunil D Purohit, Anamika Singhvi & Kiran Tak 2013 Apex Publishing House, Raj. 2. Practical Botany (Part II) Author: N. C. Aery, Sunil D Purohit & Gotam K Kukda 2013 Apex Publishing House, Raj. 3. A Handbook Of Soil, Fertilizer And Manure (2nd Ed.) (pb) ISBN : 9788177544152 Edition : 02 Year : 2017 Author : Gupta PK Publisher : Agrobios (India) 4. Green Technology: An Approach For Sustainable Environment ISBN : 9788177543438 Edition : 01 Year : 2021 Author : Dr. Purohit SS Publisher : Agrobios (India) 5. Laboratory Manual Of Chemical And Bacterial Analysis Of Water And Sewage ISBN : 9788177540802 Edition : 01 Year : 2011 Author : Theroux FR , Eldridge EF , Mallmann WL Publisher : Agrobios (India) 6. Methods In Environmental Analysis: Water Soil And Air (2nd Ed.) ISBN : 9788177543087 Edition : 02 Year : 2021 Author : Gupta PK Publisher : Agrobios (India) 7. Water Treatment And Purification Technology ISBN : 9788177540024 Edition : 01 Year : 2009 Author : Ryan WJ Publisher : Agrobios (India) <u>http://vidyamidra.inflibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany</u> <u>http://heecontent.upsdc.gov.in/Home.aspx</u> <u>http://epathshala.nic.in/</u>, <u>http://epathshala.gov.in/</u>		
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.		

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

FOURTH YEAR OF HIGHER EDUCATION

FYUP / P.G. PROGRAMME

Eligibility for Admission in B.Sc. (Honours) in Botany, B.Sc. (Honours with Research) in Botany and M.Sc. (Botany)

1. A candidate who has passed B.Sc. with Botany as a major subject from any University recognized by the UGC and secured **atleast 75%** marks in B.Sc. (for SC/ST category a relaxation of 5%) shall be permitted to take admission in **B.Sc. (Honours with Research)**.
2. A candidate who has passed B.Sc. with Botany with Botany as a major subject from any University recognized by the UGC and secured **atleast 45%** marks in B.Sc. (for SC/ST category a relaxation of 5%) shall be permitted to take admission in **B.Sc. (Honours)**.
3. A candidate who has passed B.Sc. (Honours) or B.Sc. (Honours with Research) in B.Sc. with Botany as a major subject from any University recognized by the UGC and secured atleast 45% marks (for SC/ST category a relaxation of 5%) shall be permitted to take admission in **One Year M.Sc. (Botany)**.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of attendance register for candidates who have registered for the course. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not any circumstance be granted for attendance below 65%.

or

**Examination pattern as decided by
Examination Committee of the University**

or

Any other Regulatory Body

PAPER CODING AND CREDIT DISTRIBUTION

For

B.Sc. (HONOURS) in BOTANY

Year	SEMESTER	COURSE CODE	TITLE OF PAPER		THEORY/ PRACTICAL	CREDITS
Fourth Year	VII	B040701T	MICROBIOLOGY, MICROBIAL GENETICS AND APPLICATIONS		THEORY	4
		B040702T	MYCOLOGY AND PLANT PATHOLOGY		THEORY	4
		B040703T	PHYCOLOGY, LICHENOLOGY AND BRYOLOGY		THEORY	4
		B040704T	PTERIDOPHYTES, GYMNOSPERMS, AND PALEOBOTANY		THEORY	4
		B040705P	PRACTICAL		PRACTICAL	4
	VIII	B040801T	PLANT ANATOMY, DEVELOPMENT AND REPRODUCTION		THEORY	4
		B040802T	PLANT SYSTEMATICS AND TAXONOMY OF ANGIOSPERMS		THEORY	4
		B040803T	CYTOLOGY, CYTOGENETICS AND PLANT BREEDING		THEORY	4
		B040804T	CONSERVATION OF PLANT DIVERSITY, PLANT PROPAGATION AND IPR	CHOOSE ANY ONE	THEORY	4
		B040805T	INDUSTRIAL MICROBIOLOGY		THEORY	4
		B040806T	ETHNOBOTANY, PHARMACOLOGY AND PHYTOCHEMISTRY		THEORY	4
		B040807P	PRACTICAL			PRACTICAL

PAPER CODING AND CREDIT DISTRIBUTION

B.Sc. (HONOURS WITH RESEARCH) IN BOTANY

YEAR	SEMESTER	COURSE CODE	TITLE OF PAPER		THEORY/ PRACTICAL	CREDITS	
FOURTH YEAR	VII	B040701T	MICROBIOLOGY, MICROBIAL GENETICS AND APPLICATIONS	CHOOSE ANY THREE	THEORY	4	
		B040702T	MYCOLOGY AND PLANT PATHOLOGY		THEORY	4	
		B040703T	PHYCOLOGY, LICHENOLOGY AND BRYOLOGY		THEORY	4	
		B040704T	PTERIDOPHYTES, GYMNOSPERMS, AND PALEOBOTANY		THEORY	4	
		B040705P	PRACTICAL			PRACTICAL	4
		B040706R	RESEARCH PROJECT IN BOTANY*				4
	VIII	B040801T	PLANT ANATOMY, DEVELOPMENT AND REPRODUCTION			THEORY	4
		B040802T	PLANT SYSTEMATICS AND TAXONOMY OF ANGIOSPERMS			THEORY	4
		B040803T	CYTOLOGY, CYTOGENETICS AND PLANT BREEDING			THEORY	4
		B040804T	CONSERVATION OF PLANT DIVERSITY, PLANT PROPAGATION AND IPR	CHOOSE ANY ONE	THEORY	4	
		B040805T	INDUSTRIAL MICROBIOLOGY		THEORY	4	
		B040806T	ETHNOBOTANY, PHARMACOLOGY AND PHYTOCHEMISTRY		THEORY	4	
		B040807P	PRACTICAL			PRACTICAL	4
		B040808R	RESEARCH PROJECT IN BOTANY*				4

*Research Project in Botany of both the Semesters (VII and VIII) will be jointly evaluated at the end of the Semester VIII as per University Guidelines.

STRUCTURE OF BOTANY COURSE IN FOURTH YEAR OF HIGHER EDUCATION

FOR

DEGREE IN BACHELOR OF SCIENCE ((APPRENTICESHIP / INTERNSHIP EMBEDDED) IN BOTANY

YEAR	SEMESTER	PAPER TITLE	CREDIT
FOURTH YEAR	VII & VIII	As per the Guidelines laid by the University	40

**DETAILED BOTANY SYLLABUS
FOR
FOURTH YEAR
OF HIGHER EDUCATION**

SEMESTER - VII

B040701T- Microbiology, Microbial Genetics and Applications

Credits: 4

M.M.: 25+75

Unit I

History of Microbiology; Isolation, purification and culturing of microbes from soil, water and air; Important criteria used for classifications of micro-organisms. Classification of bacteria based on Bergey's Manual of Systematic bacteriology.

Unit II:

Archaeobacteria and Eubacteria: Characters, Ultrastructure, nutrition and economic importance; Cyanobacteria: General characteristics, structure and importance; Nitrogen metabolism; Phytoplasma: General characteristics, structure and role in causing plant diseases.

Unit III:

Virus: characteristics and ultrastructure of Plant viruses and bacteriophages; Nomenclature and classification; replication, transmission and economic importance of viruses; viroids, virusoids and prions.

Unit IV:

Viral and bacterial genomes; Recombination in viruses and bacteria (transformation, conjugation and transduction); Nif genes, Molecular Mechanism of Conjugation and Transformation; Fine structure of gene; Gene expression and regulation in prokaryotes;

Unit V:

Fermentation technology; Plasmids: types and applications; Basic principles of immunology, vaccines and antibodies, Biopesticides; Bioremediation; degradation of xenobiotics Biosensors; Microbial enzymes; Microbes in nanobiotechnology.

B040702T -Mycology and Plant Pathology

Credits: 4

M.M.: 25+75

Unit I:

General characteristics and taxonomy of fungi; Cell Ultrastructure; Heterothallism, Heterokaryosis and Parasexual cycle; Asexual & Sexual reproduction, Nutrition, Fungal Sex hormones; Structure, nutrition and reproduction in Mastigomycotina and Zygomycotina.

Unit II:

Structure, nutrition and reproduction in Ascomycotina, Basidiomycotina and Deuteromycotina; General characteristics of slime moulds.

Unit III:

Fungi in Industry, secondary metabolites, medicine, food and agriculture; Mycorrhizae: Types and significance, Mycotoxins.

Unit IV:

General introduction, history and principles of Plant Pathology; Classification of Plant Diseases; Pathogenesis and defence mechanism; Role of environmental factors, forecasting and plant disease epidemiology.

Unit V:

Important diseases caused by fungi, bacteria, viruses, mycoplasma and nematodes: Transmission and disease cycle, symptoms and management through physical, chemical, cultural, biological and regulatory methods; Integrated Pest and Disease Management.

B040703T- Phycology, Lichenology and Bryology

Credits: 4

M.M.: 25+75

Unit I:

General characteristics and classification of algae; Cell ultrastructure and thallus organization, reproduction, heterocyst and akinete development, algal pigments, food reserves, flagellation, their phylogenetic and taxonomic importance. Distribution, structure and reproduction in Chlorophyta and Charophyta.

Unit II:

Range of thalli and reproduction in Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta; Algal blooms, Biofertilizers, Algae as food, feed and uses in industry.

Unit III:

Classification and distribution of Lichens, thallus organization, physiology and reproduction, Lichens as bioindicators, bioprospection, Lichenometry.

Unit IV:

General characteristics and classification of bryophytes; Diversity; Ecological and economic importance of bryophytes; Distribution, structure and reproduction in Marchantiales, and Jungermanniales.

Unit V:

Distribution, structure and reproduction in Anthocerotales, Sphagnum, Funaria, Polytrichales, Bryales.

B040704T- Pteridophytes, Gymnosperms and Palaeobotany

Credits: 4

M.M.: 25+75

Unit I:

Classification and origin of Pteridophytes; Fossil pteridophytes; Stelar theory; Telomethy; Heterospory: occurrence, causes and significance. Economic importance of pteridophytes.

Unit II:

Comparative study of Psilopsida, Lycopsida, Sphenopsida and Pteropsida with reference to structure, reproduction and life cycle.

Unit III:

Classification of gymnosperms up to the rank of orders. General account of Pteridospermales (Lyginopteridaceae, Glossopteridaceae), Bennettiales, Cordaitales.

Unit IV:

General account of Cycadales, Ginkgoales, Coniferales, Ephedrales, Gnetales and Welwitschiales. Distribution of Gymnosperms in India, Economic importance of gymnosperms.

Unit V:

Principles of Palaeobotany; Geological time scale; Fossilization: process and types; Carbon dating technique; Paleobotany in India.

B040705P - PRACTICAL (Based on Theory Syllabus)

B040706R - RESEARCH PROJECT (Total duration one year; to be started in Semester VII but evaluated at the end of Semester VIII)

SEMESTER – VIII

B040801T- Plant Anatomy, Development and Reproduction

Credits: 4

M.M.: 25+75

Unit I:

Organization of Shoot and Root Apical Meristem; Control of cell division and tissue differentiation; vascular tissue differentiation; secretory ducts and laticifers; root hairs, root-microbe interactions, root nodules.

Unit II:

Cambium and derivative tissues, secondary xylem and phloem, anomalous secondary growth; wood development in relation to environment. Leaf growth and differentiation; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. Floral development and differentiation; Genetics and use of mutants; accessory floral organs.

Unit III:

Ovary- placentation and types of ovules; Microsporogenesis and megasporogenesis, Pollination, methods and contrivances promoting self and cross-pollination; molecular mechanisms of self-incompatibility.

Unit IV:

Pollen-pistil interaction, double fertilization; post fertilization changes in embryo sac; endosperm: Structure and development; Polyembryony; apomixes.

Unit V:

Seed germination and seedling growth: metabolism of nucleic acids, proteins and mobilization of food reserves, tropisms, hormonal control of seedling growth; gene expression and role of mutants in understanding seedling development.

B040802T - Plant Systematics and Taxonomy of Angiosperms

Credits: 4

M.M.: 25+75

Unit I:

Angiosperm characters: evolutionary trends; Species concept; contribution of Ancient India in taxonomy and classification of plants; Brief study, merits and demerits of Bentham and Hooker's, Engler and Prantl's and Hutchinson's systems of classification.

Unit II:

Botanical nomenclature: International code of nomenclature (ICN); Principles: rules and recommendations; Typification, priority, rules of effective and valid publications; retention and choice of names; Conservation of names, Name changes, Synonyms, Basionyms.

Unit III:

Taxonomic evidences, and molecular approaches: Morphology, anatomy, cytology, palynology, embryology, phytochemistry, Genome analysis; Angiosperm phylogeny groups (APG); Application of DNA markers.

Unit IV:

Taxonomic tools: Taxonomic keys, field and Herbarium techniques; Plant Collection and Documentation; GIS; Important International and National Herbaria and Botanical Gardens, their role in conservation of biodiversity⁹⁴.

Unit V:

Taxonomic features, systematic phylogeny and economic importance of families: Ranunculaceae, Asteraceae, Rosaceae, Rutaceae, Fabaceae, Asclepiadaceae, Acanthaceae, Apiaceae, Lamiaceae, Euphorbiaceae, Moraceae, Amaryllidaceae, Poaceae.

B040803T - Cytology, Cytogenetics and Plant Breeding

Credits: 4

M.M.: 25+75

Unit I:

Structure and function of cell wall; cytoskeleton; and plasmodesmata; Plasma membrane and membrane transport; nucleus and nucleolus; Structure, genome organization and function of mitochondria and chloroplast; Ultrastructure and function of endoplasmic reticulum, golgi apparatus, microbodies, lysosomes, peroxisomes, vacuole.

Unit II:

Ribosomes, t-RNAs; Protein sorting; chromosome structure; specialized chromosomes; DNA packaging, Centromere and Telomere; C- value paradox, Genetic and physical mapping of genes; Apoptosis; Cell Cycle: molecular mechanism of regulation.

Unit III:

Genetics of chloroplast and mitochondria,; Nuclear and cytoplasmic gene interaction, Sex determination in plants, Fine structure of gene, Introns and RNA splicing; Linkage groups, genetic markers; crossing over, Rec A and RecBCD enzymes.

Unit IV:

Mutations: physical and chemical mutagens; molecular basis of mutation; Transposable elements and mutations; DNA damage and repair mechanism; Structural alterations in chromosomes; Robertsonian and B-A translocations; Numerical alterations in chromosomes; effect of aneuploidy on phenotype in plants.

Unit V:

Introduction to Plant Breeding; plant introduction; Methods of selection and hybridization; selfing and crossing techniques, male sterility, Genetic basis of heterosis and inbreeding; Polyploidy and its significance; alien gene transfer of genome, chromosome and chromosome segment.

ELECTIVE PAPERS: Choose any one (B040804T/B040805T/B040806T)

B040804T - Conservation of Plant Diversity, Plant Propagation and IPR

Credits: 4

M.M.: 25+75

Unit-I:

Plant Diversity: concepts, significance and application; Current conservation Status and need for conservation, Conservation Status Assessment of threatened species, Red list index; Conservation status by IUCN red list category and definition; Biodiversity in the World: genetic, species and ecosystem diversity; Biodiversity hotspots in India and the World, their role in conservation, Climate change and biodiversity.

Unit-II:

Factors affecting biodiversity (biotic and abiotic), Reason for conservation deterioration (degradation of ecosystem, loss of mobility, expansion of vegetation, international trade and artificial conservation), Types of conservation (preventive, remedial and restoration).

Unit-III:

In situ conservation Protected areas, National parks, Wildlife sanctuaries, Biosphere reserves, Sacred forests; Ex situ conservation- Seed banks, Sacred groves, Botanical gardens; Cryopreservation, Natural reserves, Marine parks, Gene banks.

Unit-IV:

Global strategy for plant conservation (GSPC), Model for plant development conservation and sustainable use; Conservation programmes -Non-governmental organizations (NGOs), Governmental bodies -UNEP, DST, MOEF, FSI, CPCB, NMPB, AYUSH.

Unit-V:

Intellectual Property Rights: Introduction, Types, Need and Relevance, WIPO; WTO-TRIPS; National IPR Policy; Patents: Patentability Requirements, Types (process and product), Procedure, Specification, Infringement and remedies; Copyright and Trademarks: Basic Principles, Rights, and infringement; Geographical Indications; Plagiarism; Bioprospecting; Biopiracy; Bioethics.

B040805T- Industrial Microbiology

Credits: 4

M.M.: 25+75

Unit-I:

Introduction and scope of industrial microbiology; Biology of industrially important microbes; Principles of Biofermentation, fermentor design, types; fermentations- batch, continuous etc. Culture parameters (pH, oxygen, temperature, foam etc.), fermentation media, raw materials used in media production, antifoaming agents, buffers, Isolation, maintenance, preservation of industrially important strains.

Unit-II:

Downstream processing: Filtration, Ultracentrifugation, recovery of biological products by distillation, superficial broth extraction; Production aspects: Strain improvement strategies, substrates, Production optimization; Immobilization methods; Designer microbes using synthetic genome.

Unit-III:

Microbes in medicines: Antibiotics (production of penicillin and streptomycin), Interferons, Vaccines, Hormones, Vitamins, Novel medicines from microbes. Bioplastics, Pigments, Microbial transformations.

Unit-IV:

Production of Enzymes: amylase, protease. Production of Organic acids: citric acid, acetic acid, Production of Amino acids: glutamic acid, lysine. Bioremediation degradation of xenobiotics.

Unit-V:

Production of Alcoholic beverages: beer and wine; Vinegar production; Production of biofuels: ethanol, methane, biogas; Microbial Biofertilizers and Biopesticides.

B040806T- Ethnobotany, Pharmacognosy and Phytochemistry

Credits: 4

M.M.: 25+75

Unit - I:

Ethnobotany: Introduction; Brief history of ethnobotanical studies in the world and in India; Subdisciplines of ethnobotany; Scope of ethnobotany with special reference to medicinal plants. Basic concepts of Folk medicine and Ayurveda.

Unit - II:

Pharmacognosy: Definition, history, scope and development; Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins); Preparation of crude and commercial drugs; preparation of infusions, decoctions, lotions, washes, insect repellents, ointments, tinctures, herbal syrups, herbal oils and herbal salves.

Unit - III:

Drugs from roots and their pharmacognosy: *Glycyrrhiza glabra*, *Withania somnifera*. Drugs from rhizome and their pharmacognosy: *Zingiber officinale*, *Curcuma longa*. Drugs from Leaves and their pharmacognosy: *Andrographis paniculata*, *Clitoria ternatea*. Drugs from Bark and their pharmacognosy: *Terminalia arjuna*, *Holorrhena antidysentrica*.

Unit - IV:

Drugs from Bulbs and their pharmacognosy: *Allium sativum*, *Urginea indica*. Drugs from Flowers and their pharmacognosy: *Crocus sativus*, *Spilanthes acmella*. Drugs from Seeds and their pharmacognosy: *Piper longum*, *Mucuna pruriens*. Drugs from Fruits and their pharmacognosy: *Carum cuminum*, *Emblica officinalis*.

Unit - V:

Phytochemistry (Drug constituents): Carbohydrates, Cardiac glycosides, Alkaloids, Flavonoids, Tannins, Volatile Oils, Resins, Quinines and Steroids. Quality control of Drugs of Natural Origin: adulteration and evaluation by organoleptic, microscopic, physical, chemical and biological methods.

B040807P - PRACTICAL (Based on Theory Syllabus)

B040808R RESEARCH PROJECT (Total duration one year; to be started in Semester VII but evaluated at the end of Semester VIII)

FIFTH YEAR OF HIGHER EDUCATION

PAPER CODING AND CREDIT DISTRIBUTION

M.Sc. (BOTANY)

YEAR	SEMESTER	COURSE CODE	TITLE OF PAPER		CREDITS
FIFTH YEAR	IX	B040901T	PLANT PHYSIOLOGY AND BIOCHEMISTRY		4
		B040902T	ECOLOGY AND ENVIRONMENT CONSERVATION		4
		B040903T	INTEGRATED PEST AND DISEASE MANAGEMENT	CHOOSE ANY ONE	4
		B040904T	ECOTOURISM AND HERITAGE CONSERVATION		4
		B040905T	GREEN TECHNOLOGIES, GREEN AUDITION AND CIRCULAR ECONOMY		4
		B040906T	ADVANCED PHYCOLOGY	CHOOSE ANY ONE	4
		B040907T	FOREST BOTANY, DENDROLOGY AND ECONOMICS		4
		B040908T	SOIL CONSERVATION AND RECLAMATION		4
		B040909P	PRACTICAL		4
		B0409010R	RESEARCH PROJECT IN BOTANY*		4
	X	B041001T	PLANT RESOURCES AND UTILIZATION		4
		B041002T	MOLECULAR BIOLOGY, BIOTECHNOLOGY AND BIOINFORMATICS		4
		B041003T	PLANT NURSERY, GARDENING AND LANDSCAPING	CHOOSE ANY ONE	4
		B041004T	BIOTECHNOLOGY AND HUMAN WELFARE		4
		B041005T	CROP GENETICS AND PLANT BREEDING		4
		B041006T	WEED BIOLOGY AND MANAGEMENT	CHOOSE ANY ONE	4
		B041007T	SEED PATHOLOGY		4
		B041008T	PLANT GENOMICS AND PROTEOMICS		4
		B041009P	PRACTICAL		4
		B0410010R	RESEARCH PROJECT IN BOTANY*		4

***Research Project in Botany of both the Semesters (IX and X) will be jointly evaluated at the end of the Semester X as per University Guidelines**

SEMESTER – IX

B040901T - Plant Physiology and Biochemistry

Credits: 4

M.M.: 25+75

Unit I:

Membrane transport and translocation, membrane transport proteins; Transpiration, mechanism of stomatal opening and closing; Mineral Nutrition, Enzymes: General characteristics and classification, active sites, isozymes, coenzymes Regulation of enzyme activity and allosteric mechanism, kinetics of enzyme catalysis; Michaelis-Menten equation.

Unit II:

Photosynthesis: Historical background, photosynthetic pigments and light harvesting complexes, Carbon assimilation; Calvin cycle, Photorespiration (C2 Cycle) and C4 cycle; CAM pathway; synthesis of starch and sucrose.

Unit III:

Respiration and Lipid metabolism: Glycolysis, Krebs' Cycle Pentose phosphate Pathway, electron transport and ATP synthesis; Glyoxylate cycle; Alternate oxidase system, Structure and functions of lipids, fatty acid biosynthesis, lipid catabolism. Nitrogen and sulphur metabolism: Biological nitrogen fixation, nodule formation and nod factors; mechanism of nitrate uptake and reduction; ammonia assimilation; sulphur assimilation. Secondary metabolites and their function.

Unit IV:

Photoperiodism; Floral induction, genetic and molecular analysis; Vernalization; Phytochromes, cryptochromes; Phytohormones, Brassinosteroids, Polyamines, Jasmonic acid and Salicylic acid.

Unit V:

Plant responses to biotic and abiotic stress, mechanism of tolerance, HR and SAR; Stress Proteins (HSP, LEA etc.); Water deficit, drought resistance salinity, metal, temperature, light and oxidative stress; Programmed cell death (PCD) in plants during vegetative and reproductive stages; PCD and senescence.

B040902T - Ecology and Environment Conservation

Credits: 4

M.M.: 25+75

Unit I:

Ecosystem structure and function; primary production (methods of measurement); energy dynamics (trophic organization, energy flow pathways and ecological efficiency); Concept of carrying capacity; Biogeochemical cycles (C, N, P, S); Major terrestrial biomes, Vegetation patterns of India.

Unit II:

Synecology- community and continuum; characters and coefficients, inter and intra-specific associations; Concept of ecological niche; Autecology; Plant responses to environmental factors (climate, edaphic, Biotic, topographic and geographic factors); Temporal changes (cyclic and noncyclic); Ecological succession (Relay floristics and initiation floristic composition, facilitation, tolerance and inhibition models).

Unit III:

Biodiversity: levels and role in ecosystem functioning; Endemism, Hotspots; Speciation and extinction; IUCN categories of threat; Strategies of conservation: in situ (sanctuaries, national parks, biosphere reserves, wet lands, mangroves and coral reefs) and ex-situ (botanical gardens, gene banks, seed banks, cryobanks); International efforts and Indian initiatives; Role of NSC, BSI, NBPGR, ICAR, CSIR, DST and DBT in conservation.

Unit IV:

Air, water and soil pollution: causes, effects, control and quality parameters; Bio-indicators; Acid rain; Greenhouse gases, ozone depletion and Global warming; Consequences of Climate change; Radioactive and Noise pollution, Remediation of water and soil pollution.

Unit V:

Ecosystem stability: Concepts (resistance and resilience), Role of biodiversity; Plant invasions and introductions; Environmental Legislation; Ecological management; Environment Impact Assessment; Sustainable development, Sustainability indicators.

ELECTIVE PAPER: Choose any one (B040903T/ B040904T/B040905T)

B040903T – Integrated Pest and Disease Management

Credits: 4

M.M.: 25+75

Unit-I:

General introduction to Integrated Pest and Disease Management; History and modern concepts; Principles of Plant Pathology; Koch's postulates; Developing IPM programmes; Chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases.

Unit-II:

Transmission of diseases; Pathogenesis; Effect of environmental factors on disease development; Epidemiology and Disease forecasting; Pre-existing structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds; Molecular aspects of host pathogen interactions.

Unit-III:

Introduction to economically important insect pests; Symptoms, disease cycle and management of important diseases caused by Bacteria, Viruses, Phytoplasma, Mycoplasma, and Nematode.

Unit-IV:

Symptoms, disease cycle and management of important diseases caused by Fungi: Blights, Rusts, Smuts, Rots, Mildews, Wilts and Damping off, Galls and curls, Blast disease of rice and Mango anthracnose; Seed Pathology, Seed certification.

Unit-V:

Management of plant diseases: Cultural, chemical, biological, regulatory, breeding for resistant varieties, Bio-insecticides: *Bacillus thuringiensis* (Bt), *Beauveria bassiana*; Molecular biology in plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants.

B040904T – Ecotourism and Heritage Conservation

Credits: 4

M.M.: 25+75

Unit-I:

Ecotourism: conserving natural and cultural heritage, forms (hard and soft ecotourism), risks benefits and disadvantages of ecotourism, Ecotourism indicators and conceptual differences between developed and developing countries, Sustainable ecotourism, characteristics and principles of sustainable ecotourism.

Unit-II:

World Tourism Organization (WTO), World Tourism & Travel Council, (WTCC), Role and functions of National and state agencies involved in promotion of ecotourism in India. Promotional measures initiated by National and State Governments in India and Private Tourism Agencies – recent trends.

Unit-III:

Planning ecotourism in Protected Areas; Visitor management: zoning, carrying capacity. Ecotourism in practice in important Protected Areas of India - Case studies of Periyar Tiger Reserve, Keoladeo National Park and Jim Corbett National Park; Limitations and problems of ecotourism.

Unit-IV:

Culture and Heritage of India- History and Significance; Problems and prospects; Architectural Heritage: Temple Architecture, Indo-Islamic Architecture, Modern Architecture, Forts and Palaces with suitable examples.

Unit-V:

Cultural Heritage: Fairs and Festivals, Performing arts, Dance and Music, Myths and Legends, Cuisines, Handicrafts; Preservation and Conservation of Monuments and Culture; Management and Marketing of Religious Tourism, Festivals and Religious Events.

B040905T – Green technologies, Green Auditing and Circular economy
Credits: 4 **M.M.: 25+75**

Unit-I:

Green technology-definition, importance, factors affecting green technology; Twelve principles of Green Chemistry; Role of Industry, Government and Institutions; Industrial Ecology and its significance in Green Technology. Green manufacturing systems; Sustainable Green Production Systems and their implementation.

Unit-II:

Classification of energy sources, their Contribution in agriculture, Biomass utilization for bio-fuel production, Availability and applications; Types of Biogas plants and gasifiers, Bio-alcohol, Biodiesel, Briquetting; Solar energy, solar collectors and energy gadgets: solar cooker, solar water heater, Application of solar energy: solar drying, solar distillation, solar photovoltaic system and their application, Wind energy and its application.

Unit-III:

Energy management, Solid Waste Management, Water management, Hazardous waste Management, E-waste management, Green Buildings: Features and benefits, Ecofriendly and cost effective materials, Generating carbon foot print data, Cleaner development technologies and mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; Carbon credits, Carbon trading, Carbon sequestration, Eco labelling.

Unit-IV:

Green Auditing: Importance and methodology; Pre-audit Stage: Establishment of Environmental Management System, Governance of Environmental Management, Declaration of Environmental Policy, Planning of Programmes/Activities, Implementation and Operations. Audit Stage: Actual Auditing, Checking of Documents and Evaluation, Review of Environment Policy, Review of Programmes/Activities. Post-audit Stage: Evaluation of Findings, Reporting with Recommendations, Preparation of Action Plan, Follow-up, Certification, Continuous Process Assessment.

Unit-V:

Linear Economy: Emergence, Economic and Ecological disadvantages; Circular Economy: Concept and its Development, Characteristics of Circular Economy: Material recovery, Waste Reduction, reducing negative externalities, Butterfly diagram, Concept of Loops Circular design, innovation and Assessment, Zero waste: Waste Management in context of Circular Economy, Circular design, Research and innovation, LCA, Circular Business Models; Linear Vs Circular Economy; Role of governments and networks, Universal circular economy policy goals, India and CE strategy.

ELECTIVE PAPER: Choose any one (B040906T/ B040907T/B040908T)

B040906T – Advanced Phycology

Credits: 4

M.M.: 25+75

Unit I:

Laboratory Culture of Algae: Culture of algae, Necessity, Types, Material, Synchronous, Continuous, Mass and “In vitro” culture. Methods of Algae isolation, Cryopreservation of algae, Strain selection, Growth kinetics and measurements of Algal growth.

Unit II:

Production of Algae: Laboratory to Land – Mass multiplication of economically important algae (Rhodophyta, Phaeophyta, Chlorophyta, Cyanophyta). Large scale cultivation, Processing, Yield chemical composition, Nutrition, Quality standard.

Unit III:

Phycoremediation: Bioremediation, Sewage disposal and waste treatment, Textile and effluent sugar industry, Single cell protein, Phycocolloids, Biofertilizers and seaweed liquid fertilizers, Tissue culture of microalgae.

Unit IV:

Algal Biotechnology and entrepreneurship development, Algae in hydrogen and hydrocarbon production biofuel, seaweed resources of the world and India.

Unit V:

Aquatic pollution, Causes and consequence: Eutrophication and its impact on water quality, Algae as indicators in assessing water quality and pollution, Algae in environmental health, Sewage treatment and treatment in industrial water quality, Algae blooms, Nuisance of algae and their control.

Practical (Advanced Phycology):

1. To study and identify various (at least 5) algae available in your locality along with their Camera Lucida drawings.
2. To survey market products of algal material.
3. To illustrate various methods prescribed for algal culture.
4. To culture any one alga (*Spirulina/ Chlorella / Scenedesmus/ Botryococcus/ Dunaliella*) in laboratory.
5. To isolate and maintain any two nitrogen fixing Blue Green Algae (BGA).
6. To isolate and *in vitro* maintenance of *Spirulina*.
7. To estimate the algal proteins of the cultured alga.

8. To extract DNA and its quantification by using suitable algal material.
9. To extract RNA and its quantification by using suitable algal material.
10. Biochemical analysis of the cultured alga for food/bio-fuel properties.
11. To Separate proteins from cultured alga by using SDS-PAGE Electrophoresis Technique.
12. To isolate algal protoplast and study its fusion.
13. To study BGA biofertilizer production technology.
14. Visit commercial algal production unit and submission of report.
15. To prepare culture medium for Algal growth.
16. To draw the Camera Lucida diagram of a given Algal slide for identification.
17. To calibrate the magnification of Algae using micrometer under low or high power of microscope.
18. To learn how the algal genus pollution index is used to determine the level of organic pollution in a water/soil sample.

B040907T – Forest Botany, Dendrology and Economics

Credits: 4

M.M.: 25+75

Unit I:

Forests – definition, classification and brief description of forest types. Forestry – scope and branches. Silviculture: scope and objectives; Site and species selection, planting, maintenance and other silvicultural operations. Types of Forest plantations and Rotations, High density short rotation plantations, pulpwood plantations and energy plantations.

Unit II:

Forest Pathology: Diseases, signs and symptoms of bacterial and fungal tree diseases (wood decay, root rot, wilt, rust, canker). Role of mycorrhizae in tree health; Forest Entomology: insect-plant relationship, population dynamics of forest insects, insect feeding groups, Insect pests of Teak, Sal, Sheesham and Pine. Integrated management of pests and diseases in Silviculture.

Unit III:

Sustainable Forest management (SFM) and livelihood strategies, Joint Forest Management (JFM) as a strategy for SFM; National Forest Policy; National Green Tribunal Act 2010.

Unit IV:

Taxonomy and its relevance to wood science. Taxonomic identification tools: bark, stem, leaf, flower, fruit, seed. Systematic positions and diagnostic features of Teak, Sal, Sheesham and Pine.

Unit V:

Forest Economics: Nature and scope; Concept of demand and supply, Measurement of National income, GNP and GDP. Application of microeconomics in solving forest resource problems, Forest products demand and supply analysis; Forest product marketing; Forest Capital Theory, concept of cost and benefits, Trade of timber and non-timber forest products (NFTPS), Ecosystem services.

B040908T – Soil Conservation and Reclamation

Credits: 4

M.M.: 25+75

Unit I:

Soils: Parent material and development of soil, Major processes of soil formation: calcification, podsolization and laterization; Soil profile, physical chemical and biological properties of soils; Soils of India, Characteristics of problem soils.

Unit II:

Soil erosion: definition and classification. Nature and extent soil erosion in India, Factors and processes of soil erosion; its impact on environment and biosphere, Rainfall erosivity and soil erodibility, Shifting cultivation, vegetative and mechanical measures of soil erosion control; Reclamation of ravine lands. Sand dune stabilization; Impact of grazing and forest fires, Control measures of grazing and forest fires.

Unit III:

Assessment and criteria for soil degradation, sedimentation and desertification; Role of climatic factors (water and temperature) for soil degradation. Technological development for management of various types of wastelands - hot desert, saline-alkali, ravine, coastal soils, laterites, rocky eroded hill slope, coal mine areas etc.

Unit IV:

Biological aspects of soil conservation: conservation farming and irrigation, role of vegetation, conservation tillage and mulch in various land climate conditions; Biological measures in dryland, rainfed, arid, semi-arid, and humid lands; Water use efficiency, selection of draught tolerant plants, role of grasses, legumes in conservation, pasture and range-land management and its improvement; Management of waterways, canal bank, bench terrace through biological means.

Unit V:

Restoration of chemically degraded soils: Acid soils – nature, distribution, formation and properties, effect of acidic, halomorphous and hydromorphic conditions on plant growth and nutrient availability. Acid sulphate soils – occurrence, distribution, characteristics and effects on plant growth and nutrient availability and its reclamation techniques.

B040909P PRACTICAL (Based on Theory Syllabus)

B0409010R - RESEARCH PROJECT (Total duration one year; to be started in Semester IX but evaluated at the end of Semester X as per University Guidelines)

SEMESTER – X

B041001T – Plant Resources and Utilization

Credits: 4

M.M.: 25+75

Unit I:

Plant biodiversity: concepts, its importance for Man; Origin of cultivated plants; Vavilov's centres of origin Primary diversity, Secondary centres, The Indo-Burma Centre; Plant introductions, Indian perspective.

Unit II:

Origin, evolution, botany, cultivation and uses of Cereals and Millets; Legumes and Pulses; Fruits and Vegetables.

Unit III:

Origin, evolution, botany, cultivation and uses of Forage/fodder crops; Oil yielding crops; Fibre crops; Spices and condiments; Medicinal and aromatic plants.

Unit IV:

Origin, evolution, botany, cultivation and uses of Beverage yielding plants; Wood and timber yielding plants, Non-wood forest products (NWFP); Gum, resin, and dye yielding plants, Latex yielding plants.

Unit V:

Avenue trees for shade, pollution control and aesthetics; Biofuel plants; innovations for meeting world food demand; Green Revolution.

B041002T – Molecular Biology, Biotechnology and Bioinformatics

Credits: 4

M.M.: 25+75

Unit I:

Structure and nature of DNA and RNAs; DNA replication; Protein synthesis in prokaryotes and eukaryotes, regulation of protein synthesis (Structural, regulatory genes and operon model), ubiquitins.

Unit II:

Basic concepts and scope of Biotechnology; Plant Cell and Tissue Culture: cell culture; embryo culture, anther culture; applications Clonal propagation, artificial seed, production of secondary metabolites, cryopreservation; Somatic hybridization and applications.

Unit III:

Recombinant DNA technology: principles, tools and techniques, choice of vectors; Gene tagging; Genetic engineering of plants: Strategies for development of transgenics with *Agrobacterium* (with suitable examples), Chloroplast information and its utility.

Unit IV:

DNA synthesis and sequencing; Preparation of molecular probes and their uses RAPD, RFLP, AFLP; Polymerase Chain Reaction; DNA fingerprinting; Genomic and cDNA libraries, Intellectual Property Rights; Ethical concerns.

Unit V:

Bioinformatics: General introduction and applications; Databases: Classification, NCBI, EMBL, PubMed; TAIR, PDB; Online tools - BLAST, ORF finder, Primer3, Protein motif and structure prediction tools.

ELECTIVE PAPER: Choose any one (B041003T/ B041004T/B041005T)

B041003T - Plant Nursery, Gardening and Landscaping

Credits: 4

M.M.: 25+75

Unit-I:

Nursery Management and Production, Plant Morphology, Plant pests, diseases and protection, Soil properties, Nutrient deficiency in plants, Common garden weeds and weed control, Greenhouse, Composts, Irrigation; Plant propagation (Cuttings: Soft stem, semi hard and hard wood; Layering, Grafting, Division and Budding), Floral decoration, Flower arrangement and Ikebana, Entrepreneurship Development.

Unit-II:

History, importance and scope of gardening; Types of gardens-formal and informal; Different styles of gardens-Hindu gardens (van), Mughal gardens, Italian gardens, English gardens, Japanese gardens; Popular gardens in India.

Unit-III:

Garden Features and Ornamentation: Water features, Paths, Hedges, Arches, Pergolas, Screens, Statues, Conservatories, Lawns, Flower beds, Shrubberies, Vertical Gardening, Terrariums, Kokedama, Container gardening, raised beds and Hanging baskets,.

Unit-IV:

Specialized Gardens (Kitchen, Rock, Water, etc.), Choice of Plants- Annuals, Perennials, Seasonals, Bulbous plants, Hedges, Topiary, Foliage and Plants, Climbers, Hydrophytes, Bonsai.

Unit-V:

Principles of Landscape Designing, Planning and Laying out, Budget and estimation, Hard-scaping and soft-scaping, Landscape designing for homes, children's parks, public places, Avenues. Landscaping softwares.

B041004T- Biotechnology and Human Welfare

Credits: 4

M.M.: 25+75

Unit-I:

Fermented foods and beverages; Industrial production of cheese and bread, Industrial production of fermented vegetables and dairy products; Industrial production of alcoholic beverages (beer, wine) and vinegar; Production of Probiotics and prebiotics; food colouring and naturally occurring flavour modifiers.

Unit-II:

Food modifying enzymes (amylase, proteases, lipases) in food processing; Amino acid production: glutamic acid and lysine; Enzymatic bioconversions (starch and sugar conversion processes); Production of Bioenergy, Bioethanol and Biodiesel, Biomethanation (Biogas from anaerobic treatment).

Unit – III:

Production of antibiotics; Gene Therapy; recombinant DNA and protein based vaccines, plant-based vaccines, Monoclonal antibody based pharmaceuticals; Microarrays; Diagnostic proteomics and metabolomics; Direct detection and identification of pathogens; Predictive biomarkers for personalized onco-therapy; DNA fingerprinting in solving crimes (murder, rape) and paternity claims.

Unit – IV:

Plant tissue culture and applications; Genetic engineering: Transgenic plants for pest, herbicide, disease resistance, abiotic stress tolerance, production of useful products, Production and uses of haploids; Biopesticides; Biofertilizers; Improvement of Nitrogen fixing microbes.

Unit – V:

Water pollution control: primary, secondary and tertiary treatment; industrial waste water and sewage treatment; Solid waste and soil pollution management: Biodegradation of xenobiotics and toxic wastes (chlorinated and non-chlorinated organic pollutants), Degradation of hydrocarbons and agricultural wastes, Phytoremediation, Environmental monitoring using bioindicators, biomarkers and biosensors; Biopolymers and Bioplastics.

B041005T - Crop Genetics and Plant Breeding

Credits: 4

M.M.: 25+75

Unit-I:

History of genetics, Mendelian Genetics, Chromosomal theory of inheritance; Mendelian inheritance and interaction of genes: Complementary, Epistasis, Inhibitory, Duplicate, Polymeric, Lethal and Additive interaction of genes. Extra chromosomal inheritance: Cytoplasmic inheritance involving chloroplast (*Mirabilis jalapa*, *Zea mays*) and Mitochondria (petite yeasts and cytoplasmic male sterility in higher plants), paternal inheritance.

Unit-II:

Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; polygenes and quantitative trait loci (QTL); Mutations and mutagenic agents, their practical application in crop improvement (brief idea of molecular basis); Population: Mendelian population, Random mating population, Frequencies of genes and genotypes, Hardy-Weinberg equilibrium.

Unit-III:

Plant Breeding: Past perspective and future, green revolution, evergreen revolution; Mating Systems: Self-fertilization, full sib mating, half sib mating, back crossing; inbreeding and backcrossing; random mating, assortative and disassortative matings, sister line crosses, convergent crosses, complex crosses, diallel selective mating. Breeding self-pollinated crops: pure line theory and its genetic basis; pure line and mass selection; pedigree method and its modification, bulk population method and its modifications. Backcross method; testing and evaluation of pure lines.

Unit-IV:

Breeding cross pollinated crops: Self-incompatibility and male sterility in crops, genetic basis and use in hybrid seed production; Heterosis, exploitation and fixation of heterosis; selection, recurrent selection; development of hybrids, synthetics and composites. Hybrid breeding: genetic consequences of hybridization (segregation and recombination of genes); composition of populations derived from hybrids; role of genotype and environment in continuous variation.

Unit-V:

Breeding methods in asexually/clonally propagated crops, Somatic mutations, examples of sugarcane and potato crops; Special breeding techniques - Mutation breeding; Breeding for abiotic and biotic stresses. Crop varieties: Identification, release and notification of crop varieties, institutions involved in release of varieties. Participatory Plant Breeding; Plant breeder's rights and regulations for plant variety protection and farmer's rights.

ELECTIVE PAPER: Choose any one (B041006T/B041007T/B041008T)

B041006T- Weed Biology and Management

Credits: 4

M.M.: 25+75

Unit-I:

Weeds: Definition, Characteristics and significance; Classification of weeds; Common Morphological characteristics of weeds. Invasion and Introduction of weeds (Case studies); weed persistence.

Unit – II:

Common weeds and their lifecycle: *Parthenium hysterophorus*, *Ageratum conyzoides*, *Cyperus rotundus*, *Cuscuta reflexa*, *Eicchornia*; Weed propagation and dissemination; Reproductive methods and ecology in specific systems, Phenology.

Unit – III:

Weed ecology, Crop weed competition/interferences; factors affecting crop weed competition; Allelopathy and weed control. Weed control methods: prevention, physical, cultural, chemical and biological control.

Unit – IV:

Herbicide classification, formulations and modes of action, Herbicide behaviour in soil and plants, Selectivity of herbicides; Adjuvants, Herbicide resistance: origin, mechanisms and management.

Unit – V:

Integrated Weed Management Programmes, Developing Weed Management Programmes, Weed management in major field and horticultural crops, Problematic weeds and their control.

B041007T- Seed Pathology

Credits: 4

M.M.: 25+75

Unit-I:

Introduction, history and importance of seed pathology; Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds; Seed structure and development in relation to infection and infestations.

Unit-II:

Mechanism of seed infection, Factors affecting seed transmission of pathogens; Evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases; Recent advances in the establishment and subsequent cause of disease development in seed and seedling; Forecasting of epidemics through seed borne infections.

Unit-III:

Important seed-borne diseases: their nature, detection, transmission, development and control, Losses caused by seed-borne diseases; Deterioration of seed by storage fungi. Production of toxic metabolites affecting seed quality and its impact on human and animal

Unit-IV:

Seed health testing, methods for detecting microorganisms; Seed testing organizations network in India; National and international seed testing rules; Seed sampling, heterogeneity test, Insect damage, Seed treatment.

Unit-V:

Seed certification and quality control: Importance; Seed quality standards definition and concept. Concept, purpose and phases of seed certification; tolerance levels; Seeds Act and Seeds rules and law enforcement; Seed inspection procedures and equipment; Role of Quality Control for import and export of seeds.

B041008T- Plant Genomics and Proteomics

Credits: 4

M.M.: 25+75

Unit I:

Introduction to Genomics, Prokaryotic and eukaryotic genome, C value paradox, CoT curve analysis, repetitive DNA, DNA sequencing methods manual & automated: Maxam & Gilbert method, Sangers method; Pyrosequencing; Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit II:

Gene analysis: methods for sequence alignment and gene annotation; Approaches to analyze differential expression of genes ESTS, SAGE, microarrays (cDNA and protein microarray) and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants, and annotation.

Unit III:

Transcriptomics and expression profiling: Genome expression analysis, RNA content and profiling, RNAi and gene silencing, genome imprinting, small RNAs and their biogenesis, Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, NCBI genome; Genomics of model plants and related crop species.

Unit IV:

Introduction and Importance of proteomics, strategies in analysis of proteome: 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF); Structure of protein and formation of oligomers; Protein solubility and interaction with solvents and solutes, activity of proteins.

Unit V:

Applied proteomics: Databases and Search engines in proteomics, Post translational protein modifications, protein localization, Identification and characterization of novel proteins, protein engineering principles.

B041009P - PRACTICAL (Based on Theory Syllabus)

B041010R - RESEARCH PROJECT (Total duration one year; to be started in Semester IX but evaluated at the end of Semester X)