CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

BOTANY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN BOTANY

SESSION 2025-2026 ONWARDS

Chhatrapati Shahu Ji Maharaj University, Kanpur

NEP Course structure

for

Four Year

Undergraduate Botany Programme

w.e.f.

Session 2025-2026

As Approved by

Board of Studies (Botany)

Chhatrapati Shahu Ji Maharaj University, Kanpur

SUBJECT: BOTANY

Name	Designation	Affiliation
Prof. Vandana Nigam	Convener	Dayanand Girls P.G. College, Kanpur
Dr. Ajit Kumar Shashnay	Director, Research Institute	Director, NBRI-Lucknow
Prof. Girjesh Kumar	Subject Expert	University of Allahabad, Prayagraj
Prof. Shashi Pandey	Subject Expert	B.H.U. Varanasi
Prof. Anil Kumar Dwivedi	Subject Expert	D.D.U. Gorakhpur
Dr. Atul Kumar Singh	Member	D.B.S. College, Kanpur
Prof. Vijay Tewari	Member	Dayanand Girls P.G. College, Kanpur
Dr. Babita Yadav	Member	Nehru P.G. College, Chhibramau, Kannauj

Invited Members:

1. **Prof. Sugandha Tiwari,** Dayanand Girls P.G. College, Kanpur
2. **Prof. Alka Srivastava,** Dayanand Girls P.G. College, Kanpur

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

Semester	Course Code	Paper Title	Theory/ Practical	Credits/ hours	Degree and Credit Required
FIRST YEAR					
I	B040101T	Microbiology & Plant Pathology	Theory	4/60	***Certificate Course in Microbial Technology & Classical Botany*** **(40 Credits)**
	B040102P	Techniques in Microbiology & Plant Pathology	Practical	2/60	
II	B040201T	Archegoniates & Plant Architecture	Theory	4//60	
	B040202P	Land Plants Architecture	Practical	2/60	
SECOND YEAR					
III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4/60	***Diploma in Plant Identification, Utilization & Ethnomedicine*** **(80 Credits)**
	B040302P	Plant Identification technology	Practical	2/60	
IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4/60	
	B040402P	Commercial Botany & Phytochemical Analysis	Practical	2/60	
	B040403R	Project	Project	3/45	
THIRD YEAR					
V	B040501T	Plant Physiology, Metabolism &Biochemistry	Theory	4/60	***Bachelor of Science*** **(3 Year UG degree)** **(120 Credits)**
	B040502T	Molecular Biology & Bioinformatics	Theory	4/60	
	B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2/60	
VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4/60	
	B040602T	Ecology & Environment	Theory	4/60	
	B040603P	Cytogenetics, Conservation & Environment management	Practical	2/60	
FOURTH YEAR					
VII	B040701T	Applied Microbiology and Plant Pathology	Theory	4/60	
	B040702T	Environmental Awareness and Social Ethics	Theory	4/60	

	B040703T	Plant Tissue Culture & Genetic Engineering &	Theory	4/60	***4 Year UG Degree (Honours)*** **(160 Credits)**
	B040704P	Applications & Techniques in Microbial and Plant Sciences	Practical	4/60	
	B040705T(a)	Plant Resource Utilization	Theory	4/60	
	B040705T(b)	Plants Systematics	Theory	4/60	
VIII	B040801T	Research Methodology	Theory	4/60	
	B040802T	Processing and Statistical Analysis of Data	Theory	4/60	
	B040803T	Techniques And Instrumentation	Theory	4/60	
	B040804P	Applied research methods, statistical analysis and Instrumentation	Practical	4/60	
	B040805Ta	Bioinformatics & Computer Applications	Theory	4/60	
	B040805Tb	Conservation of Biodiversity	Theory	4/60	
OR **(For students who secure 75% marks in the First 6 Semesters)**					
VII	B040701T	Applied Microbiology and Plant Pathology	Theory	4/60	***UG Degree (Honours with Research)*** **(160 Credits)**
	B040702T	Environmental Awareness and Social Ethics	Theory	4/60	
	B040703T	Plant Tissue Culture & Genetic Engineering	Theory	4/60	
	B040704P	Applications & Techniques in Microbial and Plant Sciences	Practical	4/60	
	B040705R	Research Project/ Dissertation/ Internship/ Field work	Project/Dissertation	4/60	
VIII	B040801T	Research Methodology	Theory	4/60	
	B040802T	Processing and Statistical Analysis of Data	Theory	4/60	
	B040803T	Techniques And Instrumentation	Theory	4/60	
	B040804P	Applied research methods, statistical analysis and Instrumentation	Practical	4/60	
	B040806R	Major Research Project/Dissertation	Project/Dissertation	4/60	

OR				
VII & VIII	12 Months Apprenticeship/ Internship through NATS or from equivalent organization/ Industry/ Institute	1(40) 1200 hours	Total Credit 40	***Apprenticeship/ Internship embedded UG Degree Programme*** **(160 Credits)**
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.				

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 Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

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

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

Programme specific outcomes (PSOs):

B.Sc. I Year / Certificate course in Microbial Technology & Classical Botany

This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. Diversity of plants and microbes, their habitat, morphology, architecture and reproduction.
2. Plant disease causing microbes, symptoms & control.
3. Economic value of plants and their use in Human Welfare.

Programme specific outcomes (PSOs):

B.Sc. II Year/ (Diploma in Plant Identification, Utilization & 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.

Programme specific outcomes (PSOs):
B.Sc. III Year / Bachelor of Science

The learning outcomes of a three years graduation course are aligned with programme learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with a multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.
3. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as a human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.
4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data**.**
5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values,
6. Strengthen mathematical and computational skills. Enable students to use ICT & AI effectively.

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

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

PSO 4	Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

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

Detailed Syllabus for
Certificate Course in Microbial Technology & Classical Botany
Or
B.Sc. First Year

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc. I		
Programme: Certificate Course in Microbial Technology & Classical Botany	Year: I	Semester: I/**Paper-I**
Subject : **Botany**		
Course Code: B040101T	Course Title : **Microbiology & Plant Pathology**	

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

1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
2. Develop conceptual skill about identifying microbes, pathogens, fungi, algae and lichens.
3. Gain knowledge about developing commercial enterprise of microbial products like biofertilizers.
4. Learn host-pathogen relationship and disease management.
5. Gain Knowledge about uses of microbes in various fields.
6. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens.
7. Gain knowledge about the economic values of this lower group of plant community.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Viruses:** Nature, classification and structure (helical and icosahedral symmetry) of plant viruses, Bacteriophages: T4 &, λ-phage; Lytic and Lysogenic cycles, Symptoms (external & internal) of virus infected plants; Transmission of plant viruses; Genome organization and replication of tobacco mosaic virus; Techniques in plant virology - purification, serology and electron microscopy, Structure and replication of viroids, Prions and mycoplasma.	**15**
II	**Bacteria:** Cell structure: Archaea, Gram-positive and Gram-negative bacteria, Bacterial Growth curve, factors affecting growth of Bacteria;	**15**

	Sporulation and reproduction and recombination, Bacterial Genome & plasmids, Economic Importance of Bacteria, Quorum sensing,	
III	**Fungi & Plant Pathology :**Classification, Structure and reproduction in fungi; Economic importance of fungi; characteristics and life cycles of the following fungi: Oomycota - *Albugo, Pythium*; Zygomycota - *Rhizopus*; Chytridiomycota - *Synchytrium*; Ascomycota - *Saccharomyces, Aspergillus, Peziza*; Basidiomycota - *Ustilago, Puccinia, Agaricus*; Deuteromycota - *Fusarium.* Disease concept & Koch's Postulates. Etiology, Symptoms, Causal organism, Disease cycle and Control measures of - Early and Late Blight of Potato, Black Stem Rust of Wheat, White rust of Crucifers, yellow vein mosaic of bhindi, Citrus Canker, Little Leaf of brinjal.	**15**
IV	**Algae:**General features, Range of Thallus Organization, Pigments, Reserve Food, Reproduction, Ultrastructure of Eukaryotic Algal Cell and Cyanobacterial Cell. Classification and Life Cycle of: Cyanophyta -*Nostoc*; Chlorophyta - *Volvox, Hydrodictyon, Oedogonium, Chara*; Bacillariophyta - *Navicula;* Xanthophyta - *Vaucheria*; Phaeophyta - *Sargassum, Ectocarpus*; Rhodophyta – *Polysiphonia.* Economic Importance of Algae. **Lichens:** Classification, Thallus Organization, Reproduction, Physiology and Role in Environmental Pollutions	**15**

Suggested Readings:

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

1ण सिंह, पांडे – जैन (n.d.). *वनस्पति विज्ञान (सम्पूर्ण)* [Complete forest science]. रस्तोगी प्रकाशन

2ण शर्मा, त्रिवेदी – धनकर 2019, *सूक्ष्म जैविकी कवक पादप रोग विज्ञान* [Elementary plant pathology]. RBD Publisher.

3ण त्रिपाठी, आशीष कुमार – त्रिपाठी, सनत कुमार (2018). *परिचायात्मक पादप रोग विज्ञान* [Introductory plant pathology]. एग्राबॉयोस इंडिया पब्लिशर

4. यादवए जिया लाल (2012). *पादप रोग विज्ञान* [Plant pathology].

5. वर्मा, श्रीता. (2020). *सूक्ष्म जैविकी, कवक एवं पादप रोग विज्ञान* [Elementary microbiology, algae and plant pathology].

6. आर्य, प्रांजल, (2020). *पादप रोग : उत्पत्ति प्रसार एवं नियंत्रण* [Plant diseases: emergence and management].
7. कुमार, अग्रवाल – सिंह, सुरेश (n.d.). *पादप रोग विज्ञान परिभाषा–कोश* [Definitional dictionary of plant pathology]. Commission for Scientific and Technical Terminology.
8. Basu, A. N. 1993. *Essentials of Plant Viruses, Vectors and Plant Diseases*. New Delhi: New Age International.
9. Kodo, C. I., and H. O. Agarwal. 1972. *Principles and Techniques in Plant Virology*. New York: Van Nostrand Reinhold Company.
10. Pelczar, M. J. 1963. *Microbiology*. New Delhi: Tata McGraw Hill.
11. Tortora, G. J., Funke, B. R., and Case, C. L. 2010. *Microbiology: An Introduction*. 10th ed. San Francisco: Pearson Benjamin Cummings.
12. Purohit, S. S., and Deo, S. 2016. *Microbiology: Fundamental and Applications*. Hindi, 3rd ed. Jodhpur: Student Edition. ISBN link
13. Purohit, S. S., and Singh, T. 2018. *Modern Microbiology*. Hindi, 1st ed. Jodhpur: Agrobios (India). ISBN link
14. Singh, R. P. 2007. *Microbial Taxonomy and Culture Techniques*. New Delhi: Kalyani Publication.
15. Dubey, R. C., and D. K. Maheshwari. 2012. *Practical Microbiology*. New Delhi: S. Chand & Company Pvt. Ltd.
16. Aneja, K. R. 1993. *Experiments in Microbiology, Pathology and Tissue Culture*. New Delhi: Vishwa Prakashan.
17. Alexopoulos, C. J., Mims, C. W., and Blackwell, M. 1996. *Introductory Mycology*. 4th ed. New York: John Wiley & Sons.
18. Sethi, I. K., and S. K. Walia. 2011. *Textbook of Fungi and Their Allies*. New Delhi: Macmillan Publishers India Ltd.
19. Webster, J., and R. Weber. 2007. *Introduction to Fungi*. 3rd ed. Cambridge: Cambridge University Press.
20. Agrios, G. N. 1997. *Plant Pathology*. 4th ed. San Diego: Academic Press.
21. Mehrotra, R. S. n.d. *Plant Pathology*. New Delhi: Tata McGraw-Hill Education.
22. Sharma, P. D. 2011. *Plant Pathology*. Meerut: Rastogi Publications.
23. Sharma, P. D. 2012. *Microbiology and Plant Pathology*. Meerut: Rastogi Publication Pvt. Ltd.

24. Rangaswamy, G. 2009. *Diseases of Crop Plants in India*. New Delhi: Prentice Hall of India.
25. Desikachary, T. V. 1959. *Cyanophyta*. New Delhi: ICAR.
26. Fritsch, F. E. 1977. *Structure and Reproduction of Algae*. Cambridge: Cambridge University Press.
27. Chopra, G. L. 1984. *A Textbook of Algae*. Meerut: Rastogi Publications.
28. Kumar, H. D. 1999. *Introductory Phycology*. 2nd ed. New Delhi: Affiliated East-West Press Pvt. Ltd.
29. Sambamurty, A. V. S. S. 2006. *A Textbook of Algae*. New Delhi: I. K. International Publishing House Pvt. Ltd.
30. Vashishta, B. R., Sinha, A. K., and V. P. Singh. 1991. *Algae*. New Delhi: S. Chand & Company Pvt. Ltd.
31. Smith, G. M. 1996. *Cryptogamic Botany*, Vol. 1. New Delhi: Tata McGraw Hill.
32. Sundar Rajan, S. 2010. *College Botany*, Vol. 1. Mumbai: Himalaya Publications.
33. Ragland, A. 2012. *Algae and Bryophytes*. Nagercoil: Saras Publication.
34. Pandey, B. P. 2014. *Modern Practical Botany*, Vol. 1. New Delhi: S. Chand & Company Pvt. Ltd.
35. Pandey, B. P. 2001. *College Botany*, Vol. 1. New Delhi: S. Chand & Company Pvt. Ltd.
36. Kumar, S., and A. S. Kashyap. 2003. *Manual of Practical Algae*. New Delhi: Campus Books International.
37. Suresh Kumar and Amar Singh Kashyap. 2014. *Manual of Practical Algae*. New Delhi: Campus Books International.

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

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

Course prerequisites:	

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

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

futurelearn.com/courses/teaching-biology-inspiring-students with-plants-in-science https://www.coursera.org/courses?query=plants

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

https://www.classcentral.com/tag/microbiology

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

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

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

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

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

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

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

https://www.onlinebiologynotes.com/algae-general-characteristics-classification/

https://www.sciencedirect.com/topics/immunology-and-microbiology/fungus

https://ucmp.berkeley.edu/fungi/fungi.html

https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf

http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293

http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction-Pl%20Path%20111.pdf

http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf

https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx

https://learn.saylor.org/course/view.php?id=23&sectionid=6821
https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf
https://lipidnanostructuresgroup.weebly.com/
https://zoology4civilservices.wordpress.com/2016/06/18/65/ https://microbenotes.com/laminar-flow-hood/

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I		
Programme: ***Certificate Course in Microbial Technology & Classical Botany***	Year:**I**	Semester: **I/Paper-II**
Subject : Botany		
Course Code: B040102P	Course Title: **Techniques in Microbiology & Plant Pathology**	

Unit	**Topic * (Minimum Any three from each unit depending on facilities)**	**No. of Lectures (60 hrs)**
1.	**INSTRUMENTS & TECHNIQUES** 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-Microscope, Incubator, Autoclave, Centrifuge, Laminar Air Flow, Shaker etc. 3. Cleaning and Sterilization of glasswares 4. Preparation of Media- Nutrient Agar and Broth 5. Preparation of Agar Slant and Agar Plate 6. Inoculation and culturing of Bacteria in Nutrient Agar and Nutrient Broth	**15**
II	**BACTERIAL IDENTIFICATION** 1. Isolation, Identification & Gram Staining Technique of Bacteria. 2. Growth Curve of Bacteria 3. Cultural characteristics of Bacteria. 4. Pure culture techniques (Types of streaking). 5. Biochemical characterization: Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.	**15**

	6. Visit to NBAIM, Mau, Varanasi (Kashi)/ IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository	
III	**MYCOLOGY & PLANT PATHOLOGY:** 1. Isolation of different fungi: Saprophytic, Coprophilous *2.*Identification of fungi by lactophenol cotton blue method. *Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria.* 3. *Agaricus*: Specimens of button stage and full grown mushroom, Sectioning of gills of *Agaricus*. 4. Preparation of fungal media (PDA) & Sterilization process. 5. Isolation of pathogen from diseased leaf. 6. Identification: Pathological specimens of Early and Late Blight of Potato, Black Stem Rust of Wheat, White rust of Crucifers, yellow vein mosaic of bhindi, Citrus Canker, Little Leaf of brinjal.	**15**
IV	**PHYCOLOGY:** 1. Type study of algae and Cyanobacteria A. Cyanophyta -*Nostoc* B. Chlorophyta - *Volvox, Hydrodictyon, Oedogonium, Chara* C. Bacillariophyta - *Navicula* D. Xanthophyta - *Vaucheria* E. Phaeophyta - *Sargassum, Ectocarpus* F. Rhodophyta – *Polysiphonia.* 2. Lichens: Crustose, Foliose and Fruticose specimens.	**15**

Suggested Readings:

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

1ण प्रयोगात्मक वनस्पति विज्ञान भाग–1 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ।

2. प्रायोगिक वनस्पति विज्ञान- Dhankar - Sharma – Trivedi ISBN Code: 978-81-8142-697-0 65, RBD Publishing House Shivaji Nagar Civil Lines,Jaipur - 302006 (Rajasthan)

3. प्रायोगिक वनस्पति विज्ञान बी.एस.सी.–1 एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी प्रकाशित वर्ष 2018

4. Aneja, K. R. 1993. *Experiments in Microbiology, Pathology and Tissue Culture*. New Delhi: Vishwa Prakashan.

5. Dubey, R. C., and D. K. Maheshwari. 2012. *Practical Microbiology*. New Delhi: S. Chand & Company Pvt. Ltd.
6. Gehlot, D. 2014. *Biofertilizer Production Manual*. Jodhpur: Agrobios (India). (In Hindi)
7. Kodo, C. I., and H. O. Agarwal. 1972. *Principles and Techniques in Plant Virology*. New York: Van Nostrand Reinhold Company.
8. Pandey, B. P. 2014. *Modern Practical Botany, Vol. I*. New Delhi: S. Chand & Company Pvt. Ltd.
9. Purohit, Sunil D., Gotam K. Kukda, and Anamika Singhvi. 2013. *Practical Botany, Part I*. Udaipur: Apex Publishing House. (Bilingual)
10. Singh, R. P. 2007. *Microbial Taxonomy and Culture Techniques*. New Delhi: Kalyani Publication.
11. Singh, Riti, and U. C. Singh. 2017. *Modern Mushroom Cultivation and Recipes*. Jodhpur: Agrobios (India). (In Hindi)
12. Gokare, A. Ravishankar, and Ranga Rao Ambati. 2019. *Handbook of Algal Technologies and Phytochemicals, Volume II: Phycoremediation, Biofuels and Global Biomass Production*. Boca Raton, FL: CRC Press.
13. Hochman, Gal, and David Zilberman. 2014. *Algae Farming and Its Bio-Products*. Cham: Springer.
14. Richmond, Amos, and Qiang Hu. 2013. *Handbook of Microalgal Culture: Applied Phycology*. Oxford: Wiley-Blackwell.
15. Sen, Surjit, Krishnendu Acharya, and Manjula Rai. 2019. *Biofertilizers and Biopesticides*. Kolkata: Technoworld.

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

Internal Assessment	**Marks**
Class Interaction	**5**
Quiz	**5**
Seminar	**7**
Minor field work/excursion/lab visit/technology dissemination etc.	**8**
	25

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

Facilities: Smart and Interactive Class

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

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

Suggested equivalent online courses:

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

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

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

https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175epdf

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/123456789/5353

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://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf

https://nhb.gov.in/pdf/Cultivation.pdf

https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf

https://www.kvkkendrapara.org/pdf/io%20Fertilizer%20Production%20and%20marketing.pdf

https://www.gbv.de/dms/tib-ub-hannover/751302945.pdf

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc. I		
Programme: Certificate Course in Microbial Technology & Classical Botany	Year: I	Semester: II/Paper-I
Subject : **Botany**		
Course Code: B040201T	Course Title : **Archegoniates and Plant Architecture**	

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

1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes theirin through typological study and create a knowledge base in understanding the basis of plant diversity & economic values.
4. Understand the details of external and internal structures of Cryptogames.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Bryophytes** Unique features of archegoniates, General characters, classification, reproduction and affinities of Bryophytes. Classification, morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros and Funaria* (Developmental details not to be included.) Economic importance of bryophytes.	**15**
II	**Pteridophytes** General characteristics, Early land plants (*Rhynia*). Classification with Examples. General account of Lycopodium, Selaginella, *Equisetum* and *Azolla* (Developmental details not to be included). Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	**15**

III	**Gymnosperms** Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction. General account of *Cycas*, *Pinus* and *Ephedra*. (Developmental details not to be included). Economic importance of Gymnosperms.	**15**
IV	**Palaeobotany** General account of Cycadofilicales, Bennettitales and Cordaitales: Geological time scale, Brief account of process of fossilization and types of fossils and study techniques; Contribution of Prof. Birbal Sahni. **Palynology:** Pollen structure**,** pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Paleopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	**15**

Suggested Readings:

Course Books published in Hindi/English

1. वनस्पति विज्ञान (सम्पूर्ण) शैवाल, कवक, लाइकेन, जीवाणु, विशाणु, ब्रायोफाइटा, टेरिडोफाइटा, जिम्नोस्पर्म तथा पूरा वनस्पति विज्ञान – लेखक– सिंह, पांडे व जैन – रस्तोगी प्रकाशन, मेरठ।
2. आवृतबीजी वनस्पति विज्ञान (टैक्सोनॉमी, एनाटॉमी, एंब्रियोलॉजी तथा इकोनामिक बॉटनी) लेखक– सिंह, पांडे व जैन – रस्तोगी प्रकाशन, मेरठ।
3. नवीन परिचयात्मक वनस्पति विज्ञान डॉ एस के गुप्ता 2017 केदार नाथ रामनाथ पब्लिशर्स
4. ए. के. शर्मा व राजेश्वरी शर्मा 2018. वनस्पाति विज्ञान बीएससी प्रथम भाग एसआर साइंटिफिक पब्लिशर्स
5. Gangulee H. S. and K. Kar 1992. College Botany Vol. I. (New Central Book Agency)
6. Chopra, R. N., and P. K. Kumra. 1988. *Biology of Bryophytes*. New Delhi: New Age International (P) Limited.
7. Rashid, A. 1998. *An Introduction to Bryophytes: Diversity, Development and Differentiation*. New Delhi: Publication House Pvt. Ltd.
8. Puri, Prem. 1985. Bryophytes: A Broad Perspective. Delhi & Lucknow: Atma Ram & Sons.
9. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
10. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.

11. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
12. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company.
13. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
14. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
15. Bhattacharya et al. 2007. A textbook of Palynology, Central, New Delhi.
16. Nair, P.K.K. 1985. *Essentials of Palynology*. New Delhi: Today & Tomorrow's Printers and Publishers.

Suggested Continuous Evaluation Methods:

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

Internal Assessment	Marks
Class Interaction	**5**
Quiz	**5**
Seminar	**7**
Minor field work/excursion/lab visit/technology dissemination etc.	**8**
	25

Course prerequisites:

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

Facilities: Smart and Interactive Class , wifi facility

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

Suggested equivalent online courses:

https://www.anbg.gov.au/bryophyte/what-is-bryophyte.html https://pteridoportal.org/portal/index.php https://www.conifers.org/zz/gymnosperms.php http://www.mobot.org/MOBOT/research/APweb/ https://milneorchid.weebly.com/plant-id-for-beginners.html https://www.botany.org/PlantImages/PlantAnatomy.php http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print

https://palynology.org/ http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html https://www.sciencelearn.org.nz/resources/100-plant-reproduction https://palaeobotany.org/

Programme/Class: ***Certificate Course in Microbial Technology & Classical Botany***	Year: **I**	Semester: **II Paper-II (Practical)**
Subject: **Botany**		
Course Code: **B040202P**	Course Title: **Land Plants Architecture**	

Course outcomes:

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

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

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

Unit	Topic (Any three from each unit)	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.	**15**

II	**Pteridophytes:** *Lycopodium*: Habit, stem T. S. strobilus V. S. *Selaginella*: Habit, rhizophore T. S, stem T . S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll., *Equisetum* - Habit, rhizome and stem T.S. and V. S. of strobilus. *Azolla* – Habitat & its structure	**15**
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.	**15**
IV	**Palaeobotany and Palynology** 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils. 4. Study of pollen morphology of the following plants –*Hibiscus, Catharanthus, Balsam, Ixora, Crotalaria, Bougainvillea, Amaryllis* (Lilly) etc. by microscopic observation. 5. Calculation of pollen viability percentage using in vitro pollen germination techniques.	**15**

Suggested Readings:

Course Books published in Hindi/English

1) प्रयोगात्मक वनस्पति विज्ञान भाग –I,II लेखक अशोक बेंद्रे तथा अशोक कुमार, रस्तोगी प्रकाशन, मेरठ
2) प्रायोगिक वनस्पति विज्ञान विभाग I,II,III त्रिवेदी शर्मा बोहरा और धनखड़
3) प्रयोगात्मक वनस्पति विज्ञान भाग –2 लेखक : अशोक बेंद्रे तथा अशोक कुमार रस्तोगी प्रकाशन, मेरठ
4) प्रायोगिक वनस्पति विज्ञान बीएससी – I,II एस बी अग्रवाल प्रकाशक–शिवलाल अग्रवाल एण्ड कम्पनी

5) Pandey, B.P., and P.S. Trivedi. 1997. *Botany, Vol. I.* 10th ed. New Delhi: Vikas Publishing House.
6) Santra, S.C., and T.P. Chatterjee. 2005. *College Botany Practical, Vol. I.* Calcutta: New Central Book Agency (P) Ltd.
7) Kumar, S., and A.S. Kashyap. 2003. *Manual of Practical Algae*. New Delhi: Campus Books International.
8) Bendre, A.M., and A. Kumar. 2014. *A Textbook of Practical Botany, Vol. I.* 10th ed. Meerut: Rastogi Publications.
9) Kumar, S., and A.S. Kashyap. 2014. *Manual of Practical Algae*. New Delhi: Campus Books International.

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

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

Detailed Syllabus of Diploma in Plant Identification, Utilization and Ethnomedicine

Or

B.Sc.-II Year

Diploma in Plant Identification, Utilization & Ethnomedicine		
Programme /Class: ***Diploma in Plant Identification, Utilization & Ethnomedicine***	Year: **II**	Semester: **III** **Paper-I**
Subject: **Botany**		
Course Code: **B040301T**	Course Title: **Flowering Plants Identification & Aesthetic Characteristics**	

Course outcomes:

After the completion of the course the students will be able to:

1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
3. To compare the different approaches to classification with regard to the analysis of data.
4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, set up a farm or run a plantation consultancy firm

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60hrs)**
I	**Systematics & Aesthetic Characteristics of Plants**: Principles of classification and nomenclature. Comparative Study of different classification system viz. Artificial (Linnaeus), Natural (Bentham and Hooker), Phylogenetic (Engler and Prantl and Takhtazan) and Angiosperm Phylogeny Group (APG IV). Taxonomic resources: Herbarium and Botanical gardens. Aesthetic characteristics of plants. Famous gardens of India, green houses, Indoor garden, Roof garden, Topiary, Bonsai	**15**

II	**Identification of Angiosperms families:** Taxonomic study of following families and their economic importance: **Dicots:** Ranunculaceae, Rutaceae, Malvaceae, Fabaceae, Cucurbitaceae, Lamiaceae, Solanaceae, Asteraceae, Apocynaceae, Rubiaceae, Asclepiadaceae, **Monocots:** Liliaceae and Poaceae	**15**
III	**Angiosperm Morphology:** Morphology of roots, Stem and leaf. Plant modifications: Phylloclade, Cladode and Phyllodes. Root-shoot transition. Type of inflorescences; flowers, fruits and types of placentation. **Plant Anatomy:** Meristematic and permanent tissues, Anatomy of root, stem and leaf. Apical meristems and theories of apical organization: Apical cell theory, Histogen theory, Tunica Corpus Theory. **Secondary growth**: Root and stem-cambium (structure and function) annual rings. Primary and Secondary Anomalies in stem- *Nyctanthes, Bignonia, Boerhaavia, Dracaena.*	**15**
IV	**Reproductive Botany** Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Germination of pollen grain, structure of male gametophyte, Double Fertilization, structure of dicot and monocot embryo, Endosperm development and its morphological nature; Apomixis and Polyembryony.	**15**

Suggested Readings:

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

1. पांडेय, एस. के., और एन. पी. सोनी. 2016.उद्यान और नर्सरी प्रबंधन. जोधपुर: एग्रोबायोस (इंडिया).
2. Pandey, Arun K., and Shruti Kansana. 2020. *Plant Systematics*. New Delhi: Jaya Publishing House.
3. Singh, G. 1999. *Plant Systematics: Theory and Practice*. New Delhi: Oxford and IBH.
4. Stace, C. A. 1989. *Plant Taxonomy and Biostatistics*. 2nd ed. London: Edward Arnold.

5. Davis, P. H., and V. H. Heywood. 1963. *Principles of Angiosperm Taxonomy*. London: Oliver and Boyd.
6. Heywood, V. H., and D. M. Moore, eds. 1984. *Current Concepts in Plant Taxonomy*. London: Academic Press.
7. Brandis, D. 1906. *Indian Trees*. 5th ed., 1971 reprint. Dehra Dun: International Book Distributors.
8. Bole, P. V., and Y. Vaghani. 1986. *Field Guide to the Common Trees of India*. Bombay: Oxford University Press.
9. Dallwitz, M. J., T. A. Paine, and E. J. Zurcher. 2003. *Principles of Interactive Keys*. http://delta-intkey.com
10. Pandey, B. P. 2007. *Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants*. New Delhi: S. Chand & Company Ltd.
11. Dutta, A. C. 2016. *Botany for Degree Students*. New Delhi: Oxford University Press.
12. Austin, R. 2002. *Elements of Planting Design*. New York: John Wiley & Sons.
13. Bertauski, T. 2005. *Designing the Landscape: An Introductory Guide for the Landscape Designer*. Upper Saddle River, NJ: Pearson Prentice Hall.
14. Thomas, H., and S. Wooster. 2008. *The Complete Planting Design Course: Plans and Styles for Every Garden*. London: Octopus Publishing Group.
15. Scarfone, S. 2007. *Professional Planting Design: An Architectural and Horticultural Approach for Creating Mixed Bed Plantings*. New York: John Wiley & Sons.
16. Randhawa, G. S., and A. Mukhopadhyay. 1986. *Floriculture in India*. New Delhi: Allied Publishers.
17. Pandey, B. P. 2007. *Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants*. New Delhi: S. Chand & Company Ltd.
18. Dutta, A. C. 2016. *Botany for Degree Students*. New Delhi: Oxford University Press.
19. Eames, E. J. *Morphology of Vascular Plants*. Stanford: Stanford University Press.
20. Dickinson, W. C. 2000. *Integrative Plant Anatomy*. San Diego, CA: Harcourt Academic Press.
21. Fahn, A. 1974. *Plant Anatomy*. USA: Pergamon Press.
22. Evert, R. F. 2006. *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development*. Hoboken, NJ: John Wiley and Sons, Inc.

23. Maheshwari, P. 1971. *An Introduction to Embryology of Angiosperms*. London: McGraw Hill Book Co.
24. Bhojwani, S. S., and S. P. Bhatnagar. 2000. *The Embryology of Angiosperms*. 4th ed. New Delhi: Vikas Publishing House.
25. Johri, B. M. 1984. *Embryology of Angiosperms*. Berlin: Springer-Verlag.
26. Raghavan, V. 2000. *Developmental Biology of Flowering Plants*. New York: Springer-Verlag.
27. Chaturvedi, S. K., and S. Chaturvedi. 2001. *Biology of Reproduction in Angiosperms*. Allahabad: Bioved Research Society.

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 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.easybiologyclass.com/topic-botany/

http://egyankosh.ac.in/handle/123456789/53530 https://www.delta-intkey.com/www/desc.htm https://milneorchid.weebly.com/plant-id-for- beginners.html

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

https://www.senecahs.org/pages/uploaded_files/Plant%20Classification.pdf
https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_%20S_%20Nongbri%20III%20Sem%20ppt.pdf https://www.brainkart.com/article/Bentham-and-Hooker-s-classification-of-plants---Dicotyledonae,- Gymnospermae-and-Monocotyledonae_1000/
https://libguides.rutgers.edu/c.php?g=336690&p=2267037
https://www.delta-intkey.com/

Programme/Class: *: **Diploma in Plant Identification, Utilization & Ethnomedicine***	Year: **II**	Semester: **III** **Paper-II (Practical)**
Subject: **Botany**		
Course Code: **B040302P**	Course Title: **Plant Identification technology**	

Course outcomes:

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

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

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

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

Unit	Topic* *(Perform Any three experiments from each unit as per facility)	No. of Lecture (60Hrs)
I	**Herbarium: Plant collection, Preservation and Documentation:** 1. Stepwise Practicing Herbarium techniques: a. Field Equipments, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing, Drying, treatments and of collected plant specimens d. Mount on standard herbarium sheets e. Label them using Standard method f. Organization and Indexing 2. Preparation of E-Herbarium by using plant identification apps.	**15**
II	**Taxonomic Identification using plant structure** Classify 15 locally available plants on the basis of Taxonomic description according to Bentham and Hooker system of classification in the following families: **Dicots:** Ranunculaceae, Rutaceae, Malvaceae, Fabaceae, Cucurbitaceae, Lamiaceae, Solanaceae, Asteraceae, Apocynaceae, Rubiaceae, Asclepiadaceae, **Monocots:** Liliaceae, Cyperaceae and Poaceae	**15**
V	**Angiosperm Morphology & Anatomy** 1. To study diversity in leaf shape and other foliar features. 2. Study of trichomes & stomata. 3. To study monopodial and sympodial branching. 4. Morphology of Fruits. 5. Inflorescence types-study from fresh/preserved specimens. 6. Flowers-study of different types from fresh/preserved specimens.	**15**

	7. Modifications in Roots, stems, leaves and inflorescences. 8. Anatomy of Monocot and Dicot Leaf and Root. 9. Anatomy of Anomalous structure in stem – *Nyctanthes, Bignonia, Boerhaaviaa,* 10. Anomalous secondary growth in *Dracaena*.	
VII	**Reproductive Botany** 1. Structure of anther, microsporogenesis and pollen grains. 2. Study Of Ovules (permanent slides/specimens/photographs)-types (anatropous, orthotropous, amphitropous and campylotropous). 3. Structure of polygonum type of embryosac development (through slides or photographs). 4. Study of embryo development in monocots and dicots. 5. Study of seed germination.	**15**

Suggested Readings:

Course Books published in Hindi/ Engl sh

1. प्रयोगात्मक वनस्पति विज्ञान भाग–2, 3– लेखक अशोक बेंद्रे तथा अशोक कुमार रस्तोगी प्रकाशन, मेरठ
2. प्रायोगिक वनस्पति विज्ञान बीएससी – I,II,III एस बी अग्रवाल प्रकाशक शिवलाल अग्रवाल एण्ड कम्पनी प्रायोगिक वनस्पति विज्ञान II Author Name: - Dhankar - Sharma - Trivedi RBD Publication House
1. Practical Taxonomy of Angiosperms By : R K Sinha ISBN : 9789386768520 I.K International Publishing House Pvt. Ltd.
2. Dhopte, A.M. (2003) Principles and Techniques for Plant Sciences. - Agrobios,Jodhpur, India.
3. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
4. Womersley, J. S. 1981. Plant collecting and herbarium development: A manual.
5. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehradun
6. Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST,N. Delhi
7. Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi

8. Quicke, Donald, L. J. (1993) Principles and Techniques of Commemoratory Taxonomy. Blakie, Academic and Professional, London

9. Singh, G (2004) Plant Systematics:Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.

21. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens,Kew (Reprinted 1999).

22. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.

23. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom.,Regnum Vegetabile Vol. 39. Utrecht.

24. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printer and Publishers, New Delhi.

25. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials: the South African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria.

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

resources, Display Charts

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

Suggested equivalent online courses:

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

Any Other :

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

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

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

At least three field excursions at hills/Oceans/Deserts including one Compulsory excursion to Botanical Garden, FRI/BSI and Central National Herbarium (CNH). Central Research Institutes/Hot Spots

Programme /Class: ***Diploma in Plant Identification, Utilization & Ethnomedicine***	Year: **II**	Semester: **IV** **Paper-I**
Subject: **Botany**		
Course Code: **B040401T**	Course Title**: Economic Botany, Ethnomedicine and Phytochemistry**	

Course outcomes:

After the completion of the course the students will be able to:

1. Understand about the uses of plants.
2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants
3. Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

Credits:**4**	**Core Compulsory**
Max.Marks:**25+75**	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60hrs)**
I	**Origin And Domestication of Cultivated Plants & Economic Botany** Centres of origin and diversity of crop plants, domestication and introduction of crop plants. Cultivation, production and uses of - wheat, rice, maize and legumes. Plants yielding fatty (mustard, groundnut)/essential oils (mint, rose), spices (Clove, cardamom, Black pepper, Fennel, Bay leaf, Daalchini), beverages (tea, coffee), fiber (cotton, coir, jute, flax); and biofuel (Jatropha) yielding plants. Timber yielding plants (teak, sheesham), gums and resins (*Acacia* & Commiphora), dye yielding plants (*Carthamus, Indigofera)*.	**15**

II	**Ethnomedicine & IPR** Tribal knowledge of herbal medicine. Study of common medicinal plants used by tribes (Ashwagandha, Sarpgandha, Tulsi, Haldi, Bael, Aamla) Methodologies of Ethnobotanical Research. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP. Traditional Knowledge Digital Library (TKDL), Protection of Traditional Knowledge - IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments.	**15**
III	**Pharmacognosy** Preparation of drugs for commercial market, Organoleptic, Physical and Microscopic evaluation of drugs. Sources of crude drugs- roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds. Active and inert constituents of drugs, drug adulteration. Organoleptic study of *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea* and *Zingiber officinale.*	**15**
IV	**Phytochemistry :** Plant natural products, general detection, extraction and characterization procedures. Alkaloids (morphine, quinine, caffeine, ephedrine, strychinine, and Nicotine), Terpenoids (menthol, camphor, artemisinin, citral, cannabinoid, limonine, carotenoids, linalool), Flavonoids (Quercitine, anthocyanin, flavones and isoflavones, myrcitin, kaempherol), and Essential and volatile oils.	**15**

Suggested Readings:

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

1. आवृतबीजी वनस्पति विज्ञान (टैक्सोनॉमी, एनाटॉमी, एंब्रियालाजी) तथा इकोनामिक बॉटनी) लेखक– सिंह, पांडे रस्तोगी प्रकाशन, मेरठ
2. भारत की संपदा, विज्ञान संचार भवन पूसा कैंपस

3. पारिस्थितिकी एवं आर्थिक वनस्पति विज्ञान. धनकर– शर्मा– त्रिवेदी
4. Aushdhiya Paudhe (Hindi) by R.P. Sharma | 1 January 2013 YKING BOOKS
Ministry of Health, Govt. of India.
5. Kochhar, S. L. 2011. *Economic Botany in the Tropics*. 4th ed. New Delhi: Macmillan Publishers India Ltd.
6. Sambamurthy, A. V. S. S., and N. S. Subrahmanyam. 2000. *Economic Botany of Crop Plants*. New Delhi: Asiatech Publishers.
7. Sharma, O. P. 1996. *Hill's Economic Botany* (Adapted from Dr. A. F. Hill). New Delhi: Tata McGraw Hill Co. Ltd.
8. Shukla, R. S. 2000. *Forestry for Tribal Development*. India: A.H. Wheeler & Co. Ltd.
9. Singh, D. K., and K. V. Peter. 2014. *Protected Cultivation of Horticultural Crops*. India: New India Publishing Agency.
10. Reddy, P. Parvatha. 2016. *Sustainable Crop Protection Under Protected Cultivation*. Singapore: Springer.
11. Deogirikar, Amit. 2019. *A Textbook on Protected Cultivation and Secondary Agriculture*. Aurangabad, India: Rajlaxmi Prakashan.
12. Singh, B., B. Singh, N. Sabir, and M. Hasan. 2014. *Advances in Protected Cultivation*. India: New India Publishing Agency.
13. Jain, S. K., and V. Mudgal. 1999. *A Handbook of Ethnobotany*. Dehradun: Bishen Singh Mahendra Pal Singh.
14. Pal, D. C., and S. K. Jain. 1998. *Tribal Medicine*. Calcutta: Naya Prakash Publishers.
15. Jain, S. K. 1989. *Methods and Approaches in Ethnobotany*. Lucknow: Society of Ethnobotanists.
16. Acharya, N. K. 2001. *Textbook on Intellectual Property Rights*. Hyderabad: Asia Law House.
17. Guru, Manjula, and M. B. Rao. 2003. *Understanding TRIPS: Managing Knowledge in Developing Countries*. New Delhi: Sage Publications.
18. Ganguli, P. 2001. *Intellectual Property Rights: Unleashing the Knowledge Economy*. New Delhi: Tata McGraw-Hill.
19. Miller, Arthur Raphael, and Michael H. Davis. 2000. *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*. St. Paul, MN: West Group Publishers.
20. Watal, Jayashree. n.d. *Intellectual Property Rights in the WTO and Developing Countries*.

Oxford: Oxford University Press.

21. Youngken, H. W. 1948. *Textbook of Pharmacognosy*. Philadelphia: Blakiston Company.
22. Wallis, T. E. 1946. *Textbook of Pharmacognosy*. London: J & A Churchill Ltd.
23. Roseline, A. 2011. *Pharmacognosy*. Chennai: MJP Publishers.
24. Kokate, C. K., and A. P. Gokhale. n.d. *Pharmacognosy*. New Delhi: Nirali Prakashan.
25. Lewis, W. H., and M. P. F. Elvin-Lewis. 1976. *Medical Botany: Plants Affecting Man's Health*. New York: John Wiley and Sons.
26. Joshi, S. G. 2000. *Medicinal Plants*. New Delhi: Oxford and IBH.
27. Farooqui, A. A., and B. S. Sree Ramu. 2001. *Cultivation of Medicinal and Aromatic Crops*. Hyderabad: Universities Press.
28. Harborne, J. B. 1998. *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. 3rd ed. London: Chapman and Hall.
29. Tilgner, Sharol. 1999. *Herbal Medicine: From the Heart of the Earth*. 1st ed. USA: Malloy Lithographing Inc.
30. Datta, S. C., and D. Mukerji. 1952. *Pharmacognosy of Indian Roots or Rhizome Drugs*. Bulletin No. 1.
31. Chatwal, Gurdeep. 1980. *Organic Chemistry of Natural Products*. Vol. 1. Mumbai: Himalaya Publishing House.
32. Kalsi, P. S., and S. Jagtap. 2012. *Pharmaceutical, Medicinal and Natural Product Chemistry*. New Delhi: Narosa Publishing House Pvt. Ltd.
33. Raychaudhuri, S. P., ed. 1991. *Recent Advances in Medicinal, Aromatic and Spice Crops*. Vol. 1 New Delhi: Today & Tomorrow's Printers and Publishers.
34. Yashoda, D., S. Geetha, and V. Radhakrishnan. 1997. *Allied Biochemistry*. Chennai: Morgan Publications.
35. Bajpai, P. K. 2006. *Biological Instrumentation and Methodology*. New Delhi: S. Chand & Co. Ltd.
36. Wilson, K., and J. Walker, eds. 2005. *Biochemistry and Molecular Biology*. Cambridge: Cambridge University Press.
37. Wilson, K., and K. H. Goulding. 1986. *Principles and Techniques of Practical Biochemistry*. 3rd ed. London: Edward Arnold.

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online resources:

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

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

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

http://www.legalserviceindia.com/article/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

Programme: ***Diploma in Plant Identification, Utilization & Ethnomedicine***	Year: **II**	Semester: **IV** **Paper-II**
Subject: **Botany**		
Course Code: **B040402P**	Course Title: **Commercial Botany & Phytochemical Analysis**	

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

1. Know about the commercial products produced from plants.
2. Understand about the ethno-botanical details of plants.
3. Learn about the chemistry of plants & herbal preparations
4. Can become an aromatic oil producer, Pharmacologist or quality analyst in Drug Company.

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

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

Unit	**Topic** **(Perform minimum any three experiments from each unit)**	**No. of Lectures (60 hrs)**
I	**Economic Botany & Microtechnique:** 1. Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) 2. Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) 3. 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. 4. Tea- tea leaves, tests for tannin 5. Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. 6. Jute- specimen, tests for lignin on T.S. of stem and study of fiber following	**15**

	maceration technique. 7. Study of specimens of economic importance mentioned in Unit I-& II	
II	**Ethnobotany** 1. Study of common plants used by tribes. (Ashwagandha, Sarpagandha, Tulsi, Haldi, Bael, Amla, Peepal) 2. Any 5 herbal preparations. 3. Understand –Nakshtra Vatika, Navgrah Vatika and develop in your college 4. To extract the names of the plants and Botanical uses depicted in our epics. 5. Traditional Knowledge Digital Library, Mark the Geographic Indications on Map 6. Visit a tribal area and collect information on their traditional method of treatment using crude drugs. 7. Visit NISCAIR, New Delhi 8. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital	**15**
III	**Pharmacognosy** 1. Organoleptic studies of plants mentioned in the theory. 2. Morphological studies of vegetative and floral parts. 3. Microscopic preparations of root, stem and leaf. 4. Stomatal number and stomatal index. 5. Vein islet number. 6. Palisade ratio. 7. Fibres and vessels (maceration). 8. Starch test 9. Proteins and lipid test	**15**

IV	1. Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. 2. Dimensions of Calcium oxalate crystals in powdered crude drug. 3. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. 4. Extraction of Aromatic Essential oil (Lemon grass/ rose/mint/ocimum) by steam distillation method.	**15**

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

1. Plant Ecology And Economic Botany by Dhankar - Sharma - Trivedi, RBD Publication
2. फार्माकोग्नॉसी Shiva Kant, Pankaj Kumar Brahmiya : Thakur Publication
3. PHARMACOGNOSY ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANI),RM Publication
4. प्रयोगात्मक वनस्पति विज्ञान भाग 2 लेखक अशोक बेंद्रे तथा अशोक कुमार, रस्तोगी प्रकाशन मेरठ
5. Sambamurthy, A. V. S. S., and N. S. Subrahmanyam. 2000. *Economic Botany of Crop Plants*. New Delhi: Asiatech Publishers.
6. Shukla, R. S. 2000. *Forestry for Tribal Development*. India: A.H. Wheeler & Co. Ltd.
7. Jain, S. K. 1989. *Methods and Approaches in Ethnobotany*. Lucknow: Society of Ethnobotanists.
8. Pal, D. C., and S. K. Jain. 1998. *Tribal Medicine*. Calcutta: Naya Prakash Publishers.
9. Wallis, T. E. 1946. *Textbook of Pharmacognosy*. London: J & A Churchill Ltd.
10. Youngken, H. W. 1948. *Textbook of Pharmacognosy*. Philadelphia: Blakiston Company.
11. Datta, S. C., and D. Mukerji. 1952. *Pharmacognosy of Indian Roots or Rhizome Drugs*. Bulletin No. 1. Ministry of Health, Government of India.
12. Roseline, A. 2011. *Pharmacognosy*. Chennai: MJP Publishers.
13. Raychaudhuri, S. P., ed. 1991. *Recent Advances in Medicinal, Aromatic and Spice Crops*. Vol. 1. New Delhi: Today & Tomorrow's Printers and Publishers.
14. Khasim, S. M. *Botanical Microtechniques: Principles and Practice*.

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

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

Suggested equivalent online courses:

https://www.entrepreneurindia.co/Document/Download/pdfanddoc-144615-.pdf

http://nopr.niscair.res.in/handle/123456789/45825

https://www.wipo.int/export/sites/www/tk/en/resources/pdf/medical_tk.pdf

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

Programme /Class: **Bachelor of Science**	Year: **IV**	Semester: **IV/**
Subject: Botany		
Course Code:-**B040403R**	Credit: 03	Course Title: Project

Course outcomes:

After completing this course a student will have:

1. Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
2. Project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes.
3. It will promote creativity and spirit of enquiry in learners.
4. They will learn to consult Scientists, libraries, laboratories and herbarium 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.

Max.Marks:**75**		Max.Marks:**75**

SUGGESTIVE LIST OF PROJECTS

1. Prepare beds for growing nursery for herbs, shrubs and trees.
2. Develop Green house facility in college and grow plants
3. Develop hydroponics facility in college and grow plants.
4. Develop Botanical Garden In The College With Labelling Vertical gardens, roof gardens.
5. Culture Art of Making Bonsai.
6. Phytochemical Analysis of Medicinal plants
7. Bio composting and Vermicomposting.
8. Performing Aromatherapy essential Oils
9. Rural Areas: Flora of a city/village, Biodiversity of a Village.
10. Soil & seed testing service provision to farmers.
11. Plant Disease identification in farms, nurseries and orchards.

12. Digital Portal For Plants: Campus, city or particular area
13. Science Communication by Creating science documentaries on Social mediaWebsites, Blogs, Youtube, Podcast etc.
14. Science Outreach Talks and Public Sensitization for plant biodiversity conservation
15. Phytochemistry Of Medicinal Plants, their antimicrobial, nutraceutical and antioxidant properties
16. Study Of Pollen Grains in Different Flowers
17. Study Of Stomata in Different Plants
18. Study Of various type Of Secretory & Special Tissues in plants

Or any other relevant project approved by Project Mentor.

Detailed Syllabus of B.Sc.-III Year

Or

Bachelor of Science

BACHELOR OF SCIENCE (BOTANY)		
Programme: Bachelor of Science	**Year: III**	**Semester: V/Paper-I**
Subject : **Botany**		
Course Code: **B040501T**	Course Title : **Plant Physiology, Metabolism and 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.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Plant - Water Relations:** Diffusion And Osmosis, Osmotic Potential, Absorption Of Water, Ascent Of Sap. Transpiration: Significance And Factors Affecting It; Mechanism Of Stomatal Opening And Closing. **Mineral Nutrition**: Essentiality Of Elements; Macro- And Micronutrients, Their Roles And Deficiency Symptoms; Mechanism Of Ion Uptake (Passive And Active) Nitrogen Cycle And Biological Nitrogen Fixation.	**15**
II	**Photosynthesis**: Photosynthetic Pigments; Photochemical Reactions- Reaction Centres, O2 Evolution, Photophosphorylation; CO_2 Fixation - C3 And C4 Carbon Cycle, Cam Plants, Photorespiration And Glycolate Metabolism, Factors Affecting Photosynthesis. **Respiration:** Aerobic And Anaerobic Respiration; Respiratory Pathways- Glycolysis, Krebs Cycle, Pentose Phosphate Pathway; Electron Transport, Oxidative Phosphorylation, Cyanide Resistance .	**15**

III	**Growth:** General Aspects And Phases Of Growth; Phytochrome, Photoperiodism And Vernalization, Circadian Rhythm, Plant Movements- Nastic And Tropic. Seed Germination; Bud And Seed Dormancy; Abscission And Senescence. **Phytohormones:** Discovery, Physiological And Applications Of Plant Hormones- Auxins, Cytokinins, Gibberellins, Abscisic Acid And Ethylene.	**15**
IV	**Biochemistry** **Carbohydrates:** Classification And Properties Of Monosaccharides, Oligosaccharides, Polysaccharides. **Lipids:** Saturated And Unsaturated Fatty Acids, Simple Lipids, Compound Lipids And Derived Lipids. **Proteins:** Amino Acids: Structure And Classification, Essential Vs. Non-Essential; Protein Structure:Primary, Secondary (A-Helix, B-Pleated Sheet), Tertiary, Quaternary; Classification Of Proteins Based On Biological Function. **Enzymes:** Characteristics Of Enzymes; Nomenclature And Classification (IUB System – 6 Major Classes); Concept Of Cofactors, Coenzymes, And Prosthetic Groups; Models Of Enzyme Action: Lock And Key, Induced Fit Model; Michaelis-Menten Kinetics; Allosteric Enzymes; Factors Affecting Enzyme Activity	**15**

Suggested Readings:

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

1. पादप शरीर क्रिया विज्ञान तथा रसायन लेखक – डॉ एच एस श्रीवास्तव प्रकाशन – रस्तोगी प्रकाशन, मेरठ।
2. पादप शरीर क्रिया विज्ञान तथा रसायन लेखक – सिंह, पांडे तथा जैन प्रकाशन – रस्तोगी प्रकाशन, मेरठ।
3. पादप कार्यिकी एवं जनन विज्ञान Madan Kumar. 2020.
4. Dhankar, Sharma, and Trivedi. *पादप कार्यिकी एवं जनन रसायन* Jaipur: RBD Publishing.
5. Hopkins, W.G., and N.P. Hiiner. 2004. *Introduction to Plant Physiology*. 3rd ed. Hoboken: John Wiley & Sons.
6. Jain, V.K. 2004. *Fundamental of Plant Physiology*. 7th ed. New Delhi: S. Chand and Company.
7. Mukherjee, S., and A. Ghosh. 2005. *Plant Physiology*. 2nd ed. Kolkata: New Central Book

Agency.

8. Panday, S.N., and B.K. Sinha. 2006. *Plant Physiology*. 4th ed. New Delhi: Vikas Publishing House Pvt. Ltd.
9. Purohit, Sunil D., K. Ahmed, and Gotam K. Kukda. 2013. *Plant Physiology and Biochemistry* (Hindi). 1st ed. New Delhi: Student Edition. ISBN: 81-301-0035-5.Salisbury, F.B., and C.W. Ross. 1992. *Plant Physiology*. 4th ed. Belmont, CA: Wadsworth Publishing Company.
10. Srivastava, H.N. 2006. *Pradeep's Botany Vol. V*. Jalandhar: Pradeep Publications.
11. Verma, S.K. *Plant Physiology and Biochemistry*. New Delhi: S. Chand & Sons.
12. Buchanon, B., W. Gruissen, and R. Jones. 2000. *Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of Plants*. New Delhi: I.K. International.
13. Chaudhuri, D., D.K. Kar, and S.A. Halder. 2008. *Handbook of Plant Biosynthetic Pathways*. Kolkata: New Central Book Agency.
14. Lehninger, David L. Nelson, and Michael M. Cox. 2013. *Lehninger Principles of Biochemistry*. 6th ed. New York: Freeman, Macmillan.
15. Mathews, C.K., K.E. Van Holder, and K.G. Ahren. 2000. *Biochemistry*. 3rd ed. Delhi: Pearson Education.
16. Pathmanabhan, G., M. Vanangamudi, C.N. Chandrasekaran, K. Sathyamoorthy, C.R. Babu, R.C. Babu, and P.N. Boopathi. 2011. *A Handbook on Mineral Nutrition and Diagnostic Techniques for Nutritional Disorders of Crops*. 1st ed. Jodhpur: Agrobios (India). ISBN: 9788177543377.
17. Voet, D., and J.G. Voet. 2005. *Biochemistry*. 3rd ed. Hoboken: John Wiley & Sons.

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

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

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

BACHELOR OF SCIENCE (BOTANY)		
Programme: Bachelor of Science	Year: III	Semester: V/Paper-II
Subject : **Botany**		
Course Code: B040502T	Course Title : **Molecular Biology and Bioinformatics**	

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

1. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Know about Processing and modification of RNA and translation process, function and regulation of expression.
3. Gain working knowledge of the practical and theoretical concepts of bioinformatics.

Credits : **4**	**CC / Elective**
Max. Marks: **25+75**	Min. Passing Marks :

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Genetic material & Regulation of gene expression** Historical Perspective: Griffith's And Avery's Transformation Experiments, Hershey-Chase- Bacteriophage Experiment, Types Of Genetic Material. DNA structure, Types of DNA, DNA Replication (Prokaryotes and Eukaryotes)- Bidirectional, Semiconservative, θ (Theta) mode of replication. Types of RNA (mRNA, tRNA, rRNA), RNA polymerases; Transcription, Genetic Code, Translation, Regulation of Gene Expression in Prokaryotes: Lac Operon.	**15**
II	**Principles & Applications of Molecular Biology Techniques** Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA Sequencing- Sanger Sequencing, Next Generation Sequencing (Pyrosequencing and Illumina Sequencing) , PCR and Reverse Transcriptase-PCR. Gene editing -CRISPR/Cas systems.	**15**

III	**Plant Biotechnology** Recombinant DNA technology: Vectors, Restriction Enzymes, Molecular Probes, Genomic and cDNA libraries, Indirect gene transfer methods (Agrobacterium mediated transfer), Direct Gene transfer methods (Electroporation, Particle Bombardment, Microinjection, PEG, silicon carbide),Transgenic plants (Flavr Savr tomato, Bt cotton, Golden rice, Round Up Ready soybean) Plant Cell, Tissue And Organ Culture: Concept Of Totipotency, Technique Of Plant Tissue Culture, Media Preparation, Callus Cultures, Cell Suspension Cultures, Micropropagation, Somaclonal Variation, Somatic Hybridization, And Synthetic Seeds.	**15**
IV	**Bioinformatics & its Applications** Computers in Biology (MS Office, PPT, MS Excel, Number Systems), Scope and applications of bioinformatics, Introduction to biological databases (NCBI,EMBL- EBI, JDBD), Types of Sequence Alignment (Global & Local, Pairwise & Multiple Sequence Alignment), Methods of Sequence Alignment: Dot-matrix Method, Dynamic Programming, Word or k-tuple Method, Exhaustive Algorithms, Heuristic Algorithm (BLAST & FASTA), Phylogenetic Tree Construction: Types (Rooted, Unrooted, Cladogram & Phylogram), Methods (Distance Vs. Discrete or Character Based), Steps in Construction of Phylogenetic Tree.	**15**

Suggested Readings:

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

1. निगम, डॉ. अर्चना. 2020. *जैव प्रौद्योगिकी एवं आनुवांशिक अभियांत्रिकी*. हिंदी, हार्डकवर संस्करण.
2. पुरोहित, सुनील डी., के. अहमद, और गोतम के. कुकड़ा. 2013. *प्लांट फिजियोलॉजी एंड बायोकैमिस्ट्री*. पाठ्यपुस्तक (हिंदी). ISBN: 81-301-0035-5.
3. राय, डॉ. पूजा. 2020. *आणविक जीवविज्ञान एवं जैव तकनीक*. भोपाल: तकनीकी प्रकाशन.
4. शर्मा, डॉ. ए., और त्रिवेदी, डॉ. एस. 2020. *मॉलिक्यूलर बायोलॉजी एंड बायोटेक्नोलॉजी*. अजमेर: आरबीडी पब्लिकेशन्स.

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

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

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

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

Internal Assessment	**Marks**
Class Interaction	**5**
Quiz	**5**

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering

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

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

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

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

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

https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907 https://nptel.ac.in/courses/102/103/102103013/

Programme /Class: ***Bachelor of Science***	Year: **III**	Semester: **V** **Paper-III**
Subject: **Botany**		
Course Code: **B040503P**	Course Title: **Experiments In Physiology, Biochemistry & Molecular Biology**	

Course outcomes:

After the completion of the course the students will be able to:

1. Understand the physiological processes undergoing in plants along with their metabolism
2. Identify Mineral deficiencies based on visual symptoms
3. Understand and develop skill for conducting molecular experiments for genetic engineering

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

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

Unit	**Topic*** ***(Perform any three from each unit based on facility)**	**No. of Lectures (60 hrs)**
I	**Plant water relation, Mineral Nutrition and translocation in phloem** 1. Determination of Osmotic Potential of plant cell sap by plasmolytic method using leaves of *Rhoeo / Tradescantia*. 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q10. 4. Experiment to demonstrate the Transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of Stomata (dicot & monocot) 7. Determination of Rate of Transpiration using cobalt chloride method. 8. Experiment to measure the Rate of Transpiration by using Farmer's Potometer 9. Experiment to measure the Rate of Transpiration by using Ganong's potometer 10. Effect of Temperature on Membrane Permeability by colorimetric method. 11. Study of Mineral Deficiency symptoms using plant material/photographs.	**8**

II	**Photo Synthesis & Respiration** 1. Separation of Plastidial Pigments by Solvent and Paper Chromatography. 2. Estimation of total Chlorophyll content from different chronologically aged leaves (young, mature and senescent) by Arnon method. 3. Effect of H_2CO_3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). 4. Measurement of oxygen uptake by respiring tissue (per g/hr.) 5. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble 6. Determination of the RQ of germinating seeds.	**8**
III	**Plant Development, Movements, Dormancy & Responses** 1. Geotropism and Phototropism — Klinostàt 2. Hydrotropism a. Measurement of Growth — Arc and Liver Auxanometer 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. Qualitative Analysis of carbohydrates, 4. Estimation of reducing sugar by anthrone method, 5. Qualitative Analysis of Lipids 6. Qualitative analysis of Amino acids and Proteins 7. Purification of acid phosphatase from sprouted moong 8. Purification of peroxidase from radish 9. Enzyme kinetics of acid phosphatase/ Enzyme kinetics of peroxidase/ alpha- amylase	**8**

V	**Genetic material** 1. Instruments and equipments used in molecular biology. 2. Isolation of Genomic DNA 3. Isolation of DNA from plants 4. Examination of the purity of DNA by Agarose Gel Electrophoresis. 5. Quantification of DNA by UV-Spectrophotometer 6. Estimation of DNA by Diphenylamine method.	**7**
VI	**Plant tissue culture** 1. Familiarization of instruments and special equipments used in the Plant Tissue Culture experiments 2. Preparation of Plant Tissue Culture Medium, Sterilization, Preparation of Stock Solutions of nutrients for MS Media. 3. Surface sterilization of plant materials and inoculation in the medium. 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing – Demonstration	**7**
VII	**Genetic Engineering** 1. Construction of restriction map of circular and linear DNA from the data provided. 2. Isolation of Plasmid DNA. 3. Restriction digestion and Gel Electrophoresis of Plasmid DNA (demonstration/ photograph). 4. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results. 5. Demonstration of PCR 6. Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by Electroporation, Microinjection, Microprojectile Bombardment. 7. Study of steps of Genetic Engineering for production of Bt cotton, Golden Rice, FlavrSavr Tomato through photographs.	**7**

VIII	**Bioinformatics** Exploration of databases- Nucleic acid databases (NCBI,GenBank, EMBL, DDBJ, NDB), Protein databases (PIR, Swiss-Prot, TrEMBL, PDB). Types of Sequence Alignment(Global & Local, Pairwise & Multiple Sequence Alignment) Methods of Alignment (BLAST and FASTA) Phylogenetic Tree Construction: Types (Rooted, Unrooted, Cladogram & Phylogram), Steps in construction of Phylogenetic Tree.	**7**

Suggested Readings:

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

1. चंद्र, अशोक, और अशोक कुमार. 2020. *प्रयोगात्मक वनस्पति विज्ञान: भाग 3*. मेरठ: रस्तोगी प्रकाशन.

2. Akhtar, Inam. 2012. *A Laboratory Manual of Plant Physiology, Biochemistry and Ecology*. 1st ed. Jodhpur: Agrobios (India). ISBN: 9788177544589.
3. Dashek, W.V., ed. 1997. *Methods in Plant Biochemistry and Molecular Biology*. Boca Raton, FL: CRC Press.
4. Henry, R.J. 1997. *Practical Application of Plant Molecular Biology*. London: Chapman & Hall.
5. Karp, G. 2010. *Cell and Molecular Biology: Concepts and Experiments*. 6th ed. Hoboken, NJ: John Wiley & Sons, Inc.
6. Padmanaban, G., C.N. Chandrasekaran, A.U. Thangavelu, R. Sivakumar, N. Kalimuthu, P. Boominathan, and P. Anbarasan. 2016. *Advanced Methods in Physiology and Biochemistry*. 1st ed. Jodhpur: Agrobios. ISBN: 9789381191132.
7. Thimmaiah, S.R. 2004. *Standard Methods of Biochemical Analysis*. New Delhi: Kalyani Publishers.
8. Wilson, K., and J. Walker. [Year not specified]. *Practical Biochemistry: Principles and Techniques*. Cambridge, U.K.: Cambridge University Press.

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

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

BACHELOR OF SCIENCE (BOTANY)		
Programme: Bachelor of Science	Year: III	Semester:VI Paper-I
Subject : **Botany**		
Course Code: B040601T	Course Title : **Cytogenetics, Plant Breeding and Nanotechnology**	

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

1. Acquire knowledge on cell ultrastructure.
2. Understand the structure and chemical composition of chromatin and concept of cell division.
3. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.
4. Understand the concept of 'one gene one enzyme hypothesis' along with the molecular mechanism of mutation.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Cell Biology** Structure of Prokaryotic Cell and Eukaryotic Cells. Function of Cell Wall, Plasma Membrane, Ribosomes, Endoplasmic Reticulum, Golgi Apparatus, Mitochondria, Chloroplast, Lysosomes, Peroxisomes. Organization of Nucleus . Nomenclature & Structure of Chromosomes (Nucleosome Model). Special types of Chromosomes (Lampbrush Chromosomes and Polytene Chromosomes & B Chromosomes). Karyotype and Ideogram. Cell Cycle & Cell Division (Mitosis, Meiosis). Variation in Chromosome (Numerical and Structural Aberrations).	**15**
II	**Genetics** Chromosome Theory of Inheritance, Crossing Over and Linkage, Incomplete and Codominance; Interaction of Genes: Incomplete Dominance, Codominance, Lethal	**15**

	Genes; Complementary, Supplementary, Epistasis and Duplicate Gene Interactions. Pleiotropy, Polygenic Inheritance, Multiple Alleles. Extranuclear Inheritance. Patterns of Sex Determination in Plants.	
III	**Plant Breeding & Biostatistics** Plant introduction, Acclimatization, Selection – Mass Selection, Pure Line Selection and Clonal Selection. Hybridization: Intergeneric, Interspecific, Inter Varietal Hybridization with examples. Composite and Synthetic Varieties, Heterosis , Mutation Breeding, Molecular Breeding , Achievements of India in Crop Breeding (Wheat & Rice). Biostatistics: Data and Sampling, Measures of Central Tendency- Arithmetic Mean, Mode and Median; Measurement of Dispersion- Coefficient of Variation, Standard Deviation, Standard Error of Mean; Test of Significance; Chi-Square Test for Goodness of Fit. Computer Application in Biostatistics- MS Excel and SPSS	**15**
VI	**Nanotechnology** Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). 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.	**15**
Suggested Readings: ***Course Books published in Hindi may be prescribed by the Universities.*** 1. शर्मा और त्रिवेदी. 2020. *कोशिका जीवविज्ञान, आणविक जीवविज्ञान एवं जैव प्रौद्योगिकी*. अजमेर: आरबीडी पब्लिकेशन्स.		

2. गुप्ता, पी.के. 2016. *कोशिका विज्ञान, आणविक जीवविज्ञान, विकास एवं पारिस्थितिकी*. मेरठ: रस्तोगी प्रकाशन.
3. वैज्ञानिक एवं तकनीकी शब्दावली आयोग (CSTT). 2015. *विज्ञान एवं प्रौद्योगिकी शब्दावली*. नई दिल्ली: वैज्ञानिक एवं तकनीकी शब्दावली आयोग.

Cell Biology

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

Genetics

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

Plant Breeding

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

Biostatistics

1. Annadurai, B. 2007. *Textbook of Biostatistics*. New Delhi: New Age International.
2. Gomez, A. A., and A. A. Gomez. 1984. *Statistical Procedures for Agricultural Research*. New York: John Wiley & Sons.
3. Gupta, S. C. 2016. *Fundamentals of Statistics*. Mumbai: Himalaya Publishing House.
4. Kapoor, V. K. 2007. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand & Sons.
5. Murty, B. S., P. Shankar, Baldev Raj, B. B. Rath, and James Murday. 2012. *Textbook of Nanoscience and Nanotechnology*. New Delhi: Springer.
6. Nageshwar Rao, G. 2007. *Statistics for Agricultural Sciences*. New Delhi: BS Publications.
7. Nigam, A. K., and V. K. Gupta. 1979. *Handbook on Analysis of Agricultural Experiments*. New Delhi: IASRI Publications.

   Panse, V. G., and P. V. Sukhatme. 1985. *Statistical Methods for Agricultural Workers*. New Delhi: Indian Council of Agricultural Research.
9. Rangaswami, R. 2009. *A Textbook of Agriculture Statistics*. Hyderabad: New Age International.
10. Sharma, A. K. 2005. *Textbook of Biostatistics I*. New Delhi: Discovery Publishing House.
11. Snedecor, G. W., and W. G. Cochran. 1989. *Statistical Methods*. Iowa: Iowa State University Press.
12. Taylor. 2008. *Biological Sciences*. Cambridge: Cambridge University Press.
13. Das, M. N., and N. C. Giri. 1986. *Design and Analysis of Experiments*. New Delhi: Wiley Eastern Ltd.

Nanotechnology

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

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

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

B.A. (Curators), B.A. Geology.

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

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

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

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

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

Further Suggestions:

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

Programme/Class: ***Bachelor of Science***	Year: **III**	Semester: **VI** **Paper-II**
Subject: **Botany**		
Course Code: B040602T	Course Title: **Ecology & Environment**	

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

1. understand the complex interrelationship between organisms and environment;
2. to understand the methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. get the knowledge which will be critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Ecology and Ecosystem** Definition of Ecology, Abiotic and Biotic Components, Renewable and Non-Renewable Sources of Energy. Ecological Succession- Primary & Secondary, Hydrosere & Xerosere. Food chains and Food Webs, Ecological Pyramids, Ecological Niche, Ecotypes, Ecological Indicators. Ecosystem: Concepts and Components, Types of Ecosystems : Terrestrial ans Aquatic Ecosystems. Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	**15**
II	**Phytogeography :** Phytogeographical regions of India and World, Vegetational types of Uttar Pradesh Agroecological and Floristic zones of India. Natural Vegetation of India, Static and Dynamic plant Geography, Basic Principles governing Geographical Distribution of Plants. Soil formation, Soil profile, Composition & Properties of soil. Soil types. Soil erosion and soil conservation. Geographical Information System: definitions and components; GIS software packages; Remote sensing and GIS in land use planning, forest resources and agriculture studies.	**15**
III	**Biodiversity conservation & Sustainable development** Definition – Genetic, Species, and Ecosystem Diversity. Value of Biodiversity, Hotspots of Biodiversity, Threats to Biodiversity. Endemic and Endangered Species of Plants in India. Ex-situ and In-situ conservation, Red Data Book, Botanical Gardens, National Parks, Sanctuaries, Ramsar Sites, Bioreserves. Role of Seed Bank and Gene Bank . Role of NBPGR, FAO, BSI. Strategies of Sustainable Development, Sustainable Agriculture, India's Environment Action Programme. Carbon Credit: Concept, Exchange of Carbon Credits. Ecological Footprint with emphasis on Carbon Footprint. Concept of Energy and Green Audit.	**15**

IV	**Pollution, Waste management & Environmental ethics:** Environmental Pollution, Environmental Protection Laws, Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust. Bioremediation, Physical, Chemical and Biological Processes of Wastewater Treatment. Design and Operation of Sewage Treatment Plant. Regulatory framework for Pollution Monitoring and Control; Case study : Ganga Action Plan; Yamuna Action Plan; Implementation of CNG; Disposal of waste -Incineration, Pyrolysis, Composting and Biogas Production, Circular Economy and sustainability.	**15**

Suggested Readings:

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

पर्यावरण अध्ययन एवं संबंधित विषय

1. चौधरी, बी. एल., और जितेन्द्र पाण्डेय। 2013। *पर्यावरण अध्ययन (हिंदी)*। जयपुर: एपेक्स पब्लिशिंग हाउस। पृष्ठ: 340 + XII। आईएसबीएन: 81-301-0004-5।
2. महनोट, एस. सी., और पी. के. सिंह। *मिट्टी एवं जल संरक्षण*। जयपुर: एपेक्स पब्लिशिंग हाउस। आईएसबीएन: 978-81-301-0071-5।
3. भाटिया, बी., जैन, बी., कोहली, बी., श्रीवास्तव, बी., सिंह, बी., और वर्मा, बी। *इकोलॉजी एवं पर्यावरण जीवविज्ञान*। रायपुर: आरबीडी प्रकाशक।
4. हुसैन, माजिद। 2020। *पर्यावरण एवं पारिस्थितिकी* (पाँचवाँ संस्करण)। पेपरबैक।
5. चौधरी, बी. एल., गोतम के. कुकड़ा, और जितेन्द्र कुमार जोशी। *पर्यावरण जीवविज्ञान एवं वनस्पति भूगोल*। जयपुर: एपेक्स पब्लिशिंग हाउस। आईएसबीएन: 978-81-301-0064-7।
6. पुरोहित, डॉ. एस. एस., डॉ. पी. पी. देव, और डॉ. अशोक के. अग्रवाल। 2015। *यूजीसी यूनिफाइड: पर्यावरण विज्ञान (हिंदी)*। पहला संस्करण। आगरा: एग्रोबायोस इंडिया। आईएसबीएन: 9788177545814।
7. *श्रीमद् भगवद्गीता*। गीता प्रेस, गोरखपुर।
8. *गुरुड पुराण*। गीता प्रेस, गोरखपुर।

Ecology

1. Ambasht, R.S., and N.K. Ambasht. *A Text Book of Plant Ecology*. Latest ed. CBS Publication & Distributors.
2. Begon, M., J.L. Herper, and C.R. Townsend. 3rd ed. *Ecology: Individuals, Populations and Communities*. Oxford: Blackwell Science.

3. Cain, M.L., Bowman, W.D., and Hacker, S.D. 2014. *Ecology*. 3rd ed. Sinauer Associates.
4. Chapman, J.L., and M.J. Riss. Latest ed. *Ecology: Principles and Applications*. Cambridge University Press.
5. Gurevitch, J., et al. 2002. *The Ecology of Plants*. Sinauer Associates.
6. Kumar, H.D. Latest ed. *Modern Concept of Ecology*. Vikas Publishing House.
7. Kimar, U., and M.J. Asija. 2005. *Biodiversity: Principles & Conservation*. Student Edition, Agrobios (India).
8. Mackenzie, et al. Latest ed. *Ecology*. Viva Books.
9. Mani, M.S. Latest ed. *Bio-Geography of India*. Springer-Verlag.
10. Mitra, D., J.K. Guha, and S.K. Chowdhury. 7th ed. *Studies in Botany*, Vol. II. Moulik Library.
11. Odum, F.P. Latest ed. *Fundamentals of Ecology*. Saunders.
12. Sharma, P.D. Latest ed. *Elements of Ecology*. Rastogi Publications.
13. Shukla, R.S., and P.S. Chandel. Latest ed. *Plant Ecology*. S. Chandel and Co.
14. Singh, P.S., and U.K. Agarwal. Latest ed. *Concept of Ecology*. S. Chand & Company.
15. Verma, P.S., and U.K. Agarwal. Latest ed. *Concept of Ecology*. S. Chand & Company.
16. Vasudevan, N. 2006. *Essentials of Environmental Science*. Narosa Publishing House.
17. Singh, J.S., S.P. Singh, and S. Gupta. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publications.

Geographic Information Systems & Remote Sensing

1. Demers, M.N. 2005. *Fundamentals of Geographic Information System*. Wiley & Sons.
2. Lo, C.P., and A.K.W. Yeung. 2002. *Concepts and Techniques of Geographic Information Systems*. Prentice-Hall of India.
3. Richards, J.A., and X. Jia. 1999. *Remote Sensing and Digital Image Processing*. Springer.
4. Sabins, F.F. 1996. *Remote Sensing: Principles and Interpretation*. W.H. Freeman.

Biodiversity and Conservation

1. Krishnamurthy, K.V. 2003. *An Advanced Text Book on Biodiversity*. Oxford & IBH Publishing Co. Ltd.
2. Primack, R.B. 1993. *Essentials of Conservation Biology*. Sinauer Associates.
3. Sodhi, N.S., and P.R. Ehrlich, eds. 2010. *Conservation Biology for All*. Oxford University Press.

4. Sodhi, N.S., L. Gibson, and P.H. Raven. 2013. *Conservation Biology: Voices from the Tropics*. Wiley-Blackwell.
5. Singh, J.S., and S.P. Singh. 1987. "Forest Vegetation of the Himalaya." *The Botanical Review* 53:80-192.
6. Kumar, U., and M.J. Asija. 2005. *Biodiversity: Principles & Conservation*. Agrobios (India).
7. Anonymous. 1997. *National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet)*. National Bureau of Plant Genetic Resources, New York.

Climate Change and Environmental Science

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

Environmental Pollution and Engineering

1. Abbasi, S.A. 1998. *Environmental Pollution and its Control*. Cogent International, Pondicherry.
2. Abbasi, S.A., and E.V. Ramasamy. 1999. *Biotechnological Methods of Pollution Control*. Universities Press (India) Limited, Hyderabad.
3. Peavy, H.S., D.R. Rowe, and G. Tchobanoglous. 1985. *Environmental Engineering*. McGraw Hill Book Company, Singapore.
4. Rand, M.C., A.E. Greenberg, and M.J. Taras, eds. 1995. *Standard Methods for the Examination of Water and Wastewater: 19th edition*. American Public Health Association (APHA), Washington, D.C.

5. Scragg, A. 1999. *Environmental Biotechnology*. Addison Wesley Longman, Singapore.
6. Tchobanoglous, G. 1988. *Wastewater Engineering: Treatment, Disposal, Reuse*. Tata McGraw Hill, New Delhi.
7. Aarve, V.P., W.A. William, and D.R. Debra. 2002. *Solid Waste Engineering*. Cengage Learning, USA.
8. George, T., H. Hilary, and A.V. Samuel. 1993. *Integrated Solid Waste Management: Engineering Principles and Management Issues*. McGraw Hill.
9. George, T., and F. Frank. 2002. *Handbook of Solid Waste Management*. 2nd ed. McGraw Hill.
10. Kanthi, L.S. 2000. *Basics of Solids and Hazardous Waste Management Technologies*. Prentice Hall

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

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ 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/moocuturelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science https://www.coursera.org/courses?query=plants http://egyankosh.ac.in/handle/123456789/53530

Programme/Class: *Bachelor of Science*	Year: **III**	Semester: **VI Paper-III**
Subject: **Botany**		
Course Code: B040603P	Course Title: **Lab on Cytogenetics, Conservation & Environment management**	

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

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

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

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

Unit	**Topic (Any three 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 Onion/*Rhoeo/Crinum* 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa.*	**15**

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. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.	**15**
III	**Plant Breeding & Biostatistics:** 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. Computer application in biostatistics - MS Excel and SPSS	**15**
IV	**Nanotechnology** 1. Synthesis of metal nanoparticles using plant extracts and characterization. 2. Synthesis and characterization of polymeric nanoparticles for drug delivery. 3. Synthesis and characterization of lipid based nanoparticles for drug delivery. 4. Determination of antimicrobial properties of silver nanoparticles .	**15**

V	**Ecology & Ecosystem** 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites	**15**
VI	**Phytogeography:** 1. Marking of vegetation types of India, World & Uttar Pradesh on maps 2. Phytogeographical areas of India 3. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 4. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 5. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 6. Soil Profile study 7. Soil types of India-Map	**15**
VII	**Biodiversity, Conservation and Sustainable Development** 1. Study of plant community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density, abundance and IVI of components species (to be done during excursion/field visit exercise). 2. Green auditing of the College Campus- Demo 3. Conducting Waste audit of your institution.	**15**

VIII	**Pollution & Waste management** 1.Study of instruments used to measure Microclimatic Variables: Soil Thermometer, Anemometer, Psychrometer/Hygrometer, Rain Gauge and Lux Meter 2. Estimation of Chloride and Dissolved Oxygen Content in water sample 3.Comparative Anatomical Studies of leaves form polluted and less polluted areas. 4. Measurement of Dissolved Oxygen by Azide Modification of Winkler's Method. 5.Determination of Dissolved Oxygen of water samples from polluted and unpolluted sources. 6.Microbiological Assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water Making Compost/Vermicompost from kitchen waste by Enzymes/ Bio decomposer/ Whey with Dung.	**15**

Suggested Readings: as in papers above:

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

1. पुरोहित, सुनील डी., अनामिका सिंहवी, तथा किरण टाक। 2013 *प्रायोगिक वनस्पति विज्ञान (भाग–III)*। अजमेर: एपेक्स पब्लिशिंग हाउस।
2. एरी, एन. सी., सुनील डी. पुरोहित, तथा गोतम के. कुकड़ा 2013 *प्रायोगिक वनस्पति विज्ञान (भाग–II)*। अजमेर: एपेक्स पब्लिशिंग हाउस।
3. Gupta, P.K. 2017. *A Handbook of Soil, Fertilizer and Manure*. 2nd ed. Jodhpur: Agrobios (India).
4. Purohit, S.S. 2021. *Green Technology: An Approach for Sustainable Environment*. Jodhpur: Agrobios (India).
5. Theroux, F.R., E.F. Eldridge, and W.L. Mallmann. 2011. *Laboratory Manual of Chemical and Bacterial Analysis of Water and Sewage*. Jodhpur: Agrobios (India).
6. Gupta, P.K. 2021. *Methods in Environmental Analysis: Water, Soil and Air*. 2nd ed. Jodhpur: Agrobios (India).
7. Ryan, W.J. 2009. *Water Treatment and Purification Technology*. Jodhpur: 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/)

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

Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

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

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

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VII** **Paper-I**
Subject: **Botany**		
Course Code: **B040701T**	Course Title: **Applied Microbiology And Plant Pathology**	

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the impact and significance of microbes in maintaining a healthy ecosystem.
2. Gain knowledge about microbial formulations used as biopesticides or biofertilizers.
3. Learn about the host –pathogen interaction and disease management.
4. Gain knowledge about uses of microbes for plant growth promotion and as biocontrol agents.
5. Learn about the methods for detection of plant pathogens.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	Microbial symbioses and their significance, Plant microbiome and plant health (PGPR and defence priming), Biofertilizers and biopesticides, Microbial fermentations, antibiotics, vaccines, Microbes in bioremediation, Biological control and IPM	**15**
II	Impact of crop diseases on global food security, Stages in the development of disease in plants, Bacterial secretion systems, effectors and pathogenesis, Plant immunity, Biochemistry of host-virus interaction (Hypersensitive response), systematic acquired resistance (SAR), Engineering pathogen resistance in plants	**15**
III	Purification of plant viruses, Serological and molecular methods for detection and identification of plant viruses and bacteria Modern methods of plant virus control (cross protection, PDR, RNAi, CRISPR-Cas system) Viral and Bacterial diseases: Symptoms, Causal organism, Disease cycle and Control measures of - Mosaic	**15**

	diseases on Tobacco, Yellow vein mosaic of bhindi, Tomato leaf curl, Citrus canker, Soft rot of fruits and vegetables, Scab of potato, Little leaf of brinjal	
IV	Molecular identification of fungal species, Mycorrhizal fungi and their significance, Fungal diseases and their control: Symptoms, Causal organism, Disease cycle and Control measures of – Damping off of seedlings, White rust of Crucifers, Late blight of Potato, Loose smut of wheat, Black stem rust of wheat, Early blight of potato, Red rot of sugarcane, Wilt of arhar.	**15**

Suggested Books:

1. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
4. Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
5. Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
6. Rangaswamy, G. 2009, Disease of Crop Plants in India, Prentice Hall of India, New Delhi.
7. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
8. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
9. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
10. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
11. Sundar Rajan. S. 2010.College Botany Volume I, Himalaya Publications, Mumbai.
12. Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

Suggested Reading:

1. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
2. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture,

Vishwa Prakashan, New Delhi.

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

Internet:

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

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

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

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

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

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

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

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-

http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf

https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStra

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VII** **Paper-II**
Subject: **Botany**		
Course Code: **B040702T**	Course Title: **Environmental Awareness And Social Ethics**	

Course Outcome:

After the completion of the course the students will be able to:

1. Understand the relationship of humans and environment and their moral obligation to protect the environment.
2. Promote sustainable development of the planet.
3. Generate environment consciousness in themselves and the community.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Pollution and Waste management:** Types, causes, and effects of pollution. Environmental protection laws, Regulatory framework for pollution monitoring and control. Major pollutants and their impact. Air Quality Index (AQI) and water quality parameters, Waste management strategies and technologies. Bioremediation, Sewage disposal mechanism.	**15**
II	**Types of waste & Circular Economy:** Types of waste: solid, liquid, hazardous, e-waste, biomedical collection and disposal, Recycling of solid wastes (hazardous & non-hazardous), collection and segregation, Methods of waste management- sanitary landfill, composting, incineration, pyrolysis, Biogas production, Circular Economy & sustainability. Case studies (e.g., urban smog, river pollution), Ganga Action Plan; Yamuna Action Plan; implementation of CNG.	**15**

III	**Environmental Audit & Sustainability** Environmental Audit- scope, and significance, Environmental Audit Process (Stages: Pre-audit, on-site audit, post-audit, Checklists, interviews, site inspections, Reporting and follow-up actions), Campus green audit (energy, water, biodiversity, waste). Principles of sustainable development, Sustainable resource management; Environmental Management Systems (EMS): ISO 14001 standard. Indicators and Metrics of Sustainability: Ecological footprint, carbon footprint. India's environment action programme, Policy and Community Engagement.	**15**
IV	**Environmental ethics, Carbon Credits and 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.	**15**

Suggested Reading:

1. Purohit, S. S. 2021. *Green Technology: An Approach for Sustainable Environment*. 1st ed. Jodhpur: Agrobios (India).
2. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. Leiden: Martinus Nijhoff Publishers.

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Programme/Class: **4 Year UG degree (Honours)**	Year: **IV**	Semester: **VII** **Paper-III**
Subject: **Botany**		
Course Code: **B040703T**	Course Title: **Plant Tissue Culture & Genetic Engineering**	

Course Outcome:

After the completion of the course the students will be able to:

- Understand the principles and applications of plant tissue culture.
- Gain foundational knowledge of genetic engineering techniques in plants.
- Develop practical skills in tissue culture and molecular biology.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction to Plant Tissue Culture** Historical Development, Principles, components and techniques of *in vitro* plant cultures. Cellular totipotency, Differentiation, and Morphogenesis. Components and preparation of Murashige and Skoog (MS) medium. Role of plant growth regulators in plant tissue culture. Sterilization Techniques for plant materials, culture media, culture vessels and tools. Types of explants, Callus and Suspension Cultures, Stages of Micropropagation, Direct and Indirect Organogenesis.	**15**
II	**Applications of Plant Tissue Culture** Somaclonal Variation: causes of somaclonal variation and Applications in plant breeding and crop improvement; Meristem Culture for Virus-Free Plants. Production of Haploids; Somatic Embryogenesis and Synthetic Seed Production. Methods of protoplast isolation, Somatic Hybridization and Cybrid Production. Cryopreservation and Germplasm Conservation. Secondary Metabolite Production.	**15**

III	**Genetic Engineering Basics** Isolation of genomic and plasmid DNA, Cloning vectors (plasmids, cosmids, bacteriophages, YAC, BAC), Restriction digestion and ligation, Transformation, Selection of recombinants. Gene libraries, Recombinant vaccines, Recombinant interferon. Polymerase Chain Reaction (PCR & RT-PCR). Gene silencing and RNA interference, CRISPR-Cas9 and genome editing.	**15**
IV	**Genetic Transformation and Transgenic Plants** Gene Transfer Methods in Plants: *Agrobacterium*-mediated transformation, Electroporation, Microinjection and biolistic methods. Selectable marker and reporter genes. Development of genetically modified crops-Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean), Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice), Improved horticultural varieties (Moondust carnations). Role of transgenics in bioremediation. Biosafety regulations and ethical considerations.	**15**

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1. Razdan, M.K. (2003). *Introduction to Plant Tissue Culture*. Science Publishers.
2. Bhojwani, S.S., & Razdan, M.K. (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science.
3. Ramawat, K.G. (2008). *Plant Biotechnology*. S. Chand & Co Ltd.
4. Smith, R.H. (2012). *Plant Tissue Culture: Techniques and Experiments* (3rd ed.). Academic Press.
5. Dubey, R.C., 2005 A Textbook of Biotechnology S.Chand & Co, New Delhi.
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7. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi
8. Senger, Gupta and Sharma. 2010. Laboratory manual on Biotechnology. WH Publishers. UK.
9. Singh, B.D. 2008. Biotechnology. Narosa Publishing. New Delhi.

10. A. J. Nair. Basics of Biotechnology- Laxmi Publications, New Delhi.
11. S S Purohit and S K Mathur; Biotechnology-Fundamentals and Application- Agrobotanica, India.
12. A. J. Nair Introduction to Genetic Engineering & Biotechnology. Jones & Bartlett Publishers, Boston,USA.
13. H S Chawla Introduction to Plant Biotechnology-; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
14. H D Kumar Modern concept of Biotechnology, Vikas Publishing House, Pvt. Ltd., New Delhi.

Suggested Readings:

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

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Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VII** Paper-IV
Subject: **Botany**		
Course Code: **B040704P**	Course Title: **Applications in Microbial and Plant Sciences**	

Course Outcome:

After the completion of the course the students will be able to:

1. Isolate and study plant pathogens in order to correctly identify them.
2. Learn to devise methods of controlling plant pathogens based on the nature of propagules and mode of transmission.
3. Practice biological control of pests instead of depending on harmful chemical pesticides.

4. Learn to mitigate the use of chemical fertilizers, and increase the use of biofertilizer.
5. Understand techniques that are useful in the study of plant pathogens and biomolecules.
6. Learn about the host responses to stress, and its quantification.

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Experimental Plant Pathology:** 1. Study of fermentative diversity of bacteria. 2. Isolation and characterization of soil bacteria. 3. Morphology and staining of nitrogen fixing bacteria. 4. Enumeration of rhizosphere to non rhizosphere population of bacteria. 5. Isolation of antagonistic bacterial sp. from the rhizosphere. 6. Isolation of Phosphate solubilizing microorganisms. 7. Microscopic observations of root colonization by VAM fungi. 8. Isolation of phyllosphere microflora.	**15**
II	**Applied Microbiology:** 1. Study of diseased plant specimens and materials 2. Preparation of media for isolation of the pathogen: bacteria (NA) and fungi (PDA). 3. Isolation of pathogens from infected material 4. Study of the hypersensitive response during virus infection 5. Insect transmission of plant virus 6. Purification of plant virus 7. Serological detection of plant viruses	**15**
III	**Plant Tissue Culture & Genetic Engineering** 1. Preparation of MS medium. 2. Surface-sterilization of explants, inoculate on MS medium with 2,4-D, observe callus formation over 2–3 weeks. 3. Excise nodal segments, culture on MS + BAP (and a low auxin),	**15**

	subculture every 3 weeks; count shoots per explant. 4. Transfer microshoots to half-strength MS with IBA, once roots form (~2 weeks), harden plantlets in greenhouse pots. 5. Synthetic (Alginate) Seed Production: Encapsulate somatic embryos or microshoots for synthetic seeds. Mix explants with sodium alginate + $CaCl_2$ drop-wise, form beads, store briefly and germinate aseptically. 6. Enzymatic Protoplast isolation 7. Study of methods of gene transfer through photographs: Agrobacterium- mediated, direct gene transfer by Electroporation, Microinjection, Microprojectile Bombardment. 8. Study of steps of Genetic Engineering for production of Bt cotton, Golden Rice, FlavrSavr Tomato through photographs**.**	
IV	**Techniques and Instrumentation:** 9. Chromatographic procedures (gel filtration) for separation of low molecular and high molecular weight leaf extract components. 10. Thin layer chromatography for detection of amino acids 11. Isolation of proteins from leaf sap through precipitation and centrifugation. 12. Separation of proteins by electrophoresis.	**15**

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2. Prescott's Microbiology, J. Willey, L. Sherwood, 10th edition, 2017, McGraw-Hill Education.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology,
4. Edited by A. Hofmann, S. Clokie, 8th edition, 2018, Cambridge University Press.
5. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier.
6. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and
7. Bartlett Learning.
8. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016,
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10. Text Book of Mycology by A.K. Sarbhoy; ICAR Publications, New Delhi, 2006.

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

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Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VII** **Paper-V**
Subject: **Botany**		
Course Code: **B040705T(a)**	Course Title: **Plant Resource Utilization**	

Course Outcome:

After the completion of the course the students will be able to:

1. Gain knowledge about the introduction, cultivation and domestication of crops.
2. Get an insight into the cultivation practices of some major crops.
3. Learn about the commercial products obtained from plants 4. Gather information on methods of conserving plant diversity

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60 hrs)**
I	Centres of diversity of plants, origin of crop plants, domestication and introduction of crop plants. Cultivation, production and uses of - wheat, rice, maize and legumes	**15**
II	medicinal (*Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea, Zingiber officinale* etc.) and psychoactive Plants (Cannabis, Tobacco, Opium-Poppy)	**15**
III	Plants yielding fatty/essential oils, spices, beverages (tea, coffee, cocoa), fiber (cotton, coconut, jute, flax), Timber yielding plants (teak, sheesham, mango, deodar, sal), gums and resins (*Acacia, Commiphora, Pinus*), dye yielding plants (*Carthamus, Indigofera, Rubia, Haematoxylum*) and petro plants.	**15**

IV	Conservation of plant resources for agriculture and forestry. *In situ* conservation: sanctuaries, national parks, biosphere reserves, wetlands, mangroves. *Ex situ* conservation: field gene banks, seed banks, cryobanks.	**15**

Suggested Practicals:

1. Food Crops: Morphology, anatomy, micro-chemical test for stored material: Wheat, rice, maize, chickpea, potato, sweet potato, sugarcane, 2. Study of any five important crops used for fodder / forage purpose: Jowar, Bajra, lucerne, Maize etc. 3. Plant fibers: Cotton, jute, sun hemp, coir, silk cotton: Morphology microscopic study anatomy of whole fibers, using appropriate staining methods. 4. Medicinal and aromatic plants: At least 5 medicinal and 5 aromatic plants and their morphology, anatomy, phyto-chemistry. 5. Oil yielding crops: Mustard, groundnut, soybean, coconut, sunflower, castor: Morphology, microscopy of oil yielding tissue, test for oil, acid, Iodine numbers. 6. Gum, resin, tannin, dye yielding plants.

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1. Chiras, DD., Reganold, JP., 2009, Natural Resource Conservation: Management for a Sustainab Future, 10th edition, Pearson

2. Daniel,WW., Cross, CL., 2014, Biostatistics: Basic Concepts and Methodology for the Heal Sciences, Wiley Student Edition.

3. Erdtman, G., 2007, An Introduction to Pollen Analysis, Read Books

4. Kochhar, SL., 2012, Economic Botany in the Tropics, 4 th edition, Macmillan India

5. Mahajan, BK., 2010, Methods in Biostatistics for Medical Students and Research Workers, 7 edition, Jaypee Publishers

6. Trivedi, PC., Sharma, N., 2010, Plant Resource Utilization and Conservation, Pointer Publishers,

Suggested Readings:

1. Chandel K. P. S. Shukla G. and Sharma Neelam.1996. .Biodiversity in Medicinal and Aromat Plants in India – Conservation and Utilization, Indian Bureau of Plant Genetic Resources, New Delhi

2. Kaufman Peter B. et al. 1999. Natural Products from Plants, CRC Press. UK.

3. Primack R.B. 2000. A Primer of Conservation Biology, Sinauer Asso. Publ., Massachusetts. USA.

4. Sahoo S. 2002. Plant Resource Utilization. Allied Publishers. Nagpur.

5. Singh J.S. Singh S.P. and Gupta S.R., 2006, Ecology, Environment and Resource Conservatio Anamya Publication, New Delhi,

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Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VII** **Paper-V**
Subject: **Botany**		
Course Code: **B040705T(b)**	Course Title: **Plant Systematics**	

Course Outcome:

After the completion of the course the students will be able to:

1. Learn how plant specimens are collected, documented, and curated for a permanent record
2. Observe, record, and employ plant morphological variation and the accompanying descriptive terminology
3. Gain experience with the various tools and means available to identify plants and trace their phylogeny
4. Develop observational skills and field experience
5. Identify a taxonomically diverse array of native plants
6. Recognize common and major plant families
7. Comprehend the concepts of plant taxonomy and classification of Angiosperms according to modern approaches.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60 hrs)**
I	Principles, Relevance and role of Plant Systematics, Binomial nomenclature, Comparative study of different classification systems along with merits and demerits viz. Bentham and Hooker, Engler and Prantl, Hutchinson, Takhtajan & APG system. Origin and Evolution of	**15**

	Angiosperms. Modern trends in Plant taxonomy: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups). Pleomorphism and apomorphy.	
II	Herbarium & Botanical Gardens. ICN (History, Principles and Applications), Protologue and Botanic literature (Monographs, Icons, Floras and Taxonomic literature). Species Concept: Various models, Speciation and Variation. Phytogeography with special reference to discontinuous areas, endemism, hotspots and hottest hotspots, GIS and Phylocode.	**15**
III	Interesting taxonomic features and interrelationships of following Dicot families: Ranunculaceae, Nymphaeaceae, Nelumbonaceae, Malvaceae, Bombacaceae, Rutaceae, Leguminosae (Fabaceae), Rosaceae, Myrtaceae, Cucurbitaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae & Asclepiadaceae.	**15**
IV	Interesting taxonomic features and inter-relationships of following Monocot families: Alismataceae, Arecaceae, Commelinaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae and Zingiberaceae. Special features of Insectivorous/Parasitic and Saprophytic families. Modern tools and evidence of taxonomy viz: Role of Plant Morphology, Anatomy, Embryology and Palynology in plant taxonomy, Cytotaxonomy, Chemotaxonomy, Numerical taxonomy.	**15**

Suggested Practicals:

1. Taxonomic Identification of plants related to above given families.
2. Herbarium: Plant collection, Preservation and Documentation.

Suggested Books:

https://womengovtcollegevisakha.ac.in/departments/A%20Textbook%20of%20Practical%20Botany%20II%20(%20PDFDrive%20).pdf

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2. Eames, A. J. 1961. *Morphology of Angiosperms*. New York: McGraw Hill.
3. Naik, V. N. 1984. *Taxonomy of Angiosperms*. New Delhi: Tata McGraw-Hill Publishing Company.
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https://www.delta-intkey.com/

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper-I**
Subject: **Botany**		
Course Code: **B040801T**	Course Title: **Research Methodology**	

Course Outcome:

The undergraduate students will develop a research orientation and become acquainted with the fundamentals of research methods.

1. Understand the basic concepts and techniques used in research viz. sampling techniques, research designs and techniques of analysis.
2. Develop understanding of the basic framework of research process.
3. Learn how to review literature and collect data
4. Develop an understanding of the ethical dimensions of conducting applied research.
5. Appreciate the components of scholarly writing and evaluate its quality.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60 hrs)**
I	**Basic Concepts of Research:** Meaning of research in biological sciences; Research methods *vs.* Research methodology; Motivation and objectives of research problem. Selecting and formulating a research problem. Types of research: Descriptive *vs.* Analytical, Applied *vs.* Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs.* Empirical	**15**

II	**Research Design and Survey of Literature:** Concept and need, Identification of Research problem, defining and delimiting Research problem. Basic principles of research design-objectives, introduction, rationale of work, material and methods, designing experiments. Necessity and importance of review of literature in defining a research problem; Primary and secondary sources of literature-reviews, treatise, monographs, web as a source for searching literature. Identifying the gap areas from literature review.	**15**
III	**Data Collection, Analysis and Scientific writing**: Observation and collection of data. Data processing, analysis, interpretation and their applications. Format of writing research paper, popular scientific articles for general awareness, review and reports-layout, structure, language, illustrations and tables. Procedure of reference citation. Principles of biostatistics. Computer application: Operating systems, software.	**15**
IV	**Application of Results and Ethics**: Environmental impacts, Ethical issues, Ethical committees, Commercialization, Copy right; Royalty, Intellectual property rights and patent law; Trade related aspects of intellectual property rights. Reproduction of published material. Impact factor and citation index. Plagiarisms. Reference citation and acknowledgement. Reproducibility and accountability.	**15**

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2. Pawar, B. S. 2009. *Theory Building for Hypothesis Specification in Organizational Studies*. New Delhi: Response Books.
3. Kothari, C. R. n.d. *Research Methodology: Methods and Techniques*. New Delhi: New Age Publisher.

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1. Dawson, C. 2002. *Practical Research Methods*. New Delhi: UBS Publishers.
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3. Neuman, W. L. 2008. *Social Research Methods: Qualitative and Quantitative Approaches*. Upper Saddle River, NJ: Pearson Education.
4. Best, John W., and James V. Kahn. *Research Methodology*. New Delhi: PHI Learning Pvt. Ltd.
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Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper-II**
Subject: **Botany**		
Course Code: **B040802T**	Course Title: **Processing and Statistical Analysis of Data**	

Course Outcome:

1. Students will learn how to analyze both quantitative and qualitative data using appropriate statistical and qualitative analysis techniques.
2. Applying data preprocessing methods to remove redundancy and incomplete data.
3. Characterizing patterns discovered through association rule mining.
4. Developing data mining applications for analysis using various tools.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Processing of Data** Data Processing and Editing, Classification and Coding, Transcription, Tabulation, and Graphical Representation, Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Introduction to Statistical Software: MINITAB.	**15**
II	**Statistical Analysis of Data** Statistical Analysis, Measures of Central Tendency, Measures of Dispersion, Measures of Association/Relationship, Probability distributions: Binomial, Poisson, Uniform, Normal and Exponential, Hypothesis Testing, Confidence Interval, Test of Significance, Comparison of Two Proportions, Comparison of Means (z test, t test, two sample t test, paired-t test), ANOVA, Nonparametric Methods. Computer application in statics-MS-Excel & SPSS	**20**
III	**Report Writing** Types of Reports, Planning of Report Writing, Research Report Format, Principles of Writing, Documentation, Data and Data Analysis, Reporting in a Thesis, Writing of Report, Typing of Report, Briefing.	**10**

IV	**Web Search** Introduction to internet, Use of internet and search engine like Google scholar, Yahoo etc., Use of internet in Research activities, Submission of paper in Archive Electronic Mail System, Cyber law, working knowledge of Math SciNet, PubMed, JSTOR, Shodhganga, EBSCOhost and other online journals.	**15**

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2. Gupta, S. P. 2014. *Statistical Methods*. 44th ed. New Delhi: Sultan Chand & Sons.
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4. Goon, A. M., M. K. Gupta, and B. Dasgupta. 2005. *Fundamentals of Statistics*. Vol. 1. Kolkata: World Press.
5. Kothari, C. R. 2004. *Research Methodology: Methods and Techniques*. 2nd ed. New Delhi: New Age International Publishers.
6. Kumar, Ranjit. 2011. *Research Methodology: A Step-by-Step Guide for Beginners*. 3rd ed. New Delhi: Pearson Education India.
7. Field, Andy. 2013. *Discovering Statistics Using IBM SPSS Statistics*. 4th ed. London: Sage Publications.
8. Hair, Joseph F., William C. Black, Barry J. Babin, and Rolph E. Anderson. 2010. *Multivariate Data Analysis*. 7th ed. Upper Saddle River, NJ: Pearson Prentice Hall.
9. Pallant, Julie. 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. 7th ed. London: Routledge.
10. Tabachnick, Barbara G., and Linda S. Fidell. 2019. *Using Multivariate Statistics*. 7th ed. Boston: Pearson.
11. Wilcox, Rand R. 2010. *Fundamentals of Modern Statistical Methods: Substantially Improving Power and Accuracy*. 2nd ed. New York: Springer.

Suggested Readings:

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

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper-III**
Subject: **Botany**		
Course Code: B040803T	Course Title: **Techniques And Instrumentation**	

Course Outcome:

After the completion of the course the students will be able to:

- Introduce fundamental laboratory techniques and instrumentation used in plant science research.
- Develop practical skills in microscopy, spectroscopy, chromatography, and molecular biology techniques.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Histological & Microscopy Techniques** Sample preparation: fixation, dehydration, embedding. Sectioning methods: microtomy. Staining and mounting procedures. Microscopic Types: simple, compound, bright field, dark field, phase contrast, fluorescence, confocal, transmission electron microscopy, scanning electron microscopy. Microscopic measurements and imaging techniques.	**15**
II	**Microbiological and Immunological Techniques** Sterilization methods and culture techniques, Media preparation and microbial cultivation, Staining methods: simple and differential, Immunoassays: ELISA, Radioimmunoassay, Agglutination tests.	**15**
III	**Chromatography, Spectroscopy & Radioisotopic Techniques** Principles and applications of Chromatographic Techniques -Paper chromatography, TLC, GC Flow Cytometry, HPLC. Principles and applications of Colorimetry and Spectroscopic techniques- Ultraviolet-Visible, Chlorophyll Fluorescence, Raman, NMR & MALDI-ToF-MS. Nature of radioactivity, types of decay, units of radioactivity Applications in plant research and safety protocols	**15**

IV	**Molecular Biology Techniques** DNA/RNA isolation and purification, Centrifugation: differential, density gradient, ultracentrifugation, Gel electrophoresis: agarose and SDS-PAGE. Detection of Proteins and Nucleic Acids (Western Transfers, Immuno-blots, Northern and Southern blot), DNA chip technology and Microarray, PCR and its applications.	**15**

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Suggested Readings:

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2. Sambrook, J., E. F. Fritsch, and T. Maniatis. 1989. *Molecular Cloning: A Laboratory Manual*. 2nd ed. Cold Spring Harbor Laboratory Press.
3. Phillip Sheeler and Donald E. Bianchi. 2006. *Cell and Molecular Biology*. John Wiley and Sons, Inc., U.K.
4. Roe, Simon, ed. 2001. *Protein Purification Techniques: A Practical Approach*. 2nd ed. Oxford University Press.
4. S.K. Sawhney and Randhir Singh. 2000. *Introductory Practical Biochemistry*. Narosa Publishing House.
5. Bisen, P. S., and A. Sharma. 2012. *Introduction to Instrumentation in Life Sciences*. CRC Press.
6. Hegyi, G. et al. 2013. *Introduction to Practical Biochemistry*. ELTE Faculty of Natural Sciences.
7. Spector, D. L., and R. D. Goldman. 2006. *Basic Methods in Microscopy*. Cold Spring Harbor Laboratory Press.
8. Cazes, J., ed. 2009. *Encyclopedia of Chromatography*. 3rd ed. Taylor & Francis.
9. Ruzin, S. E. 1999. *Plant Microtechnique and Microscopy*. Oxford University Press.
10. Wilson, K., and J. Walker. 2000. *Principles and Techniques of Practical Biochemistry*. 5th ed. Cambridge University Press.
11. R. Boyer. 2000. *Modern Experimental Biochemistry*. Pearson Education, Asia.
12. E.J. Hewitt. 1966. *Sand and Water Culture Methods Used in the Study of Plant Nutrition*.

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http://ecoursesonline.iasri.res.in/course/view.php?id=282

https://www.docsity.com/en/subjects/biochemistry-and-instrumentation/

https://www.longdom.org/scholarly/biochemistry-techniques-journals-articles-ppts-list-3172.html

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper-IV Practical**
Subject: **Botany**		
Course Code: **B040804P**	Course Title: **Applied research methods, statistical analysis and Instrumentation**	

Course Outcome: After practical experience the students will be able to

1. Apply appropriate research methodologies to design, conduct, and evaluate scientific investigations in applied disciplines.
2. Perform statistical data analysis using tools such as SPSS or Excel to interpret and validate experimental results.
3. Operate and calibrate essential laboratory instruments (e.g., spectrophotometers, chromatographs) and interpret their outputs effectively.
4. Develop accurate scientific reports and presentations by integrating research findings, statistical insights, and instrumentation data.

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Bioinformatics Exercises** 1. Bioinformatics Resources: NCBI, EBI, DDBJ, RCSB, ExPASy 2. Database search engines: EntrezDBGET 3. Open access bibliographic resources and literature databases a. PubMed b. BioMed Central c. Public Library of Sciences (PloS) d. CiteXplore. 4. Bioinformatics Resources at the species level a. ICTV Database b. AVIS c. Viral genomes at NCBI 5. Sequence databases: a. Nucleic acid sequence databases: GenBank, EMBL, DDBJ; b. Protein sequence databases:	**15**

	Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; c. Repositories for high throughput genomic sequences: EST, STS, GSS. d. Genome Databases at NCBI, EBI, TIGR, SANGER 6. Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP, DSSP 7. Derived Databases: InterPro, Prosite, Pfam, ProDom 8. Sequence file formats: GenBank, FASTA 9. Protein and nucleic acid properties: Proteomics tools at the ExPASy server, EMBOSS	
II	**Genetic Engineering** 1. Construction of restriction map of circular and linear DNA from the data provided. 2. Isolation of plasmid DNA. 3. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 4. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	**15**
III	**Biostatistics:** 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2. Calculation of correlation coefficient values and finding out the probability. 3. Determination of goodness of fit in Mendelian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 4. Computer application in biostatistics - MS Excel and SPSS	**15**
IV	**Biodiversity** 1. Study of plant community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density, abundance and Importance Value	**15**

	Index (IVI) of species (to be done during excursion/field visit exercise). 2. Marking of vegetation types of Uttar Pradesh, India & World on map.	

References

Applied Research Methods

1. Kothari, C. R., and Gaurav Garg. 2019. *Research Methodology: Methods and Techniques*. New Delhi: New Age International Publishers.
2. Kumar, Ranjit. 2011. *Research Methodology: A Step-by-Step Guide for Beginners*. New Delhi: Pearson Education India.

Statistical Analysis for Biological Research

1. Pallant, Julie. 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. 7th ed. London: Routledge.
2. Sokal, Robert R., and F. James Rohlf. 2012. *Biometry: The Principles and Practice of Statistics in Biological Research*. 4th ed. New York: W. H. Freeman.
3. Zar, Jerrold H. 2010. *Biostatistical Analysis*. 5th ed. Upper Saddle River, NJ: Pearson Education.

Instrumentation in Biology

1. Skoog, Douglas A., F. James Holler, and Stanley R. Crouch. 2017. *Principles of Instrumental Analysis*. 7th ed. Boston: Cengage Learning.
2. Willard, Hobart H., Lynne L. Merritt, John A. Dean, and Frank A. Settle. 2004. *Instrumental Methods of Analysis*. New Delhi: CBS Publishers & Distributors.

Bioinformatics and Data Analysis

1. Mount, David W. 2004. *Bioinformatics: Sequence and Genome Analysis*. 2nd ed. New York: Cold Spring Harbor Laboratory Press.
2. Xiong, Jin. 2006. *Essential Bioinformatics*. New York: Cambridge University Press.

Suggested Readings:

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

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper-V**
Subject: **Botany**		
Course Code: B040805Ta	Course Title: : **Bioinformatics and Computer Application**	

Course Outcome:

After the completion of the course the students will be able to:

1. Learn fundamentals of computer application and Bioinformatics
2. Learn about biological databases and their use
3. Learn about phylogenetic analysis and its importance

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic	No. of Lectures (60 hrs)
I	Computer fundamentals: MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps, programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, and computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	**15**

II	Biological databases : Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)	**15**
III	Data Generation and Data Retrieval : Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez).	**15**
IV	Phylogenetic analysis : Introductory concepts of -Similarity, identity and homology, Alignment – local and global alignment, pairwise 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.	**15**

REFERENCES

Books:

1. Ghosh, Zhumur, and Bibekanand Mallick. 2012. *Bioinformatics: Principles and Applications*. New Delhi: Oxford University Press.
2. Rastogi, S. C., Namita Mendiratta, and Parag Rastogi. 2011. *Bioinformatics: Concepts, Skills & Applications*. New Delhi: CBS Publishers & Distributors Pvt. Ltd.
3. Baxevanis, Andreas D., and B. F. Francis Ouellette. 2009. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. New Delhi: Wiley India Pvt. Ltd.
4. Xiong, Jin. 2006. *Essential Bioinformatics*. New York: Cambridge University Press.

Suggested Reading:

1. Mount, David W. 2004. *Bioinformatics: Sequence and Genome Analysis*. 2nd ed. New York: Cold Spring Harbor Laboratory Press.
2. Attwood, Teresa K., and David J. Parry-Smith. 1999. *Introduction to Bioinformatics*. New Delhi: Pearson Education.

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Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **VIII** **Paper**-V
Subject: **Botany**		
Course Code: **B040805Tb**	Course Title: **Conservation Of Biodiversity**	

Course Outcome:

After the completion of the course the students will be able to:

1. Get an overview of the significance of plant diversity, and an insight into global strategies for developing workable models for its exploration and conservation
2. Develop an understanding of the importance of national parks, biosphere reserves and sanctuaries
3. Understand the role played by government and non-government organizations in conserving biodiversity

Credits: 4	Core Compulsory
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	**Topic**	**No. of Lectures (60 hrs)**
I	Plant diversity concepts, importance of Species diversity in Ecosystems, Ecosystem functions and services. · Levels of Biodiversity - Ecosystem diversity, Species diversity and its measure, Species - richness, evenness, abundance and genetic diversity. · Abiotic and biotic factors affecting biodiversity, causes of biodiversity loss (viz. ecosystem, degradation, land-use change, fragmentation, invasive species, climate change, pollution, overexploitation and co-extinctions).	**15**
II	Need for biodiversity conservation, Types of conservation (preventive, remedial and restoration).· Current status of biodiversity conservation and Red list index. · Conservation status by IUCN red list categorized criteria (DD, LC, NT, VU, EN, CR, EW and EX). · Community based conservation strategies, Indigenous and traditional knowledge in biodiversity.	**15**

III	In situ conservation - Protected areas and its types, Biosphere reserves, National parks, Wildlife sanctuaries and Sacred groves. · Ex situ conservation- Botanical gardens, Seed banks. · In-vitro storage of germplasm and cryopreservation. · Concept of diversity hot spots, Biodiversity hotspots in India.	**15**
IV	International and National conservation policies. · Role of government agencies and NGOs in plant conservation. · General account of important authorities and institutions - UNEP, DST, MoEF, BSI, NBPGR, CPCB, NMPB, AYUSH.	**15**

Suggested Readings:

1. Dutta, Bijan Bihari. *A Handbook of Plant Resource Utilization and Conservation*. [Place of publication not provided]: [Publisher not provided].
2. Hawksworth, David L., and Alan T. Bull, editors. [Year not provided]. *Plant Conservation and Biodiversity*. [Place of publication not provided]: Springer.
3. Hosetti, B. B., and S. Ramkrishna. *Biodiversity: Concepts and Conservation*. Jaipur: Aavishkar Publishers and Distributors.
4. Sharma, Dushyant Kumar. *Biological Diversity and Its Conservation*. [Place of publication not provided]: Daya Publishing House.

Apprenticeship/ Internship embedded UG Degree Programme

Programme/Class: 4 Year UG degree (Honours)	Year: **IV**	Semester: **V II & VIII**
Subject: **Botany**		
Course Code:**B040805**	Course Title: **Major Research Project/Dissertation**	
Course Outcome The full semester External Project/Dissertation is designed to ensure that the student is able to apply the knowledge gained in the previous semesters in specific areas of interest in a problem solving environment, gaining bench-experience, to serve as a springboard for a professional future.		
Credits: **40**		
External Project/Dissertation External Project/Dissertation for Semester VIII will be carried out by the students in various recognized/established labs of Parent/Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, Industry, Government Departments etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).		