KISAN POST GRADUATE COLLEGE, BAHRAICH (UP) 271801
(Autonomous)

Proposed Structure of syllabus for the
PROGRAM: UG (B.Sc.)

SUBJECT: BOTANY

Syllabus developed/proposed by

S.No.	Name	Designation	Department	College/University
1.	Dr. Gopal Krishna Shukla	Convener	Botany	Kisan P.G. College, Bahraich
2.	Prof. S.N. Pandey	University Nominee	Botany	University of Lucknow, Lucknow
3.	Dr.N.K. Singh (Retd.)	Subject Expert	Botany	M.L.K.P.G. College, Balrampur
4.	Dr. P.K. Shukla	Subject Expert	Botany	Brahmanand P.G. College, Kanpur
5.	Dr. Anand Kumar Srivastava	Member	Botany	Kisan P.G. College, Bahraich
6.	Dr. Suresh Chandra Shukla	Member	Botany	Kisan P.G. College, Bahraich
7.	Dr. Rahul Kumar Singh	Member	Botany	Kisan P.G. College, Bahraich
8.	Dr. S.C. Tripathi (Retd.)	Invited Member	Botany	Kisan P.G. College, Bahraich

SEMESTER WISE TITLES OF THE PAPERS IN UG (BOTANY)					
Year	Semester	Course Code	Paper Title	Theory/Practical	Credits
CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & APPLIED BOTANY					
FIRST	SEM-I	B040101T	MICROBIOLOGY AND PLANT PATHOLOGY	THEORY	4
		B040 102P	TECHNIQUES IN MICROBIOLOGY & PLANT PATHOLOGY	PRACTICAL	2
	SEM-II	B040201T	ARCHEGONIATES &PLANT ARCHITECTURE	THEORY	4
		B040202P	LAND PLANT ARCHITECTURE	PRACTICAL	2
DIPLOMA IN PLANT IDENTIFICATION ,UTILIZATION & ETHNOMEDICINE					
SECOND	SEM-III	B040301T	FLOWERING PLANTS IDENTIFICATION &AESTHETIC CHARACTERISTICS	THEORY	4
		B040302P	PLANT IDENTIFICATION TECHNOLOGY	PRACTICAL	2
	SEM-IV	B040401T	ECONOMIC BOTANY ,ETHNOMEDICINE AND PHYTOCHEMISTRY	THEORY	4
		B040402P	COMMERCIAL BOTANY AND PHYTOCHEMICAL ANALYSIS	PRACTICAL	2
DEGREE IN BACHELOR OF SCIENCE					
THIRD	SEM-V	B040 501T	PLANT PHYSIOLOGY, METABOLISM & BIOCHEMISTRY	THEORY	4
		B040502T	MOLECULAR BIOLOGY & BIOINFORMATICS	THEORY	4
		B040503P	EXPERIMENTS IN PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY	PRACTICAL	2
		B040504R	PROJECT- I	PRACTICAL	3
	SEM-VI	B040601T	CYTOGENETICS, PLANT BREEDING & NANOTECHNOLOGY	THEORY	4
		B040602T	ECOLOGY & ENVIRONMENT	THEORY	4
		B040 603P	CYTOGENETICS, CONSERVATION & ENVIRONMENT MANAGEMENT	PRACTICAL	2
		B040604R	PROJECT- II	PRACTICAL	3

Subject prerequisites:

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

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) 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 Program covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

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

Program Outcomes (POs)

PO1: 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.

PO2: 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 and increase awareness in judicious use of plant resources by recognizing the ethical value system.

PO3: 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

PO4: Certificate and diploma courses are framed to generate self- entrepreneurship and self employability, if multi exit option is opted.

PO5: Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

Program Specific Outcomes (PSOs)		
First Year	***B.Sc. I Year / Certificate course in Microbial Technology & Applied Botany***	This Program 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.
Second Year	***B.Sc. II Year/ Diploma in Plant Identification, Utilization and Ethnomedicine***	This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromising on academic 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, and protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.
Third Year	***B.Sc. III Year / Degree in Bachelor of Science***	The learning outcomes of a three years graduation course are aligned with Program learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with 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.

Proposed Year wise Structure of B.Sc. in Botany (CORE / ELECTIVE COURSES & PROJECTS)											
	Subject: Botany										Total Credit/ hrs
Course/ Entry –Exit level	Year	Sem.	Paper I	Credit/ hrs	Paper II	Credit/hrs	Paper III	Credit/ hrs	Research Project	Credit	
Certificate Course In Microbial Technology & Applied Botany	I	I	Microbiology & Plant Pathology	4/60	Techniques in Microbiology & Plant Pathology	2/60	-	-	Nil	Nil	6/120
		II	Archegoniate & Plant Architecture	4/60	Land Plants Architecture	2/60	-	-	Nil	Nil	6/120
Diploma in Plant Identification, Utilization & Ethnomedicine	II	III	Flowering Plants Identification & Aesthetic Characteristics	4/60	Plant Identification technology	2/60	-	-	Nil	Nil	6/120
		IV	Economic Botany, Ethnomedicine & Phytochemistry	4/60	Commercial Botany & Phytochemical Analysis	2/60	-	-	Nil	Nil	6/120
Bachelor of Science	III	V	Plant Physiology, Metabolism & Biochemistry	4/60	Molecular Biology & Bioinformatics	4/60	Experiments in physiology &Biochemistry	2/60	Project-I*	3/45	13/205
		VI	Cytogenetics, Plant Breeding & Nanotechnology	4/60	Ecology & Environment	4/60	Cytogenetics, Conservation & Environment management	2/60	Project-II *	3/45	13/205
Comments	Total Credits/Hrs. / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/ Virtual/ ICT based as per choice of the Institution) * Suggestive List of Projects mentioned in Detailed Paper Syllabus.										

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/ Biotechnology /Microbiology
Third Major Subject can be from Science or Any other faculty of UGC /AICTE – (Arts/ Agriculture/ Education/ law/ Commerce)
Fourth 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 Performance	5	Viva Voce on Practical's	10
Quiz/Test/House exam	10	Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models/ Assignment	10
Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training.	10	Table work / Experiments Performance	45
Total	25	Practical Record File	10
		Total	75

B.Sc. I (SEMESTER-I) PAPER-I

Title: *Certificate Course in Microbial Technology & Applied Botany*

Programme : *Certificate Course in Microbial Technology & Applied Botany*	Year: I	Semester: I
Subject: BOTANY		
Course Code: B040101T	**Course Title: *Microbiology and 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. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens
3. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
4. Gain knowledge about developing commercial enterprise of microbial products.
5. Learn host –pathogen relationship and disease management.
6. Gain knowledge about the economic values of this lower group of plant community.

Credits: 4	Core / Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0	

Unit	Topics	No. of Lectures
I	**A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/ assignments / self-study mentioned under Continuous Internal Evaluation (CIE).** **B. Microbial Techniques & instrumentation** Microscopy – Light, phase contrast, Scanning and transmission electron microscopy, Staining techniques for light microscopy, Common equipment of microbiology lab and principle of their working – Autoclave, Oven, Laminar air flow, Centrifuge. Colorimetry and spectrophotometry, Immobilization methods, fermentation and fermenters.	8
II	**Microbial world** Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; Difference between Eubacteria and Archaebacteria; Bacterial Chemotaxis and Quorum sensing, Bacterial Growth curve, factors affecting growth of microbes; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation, reproduction and recombination in bacteria. Viruses, general characteristics, Structure of viruses, Bacteriophages, Structure of T4 &, λ-phage; Lytic and Lysogenic cycles, Viroid, Prions , Mycoplasma, Actinomycetes. Plasmids and their economic uses.	8
III	**Phycology** Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – *Nostoc, Chlorella*, *Volvox, Oedogonium, Chara; Sargassum, Ectocarpus, Polysiphonia.* Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation-Symbiosis; Commercial products of algae –biofuel, Agar.	7
IV	**Mycology** General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification up to class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina: *Phytophthora*. Zygomycotina: *Rhizopus,* **Ascomycota:** *Penicillium* **Basidiomycotina:** *Puccinia, Ustilago, Agaricus;* **Deuteromycotina:** *Alternaria*. Heterothallism, Heterokaryosis & Parasexuality	7
V	**Mushroom Cultivation, Lichenology & Mycorrhiza** Mushroom cultivation. General account of lichens, reproduction and significance; *Mycorrhiza: ectomycorrhiza* and *endomycorrhiza* and their significance.	7
VI	**Plant Pathology** History of plant pathology; of world and India, Contribution of Indian Phytopathologists. Symptoms; of fungal, bacterial and viral diseases. Inoculum; inoculation and inoculums potential. Terminology in phytopathology. Koch's postulate. Mechanism of infection; brief idea about Pre-penetration, Penetration and Post-penetration. Disease cycle.	7

	Defense mechanism with special reference to phytoalexin. Disease management; Resistance – systemic ,acquired and induced systemic fungicides- Chemical (Bordeaux mixture,lime sulphur), biological (*Trichoderma*), Tobacco decoction,Neem cacke and oil.	
VII	**Diseases and Control** Symptoms, causal organisms, disease cycle and control measures of: 1. Damping-off of seedlings. 2. White rust of crucifer 3. Red Rot of Sugarcane 4. Wilt of Arhar 5. Late and Early Blight of potato. 6. Black stem rust of wheat 7. Citrus canker 8. Little leaf of Brinjal 9. Mosaic Disease of Tobacco and Cucumber Disease management: Quarantine, Chemical ,Biological, Integrated Pest Disease Management.	**8**
VII	**Applied Microbiology** Food fermentations and food produced by microbes, amino acids, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Mass production of bacterial biofertilizers, blue green algae, *Azolla* and *mycorrhiza*. Plant Growth Promoting Rhizobacteria, Biopesticides— *Trichoderma sp.* and *Pseudomonas*, Single cell proteins, Organic farming inputs, Microbiology of water, Bioploymers, Bioindicators, Biosensors, Bioremediation, Production of biofuels, biodegradation of pollutants and biodeterioration of materials & Cultural Property.	**8**

Suggested Readings:

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

Unit-I A:

https://indianculture.gov.in/rarebooks/economic-botany-india

https://www.infinityfoundation.com/mandala/t_es/t_es_tiwar_botany_frameset.htm

ii.https://www.researchgate.net/publication/335715457_Ancient_Indian_rishi's_Sages_knowledge_of_botany_and_medicinal_plants_since_Vedic_period_was_much_older_than_the_period_of_Theophrast us_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, NewDelhi.
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., NewDelhi.
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 the 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 (Max. Marks: 25): Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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/ 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: 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/

Further Suggestions:

B.Sc. I (SEMESTER-I) PAPER-II

Title: ***Certificate Course in Microbial Technology & Applied Botany***

Programme : ***Certificate Course in Microbial Technology & Applied Botany***	**Year: I**	**Semester: I**
Subject: BOTANY		
Course Code: B040101P	**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. Practical skills in the field and laboratory experiments in Microbiology & Pathology. 3. Learn to identify Algae, Lichens and plant pathogens. 4. Can initiate his own Plant & Seed Diagnostic Clinic 5. Can start own enterprise on microbial products		
Credits: 2	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2		
Unit	**Topics (Minimum Any three from each unit depending on facilities)**	**No. of Lectures**
I	**INSTRUMENTS & TECHNIQUES** 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments: A. Compound microscope B. Incubator C. Autoclave D. Centrifuge E. Laminar Air Flow F. pH Meter 4.Buffer preparation and titration 5.Cleaning and sterilization of glass wares 6. Preperation of Media-Nutrient agar and Broth. 7. Inoculation and culturing of Bacteria in NA and NB. 8. Prepration of agar slant, stab agar plate.	**7**
II	**BACTERIAL IDENTIFICATION** 1. Isolation of bacteria. 2. Identification of bacteria. 3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 4. Cultural characteristics of bacteria on NA. 5. Pure culture techniques (Types of streaking). 6. Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.	8
III	**MYCOLOGICAL STUDY:** *1.* Identification of fungi by lactophenol cotton blue method. *A. Rhizopus* *B. Penicillium* *C. Puccinia* *D. Alternaria* *E. Agaricus*: Specimens of button stage and full grown mushroom. *F.* Lichens: Crustose, Foliose and fruticose specimens.	8
IV	**PHYCOLOGY:** 1. Type study of algae and Cyanobacteria –*Spirullina, Nostoc.* Chlorophyceae - *Chlorella*, *Volvox, Oedogonium, Cladophora,*and *Chara;* Xanthophyceae – *Vaucheria;* Bacillariophyceae – *Pinnularia.,* Phaeophyceae – *Ectocarpus, R*hodophyceae – *Polysiphonia.*	7
V	**EXPERIMENTAL PLANT PATHOLOGY** 1. Preparation of fungal media (PDA) &Sterilization process. 2. Isolation of pathogen from diseased leaf. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia*, Few viral and bacterial plant diseases.	8
VI	**PRACTICALS IN APPLIED MICROBIOLOGY-1** 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non rhizosphere population of bacteria. 3. Isolation of antagonistic Pseudomonas from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of Azospirillum sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms.	**8**
VII	**PRACTICALS IN APPLIED MICROBIOLOGY-2**	**8**

	1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria	
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. 5. Alcohol production from Sugarcane Juice.	**6**

Suggested Readings:

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

1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
5. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
6. Sambamurty. A.V.S.S. 2006, A Textbook of Algae, I. K. International Publishing House, Pvt. Ltd.,
7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
8. https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf
9. http://nhb.gov.in/pdf/Cultivation.pdf
10. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
11. Sen, Surjit,Acharya, Krishnendu, Rai, Manjula 2019 IBSN - 978-93-88347-23-5 - Biofertilizers and Biopesticides .Technoworld, Kolkata
12. http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf
13. http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf
14. Hochman,Gal,Zilberman,David 2014 IBSN-1461493285- Algae Farming and Its Bio-Products Springer
18. Gokare A. Ravishankar , Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
19. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:97804706738

Suggestive Digital Platforms/ Web Links:

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

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

S. No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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/ Biotech/ Forestry/ Microbiology/Gardening /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%5B8
171339239%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/

B.Sc. I (SEMESTER-II) PAPER-I

Title: Certificate Course in Microbial Technology & Applied Botany

Programme : Certificate Course in Microbial Technology & Applied Botany	**Year: I**	**Semester: II**
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	Topics	No. of Lectures
I	**Introduction to Archegoniates & Bryophytes** Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia* , *Anthoceros and Sphagnum*. (Developmental details not to be included). Economic importance of Bryophytes.	**7**
II	**Pteridophytes** General characteristics, Early land plants (*Rhynia*), Lycopodium, Selaginella, Marsilea ,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 with special reference to structure and reproduction of Cycas, Ginkgo, Pinus, and Ephedra. Economic importance of Gymnosperms.	8
IV	**Palaeobotany** General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; fossilization & types of fossils and study techniques; Contribution of Birbal Sahni	8
V	**Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence)** Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	**Plant Anatomy** Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Secondary growth in Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - *Bignonia, Boerhaavia, Dracaena,Nyctanthes.*	**7**
VII	**Reproductive Botany** Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	**8**
VII	**Palynology** Pollen structure, pollen morphology, pollen allergy , Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	**7**

Suggested Readings:

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

1. 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 company
8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
12. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.

13. Bhojwani, S.S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,
14. P.K.K. Nair- A textbook of Palynology.
15. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
16. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
17. E.J.Eames . Morphology of Vascular Plants, Standard University Press.
18. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
19. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
20. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

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

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
		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/

Further Suggestions:

Any remarks/ suggestions:

B.Sc. I (SEMESTER-II) PAPER-II
Title: Certificate Course in Microbial Technology & Classical Botany

Programme : ***Certificate Course in Microbial Technology & Classical Botany***	**Year: I**	**Semester: II**
Subject: Botany		
Course Code: B040201P	**Course Title: Land Plant Architecture**	

Course outcomes:
1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. 2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants.
3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense. 4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants 5. Understand the composition, modifications, internal structure &architecture of flowering plants for becoming a Botanist.

Credits: 2	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

Unit	Topics	No. of Lectures
I	**Bryophytes:** Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). *Sphagnum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	**8**
II	**Pteridophytes:** *Lycopodium*: Habit, stem T. S. stobilus V. S., *Selaginella*: Habit, rhizophore T. S, stem T. S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. *Marsillea* - Habit, rhizome and stem T.S. and V. S. of strobilus. *Azolla* – Habitat & its structure.	7
III	**Gymnosperms** 1. *Cycas* – 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. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. *Ephedra* & *Thuja*: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed. 3. *Ginkgo* Habit, stem T.S. and Male and Female cone	8
IV	**Palaeobotany & Palynology** 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientis 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 - *Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes* . Study of primary and secondary growth in the root and stem of monocots(Maize) and dicots (Sunflower) by section cutting and permanent slides. Study of internal structure of dicot and monocot leaves. Study of structure of stomata (*Tradescantia*)	**8**

VII	**Reproductive Botany** 1. Structure of anther, pollen grains 2. Structure of ovule and embryo sac. 3. Study of seed germination. 4. Study of pollen morphology of the following plants –*Hibiscus, Vinca, Ixora,* by microscopic observation	**8**
VIII	**Commercial Uses and Production technology** 1. *Azolla* production 2. Production technology of Resins 3. Production and propagation of Ornamental *Pteris*, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and *Thuja* oil.	**8**

Suggested Readings:

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

Pandey, BP and Trivedi, P.S. 1997. Botany Vol. I(10th edition). Vikas Publishing House.
Pandey, BP; Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.
Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.
Kumar, S and Kashyap. 2003. Manual of Practical Algae. Campus Books International, New Delhi
Bendre and Kumar A text book of Practical Botany. Vol I,II., Rastogi Pub. Meerut.

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.M.S.

Suggestive Digital Platforms/ Web Links:

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S. No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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/ Biotech/ 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_projct_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.pd

B.Sc. II (SEMESTER-III) PAPER-I

PROGRAMME: DIPLOMA IN PLANT IDENTIFICATION, UTILIZATION AND ETHNOMEDICINE	**YEAR: II**	**SEMESTER: III**
SUBJECT: BOTANY		
COURSE CODE: B040301T	**COURSE TITLE: Flowering Plant Identification and Ethnomedicine**	

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	Topics	No. of Lectures
I	**Taxonomic Resources & Nomenclature** Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. 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), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (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) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae , Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae	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)-Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, 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, PHYLIP, Digital Taxonomy ; Virtual Herbarium: Indian Virtual Herbarium, Virtual Herbarium of Royal Botanic Garden, Kew. Descriptive Language for Taxonomy (DELTA), GPS tagging. Plant Identification Apps, Internet Directory for Botany.	**7**
VII	**Computer usage & Android Applications** MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, Number system, conversion device,secondary storage media	**7**
VII	**Aesthetic Characteristics of Plants:** Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai.	**8**

Suggested Readings:

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

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 I ndia. 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 ELearning‖ 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.

Suggestive Digital Platforms/ Web Links:

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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/ 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: Suggested equivalent online courses:

Suggested equivalent online courses:
https://www.easybiologyclass.com/topic-botany/
http://egyankosh.ac.in/handle/123456789/53530 https://www.deltaintkey.
com/www/desc.htm https://milneorchid.weebly.com/plant-id-forbeginners.
html https://plants.usda.gov/classification.html
https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf
https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_%20S_%20Nongbri%20III%20Sem%20ppt.pdf
https://www.brainkart.com/article/Bentham-and-Hooker-s-classification-of-plants---Dicotyledonae,-Gymnospermae-and-Monocotyledonae_1000/
https://libguides.rutgers.edu/c.php?g=336690&p=2267037

https://www.delta-intkey.com

Further Suggestions:

Any remarks/ suggestions:

B.Sc. II (SEMESTER-III) PAPER-II

PROGRAMME: DIPLOMA IN PLANT IDENTIFICATION, UTILIZATION AND ETHNOMEDICINE	YEAR: II	SEMESTER: III
SUBJECT: BOTANY		
COURSE CODE: B040302P	COURSE TITLE: PLANT IDENTIFICATION TECHNOLOGY	

Course outcomes: After the completion of the course the students will be able:

1. To learn how plant specimens are collected, documented, and curated for a permanent record.
2. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology.
3. To gain experience with the various tools and means available to identify plants.
4. To develop observational skills and field experience.
5. To identify a taxonomically diverse array of native plants.
6. To recognize common and major plant families.
7. To Understand aesthetic characters of flowering plants by making landscapes, gardens, bonsai, miniatures.
8. Comprehend the concepts of plant taxonomy and classification of Angiosperms.

Credits: 2	Core / Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topics	No. of Lectures
I	**Herbarium: Plant collecting, Preservation and Documentation:** Stepwise Practicing Herbarium techniques: **a.** Field equipments, Global Positioning System (GPS) instrument & Collection of wild plants**. 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** Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.	8
III	**Identification during excursions** a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making Field Note Book and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons	8
IV	**COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGI , BRYOPHYTES, PTERIDOPHYTES (Two each)**	7
V	**Botanical Nomenclature & reporting Method:** **a.** Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI **b. Author Citation, Effective Publication and Principle of Priority:** To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journals.	7
VI	**COMPUTERS** 1. Learning to use EXCEL Microsoft, PowerPoint and word., working with folder and windows utility., create and manage files and folder tree. 2. Practicing browsing different sites using search engines, practice and understand different E-mail services –outlook yahoomail,rediffmail etc.practicing ,creating email accounts ,sending ,receiving and storing of mails 3. Create and Participate in virtual conferencing in an interactive Zoom meeting	7
VII	1. Use of Taxonomic Software (Dichotomous Key) 2. Make line drawing of Plants for description. 3.Using of plant identification apps on android phones	8
VIII	1. Create a Bonsai of any plant 2. Draw Layouts of various types of gardens 3. Plant Propagation methods practice	8

Suggested Readings:

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

1. Day, S.C. (2003) Complete Home Gardening. (2003) Agrobios, Jodhpur, India.
2. Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios,Jodhpur, India.
3. Khan, M.R. (1995) Horticulture and Gardening - NiraliPrakashan, Pune. India.
4. Pramila Mehra Gardening for everyone-. Hind pocket book private limited, New Dehli.
5. Kumarsen V. Horticulture ,Saras Publication
6. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
7. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
8. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
9. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
10. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
11. Womersley, J. S. 1981. Plant collecting and herbarium development: A manual.
12. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; DehraDu
13. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. http://deltaintkey.Com https://www.naace.co.uk/school-improvement/ict-mark/
14. Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST,N. Delhi
15. Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi
16. Primak, R. B. (2004) A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers
17. Quicke, Donald, L. J. (1993) Principles and Techniques of Commemoratory Taxonomy. Blakie,Academic and Professional, London
18. Singh, G (2004) Plant Systematics:Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
19. Practical Taxonomy of Angiosperms By : R K Sinha ISBN : 9789386768520 I.K International Publishing House Pvt. Ltd. Delhi.
20. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens,Kew (Reprinted 1999).
21. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.
22. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Taxonomy ,Regnum Vegetabile Vol. 39. Utrecht.
23. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow‘s Printer and Publishers, New Delhi.
24. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials:the Southe African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25 SABONET Pretoria.

Suggestive Digital Platforms/ Web Links:

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class

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

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

Suggested equivalent online courses:

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

Any Other :

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

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

For every study tour take the prior permission of the head of the department and Principal.

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

B.Sc. II (SEMESTER-IV) PAPER-I

Programme : *Diploma in Plant Identification, Utilization and 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. To 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	Topics	No. of Lectures
I	**Origin and domestication of cultivated plants** Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; 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, and economic uses yielding Edible & essential oils; Sugar, Starch; 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, Gerbera, Gladiolus, Anthurium/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponic	7
IV	**IPR & Traditional Knowledge** IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library (TKDL),Protection of traditional knowledge and protection of plant varieties and biotech inventions.	8
V	**Ethnobotany** Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	8
VI	**Medicinal aspects** Study of common plants used by tribes (*Aegle marmelos, Ficus religiosa, Cynodon dactylon, Eclipta alba, Oxalis, Ocimum sanctum* and *Trichopus zeylanicus)* Ethnobotanical aspect of conservation and management of plant resources, 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: *Tinospora, Acorus, Ocimum*, *Turmeric* and *Aloe*. Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration	**8**
VII	**Pharmacognosy** Preparation of drugs for commercial market - Organoleptic evaluation of drugs – Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Sources of crude drugs (roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds) and Drug Adulteration. Organoleptic study of *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Eclipta alba, Emblica officinalis, Withania somnifera, Phyllanthus amarus, Vinca rosea* and *Zingiber officinale*	**8**
VIII	**Herbal Preparations & Phytochemistry :** Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities.	**7**

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer. Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture.Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
11. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
12. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
13. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
14. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
15. Jain, S. K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh,Dehradun.
16. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.London.
17. Joshi, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
18. Kokate, C. and Gokeale- Pharmocognacy- Nirali Prakashan, NewDelhi.
19. Lad, V. 1984. Ayurveda – The Science of Self-healing. Motilal Banarasidass, New Delhi.
20. Lewis, W. H. and M. P. F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A
a. Wiley Inter science Publication. John Wiley and Sons, New York.
21. Farooqui, A. A. and Sreeraman, B. S. 2001. Cultvation of medicinal and aromatic crops. Universities Press.
22. Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
23. Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai.
Chatwal, 1980. Organic chemistry of natural productis. Vol. I. Himalaya Publishing house.
24. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
25. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.
26. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
27. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
28. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth.Edn. 1, Printed in the USA by Malloy Lithographing Inc.
29. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
30. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizoms drugs. Bulletin No.1 Ministry of Health, Govt. of India.
31. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
32. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
33. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today& Tomorrow's printers and publishers, New Delhi.
34. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
35. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
36. k. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn Edward Arnold, London.

This course can be opted as an elective by the students of the 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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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/ Biotech/ Forestry)

Facilities: Smart and Interactive Class

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

Suggested equivalent online resourses:

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/l98-Intellectual-Property-and-Traditional-knowledge.html
https://www.brainkart.com/article/Economic-importance-Plants---Food,-Rice,-Oil,-Fibre,-Timber-yielding-plant_1095/
https://www.loc.gov/rr/scitech/tracer-bullets/economic-botanytb.html
http://nsdl.niscair.res.in/bitstream/123456789/127/1/Fibre%20crops%2C%20bamboo%2C%20timber%20-%20Final.pdf
https://www2.palomar.edu/users/warmstrong/econpls.htm
https://www.longdom.org/proceedings/phytochemistry-and-phytoconstituents-of-herbal-drugs-and-formulations-1668.htm

Further Suggestions:

Any remarks/ suggestions:

B.Sc. II (SEMESTER-IV) PAPER-II

Programme : *Diploma in Plant Identification ,Utilization and Ethno medicine*	Year: II	Semester: IV Paper-II (Practical)
Subject: BOTANY		
Course Code: B040402P	**Course Title: Commercial Botany and Phytochemical Analysis**	

Course outcomes: After the completion of the course the students will be able to:
1. Know about the commercial products produced from plants.
2. Gain the knowledge about cultivation practices of some economic crops.
3. Understand about the ethnobotanical details of plants.
4. Learn about the chemistry of plants &herbal preparations
5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.

Credits: 2	**Core Compulsory**
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

Unit	Topics (Perform minimum any three experiments from each unit)	No. of Lectures (60 hrs)
I	**Economic Botany & Micro technique:** Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro hemical 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-& I	**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. *Aegle marmelos, Ficus religiosa, Cynodon dactylon.* 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 Poultice/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: ***Course Books published in Hindi may be prescribed by the Universities***.

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

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/

B.Sc. III (SEMESTER-V) PAPER-I

Programme: *Bachelor of Science*	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	Topics	No. of Lectures
I	**Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem** Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops. Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model	**7**
II	**Carbon Oxidation** Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.	7
III	**Nitrogen Metabolism** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.	8
IV	**Lipid Metabolism & Photosynthesis** Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation. ; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance.	7
V	**Plant Development, Movements, Dormancy & Responses** Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence.	8
VI	**Biomolecules** *Carbohydrates:* Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). *Lipids*: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.	**8**
VII	**Proteins**: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramchandran plot,tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins **Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleic acids,Nucleic acid denaturation &Re-naturation , MiRN	**7**
VIII	**Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced- fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes. Phytonutrients, Nutraceuticals, dietary supplements and antioxidants.	**8**

Suggested Readings:

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

1. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
2. A Handbook On Mineral Nutrition And Diagnostic Techniques For Nutritional Disorders Of Crops (pb)ISBN 9788177543377Edition : 01Year : 2011Author : Pathmanabhan G , Vanangamudi M , Chandrasekaran CN , Sathyamoorthi K , Babu CR , Babu RC , Boopathi PNPublisher : Agrobios (India)
3. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
5. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
6. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
7. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book. Agencies.
8. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
9. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
11. Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
12. Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
13. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
14. Ramesh Gupta. Efficacy, Safety and Toxicity brings together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
15. Harborne,J.B.1973 .Phytochemical Methods. John Wiley & Sons, New York.
16. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
17. 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 the 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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	Total	25

Course prerequisites: Qualification: 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

Further Suggestions:

Any remarks/ suggestions:

B.Sc. I (SEMESTER-V) PAPER-II

Programme : : *Bachelor of Science*	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	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topics (Perform minimum any three experiments from each unit)	No. of Lectures (60 hrs)
I	**Genetic material** Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi– conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi– conservative, semi discontinuous RNA priming, Ǿ (theta) mode of replication, replication of linear, dsDNA, replicating the 5´end of linear chromosome including replication enzymes.	**7**
II	**Transcription & Regulation of gene expression** Types of structures 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; and in Eukaryotes.	7
III	**Principles & Techniques of genetic engineering** Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Antibody Engineering	8
IV	**Applications of Genetic engineering** Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns..	7
V	**Bioinformatics & its applications** Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	8
VI	**Biological databases :** Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss- Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,).	**8**
VII	**Data Generation and Data Retrieval** Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez).	**7**
VIII	**Phylogenetic analysis** Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.	**8**

1. Bioinformatics Paperback – 1 January 2015 by Dr Archana Pandeya (Author), Santosh Choubey (Editor), & 2 More Hindi AISECT Ltd.
2. BIOTECHNOLOGY AND GENETIC ENGINEERING (Hindi, Hardcover, Dr. Archna Nigam)
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 : 01Year : 2018 Author :Dr. Parihar P

Suggestive Digital Platforms/ Web Links:

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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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/

B.Sc. III (SEMESTER-V)

Programme : *Bachelor of Science*	Year: III	Semester: V Paper-III (Practical)
Subject: BOTANY		
Course Code: B040503P	Course Title: *Experiment in Physiology, Biochemistry and 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: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

Unit	Topics (Perform minimum any three experiments from each unit)	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 photometer. **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 — Klinostàt 2. Hydrotropism a. Measurement of growth — Arc and Liver Auxonometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains. 5. Test of seed viability by TTC method. *6.* To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA bioassay)	8
IV	**Techniques for biochemical analysis** 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. 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	8

	10. Testing of adulterants in food items.	
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. 6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA -Demonstration of PCR.	**7**
VIII	**Applications of Genetic engineering** 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacteriummediated, 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. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. A Laboratory Manual Of Plant, Physiology, Biochemistry And Ecology ISBN 9788177544589 Edition : 01Year : 2012Author : Akhtar InamPublisher : Agrobios (India)
3. Advanced Methods In Physiology And Biochemistry (pb)ISBN : 9789381191132Edition : 01Year : 2016 Author : Padmanaban G , Chandrasekaran CN , Thangavelu AU , Dr. Sivakumar R , Kalimuthu N , Dr. Boominathan P , Dr. Anbarasan P,Agrobios.
4. Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
5. Wilson and Walker.Practical Biochemistry: Principles and Techniques. Cambridge University Press.U.K.
6. Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
7. Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London

Suggestive Digital Platforms/ Web Links:

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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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

Lab requisites: Electrophoresis units, Gelrocker, UV-transilluminator, Vortex Mixer, Shaker, CVT, HiMedia Biotechnology &Molecular biology Kits/Chemicals, Micropipettes, Elisa reader/Microtitre Reader.

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

B.Sc. III (SEMESTER-V)

Programme : *Bachelor of Science*	Year: III	Semester: V/ Project-I Paper-IV (Practical)
Subject: BOTANY		
Course Code: B040504R	**Course Title: *Project in Botany for Pre-graduation***	

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: 25+75	Min. Passing Marks:

total no. of lectures-tutorials-practical (in hours per week): 0-0-3

Unit	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. 12.Study of stomata in different plants **13.** 13.Study of various types of secretary and special tissues in plants

Refer: libraries, journals, Memoirs, Encyclopedias, herbaria, Museums, etc.

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class Performance	5
2	Seminar	10
3	Thesis Dissertation	10
	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/ 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-hX5JQhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE
- http://www.dli.ernet.in/
- http://www.ulib.org/
- http://www.tkdl.res.in/
- http://www.vigyanprasar.gov.in/digilib
- Directory of Open Access Repositories (DOAR)http://www.opendoar.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

B.Sc. III (SEMESTER-VI) PAPER-I

Programme: *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 ultra-structure.
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	Topics	No. of Lectures
I	**Cell biology** Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram.Cell cycle: G0, G1, S and G2 phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical aberrations)- anueploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	8
II	**Genetics** Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants.	7
III	**Plant breeding** Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization – Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, intergeneric, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	8
IV	**Biostatistics:** Definition, statistical methods, basic principles, 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. Computer application in biostatistics - MS Excel and SPSS.	7
V	**Plant tissue culture** Principles, components and techniques of *in vitro* plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	8
VI	**Nanotechnology** Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	**7**
VII	**Artificial Intelligence in Plant Sciences** Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic , Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis ; 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 development for Android Mobile phones, ICT Applications for different crops and horticulture.	**7**

Suggested Readings:

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

1. Cell Biology And Genetics (Hindi) 2/e PB . Gupta P K (Hindi) rastogi Publications
2. PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct PublishingISBN: ISBN: 9781698665283 Authors:H. R. Dagla Jai Narain Vyas University
3. Biotechnology: Fundamentals And Application (hindi) (hb) ISBN : 9788177544732Edition : 03Year : 2018Author : Dr. Purohit SS , Mathur S
4. Biotechnology (Hindi) (Hindi, Paperback, B.D.Singh) Hindi Publisher: Kalyani Pubishers ISBN: 9789327246070, 9327246071
5. Cytogenetics, Plant Breeding, Evolution and Biostatistics ISBN #: 978-81-301-0066-1Sunil
D Purohit & Gotam K Kukda, Apex Publishing House
6. Genetics and Biotechnology Sunil D Purohit, K. Ahmed & Gotam K Kukda Apex
Publishing House
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 –; Oxfird & 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 willey 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 Books 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
31. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
32. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
33. Twymann, 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 ,Panama 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
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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.
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46. V.Rajaraman Introduction to Information Technology, Prentice Hill.
47. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
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50. Nageshwar Rao G.(2007)Statistics for Agriculture Sciences BS Publications. New Delhi
51. NigamA.K. andGupta,V.K.(1979)Hand book on Analysis of Agricultural Experiments.. IASRI Publication, New Delhi.
52. Padap Prajanan (Hindi) Hardcover – 1 January 2016 by Chandra Prakash Shukl (Author)
Pointer Publishers, Jaipur
53. Plant Breeding : Principle and Methods B D Singh - in hindi
54. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.

55. 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.
56. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
57. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
58. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H.Freeman.
59. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company.
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61. Snedecor GW. & Cochran WG. (1989) Statistical Methods . Iowa State University Press.
62. Design and Analysis of Experiments by Das M.N. and Giri N.C.(1986). Wiley Eastern Ltd., New Delhi.
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64. Gupta, S.C. (2016) Fundamentals of Statistics .Himalaya Publishing House Mumbai - 400004, Maharashtra, India.
65.V.K. Kapoor (2007) Fundamentals of Applied statistics by Sultan Chand and Sons, New Delhi- 110 002
66. Yubing Xie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
67. Sulabha K. Kulkarni. 2014 ,Nanotechnology : Principles and Practices. CP publishing, New Delhi.
68. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer
69. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
70. Sharma A.K. 2005. Text Book Of Biostatistics I, Discovery Publishing House.
71. Annadurai, B. 2007. Text Book of Biostatistics. New Age International.
72. Gurumani, N. 2010. An Introduction to Biostatistics (2nd Edn). MJP Publishers.
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74. R. Stephen Crespi, Tibtech, Patenting in Biotechnology - Part I, Vol. 9, 117-122, 1991.
75. Pattnaik, P.K., Kumar, R., Pal, S., Panda, S.N. (Eds.)IoT and Analytics for Agriculture,2020
76. https://www.springer.com/gp/book/9789811391767
77. https://www.springer.com/gp/book/9789811550720
78. 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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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

Any remarks/ suggestions:

B.Sc. III (SEMESTER-VI) PAPER-II

Programme : : *Bachelor of Science*	**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**
Max. Marks: 25+75	**Min. Passing Marks:**

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

Unit	Topics	No. of Lectures (60 hrs)
I	**Natural resources & Sustainable utilization**: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.	**7**
II	**Ecology & Ecosystem** Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic components-Energy flow in an ecosystem. Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. 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 processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation.	7
IV	**Biodiversity and its conservation:** Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. ***Conservation of Biodiversity:*** Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioreserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.	7
V	**Phytogeography:** Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetation types in Uttar Pradesh.	7
VI	**Environmental audit & Sustainability** Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India‘s environment action Program: Issues, approaches and initiatives towards Sustainability; Sustainable development in practice.	**8**

VII	**Pollution, Waste management & Circular Economy** Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoringand control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous)-classification, 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, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.	**8**

Suggested Readings:

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

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.

Suggestive Digital Platforms/ Web Links:

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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance/Participation/ Interaction	5
2	Quiz/Test/House Examination	10
3	Written assignment/Presentation/Excursion	10
	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/ 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
uturelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
https://www.coursera.org/courses?query=plants
http://egyankosh.ac.in/handle/123456789/53530

B.Sc. III (SEMESTER-VI)

Programme : *Bachelor of Science*	Year: III	Semester: VI Paper-III (Practical)
Subject: BOTANY		
Course Code: B040603P	**Course Title:** ***Lab on Cytogenetics, Conservation and Environment Management***	

Course outcomes: After the completion of the course the students will be able:

1. To perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.
2. Can be employed in environment impact assessment companies & start his own venture.

Credits: 2	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

Unit	Topics (Perform minimum any three experiments from each unit)	No. of Lectures (60 hrs)
I	**Cell biology** 1. Study of plant cell structure with the help of epidermal peal mount of 1. Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer 4. (Yeast/pollen grains) 5. 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: I **c.** Complementary genes 9: 7 **d.** Duplicate genes with cumulative effect 9: 6: 1 **e.** Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding Techniques-Hybridization, case studies of mutation, polyploidy, masculation experiment	8
III	**Biostatistics:** 1. Univariate analysis of statistical data: Statistical tables, mean, mode, 1. 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. 4. Computer application in biostatistics - MS Excel and SPSS	7
IV	**Plant tissue culture** 1. Familiarization of instruments and special equipments used in the plant 2. tissue culture experiments 3. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 4. Surface sterilization of plant materials for inoculation (implantation in the medium) 5. Micropropagation of potato/tomato/ - Demonstration 6. 5.Protoplast isolation and culturing – Demonstration	8
V	**Ecology & Environment** 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, 1. 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 (Orobanche) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus.	8

	5. Field visit to familiarize students with ecology of different sites	
VI	**Soil Formation, Properties & Conservation** 1. Determination of pH of various soil and water samples (pH meter, 2. universal indicator/Lovibond comparator and pH paper) 3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 5. Soil Profile study 6. 5. Soil types of India-Map	**8**
VII	**Biodiversity and Phytogeography:** 1. Study of community structure by quadrat method and determination of a. Minimal size of the quadrat, b. 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. 3. Phytogeographical areas of India	**7**
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 form 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 1. 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:

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

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 : 9788177544152Edition : 02Year : 2017Author : Gupta PKPublisher : Agrobios (India)
4. Green Technology: An Approach For Sustainable Environment ISBN : 9788177543438Edition :
1. 01Year : 2021Author : Dr. Purohit SSPublisher : Agrobios (India)
5. Laboratory Manual Of Chemical And Bacterial Analysis Of Water And SewageISBN :
2. 9788177540802Edition : 01Year : 2011Author : Theroux FR , Eldridge EF , Mallmann WLPublisher : Agrobios (India)
6. Methods In Environmental Analysis: Water Soil And Air (2nd Ed.) ISBN : 9788177543087Edition : 02Year : 2021Author : Gupta PKPublisher : Agrobios (India)
7. Water Treatment And Purification Technology ISBN : 9788177540024Edition : 01Year 2009Author : Ryan WJPublisher : Agrobios .India

http://vidyamitra.inflibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany
http://heecontent.upsdc.gov.in/Home.aspx
(http://epathshala.nic.in/, http://epathshala.gov.in/)

Suggestive Digital Platforms/ Web Links:

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 (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class performance	5
2	Quiz/Test/House exam	10
3	Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training	10
	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

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.

B.Sc. III (SEMESTER-VI)

Program: *Bachelor of Science*	Year: III	Semester: VI /Project-II Paper-IV (Practical)
Subject: BOTANY		
Course Code: B040604R	**Course Title:** ***Project in Botany for Graduation***	

Course outcomes:

After completing this course a student will have:

- 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: 3	Core Compulsory
Max. Marks: 25+75	**Min. Passing Marks:**

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3

Unit	Suggestive List of Projects
	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. Develop botanical garden in the college with labelling Vertical gardens, roof gardens. Culture & art of making bonsai. Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing) Phytochemical Analysis of Medicinal plants Bio composting and Vermi composting. Performing Aromatherapy by essential Oils

Refer: libraries, journals, Memoirs, Encyclopedias, Herbaria, Museums, etc.

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

Suggested Continuous Evaluation Methods (Max. Marks: 25)

S.No.	Assessment Type	Max. Marks
1	Class Performance	5
2	Seminar	10
3	Thesis Dissertation	10
	Total	25

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 fromn 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/

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-hX5JQhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

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

http://www.tkdl.res.in/, http://www.vigyanprasar.gov.in/digilib

Directory of Open Access Repositories (DOAR)http://www.opendoar.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