

Certificate Course in Microbial Technology and Classical Botany (Year: 1)

Course Code: B040101T

Some minor amendments have been suggested, such as -

Unit I A. Inclusion of Indian Botanists of all branches in parenthesis where Eminent Indian Botanists is given.

IB. Elementary knowledge of.... Prefixed in the beginning.

II. Bacteria and plasmids to be studied together. Addition of TMV and retro viruses, mycophages.

III. Addition of flagella, Types of (before reproduction), 'Comparative' Life Cycle of (prefixed) before given genera. Removal of *Hydrodictyon*, Addition of 'Phycoviruses' and 'diatomite'.

IV. Added 'Comparative study of' general characteristics; *Synchytrium*

V & VI accepted as such

VII. Deleted 'False Smut of Rice/ Brown spot of rice'

VIII. Added 'Elementary knowledge of', amino acid production (rearranged), *Spirulina* added as example of single cell protein, added 'Microbial Biofactories (*E.coli* and Yeast) for production of recombinant proteins'

Addition of a reference book on Eminent Indian Botanists: Past & Present by P.S. Narayan & T. Pullaiah (2011).

Course Code: B040102 P:

4 practicals added in 2nd unit.

Course Code: B040201T:

Unit I: Added *Funaria*;

Unit II: Added (fossil) after early. Added comparative study of morphology, anatomy and reproduction in *Selaginella*, *Equisetum* and *Azolla*.

Unit III: Added 'with special reference to *Cycas*, *Ginkgo*, *Pinus*, *Ephedra*'

Unit IV: Added 'Pentoxylales', deleted 'contributions of Birbal Sahni' as Indian Botanists are already mentioned in Unit I of first paper.

Unit VI: Added 'Periderm'

Course Code: B040202P Added in Unit VII: Reproductive tissue processing, Block preparation and Microtomy technique

Course Code: B040301T

Unit I: Added 'Artificial' before keys, deleted 'single access and multiple accesses'.

Diploma in Plant Identification, Utilization & Ethnomedicine (Year: 2)

Course Code: B040401T

Unit VI: Added "*Embllica officinalis*, *Rauwolfia serpentina*", deleted "*Cynodondactylon*, *Trichopuszeylanicus*"

Unit VII: Deleted "*Vinca rosea*" and added "*Catharanthus roseus*". Deleted Repetitive "carotenoids".

Course Code: B040301T

Unit I: Added 'Artificial' before keys, deleted 'single access and multiple access'. Relocated 'Binomial Nomenclature', replaced 'names' with 'taxa'.

Unit II: Replaced Engler and Prantl's classification with Takhtajan's.

Unit III & IV: Rearranged families bringing Papaveraceae and Apiaceae in Unit III and Apocyanaceae, Asclepiadaceae, Solanaceae, Acanthaceae and Lamiaceae in Unit IV. Deleted Orchidaceae. In both the units 'A study' is replaced with 'A comparative study'.

Unit V: Subtitle 'Modern trends in Plant taxonomy' is replaced with 'Phylogenetic Systematics'. Biometrics is specified in parentheses as 'Neighbour Joining'; Cladistics is specified as 'basics and methodology', supraspecific taxa added before (Monophyletic....).

Unit VI: Deleted software OP02.010H11YLIP. Added software PAUP and MESQUITE.

Unit VII: Added 'Character analysis in subtitle. Added Concept of Character, Selection of characters, Character coding, Character step matrix, Character x Taxon Matrix' and deleted 'aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media'.

VIII: Prefixed 'Elementary knowledge of'

Bachelor of Science Course (Year: 3)

Course Code: B040501T

Unit VIII: Added "Elementary knowledge of" before phytonutrients

Course Code: B040502T

Unit II: Added "RNAi and Gene editing"

Unit III: Added "Enzymes used in Genetic Engineering and Gene Cloning"

Unit V: Added "Primer designing"

Course Code: B040503P

Unit IV: Added practical exercises on "Purification of acid phosphatase from sprouted moong/ Purification of peroxidase from radish" and "Enzyme kinetics of acid phosphatase/ Enzyme kinetics of peroxidase/ alpha-amylase"

Course Code: B040601T

Unit I: Deleted terms "G0, G1, S and G2 phases" after Cell cycle

Unit V: Added "Elementary knowledge of" for Plant tissue Culture syllabus content

Unit VII: Added "Elementary knowledge of" for Artificial syllabus contents.

Course Code: B040602T

Unit II: Added after Abiotic and biotic "components and their interrelationship, Biogeochemical and hydrological cycles", "Concept of Ecological perturbations and balance", Production was prefixed by "Primary and secondary", and "and Components" in the end of this sub-section was deleted as they conveyed no meaning. Sub-section on Types of ecosystems was rearranged with some additions as "Natural and Man-made-Forest Ecosystem, Grassland, Aquatic and Agro- Ecosystems"

Unit IV: In the sub-section on Value of biodiversity: "Indian" socio-"cultural," ethical and aesthetic "and" were added, and "option values" were deleted, as they conveyed no meaning here. While "ecad" was added to understand its contrasting characteristic in

reference to ecotype, "Indian value system" was added in reference to conservation practices followed since ancient times.

Unit VI: "Elementary knowledge of" was prefixed to this section of syllabus.

In suggested Reading, "Shrimad Bhagvadgeeta, Garud Puran" have been recommended for the holistic understanding of Ecology, Biodiversity and underlying unity of all lives and environment around them.

Course Code: B040603P

Unit VII: Added determination of "IVI of species" (excursion/field exercise)"inEcology practical

Annexure 3 (a)

Syllabus Proposed for Minor/Elective Papers in Botany

Programme/Class: Certificate Course		Year: I	Semester: I/II Paper- Minor/ Elective
Subject: Offered by Botany			
Course Code: 04		Course Title: Disaster Management system in India	
Course outcomes:			
<ol style="list-style-type: none"> 1. The course focuses on basic concept of disaster(s) and disaster management, their significance and types. 2. The course will enable to develop the analytical skills to study relationship between vulnerability, disasters, disaster prevention and risk reduction. 3. The knowledge creates awakened group for integrated disaster management in the country. 4. It will enable young people in each city district or village to understand and explore avenues of reducing disaster risks and work towards preparedness and contribute towards minimizing losses and saving lives. 			
Credits: 5		Minor/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-1-0			
Unit	Topic	No. of L+T (75hrs)	
I	Overview and understanding of Disaster, definitions of Disaster, Hazard, Vulnerability, Resilience and Risks.	8	
II	Classification of disaster, natural hazards and Man-made disasters, Causes and social impacts, urban disasters, pandemics and climatic change.	10	
III	Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders. CBRN disaster, NDMA, NDRF, NIDM, STATE DM.	12	
IV	Disaster Risk Management in India: Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Fire, Waste Management Institutional arrangements	12	
V	Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation	11	
VI	Disaster-induced Refugee problem – Problems of women and children during disasters; Principles of psycho-social care, issues and recovery Relationship between disasters, development and vulnerabilities	8	
VII	Equity issues in disasters; Issues of rehabilitation and resettlement of survivors; Stakeholders in disaster relief management	6	
VIII	Disaster risk reduction – Strategies, Preparedness plans, Action Plans and procedures, Early Warning systems; Factors contributing to vulnerability. Capacity building	8	
	Suggested Reading:		
	<ol style="list-style-type: none"> 1. Disaster Management R. Subramanian Vikas Publishing House - Business & Economics. 2. Gupta Anil K, Sreeja S. Nair. 2011 Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi. 3. Indian Journal of Social Work 2002. Special Issue on Psychosocial Aspects of Disasters, Volume 63, Issue 2, April. 4. Kapur, Anu & others, 2005: Disasters in India Studies of grim reality, Rawat Publishers, Jaipur 5. Kapur Anu 2010: Vulnerable India: A Geographical Study of Disasters, IIA Sand Sage Publishers, New Delhi. 6. Govt. of India: Disaster Management Act 2005, Government of India, New Delhi. 7. Government of India, 2009. National Disaster Management Policy. 		

InternalAssessment	Marks
ClassInteraction	5
Quiz	5
Seminar	7
Assignment(Charts/Flora/RuralService/TechnologyDissemination)	8
	25

Courseprerequisites:

Qualification: Tostudythiscourse, astudentmusthavequalified 10+2/NSQFlevel3 fromSectorSkillCouncils/Diplomaholder fromITlin(Biology/Agriculture/Blotech/Forestry/Microbiology/Gardening/biomedicalScience.

Facilities: SmartandInteractiveClass

OtherRequisites: Videocollection, Books, CDs, AccesstoOn-lineresources, DisplayCharts

Suggestedequivalentonline courses:

onlinecourses.swayam2.ac.in/cec19_hs20/preview

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Programme/Class: Diploma Course		Year: II	Semester: III/IV Paper- Minor/ Elective
Subject: Offered by Botany			
Course Code: 04		Course Title: Global Environment and Challenges	
Course outcomes:			
<ol style="list-style-type: none"> 1. To acquaint the students with complex environment and global change driven by humans, their impact and mitigation; 2. To make them understand importance of biodiversity, conservation and its role in maintaining structure and health of global ecology. 3. This knowledge is critical in understanding the adverse impact of human's consumerist nature, evolving strategies for sustainable development and natural resource management. 4. It will enable the students to know more about the challenges posed by massive economic growth, reckless development, unplanned strategies, and overutilization of natural resources. 5. It will facilitate the students to critically examine the leading discussion and practices of development, so as to enable them to participate effectively in decision making at various levels. 			
Credits: 5			Minor/Elective
Max. Marks: 25+75			Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): 3-2-0			
Unit	Topic	No. of Lectures + Tutorials (75hrs)	
I	Global Change: Driving factors, Anthropocene characteristics; Global land cover and land use change; Multiple impacts of land use change; Global climate change: Causes, effects and mitigation strategies; stratospheric ozone loss	12	
II	Environmental Pollution: Causes and effects of air, water, soil, noise, radioactive pollution; Basic pollution abatement practices and technologies; Role of plants in reducing pollution impact	14	
III	Invasive Ecology: Biotic Invasions; Invasive Alien Species (IAS), Invasibility characteristics, Phenotypic plasticity; Extent and mechanisms of biological invasions; Ecological and economic impacts; Management strategies	10	
IV	Loss of Biodiversity: Biodiversity as indicator of well-being of an ecosystem; hot spots, ecotourism Threats and pattern of biodiversity loss - Natural and anthropogenic causes; IUCN threat categories, Red data books; Conservation and restoration of biodiversity - Indian socio-cultural value system for nature's conservation.	8	

V	Global Water Crisis: Distribution, withdrawal and consumption patterns Causes and effects of water crisis; Water conservation approaches	8
VI	Global Energy Crisis: Sources of energy supply; Current potential and future prospects of energy sources; Energy crisis; Energy conservation strategies	8
VII	Challenges of Urbanization: Trends of urbanization; Environmental impact of urbanization; Concept of green cities and sustainability.	8
VIII	Agro-Ecological Construction Strategies: Ecological home garden, medicinal plant garden, Kitchen garden; Vertical Stratification principle and application; man-made plant/forest communities (fruit-tree/commercially important tree/medicinal plant/pepper/tea/coffee/creeper or climber-crop plant combinations); home/kitchen recyclable wastes (urban/rural) and Applied leaf biomass as manure in ecological constructions. Every household as experimental station.	7

Suggested Readings:

1. McConnell, R. (2008) Environmental issues: An introduction to sustainability. Pearson.
2. Wali, M.K., Fatih Evrendilek, M. Siobhan Fennessy (2009) The environment: science: Issues and solutions. CRC Press.
3. Neelin, J. (2011) Climate change and climate modelling. Cambridge University Press.
4. John Marshall, R. Alan Plumb (2008) Atmosphere, ocean and climate dynamics: An introductory text. Elsevier
5. Phillips, B., D. Thomas, A. Fothergill, L. Blinn-Pike (2009) Social vulnerability to disasters. CRC Press.
6. Hill, M. (2010) Understanding environmental pollution. Cambridge University Press.
7. Environmental Studies (Hindi) ISBN 81-301-0004-5 B.L. Chaudhary & Jitendra Pandey Edition: 2013 Pages: 340 + XII Apex Publishing House
8. Soil and Water Conservation ISBN 978-81-301-0071-5 S.C. Mahnot & P.K. Singh Apex Publishing House
9. Ecology and Environmental Biology (ikjflFkfrdh ,oai;kZoj.k tSfodh½ by RBD
Publisher Author: Bhatia - Jain - Kohli - Shrivastava - Singh - Verma
10. Parris, Kirsten M., 2016, Ecology of Urban Environments, Wiley Blackwell
11. Garud Puran, Latest Edition, Geeta Press, Gorakhpur
12. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
13. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
14. Begon, M., Herper, J.L. and Townsend, C.R. Ecology-Individuals, Populations and Communities (3rd ed), Oxford Blackwell Science
15. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company

16. Kumar, U. & Asija, M. J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
17. Krishnamurthy, K. V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBHP Publishing Co. Ltd.
18. Primack, R. B. Essentials of Conservation Biology, 1993, Sinauer Associates.
19. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
20. Singh, J. S., Singh, S. P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
21. Rogers, P. P., Jalal, K. F. and Boyd, J. A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
22. Abbasi, S. A. (1998). Environmental Pollution and its Control. Cogent International, Pondicherry.
23. Abbasi, S. A. and Ramasamy, E. V. (1999). Biotechnological Methods of Pollution Control. Universities Press (India) Limited, Hyderabad.
24. Rand, M. C., Greenberg, A. E. and Taras, M. J. (Ed.) (1995). Standard methods for the examination of water and waste water: 19th edition, American Public Health Association (APHA), Washington, D. C.
25. Scragg, A. (1999). Environmental Biotechnology, Addison Wesley Longman, Singapore.
26. Tchobanoglaus, G. (1988). Wastewater Engineering: Treatment, Disposal, Reuse. Tata McGraw Hill, New Delhi.
27. Aarve, V. P., William, A. W. and Debra, R. R. (2002). Solid waste engineering. Cengage reading, USA.
28. George, T. and Frank, K. (2002). Handbook of solid waste management: (Second edition). McGraw Hills.
29. Kanthi, L. S. (2000). Basics of Solids and hazardous waste management Technologies. Prentice Hall.
30. Hardy, J. T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
31. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
32. Manahan, S. E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
33. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
34. Mathez, E. A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
35. Mitra, A. P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India.
- Philander, S. G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications. Springer.
36. Gaston, K. J. & Spicer, J. I. 1998. Biodiversity: An Introduction. Blackwell Science, London,
37. Sodhi, N. S. & Ehrlich, P. R. (Eds). 2010. Conservation Biology for All. Oxford University Press.
38. Sodhi, N. S., Gibson, L. & Raven, P. H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.
39. Harper, C. Snowden, M. 2017, Environment and Society: Human Perspectives on Environmental issues. Taylor and Francis
40. Middleton, N. 2013, The Global Casino: An Introduction to Environmental Issues. Routledge,
41. Dave D. 2009, Biological Pollution: An Upcoming Global Threat. TERI Information Digest on Energy and Environment. 8(1) 19-33
42. Mukherjee, T. 2020, Documentation and Protection of Traditional Knowledge. In *Medicinal Plants: biodiversity, Sustainable Utilization and Conservation*. Pp 135-142 Springer, Singer
43. You, S., Sonne, C. and OK, Y. S. 2020. COVID19's Unsustainable Waste Management Science(368(6498) 1438

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/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:
onlinecourses.swayam2.ac.in/nou21_ge14/preview



SKILL DEVELOPMENT COURSES (04)

Annexure 4 (a)

CERTIFICATE COURSE B.Sc.-I	
Programme: <i>Certificate Course</i>	Year: I Semester: I/Paper-I
Subject: Botany	
Course Code: B04	Course Title: Mushroom Cultivation
Course outcomes: After the completion of the course the students will be able: <ol style="list-style-type: none"> 1. To understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory. 2. Develop skills for cultivating and identifying mushrooms, using them for commercial purposes. 3. Will understand the pathology associated with mushrooms and their pre-harvest & post-harvest management. 4. Can start own enterprise on mushrooms 	
Credits: 3	Skill Development/Optional
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in labs per week): 0-1-2	

Unit		No. of T/P (15+60 hrs)
I.	1. Introduction to mushrooms and their significance 2. Mushroom spawn (seed) production/ procurement	4T+6P
II	Mushroom cultivation 1. Button mushroom 2. Pearl mushroom 3. Oyster mushroom 4. Paddy straw mushroom. 5. Milky mushroom.	2T+ 24P
III	1. Cultivation of other economically and medicinally important mushrooms 2. Mushroom; Sectioning of gills of <i>Agaricus</i> . 3. Insect pest management in cultivated mushrooms 4. Disease management in cultivated mushrooms	3T+ 6P
IV	1. Value addition to mushrooms (nutrient quality improvement) 2. Mushroom growing unit/ house	3T+12P
V	1. Entrepreneurial skills and economics for small enterprise 2. Management of spent substrates and waste disposal of various mushroom 3. Health and Safety at workplace	3T+ 12P

Suggested Readings:

Course Books published in Hindi/English

1. प्रयोगात्मक वनस्पति विज्ञान भाग-1 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ।
2. प्रायोगिक वनस्पति विज्ञान-I Dhankar - Sharma - Trivedi ISBN Code: 978-81-8142-697-0 65, RBD Publishing House Shivaji Nagar Civil Lines, Jaipur - 302006 (Rajasthan)
- 3rd प्रायोगिक वनस्पति विज्ञान बी.एस.सी.-1 एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी प्रकाशित वर्ष : 2018
4. Practical Botany (Part I) ISBN#: 81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition: 2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual)
5. Modern Mushroom Cultivation And Recipes (hindi) (hb) ISBN: 9788177545180 Edition: 01 Year: 2017 Author: Singh Riti, Singh UC Publisher : Agrobios (India)
1. <https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>
2. <http://nhb.gov.in/pdf/Cultivation.pdf>
3. <https://www.classcentral.com/course/swayam-vocational-mushroom-production-23137>

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 from any recognized board.

Facilities: Smart and Interactive Class

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

Lab Requisites: A drum, a room, chemicals as per protocol, gunny bags, trays, racks, packaging material, inoculum, temperature and humidity control as per protocols.

Suggested equivalent online courses:

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

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

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

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

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

<https://repository.cimmyt.org/xm/1ui/bitstream/handle/10883/3219/64331.pdf>

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

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

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

<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/>

CERTIFICATE COURSE B.Sc.-I

Programme: <i>Certificate Course</i>		Year: I	Semester: II/Paper-II
Offered by: Botany			
Course Code: B04		Course Title: Organic farming	
Course outcomes: After the completion of the course the students will be able: 5. Understand the instruments, techniques, lab etiquettes and good lab practices for field work 6. Develop skills for identifying organic supplements and preparing them from raw materials for safe agriculture/horticulture. 7. Will understand the pathology associated with crops and their pre-harvest & post-harvest management. 8. Can start own enterprise on organic farming			
Credits: 3		Skill Development Optional	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in labs per week): 0-1-2			

Unit		No.ofT/P(15+60hrs)
I.	1. Introduction to organic farming and its significance 2. Concepts and Principles of Organic farming 3. Key indicators for organic farming, sustainable agriculture and climate change	4T+6P
II	1. Input management. 2. compost production, 3. vermicomposting, 4. Compost quality, 5. Compost utilization and marketing	2T+ 24P
III	1. Organic crop management: field crops, horticulture and plantation crops 2. Plant protection measures, biopesticides, natural predators, cultural practice	3T+ 6P
IV	1. Rotation design for organic system, 2. Transition to organic agriculture, 3. Farming system	3T+12P
V	1. Quality analysis of organic foods, Antioxidants and their natural source, organic food and human health 2. Standards of organic food and marketing	3T+ 12P

Suggested Readings:

Course Book published in Hindi, English

1 प्रयोगात्मक वनस्पति विज्ञान भाग-2 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ।

2 प्रायोगिक वनस्पति विज्ञान-2 Dhankar - Sharma - Trivedi ISBN Code: 978-81-8142-697 0 66, RBD Publishing House Shivaji Nagar Civil Lines, Jaipur - 302006 (Rajasthan)

3 प्रायोगिक वनस्पति विज्ञान बी.एस.सी.-2 एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी प्रकाशित वर्ष : 2018

4 Practical Botany (Part 2) ISBN#: 81-301-0008-

8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition: 2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual)

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

Suggested Continuous Evaluation Methods:

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

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

Unit		No. of T/P (15+60hrs)
I.	1. Introduction to organic farming and its significance 2. Concepts and Principles of Organic farming 3. Key indicators for organic farming, sustainable agriculture and climate change	4T+6P
II	1. Input management. 2. compost production, 3. vermicomposting, 4. Compost quality, 5. Compost utilization and marketing	2T+ 24P
III	1. Organic crop management: field crops, horticulture and plantation crops 2. Plant protection measures, biopesticides, natural predators, cultural practice	3T+ 6P
IV	1. Rotation design for organic system, 2. Transition to organic agriculture, 3. Farming system	3T+12P
V	1. Quality analysis of organic foods, Antioxidants and their natural source, organic food and human health 2. Standards of organic food and marketing	3T+ 12P

Suggested Readings:

Course Books published in Hindi, English

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- 3 प्रायोगिक वनस्पति विज्ञान बी.एस.सी.-2 एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी प्रकाशित वर्ष : 2018
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Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar/Assignment	7
Minor fieldwork/excursion/lab visit/technology dissemination etc.	8

42

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Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 from any recognized board.

Facilities: Smart and Interactive Class

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

Lab Requisites: Drum, cowdung, soil, vegetable refuge, shed dry leaves, vessel, bamboo stick

Suggested equivalent online courses:

<https://www.classcentral.com/course/swayam-organic-farming-for-sustainable-agricultural-production-14222>

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

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

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Annex. 4(c)

DIPLOMA COURSE B.Sc.-I

Programme: <i>Diploma Course</i>		Year: II	Semester: III/Paper-III
Offered by Botany			
Course Code: B04		Course Title: Pharmacognosy and Herbal Preparations	
Course outcomes: After the completion of the course the students will be able: <ol style="list-style-type: none"> 9. Understand the instruments, techniques, lab etiquettes and good lab practices for field work 10. Develop skills for identifying organic supplements and preparing them from raw materials for safe agriculture/ horticulture. 11. Will understand the pathology associated with crops and their pre-harvest & post-harvest management. 12. Can start own enterprise on organic farming 			
Credits: 3		Skill Development Optional	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in labs per week): 0-1-2			





Unit		No. of T/P (15+60hrs)
I.	1. Ethnomedicine, 2. Ayurved 3. Modern medicine	6T
II	Methods of herbal medicine preparation 1. To Develop Capsules of herbs/ 2. To Develop Herbal oils/ 3. Develop Poultice/cream	2T+ 24P
III	Pharmacognosy: Organoleptic studies of plants: 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparation of fruit, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test 8. Proteins and lipid test	3T+ 6P
IV	1. Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. 2. Dimension of Calcium oxalate crystals in powdered crude drug.	3T+12P
V	1. Preliminary phytochemical tests for alkaloids, 2. Terpenoids, 3. Glycosides, 4. Volatile oils, 5. Tannins & resins.	3T+ 12P

Suggested Readings:

Course Books published in Hindi/ English

1. प्रयोगात्मक वनस्पति विज्ञान भाग-2 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ।
2. प्रायोगिक वनस्पति विज्ञान-2 Dhankar - Sharma - Trivedi ISBN Code: 978-81-8142-697-0 65, RBD Publishing House Shivaji Nagar Civil Lines, Jaipur - 302006 (Rajasthan)
3. फार्माकोग्नॉसी Shiva Kant, Pankaj Kumar Brahmiya : Thakur Publication
4. PHARMACOGNOSY ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANT), RM Publication
5. Practical Botany (Part 2) ISBN#: 81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition: 2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual)
6. Garud Puran, Geeta Press, Gorakhpur

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

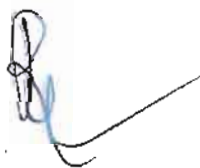
Qualification: To study this course, a student must have qualified 10+2 from any recognized board.

Facilities: Smart and Interactive Class

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

Lab Requisites: Mortar- Pestle, Soxhlet, Test tubes, Stand, Pipettes, Petri plates, Measuring cylinder, Chemicals as per protocol, Oven, Centrifuge, Spectrophotometer, Microscope, Forceps, Scalpel, Slides, Coverslips, Basic laboratory facilities for Chemistry and Botany

Suggested equivalent online courses:



DIPLOMA COURSE B.Sc.-I

Programme: <i>Diploma Course</i>		Year: II	Semester: IV/Paper-IV
Offered by Botany			
Course Code: B04		Course Title: Soil Health Assessment	
Course outcomes: After the completion of the course the students will be able to: <ol style="list-style-type: none"> 13. Understand the instruments, techniques and good lab practices for field work 14. Develop skills for identifying soil health issues and their management for safe agriculture/ horticulture. 15. Will understand to prepare soil health card for agricultural utility during pre-harvest & post-harvest management. 16. Can start own enterprise on soil health assessment 			
Credits: 3		Skill Development Optional	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in labs per week): 0-1-2			





Unit		No. of T/P (15+60hrs)
I.	1. Concept of soil health and its significance 2. Key indicators for soil health for sustainable agriculture 3. Soil Sample Collection (vertical and horizontal profiling)	4T+6P
II	Soil Physical Tests: 1. Soil texture. 2. Soil Moisture Content 3. Water Holding Capacity, Field Capacity 4. Soil Porosity 5. Soil Bulk Density 6. Soil Temperature	2T+ 20P
III	Soil Chemical Tests 1. Cation Exchange Capacity 2. Soil pH 3. Organic Carbon 4. Total Nitrogen 5. Exchangeable Na ⁺ / K ⁺ / Ca ²⁺ 6. Available Phosphorus	3T+ 20P
IV	1. Heavy metal analysis (Dithizone method) 2. Soil Seed bank and soil microbiota analysis	3T+8P
V	1. Soil Classification 2. Soil Health Card preparation 3. Recommendation regarding utility of soil sample for suitable crops	3T+ 6P

Suggested Readings:

Course Books published in Hindi/ English.

1. प्रयोगात्मक वनस्पति विज्ञान भाग-2 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ।
2. प्रायोगिक वनस्पति विज्ञान-2 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.-2 एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी प्रकाशित वर्ष : 2018
4. Practical Botany (Part 2) ISBN#: 81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition: 2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual)
5. Piper, C.S. (1944) Soil and Plant Analysis, Interscience Publications, Inc. NY.
6. ICAR (2015) Soil Health Card, Ministry of Agriculture and Farmers Welfare, Govt of India

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 from any recognized board.

Facilities: Smart and Interactive Class

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

Lab Requisites: pH meter, Soil testing kit, Glassware and chemicals as per protocols, Sieves and microsieves,

Suggested equivalent online courses:

पृष्ठांक: कोली / 353
दिनांक: 15-6-21

DEPARTMENT OF BOTANY
Ch. Charan Singh University, Meerut

Modified Common Minimum Syllabus
(As per National Education Policy-2020)

For the first three years of
Higher Education (UG)



Faculty of Science

2021

Semester-wise Titles of the Papers in B.Sc. (Botany)					
Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
<i>Certificate Course in Microbial Technology & Applied Botany</i>					
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4
		B040202P	Land Plants Architecture	Practical	2
<i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>					
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4
		B040302P	Plant Identification technology	Practical	2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	2
<i>Bachelor of Science</i>					
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4
		B040502T	Molecular Biology & Bioinformatics	Theory	4
		B040503P	Experiments in physiology, Biochemistry & molecular biology	Practical	2
		B040504R	*Project-I	Practical	3
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		B040602T	Ecology & Environment	Theory	4
		B040603P	Cytogenetics, Conservation & Environment management	Practical	2
		B040604R	*Project-II	Practical	3

Subject prerequisites:

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

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently used in the study of plant lifeforms, 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. In field, 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.	
PO1	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.
PO3	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.
PO4	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.
PO5	Certificate and diploma courses are framed to generate self-entrepreneurship and self-employability, if multi exit option is opted.
PO6	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

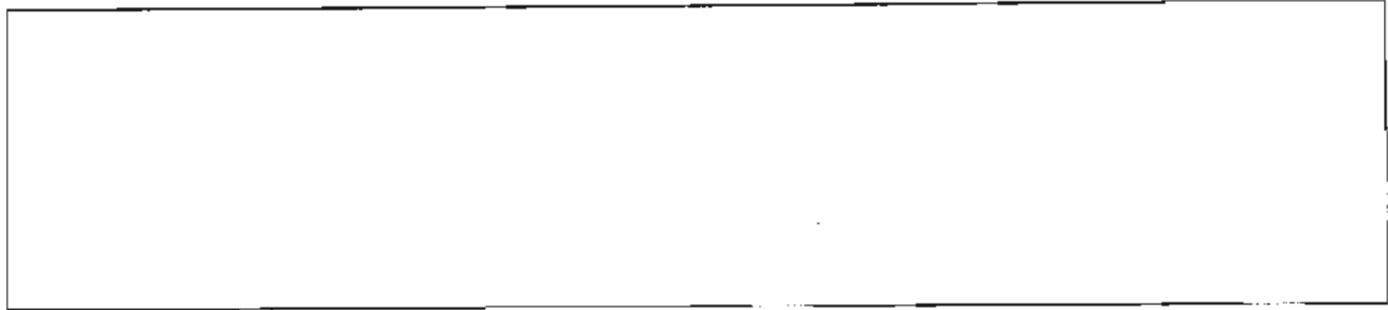
Programme specific outcomes (PSOs):
B.Sc. I Year / Certificate course in Microbial Technology & Classical Botany

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, 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 bioinformatic 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 student to use ICT & AI effectively.
7. Develop good skills in the laboratory such as observation and evaluation by the use of modern tools and technology.

PSO1

Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and the environment and the importance of conserving it. Hands-on training in various fields will develop practical skills, handling equipment and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.

PSO2	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 geneticist etc.
PSO3	Inculcate strong fundamental 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.
PSO4	Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

Year wise Structure of B.Sc. in Botany (CORE/ELECTIVE COURSES & PROJECTS)											
Subject: Botany											Total Credits /hrs/
Course/Entry -Exit Levels	Year	Sem.	Paper1	Credit/ hrs	Paper2	Credit/ hrs	Paper3	Credits /hrs	Research Project	Credit/	
Certificate Course In Microbial Technology & Applied Botany	I	I	Microbiology & Plant Pathology	4/60	Techniques in Microbiology & Plant Pathology	2/60	--		Nil	Nil	6/120
		II	Archegoniates & Plant Architecture	4/60	Land Plants Architecture	2/60	--		Nil	Nil	6/120
Diploma in Plant Identification, Utilization & Ethnomedicine	II	III	Flowering Plants Identification & Aesthetic Characteristics	4/60	Plant Identification technology	2/60	--		Nil	Nil	6/120
		IV	Economic Botany, Ethnomedicine & Phytochemistry	4/60	Commercial Botany & Phytochemical Analysis	2/60	--		Nil	Nil	6/120

<i>Bachelor of Science</i>		V	Plant Physiology, Meta bolism & Biochemistry	4/60	Molecular Biol ogy & Bioinformati cs	4/60	Experiments in physiology, Bi ochemistry &	2/60	*Proje ct-I	3/45	13/205
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	III					molecularbiology				
	VI	Cytogenetics, Plant Breeding & nanotechnology	4/60	Ecology & Environment	4/60	Cytogenetics, Conservation & Environment management	2/60	*Project-II	3/45	13/205
Comments	Total Credits/Hrs. / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/Virtual/ICT based as per choice of the Institution) *Suggestive List of Projects mentioned in Detailed Paper Syllabus									50/890

Botany Course is One of the Major Subjects for Biology Students and Minor or Elective for students of other faculties
 Second Major Subject can be Zoology/Microbiology
 Third Major Subject can be from Science or Any other faculty of UGC /AICTE – (Arts/ Agriculture/ Education/law/ Commerce)
 Fourth Subject is Minor or Elective to be selected from any one of other Faculties as per student's own interest
 One Vocational Course has to be opted from the list given in Syllabus as per NSDC guidelines
 One Co-curricular Course is compulsory

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

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CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY/B.Sc.-I

Programme: <i>Certificate Course in Microbial Technology & Classical Botany</i>	Year: I	Semester: I/Paper-I
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Subject: Botany

Course Code: B040101T	Course Title: Microbiology & Plant Pathology
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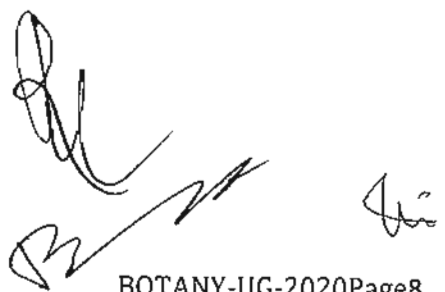
- Course outcomes:** After the completion of the course the students will be able to:
1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
 2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
 3. Gain knowledge about developing commercial enterprise of microbial products.
 4. Learn host-pathogen relationship and disease management.
 5. Learn Presentation skills (oral & writing) in life sciences by usage of computer & multimedia.
 6. Gain Knowledge about uses of microbes in various fields.
 7. Understand the structure and reproduction of certain selected bacterial algae, fungi and lichens
 8. Gain Knowledge about the economic values of this lower group of plant community.

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

Unit	Topic	No. of Lectures (60 hrs)



I	<p>A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists (in all branches), in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/assignments/self-study mentioned under Continuous Internal Evaluation (CIE).</p> <p>B. Microbial Techniques & instrumentation Microscopy – Elementary knowledge of Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.</p>	8
II	<p>Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria and plasmids; Bacterial Chemotaxis and Quorum sensing, Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria. Viruses, general characteristics, viral culture, Structure of viruses, TMV and retro viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, mycophages, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes (Actinobacteria) and their economic uses.</p>	8
III	<p>Phycology Range of thallus organization in Algae, Pigments, Flagella, Reserve food, Types of Reproduction, Classification and comparative life cycle of – <i>Nostoc, Chlorella, Volvox, Oedogonium, Chara, Ectocarpus, Sargassum, Polysiphonia.</i> Phycoviruses, Economic importance of algae – Role of algae in soil fertility – biofertilizer – Nitrogen fixation – Symbiosis; Commercial products of algae – biofuel, Agar, Diatomite.</p>	7
IV	<p>Mycology Comparative study of general characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota: General characters of True Fungi (Eumycota): Mastigomycotina: <i>Synchytrium</i>; Zygomycotina: <i>Rhizopus</i>, Ascomycotina: <i>Saccharomyces, Penicillium, Peziza</i>. Basidiomycotina: <i>Ustilago, Puccinia, Agaricus</i>; Deuteromycotina: <i>Fusarium, Alternaria</i>. Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality,</p>	7
V	<p>Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation. General account of lichens, reproduction and significance; <i>Mycorrhiza</i>: <i>ectomycorrhiza</i> and <i>endomycorrhiza</i> and their significance.</p>	7
VI	<p>Plant Pathology Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides – Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil</p>	7
VII	<p>Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late Blight of Potato, Black Stem Rust of Wheat, <i>Alternaria</i> spot' and 'White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management</p>	8

VIII	Applied Microbiology Elementary knowledge of Food fermentations and food produced by microbes, Production of amino acids, antibiotics, enzymes, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Mass production of bacterial biofertilizers, bluegreen algae, <i>Azolla</i> and <i>mycorrhiza</i> . Plant growth promoting rhizobacteria & biopesticides— <i>Trichoderma sp.</i> and <i>Pseudomonas</i> , Single cell proteins (<i>Spirulina</i>), Organic farming inputs, Microbiology of water, Biopolymers, Bioindicators, Biosensors, Bioremediation, Production of biofuels, Biodegradation of pollutants and Biodeterioration of materials & Cultural Property. Microbial Biofactories (<i>E. coli</i> and Yeast) for production of recombinant proteins	8
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Suggested Readings:

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

- वनस्पतिविज्ञान (सम्पूर्ण) शैवाल, कवक, लाइकेन, जीवाणु, विशाणु, ब्रायोफाइटा, टेरेडोफाइटा, जिम्नोस्पर्म तथा पुरावनस्पतिविज्ञान : लेखक— सिंह, पांडे व जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
- सूक्ष्म जैविकी कवक एवं पादप रोग विज्ञान त्रिवेदी शर्मा एवं धनकर rbd publisher 2019
- परिचायात्मक पादप रोग विज्ञान डॉ. आशीष कुमार त्रिपाठी, डॉ. सनत कुमार त्रिपाठी 2018 एग्राबॉयोसइंडिया पब्लिशर।
- पादप रोग विज्ञान : जियालाल यादव 2012
- डॉ. आशीष कुमार त्रिपाठी डा. फसनद कुमार त्रिपाठी 2018 परिचायात्मक पादप रोग विज्ञान एग्राबॉयोसइंडिया पब्लिशर।
- श्रीतावर्मा 2020. सूक्ष्म जैविकी, कवक एवं पादप रोग विज्ञान
- प्रांजल आर्य 2020. पादप रोग : उत्पत्ति प्रसार एवं नियंत्रण
- Microbiology Fundamental and Applications (Hindi) (pb)
- ISBN: 9788188826230 Edition: 03 Year : 2016 Author : Dr. Purohit SS, Dr. Deo Publisher : Student Edition Language: Hindi
- पादप रोग विज्ञान परिभाषा—कोश: Definitional Dictionary of Plant Pathology. Publisher Commission for Scientific and Technical Terminology.
- Modern Microbiology (Hindi) (hb) ISBN: 9788177543599 Edition : 1 Year : 2018 Author : Dr. Purohit SS, Dr. Singh T Publisher : Agrobios (India)
- Suggested books "Plant pathology by R.S. Mehrotra, Tata McGraw-Hill Education" are included in reading resources list
- Suggested book—"Eminent Indian Botanists: Past and Present (Biographies and contributions)", P. Suresh Narayan and T. Pullaiah, Regency Publications, (2011)

Unit-IA:

- <https://indianculture.gov.in/rarebooks/economic-botany-india>
- https://www.infinityfoundation.com/mandala/t/es/t/es_tivar_botany_frameset.htm
- https://www.researchgate.net/publication/335715457_Ancient_Indian_rishi's_Sages_knowledge_of_botany_and_medicinal_plants_since_Vedic_period_was_much_older_than_the_period_of_Theophrastus_A_case_study_who_was_the_actual_father_of_botany
- <https://www.scribd.com/presentation/81269920/Botany-of-Ancient-India>
- https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol17_2_17_PKBhattacharyya.pdf

vi. http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri/wgbis_info/botany_history.pdf

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

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

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

UNIT-IB.

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

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluations 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-PI%20Path%20111.pdf> http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf <https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx> <https://learn.saylor.org/course/view.php?id=23§ionid=6821> <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy> http://physics.fe.uni-lj.si/students/predavanja/Microscopy_Kulkarni.pdf <https://lipidnanostructuresgroup.weebly.com/> <https://zoology4civilservices.wordpress.com/2016/06/18/65/https://microbenotes.com/laminar-flow-hood/>

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY/B.Sc.-I

Programme: <i>Certificate Course in Microbial Technology & Classical Botany</i>	Year: I	Semester: I/Paper-II
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Subject: Botany

Course Code: B040102P

Course Title: **Techniques in Microbiology & Plant Pathology**

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

1. Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
3. Practical skills in the field and laboratory experiments in Microbiology & Pathology.
4. Learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations.
5. Can initiate his own Plant & Seed Diagnostic Clinic
6. Can start own enterprise on microbial products

Credits: 2

Core Compulsory

Max. Marks: 25+75

Min. Passing Marks:

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

Unit	Topic* (Minimum Any three from each unit depending on facilities)	No. of Lectures (60 hrs)
I.	INSTRUMENTS & TECHNIQUES 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 3. Cleaning and Sterilization of glass wares 4. Preparation of media-Nutrient Agar and Broth 5. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 6. Preparation of agar slant, stab, agar plate 7. Phenol Coefficient method to test the efficacy of disinfectants	7
II	BACTERIAL IDENTIFICATION 1. Isolation of bacteria 2. Growth curve of bacteria 3. Identification of bacteria. 4. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 5. Cultural characteristics of bacteria on NA. 6. Pure culture techniques (Types of streaking). 7. Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis. 8. Antibacterial potential of natural products 9. Replica plating 10. Bacterial transformation 11. Bacterial gene induction 12. Bacteriophage growth analysis	8
III	MYCOLOGICAL STUDY: 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. <i>Rhizopus</i> , <i>Saccharomyces</i> , <i>Penicillium</i> , <i>Peziza</i> , <i>Ustilago</i> , <i>Puccinia</i> ; <i>Fusarium</i> , <i>Curvularia</i> , <i>Alternaria</i> . 3. <i>Agaricus</i> : Specimens of button stage and full grown mushroom; Sectioning of gills of <i>Agaricus</i> . 4. Lichens: crustose, foliose and fruticose specimens.	8
IV	PHYCOLOGY: 1. Type study of algae and Cyanobacteria- <i>Spirulina</i> , <i>Nostoc</i> . Chlorophyceae- <i>Chlorella</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Cladophora</i> , and <i>Chara</i> ; Xanthophyceae- <i>Vaucheria</i> ; Bacillariophyceae- <i>Pinnularia</i> Phaeophyceae- <i>Sargassum</i> Rhodophyceae- <i>Polysiphonia</i>	7
V	EXPERIMENTAL PLANT PATHOLOGY 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. 3. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of ureidial, telial, pycnial & aecial stages of <i>Puccinia</i> , Few viral and bacterial plant diseases.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY-1 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non-rhizosphere population of bacteria. 3. Isolation of antagonistic <i>Pseudomonas</i> from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of <i>Azospirillum</i> sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of <i>Psolubilizing</i> microorganisms.	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay-cellulase, protease and amylase. 6. Immobilization of yeast.	8

	<ul style="list-style-type: none"> 7. Isolation of cellulolytic and anaerobic sulphate-reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria. 9. Overexpression of recombinant protein in Bacteria or Yeast 	
VIII	<ul style="list-style-type: none"> 1. Cultivation of Spirulina, & Chlorella in lab for biofuel 2. Visit to NBAIM, Mau, Varanasi (Kashi)/IMTECH (Institute of Microbial Technology), Chandigarh for viewing Culture Repository 3. Visit to biofertilizers and biopesticides unit to understand about the unit operation procedures 4. Mushroom cultivation for Protein 5. Alcohol production from Sugarcane Juice. 	6

Suggested Readings:

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

1. प्रयोगात्मकवनस्पतिविज्ञान भाग-1 लेखकअशोकबेंद्रे तथाअशोककुमारप्रकाशनरस्तोगीप्रकाशनमेरठ।
2. प्रायोगिकवनस्पतिविज्ञान-I Dhankar - Sharma – Trivedi ISBN Code: 978-81-8142-697-0 65, RBD Publishing House Shivaji Nagar Civil Lines, Jaipur - 302006 (Rajasthan)
3. प्रायोगिकवनस्पतिविज्ञानबी.एस.सी.-1 एस बीअग्रवालप्रकाशक : शिवलालअग्रवाल एण्ड कम्पनीप्रकाशितवर्ष : 2018
4. Practical Botany (Part I) ISBN#: 81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singh vi Edition: 2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual)
5. Modern Mushroom Cultivation And Recipes (hindi) (hb) ISBN: 9788177545180 Edition: 01 Year: 2017 Author: Singh Riti, Singh UC Publisher : Agrobios (India)
6. Biofertilizer Production Manual (hindi) (hb) ISBN: 9788177541274 Edition: 01 Year: 2014 Author: Gehlot D Publisher : Agrobios (India) Language: Hindi
1. Aneja, K.R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R.C. and Maheshwari, D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. Madhava Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
5. Pandey, B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
6. Sambamurthy, A.V.S.S. 2006, A Textbook of Algae, I.K. International Publishing House, Pvt. Ltd.,
7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
8. <https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf>
9. <http://nhb.gov.in/pdf/Cultivation.pdf>
10. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
11. Sen, Surjit, Acharya, Krishnendu, Rai, Manjula 2019 ISBN-978-93-88347-23-5-Biofertilizers and Biopesticides Technoworld, Kolkata
12. <http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf>
13. <http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf>
14. Hochman, Gal, Zilberman, David 2014 ISBN-1461493285-Algae Farming and Its Bio-Products Springer
18. Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
19. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN: 9780470673898

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluations 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 fieldwork/excursion/lab visit/technology dissemination etc.	8

Course prerequisites:

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

Facilities: Smart and Interactive Class

Other Requisites: Videocollection, 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/7926d7789d8a2f7b2075109f68c3175c.pdf>

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

<https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdf>

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

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

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

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

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

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

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

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

Programme/Class: B.Sc.-I/ <i>Certificate Course in Microbial Technology & Classical Botany</i>	Year: I	Semester: II Paper: I
Subject: Botany		
Course Code: B040201T	Course Title: ArchegoniatessandPlantArchitecture	
Course outcomes: After the completion of the course the students will be able to:		
1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms		
2. Understanding of plant evolution and their transition to land habitat.		
3. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants		
4. Understand the details of external and internal structures of flowering plants.		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		

Unit	Topic	Lectures (60hrs)
I	Introduction to Archegoniates & Bryophytes Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Funaria</i> . (Developmental details not to be included). economic importance of bryophytes	7
II	Pteridophytes General characteristics, Early (fossil) land plants (<i>Rhynia</i>). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes. Comparative study of morphology, anatomy and reproduction of <i>Selaginella</i> , <i>Equisetum</i> and <i>Azolla</i> .	8
III	Gymnosperms Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples with special reference to <i>Cycas</i> , <i>Ginkgo</i> , <i>Pinus</i> , <i>Ephedra</i> , structure and reproduction; economic importance	8
IV	Palaeobotany General account of Cycadofilicales, Bennettitales, Pentoxylales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques;	8
V	Angiosperm Morphology Morphology and modification of roots; stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	Plant Anatomy: Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization. Secondary growth - Root and stem - cambium (structure and function) annual rings, Periderm, Anomalous secondary growth - <i>Bignonia</i>, <i>Boerhaavia</i>, <i>Dracaena</i>, <i>Nyctanthes</i>	7
VII	Reproductive Botany Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, Types of pollination, Methods of pollination, Germination of pollen grain, Structure of male gametophyte, Fertilization, Structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and Polyembryony.	8
VIII	Palynology: Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	7

Suggested Readings:**Course Books published in Hindi/English**

1. वनस्पतिविज्ञान (सम्पूर्ण) शैवाल, कवक, लाइकेन, जीवाणु, विशाणु, ब्रायोफाइट, टेरिडोफाइट, जिम्नोस्पर्म तथा पुरावनस्पतिविज्ञान : लेखक- सिंह, पांडे व जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
2. आवृतबीजीवनस्पतिविज्ञान (टैक्सोनीमी, एनाटॉमी, एंब्रियोलॉजी तथा इकोनामिक बॉटनी) लेखक- सिंह, पांडे व जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
3. नवीन परिचयात्मक वनस्पतिविज्ञान डॉ एस के गुप्ता 2017 केदारनाथ रामनाथ पब्लिशर्स
4. ए.के. शर्मा व राजेश्वरी शर्मा 2018. वनस्पतिविज्ञान बीएससी प्रथम भाग एसआरसाइंटिफिक पब्लिशर्स
1. Gangulee H.S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta: Central Book Depot, Allahabad.
4. Rashid A. (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Sharma O.P. (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha B.R., Sinha A.K. and Kumar A. (2010) Botany for Degree Students - Pteridophyta, S. Chand and Company,
7. Vashishtha B.R., Sinha A.K. and Kumar A. (2010) Botany for Degree Students - Gymnosperms, S. Chand and
8. Parihar N.S. (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar S.P. (1996) Gymnosperms, New Age International Publisher.
10. Pandey B.P. (2010) College Botany Vol. II. S. Chand and Company, New Delhi
11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
12. Bhattacharya et. al. 2007. A text book of Palynology, Central, New Delhi.
13. Bhojwani, S.S. and S.P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,.
14. P.K.K. Nair - A text book of Palynology.
15. Johri, B.M. 1984. Embryology of Angiosperms. Springer-Verlag, Berlin.
16. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
17. E.J. Eames. Morphology of Vascular Plants, Standard University Press.
18. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
19. Fahn, A. (1974). Plant Anatomy. Pergamon Press, USA.
20. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

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

Suggested Continuous Evaluation Methods:

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

Internal Assessment	Marks
Class Interaction	5
Quiz	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.anbg.gov.au/bryophyte/what-is-bryophyte.html><https://pteridoportal.org/portal/index.php><https://www.conifers.org/zz/gymnosperms.php><http://www.mohot.org/MQBOT/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://palyology.org/http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html><https://www.sciencelearn.org.nz/resources/100-plant-reproduction><https://palaeobotany.org/>

Programme/Class: <i>Certificate Course in Microbial Technology & Classical Botany</i>		Year: I	Semester: II Paper-II (Practical)
Subject: Botany			
Course Code: B040202P		Course Title: Land Plants Architecture	
Course outcomes: <ol style="list-style-type: none"> 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. 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. 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. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of flower groups of plants Understand the composition, modifications, internal structure & architecture of flowering plants for becoming a Botanist. 			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic (Any three from each unit)	No. of Lectures	
I	Bryophytes: <i>Marchantia</i> -morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). <i>Sphagnum</i> -morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8	
II	Pteridophytes: <i>Lycopodium</i> : Habit, stem T. S. strobilus V. S., <i>Selaginella</i> : Habit, rhizophore T. S., stem T. S., axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. <i>Equisetum</i> -Habit, rhizome and stem T.S. and V.S. of strobilus. <i>Azolla</i> -Habitat & its structure	7	
III	Gymnosperms 1. <i>Cycas</i> - seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V.S. of ovule. <i>Pinus</i> -Branch of indefinite growth, spur shoot, T. S. of fold stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. <i>Ephedra</i> & <i>Thuja</i> : Habit, stem T.S. (young and mature), leaf T.S., male and female strobilus, V.S. of male and female cone, ovule V.S. and seed.	8	
IV	Palaeobotany 1. Morphology of <i>Rhynia</i> and fossil gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	6	

V	<p>Angiosperm Morphology</p> <ol style="list-style-type: none"> 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types - study from fresh/preserved specimens 5. Flowers - study of different types from fresh/preserved specimens 6. Fruits - study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/specimens/photographs) - types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences 	8
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VI	Plant Anatomy: Normal & Anomalous secondary thickening - <i>Bignonia, Dracaena, Boerhaaviadiffusa, Nyctanthes</i> Study of primary and secondary growth in the root and stem of monocots and dicots by section cutting and permanent slides. Study of internal structure of dicot and monocot leaves. Study of structure of stomata.	8
VII	Reproductive Botany 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule and embryo sac development (through slides). 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants - <i>Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea</i> by microscopic observation. 7. Calculation of pollen viability percentage using invitro pollen germination techniques. 8. Reproductive tissue processing, Block preparation and Microtomy technique	8
VIII	Commercial Uses and Production technology 1. Azolla production 2. Production technology of Resins 3. Production and propagation of Ornamental <i>Pteris, Cycadales, Coniferales</i> for landscaping. 4. Lab method for qualitative testing/extraction of Ephedrine, Taxol and <i>Thuja</i> oil.	7

Suggested Readings:

Course Books published in Hindi/English

प्रयोगात्मक वनस्पति विज्ञान भाग-I, II लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ
 प्रायोगिक वनस्पति विज्ञान विभाग I, II, III त्रिवेदी शर्मा बोहरा और धनखड़
 प्रयोगात्मक वनस्पति विज्ञान भाग-2 लेखक : अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ
 प्रायोगिक वनस्पति विज्ञान बीएससी-I, II एस बी अग्रवाल प्रकाशक : शिलाल अग्रवाल एण्ड कम्पनी
 Pandey, B P and Trivedi, P.S. 1997. Botany Vol. I (10th edition). Vikas Publishing House. Pandey, B P;
 Misra, Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
 Pandey, B P and Chadha. 1997. Botany Vol. III. Vikas Publishing House.
 Santra, S C and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd. Kumar, S
 and Kashyap, A.S.. 2003. Manual of Practical Algae. Campus Books International, New Delhi Bondre,
 A.M. and Kumar A textbook of Practical Botany. Vol I, II., Rastogi Pub. Meerut.
 Suresh Kumar, Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet, New Delhi.
 Santra, S C. 2005. College Botany Practical Vol. II. New Central Book Agency (P) Ltd.

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

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

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

Internal Assessment	Marks
Class Interaction	6
Fieldwork/Virtual/E-learning/Participation in group discussions	7
Industrial or Central laboratory training of two weeks in summer/winter (Compulsory)	12
	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: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator

Suggested equivalent online

courses: [https://www.easybiologyclass.com/topic-](https://www.easybiologyclass.com/topic-botany)

[botany](http://www3.botany.ubc.ca/bryophyte/index.html) <http://www3.botany.ubc.ca/bryophyte/index.html>

http://ecflora.cavehill.uwi.edu/bio_courses/bl14apl/practical_3.1.htm

<http://mvdunotes.blogspot.com/p/botany.html>

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

[v9236e.pdf](https://iinrg.icar.gov.in/library/nrg/nrg.pdf) <https://iinrg.icar.gov.in/library/nrg/nrg.pdf>

[https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model projct on Azolla cultivation.pdf](https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model%20projct%20on%20Azolla%20cultivation.pdf)

<http://arnoldia.arboretum.harvard.edu/pdf/articles/1977-37-1-propagation-manual-of-selected-gymnosperms.pdf>

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

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



Diplom in Plant Identification, Utilization & Ethnomedicine

Diplom in Plant Identification, Utilization & Ethnomedicine		
Programme/Class: Diplom 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: <ol style="list-style-type: none"> 1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification. 2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants. 3. To compare the different approaches to classification with regard to the analysis of data. 4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family. 5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications. 6. For the entrepreneur career in plants, one can establish a nursery, start a landscaping business, set up a farm or run a plantation consultancy firm. 		
Credits: 4	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0		
Unit	Topic	No. of Lectures (60hrs)
I	Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Artificial Keys. Binomial Nomenclature: Principles and rules of Botanical Nomenclature according to ICN (ranks and taxa; principle of priority, type method, author citation, valid publication).	7
II	Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Takhtajan, Angiosperm Phylogeny Group (APGIV) classification. Introduction to taxonomic evidences from cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).	8
III	Identification of Angiospermic families- I: (Families can be chosen University wise as per local available flora) A comparative study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Papaveraceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae .	8
IV	Identification of Angiospermic families- II: (Families can be chosen University wise as per local available flora) A comparative study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)- Apocynaceae, Asclepiadaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Liliaceae, Musaceae, Poaceae.	7

V	Phylogenetic systematics: BriefideaonPhenetics,Biometrics (Neighbour joining),Cladistics: Basics and Methodology;Supraspecific taxa(Monophyletic,polyphyleticandparaphyleticgroups);Plesiomorphyand Apomorphy).	87
VII	TOOLS & SOFTWARES IN PLANT IDENTIFICATION- GIS(Mappingof(i)Patterns(ii)Features(iii)QuantitiesFree PhylogeneticSoftware: PAUP and MESQUITE Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTAInternetdirectoryfor Botany.	78
VIII	Computer usage, Android Applications & Character Analysis MSOffice:PPT,MicrosoftExcel,dataentry,graphs,- GPStagging,PlantIdentificationApps. Concept of Character, Selection of characters, Character coding, Character step matrix, Character x Taxon Matrix	7
VIII	Aesthetic Characteristics of Plants: Elementary knowledge of Aestheticcharacteristicsofplants,English,Italian,French,Persian,MughalandJapanese;Feat uresofagarden(Gardenwall,Fencing,Steps,Hedge,Edging,Lawn,Trees,shrubsandshrubber ies,climbersandcreepers,rockery,Flowerbeds,Shrubbery,Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoorgarden,Roofgarden, Topiary,Bonsai.	8

Suggested Readings:

Course Books published in Hindi/English

1. आवृतबीजीवनस्पतिविज्ञान (टैक्सोनीमी, एनाटॉमी, एंब्रियोलॉजी तथा इकोनामिक बॉटनी) लेखक- सिंह, पांडे व जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
2. भारत की संपदा, विज्ञान संचार भवन इ.क.स. कृष्णन मार्ग पूसाकैपस
3. Propagation And Nursery Management (hindi) (hb) ISBN : 9788177546200 Edition : 01 Year : 2016 Author : Pandey S.K. , Soni N. Publisher : Agrobios (India)
4. Dr. Amar Singh. पादप वर्गीकी- Plant Taxonomy (An Old and Rare Book) from the category Ayurveda in our Books collection. Uttar Pradesh Hindi Sansthan, Lucknow
1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House.
2. Bole, P.V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M.J., Paine, T.A. and Zurcher, E.J. (2003). Principles of interactive keys. <http://delta-intkey.com>
5. <https://www.naace.co.uk/school-improvement/ict-mark/>
6. <https://www.socitm.gov.uk>, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.
7. K.B. Anjaria, (2015) "Electronic Herbarium and Digital Database Preparation of Common Trees of Anand District, Gujarat" MRP submitted to UGC, WRO, Pune 2015 (unpublished)
8. Lizeron Eremias and R. Subash. (2013) "E-Content Development: A Milestone In The Dynamic Progress Of E-Learning" International Journal of Teacher Educational Research (IJTER) Vol. 2 No. 1 January, 2013 ISSN: 2319-4642
9. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd, New Delhi.
10. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
11. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
12. Dutta A. C. 2016. Botany for Degree Students. Oxford University Press.
13. Davis, P.H. and V.H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
14. Heywood, V.H. and D.M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
15. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons.
16. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscapedesigner. Upper Saddle River, NJ: Pears on Prentice Hall.
17. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group.
18. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed planting s. New York: John Wiley & Sons.
19. Randhawa, C.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

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

Suggested Continuous Evaluation Methods:

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

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

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.seneca.hs.org/pages/uploaded_files/Plant%20Classification.pdf
[https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr %20S %20Nongbri%20III%20Sem%20ppt.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 to: <ol style="list-style-type: none"> 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: Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for various groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number	7	
II	Taxonomic Identification using plant structure a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae, Poaceae.	8	
III	Identification during excursions a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTEBOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, Floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	8	
IV	COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGIBRYOPHYTES, PTERIDOPHYTES (Two each)	7	
V	Botanical Nomenclature & reporting Method: a. Given nomenclature to collected plants as per ICN rules and prepare labels as per BSI b. Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic Journal	7	

	VI	COMPUTER APPLICATION AND CHARACTER CODING 1.Learning to use EXCEL Microsoft PowerPoint and Word., workingwithfolderandwindowsutility.,createandmanage filesandfoldertree, Selection of Character, Codingand Preparation of Data Matrix in MS Office or MS Excel.	7
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	<p>2. Practice browsing different sites using search engines. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails.</p> <p>3. Create and Participate in virtual conferencing in an interactive Zoom Meeting</p>	
VII	<p>Computer Application in taxonomy</p> <p>1. Use Taxonomic Softwares (Dichotomous Key) 2. Practical on Phylogenetic analysis</p> <p>3. Make lined drawing of Plants for description 4. Using of plant identification app on android phones</p>	8
VIII	<p>1. Create a Bonsai of any plant</p> <p>2. Develop a miniature garden</p> <p>3. Draw Layout of various types of gardens</p> <p>4. Plant Propagation methods practice</p>	8

Suggested Readings:

Course Books published in Hindi/ English

1. प्रयोगात्मक वनस्पति विज्ञान भाग-2 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ
2. प्रयोगात्मक वनस्पति विज्ञान भाग-3 लेखक : अशोक बेंद्रे तथा अशोक कुमार प्रकाशन : रस्तोगी प्रकाशन, मेरठ
3. प्रायोगिक वनस्पति विज्ञान बीएससी-I, II, III एस बी अग्रवाल प्रकाशक : शिवलाल अग्रवाल एण्ड कम्पनी
4. प्रायोगिक वनस्पति विज्ञान II Author Name: - Dhankar - Sharma - Trivedi RBD Publication House
1. Day, S.C. (2003) An Art of Miniature Plant Culture. - Agrobios, Jodhpur, India.
2. Practical Taxonomy of Angiosperms By: RK Sinha ISBN: 97893867685201. K International Publishing House Pvt. Ltd.
3. Day, S.C. (2003) Complete Home Gardening. (2003) Agrobios, Jodhpur, India.
4. Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios, Jodhpur, India.
5. Khan, M.R. (1995) Horticulture and Gardening. - Nirali Prakashan, Pune, India.
6. Pramila Mehra Gardening for everyone. - Hind pocket book private limited, New Dehli.
7. Kumarsen V. Horticulture, Saras Publication
8. Ramesh Bangia Learning Computer Fundamentals.,., Khanna Book Publishers
9. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
10. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
11. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
12. Bole, P.V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
13. Womersley, J.S. 1981. Plant collecting and herbarium development: A manual.
14. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Du
15. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.com>, <https://www.naace.co.uk/school-improvement/ict-mark/>
16. Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST, N. Delhi
17. Naik, V.N. (1984) Taxonomy of Angiosperms Tata McGraw-Hill Publication Com. Ltd., New Delhi
18. Primak, R.B. (2004) A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers
19. Quicke, Donald, L.J. (1993) Principles and Techniques of Commemorative Taxonomy. Blakie, Academic and Professional, London
20. Singh, G. (2004) Plant Systematics: Theory and practice Oxford and YBHP 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. DeVogel, 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.

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluations 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

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 they shall have to label the campus plants with botanical details/develop herbarial/floristic garden/conserved plants in botanical garden/contribute specimens via collection.

<p>A projects supported along with photograph 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, FRU/BSI and Central National Herbarium (CNH), Central Research Institutes/Hot Spots</p>		
<p>Programme /Class: Diploma in Plant Identification, Utilization & Ethnomedicine</p>	<p>Year: II</p>	<p>Semester: IV Paper-I</p>
<p>Subject: Botany</p>		
<p>Course Code: B040401T</p>	<p>Course Title: Economic Botany, Ethnomedicine and Phytochemistry</p>	
<p>Course outcomes: After the completion of the course the students will be able to:</p> <ol style="list-style-type: none"> 1. Understand about the uses of plants – will know one plant – one employment 2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants 3. Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times. 		
<p>Credits: 4</p>		<p>Core Compulsory</p>
<p>Max. Marks: 25+75</p>		<p>Min. Passing Marks:</p>
<p>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</p>		
Unit	Topic	No. of Lectures (60hrs)
I	<p>Origin and domestication of cultivated plants Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages.</p>	7
II	<p>Botany of oils, Fibers, timber yielding plants & dyes Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumigatories & Masticatories, Rubber, Dyes, Timber, biofuel crops.</p>	7
III	<p>Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise) Commercial greenhouse cultivation of rose, <i>Gerbera</i>, <i>Gladiolus</i>, <i>Anthurium</i>/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics.</p>	7
IV	<p>IPR & Traditional Knowledge IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotechnical inventions.</p>	8
V	<p>Ethnobotany Methodologies of ethnobotanical research: Fieldwork, Literature, Herbaria and Museum and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.</p>	8

VI	Medicinal aspects Study of common plants used by tribes (<i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Embllica officinalis</i> , <i>Eclipta alba</i> , <i>Rauvolfia serpentina</i> , <i>Oxalis</i> and <i>Ocimum sanctum</i>) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics.	8
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	Plants in primary healthcare: common medicinal plants: <i>Tinospora, Acorus, Ocimum, Turmeric</i> and <i>Aloe</i> . Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration	
VII	Pharmacognosy Preparation of drugs for commercial market - Organoleptic evaluation of drugs - Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs - roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds; organoleptic study of <i>Adhatodavasica, Andrographispaniculata, Azadirachta indica, Coriandrum sativum, Daturametel, Ecliptaalba, Emblicoeffinialis, Ocimumsanctum, Phyllanthusamarus, Ricinuscommunis, Catharanthus roseus</i> and <i>Zingiberofficinale</i> .	8
VIII	Herbal Preparations & Phytochemistry: Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and their therapeutic applications. Anthocyanins and Coumarins and their therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids, Alkaloids and pharmacological activities.	7

Suggested Readings:

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

1. आवृतबीजीवनस्पतिविज्ञान (टैक्सोनीमी, एनाटॉमी, एंजियोलॉजी तथा इकोनामिक बॉटनी) लेखक- सिंह, पांडे व जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
2. भारत की संपदा, विज्ञान संचार भवन इ.क.स. कृष्णन मार्ग पूसा कैम्पस
3. पारिस्थितिकी एवं आर्थिक वनस्पति विज्ञान- Dhankar - Sharma - Trivedi
4. Aushdhiye Poudhe (Hindi) by R.P. Sharma | 1 January 2013 YKING BOOKS
1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D. K. and K. V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M. Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adopted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K. V. (2004). An Advanced Textbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
11. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
12. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
13. Arthur Raphael Miller, Micheal H. Davis, Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
14. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
15. Jain, S.K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
16. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
17. Joshi, S.G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
18. Kokate, C. and Gokeale - Pharmacognosy - Nirali Prakashan, New Delhi.
19. Lad, V. 1984. Ayurveda - The Science of Self-healing. Motilal Banarasi Dass, New Delhi.
20. Lewis, W.H. and M.P.F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Inter science Publication. John Wiley and Sons, New York.
21. Farooqui, A. A. and Sreeraman, B.S. 2001. Cultivation of medicinal and aromatic crops. Universities Press.
22. Harborne, J.B. 1998. Phytochemical methods - a guide to modern techniques of plant analysis 3rd edition, Chapman and Hall.
23. Yesodha, D., Geetha, S. and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai. I. Gurdeep Chatwal, 1980. Organic chemistry of natural products. Vol. I. Himalaya Publishing house.
24. Kalsi, P.S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
25. Wallis, T. E. 1946. Textbook of Pharmacognosy, J & A Churchill Ltd.

26. Roseline, A. 2011. Pharmacognosy. MJ Publishers, Chennai.
27. Jain S.K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
28. Sharol Tilgner, N.D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
29. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
30. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizomes drugs. Bulletin No. 1 Ministry of Health, Govt. of India.
31. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
32. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
33. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol. 1, Today & Tomorrow's printers and publishers, New Delhi.
34. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
35. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
36. K. Wilson and K.H. Goulding. 1986. Principles and techniques of Practical Biochemistry. (3rd edn) Edward Arnold, London.

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

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluations 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

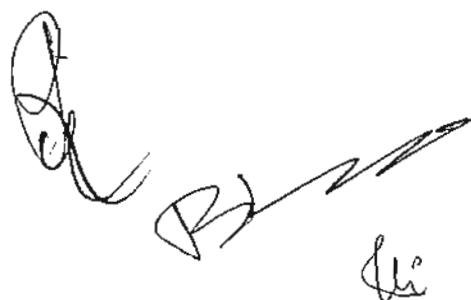
Other Requisites: Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

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/198-Intellectual-Property-and-Traditional-knowledge.html> https://www.brainkart.com/article/Economic-importance-Plants---Food,-Rice,-Oil,-Fibre,-Timber-yielding-plant_1095/ <https://www.loc.gov/rr/scitech/tracer-bullets/economic-botanytb.html> <http://nsdl.niscair.res.in/bitstream/123456789/12711/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: <i>Diploma in Plant Identification, Utilization & Ethnomedicine</i>		Year: II	Semester: IV Paper-II
Subject: Botany			
Course Code: B040402P		Course Title: Commercial Botany & Phytochemical Analysis	
Course outcomes: After the completion of the course the students will be able to:			
1. Know about the commercial products produced from plants.			
2. Gain the knowledge about cultivation practices of some economic crops.			
3. Understand about the ethnobotanical details of plants.			
4. Learn about the chemistry of plants & herbal preparations			
5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.			
Credits: 2		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2			
Unit	Topic (Perform minimum any three experiments from each unit)	No. of Lectures (60hrs)	
I	Economic Botany & Microtechnique: Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests) Legume: Pea or groundnut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea-tea leaves, tests for tannin Mustard-plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute-specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimen of economic importance mentioned in Unit I-&II	8	
II	Commercial Cultivation Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrients solutions & running models for cultivation of vegetables Development of hydroponics nutrients solutions & running models for cultivation of fodder	8	
III	Cultivating Medicinal and aromatic plants & Essential oil extraction a. Lemongrass/Neem/Zinger/Rose/Mint	7	
IV	Documentation from Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand-Nakshtra Vatika, Navgrahvatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi	7	

V	<p>Ethnobotany Study of common plants used by tribes. <i>Aegle marmelos</i>, <i>Ficus religiosa</i>, <i>Cynodon dactylon</i>. Visit tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute/ Hospital</p>	7
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VI	Instrumentation and herbal Preparations Develop Capsules of herbs/ Develop Herbal oils/ Develop Poulitice/cream Analyse some active ingredients using chromatography/Spectrophotometry	8
VII	Pharmacognosy Organoleptic studies of plants mentioned in the theory: 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test 8. Proteins and lipid test	8
VIII	Phytochemistry: Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimension of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.	7

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

1. Plant Ecology And Economic Botany by Dhankar-Sharma-Trivedi, RBD Publication
2. फार्माकोगनॉसी Shiva Kant, Pankaj Kumar Brahmia : 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 प्रकाशन रस्तोगी प्रकाशन मेरठ
5. Wallis, T.E. 1946. Textbook of Pharmacognosy, J & A Churchill Ltd.
6. Roseline, A. 2011. Pharmacognosy. MJ Publishers, Chennai.
7. Jain S.K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
8. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
9. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No. 1 Ministry of Health, Govt. of India.
10. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
11. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
12. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol. 1, Today & Tomorrow's printers and publishers, New Delhi.
13. Khasim S.M Botanical Microtechniques: Principles and Practice-
14. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. ew Delhi.
15. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency

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

Suggested Continuous Evaluation Methods:

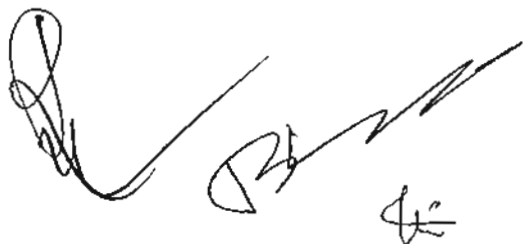
Continuous Internal Evaluations shall be based on allotted Assignment and Class Tests. The marks shall be as follows :

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

	<p>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.</p>
	<p>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/</p>

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(BOTANY)**

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BACHELOR OF SCIENCE (BOTANY)

Programme/Class: <i>Bachelor of Science</i>	Year: III	Semester: V Paper-I
Subject: BOTANY		
Course Code: B040501T	Course Title: Plant Physiology, Metabolism & Biochemistry	

Course outcomes:

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

1. Understand the role of Physiological and metabolic processes for plant growth and development.
2. Learn the symptoms of Mineral Deficiency in crops and their management.
3. Assimilate Knowledge about Biochemical constitution of plant diversity.
4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants

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

Unit	Topic	No. of Lectures (60 hrs)
I	Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.	7
II	Carbon Oxidation Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP-Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.	7
III	Nitrogen Metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acids synthesis.	8
IV	Lipid Metabolism & Photosynthesis Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation.; Photosynthesis: Pigments, Action spectra and enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM-Reaction and Significance	7
V	Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene), autonomic & paratonic movements, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence	8

VI	<p>Biomolecules <i>Carbohydrates</i>: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). <i>Lipids</i>: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers</p>	8
VII	<p>Proteins: Structure of amino acids; Peptide bonds; Level of protein structure – primary, secondary, Ramchandran plot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Re-naturation, MiRNA</p>	7
VIII	<p>Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes. Elementary knowledge of Phytonutrients, Nutraceuticals, dietary supplements and antioxidants.</p>	8

Suggested Readings:

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

- पादप शरीरक्रियाविज्ञान तथा जैव रसायन लेखक : डॉ एच एस श्रीवास्तव प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
- पादप शरीरक्रियाविज्ञान तथा जैव रसायन लेखक : सिंह, पांडे तथा जैन प्रकाशन : रस्तोगी प्रकाशन, मेरठ।
- पादप कार्यिकी एवं जनन विज्ञान. Madan Kumar. 2020.
- Plant Physiology and Biochemistry ISBN #: 81-301-0035-5 Sunil D Purohit, K. Ahmed & Gotam K Kukda Edition: 2013 Pages: 368 + VIII Text Book (Hindi)
- पादप कार्यिकी एवं जनन रसायन Dhankar - Sharma – Trivedi RBD Publishing
Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
- A Handbook On Mineral Nutrition And Diagnostic Techniques For Nutritional Disorders Of Crops (pb) ISBN : 9788177543377 Edition: 01 Year: 2011 Author: Pathmanabhan G, Vanangamudi M, Chandrasekaran CN, Sathyamoorthi K, Babu CR, Babu RC, Boopathi PN Publisher : Agrobios (India)
- Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004, S. Chand and Company.
- Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 1992, Wadsworth Publishing Company.
- Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
- Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
- Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pathways 2008, New Central Book Agencies.
- Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
- Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
- Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
- Srivastava, H.N. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
- Verma, S.K. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
- Buchanan, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
- Ramesh Gupta. Efficacy, Safety and Toxicity bring together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
- Harborne, J.B. 1973. Phytochemical Methods. John Wiley & Sons, New York.
- Watson, J.D., Baker T.A., Bell, S.P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
- P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017

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

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses: <https://www.classcentral.com/course/swayam-plant-physiology-and-metabolism-17732> <https://www.wiziq.com/course/3249-plant-physiology-in-10-live-online-classes>

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

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

Programme/Class: <i>Bachelor of Science</i>		Year: III	Semester: V Paper: II
Subject: BOTANY			
Course Code: B040502T		Course Title: Molecular Biology & Bioinformatics	
Course outcomes:			
After the completion of the course the students will be able to:			
1. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.			
2. Know about Processing and modification of RNA and translation process, function and regulation of expression.			
3. Gain working knowledge of the practical and theoretical concepts of bioinformatics			
Credits: 4		CC/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 4-0-0			
Unit	Topic		No. of Lectures (60 hrs)

I	<p>Genetic material Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi-conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semidiscontinuous RNA priming, θ (theta) mode of replication, replication of linear dsDNA, replicating the δ end of linear chromosome including replication enzymes.</p>	7
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II	Transcription & Regulation of gene expression Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes, RNAi, Gene editing	7
III	Principles & Techniques of genetic engineering Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Antibody Engineering. Enzymes used in Genetic Engineering and Gene cloning	8
IV	Applications of Genetic engineering Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moon dust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns..	7
V	Bioinformatics & its applications Computer fundamentals-programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics. Primer designing	8
VI	Biological databases: Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)	8
VII	Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	7
VIII	Phylogenetic analysis Similarity, identity and homology, Alignment-local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.	8

Suggested Readings:

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

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

~~BIO TECHNOLOGY AND GENETIC ENGINEERING (Hindi Hardcover, Dr. Archana Nigam)~~

BOTANY-UG-2020 Page 45

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

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 Evaluations shall be based on all 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>

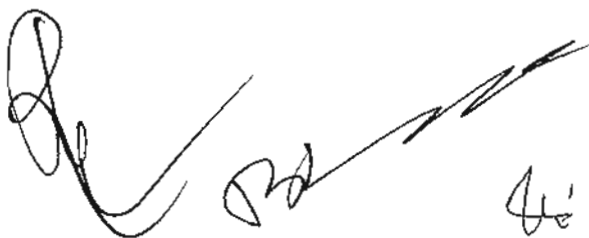
<https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907>

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

Programme/Class: <i>Bachelor of Science</i>	Year: III	Semester: V Paper-III
Subject: Botany		
Course Code: B040503P	Course Title: <i>Experiments in physiology, Biochemistry & molecular biology</i>	
Course outcomes: After the completion of the course the students will be able to:		
<ol style="list-style-type: none"> 1. Know and authentic the physiological processes undergoing in plants along with their metabolism 2. Identify Mineral deficiencies based on visual symptoms 3. Understand and develop skill for conducting molecular experiments for genetic engineering 		
Credits: 2	Core Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week) 0-0-2		
Unit	Topic* <i>*(Perform any three from each unit based on facility)</i>	No. of Lectures (60hrs)
I	Plant water relation, Mineral Nutrition and translocation in phloem 1. Determination of osmotic potential of plant cells by plasmolytic method using leaves of <i>Rhoeo/Tradescantia</i> . 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q ₁₀ . 4. Experiment to demonstrate the transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of stomata (dicot & monocot) 7. Determination of rate of transpiration using cobalt chloride method. 8. Experiment to measure the rate of transpiration by using Farmer's Potometer 9. Experiment to measure the rate of transpiration by using Ganong's potometer 10. Effect of Temperature on membrane permeability by colorimetric method. 11. Study of mineral deficiency symptoms using plant material/photographs.	8
II	Nitrogen Metabolism, Photo Synthesis & Respiration 1. Abasic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO 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). 5. Measurement of oxygen uptake by respiring tissue (perg/hr.) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott's bubble	8
III	Plant Development, Movements, Dormancy & Responses 1. Geotropism and phototropism—Klinostat 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.	8

	<p>5. Test of seed viability by TTC method.</p> <p>6. To study the effect of different concentrations of IAA on <i>Avena</i> coleoptile elongation (IAA bioassay)</p>	
IV	<p>Techniques for biochemical analysis</p> <ol style="list-style-type: none"> 1. Weighing and Preparation of solutions - percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items. 11. Purification of acid phosphatase from sprouted moong/ Purification of peroxidase from radish 12. Enzyme kinetics of acid phosphatase/ Enzyme kinetics of peroxidase/ alpha-amylase 	8
V	<p>Genetic material</p> <ol style="list-style-type: none"> 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating <i>E. coli</i> in it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method. 	7
VI	<p>Preparation of models/ charts:</p> <ol style="list-style-type: none"> 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA 4. Study of structures of : tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs 	7

VII	Genetic Engineering <ol style="list-style-type: none">1. Isolation of protoplasts.2. Construction of restriction map of circular and linear DNA from the data provided.3. Isolation of plasmid DNA.4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/photograph).5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	7
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	6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA - Demonstration of PCR	
VIII	Applications of Genetic Engineering 1. ELISA Test, 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.	7

Suggested Readings:

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

1. प्रयोगात्मक वनस्पति विज्ञान भाग 3 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तागी प्रकाशन, मेरठ

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. A Laboratory Manual Of Plant, Physiology, Biochemistry And Ecology ISBN: 9788177544589 Edition : 01 Year: 2012 Author: Akhtar Inam Publisher: Agrobios (India)
3. Advanced Methods In Physiology And Biochemistry (pb) ISBN : 9789381191132 Edition : 01 Year : 2016 Author: Padmanaban G, Chandrasekaran CN, Thangavelu AU, Dr. Sivakumar R, Kalimuthu N, Dr. Boominathan P, Dr. Anbarasan P, Agrobios.
4. Methods in Plant Biochemistry and Molecular Biology. 1997. Dashek, WV (ed.). CRC Press.
5. Wilson and Walker. Practical Biochemistry: Principles and Techniques. Cambridge University Press. U.K.
6. Thimmaiah, SR. 2004. Standard Methods of Biochemical Analysis. Kalyani Publishers.
7. Henry, RJ. 1997. Practical Application of Plant Molecular Biology. Chapman & Hall, London

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 Evaluations 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

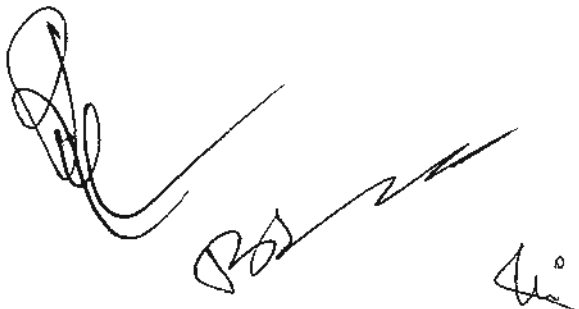
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

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

HiMediaBiotechnology&MolecularbiologyKits/Chemicals,Micropipettes,Elisareader/MicrotitreReader

Suggestedequivalentonline courses:

<https://www.edx.org/learn/molecular-biology><https://krishikosh.egranth.ac.in/handle/1/5810039999><https://www.classcentral.com/course/swyam-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>

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Programme/Class: Bachelor of Science	Year: III	Semester: VPaper-IV
Subject: BOTANY		
Course Code: -B040504R	Course Title: Project in Botany for Pre-graduation	
Course outcomes:		
<ul style="list-style-type: none"> • Project work will supplement field experimental learning and deviations from classroom and laboratory transactions. • project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes. • It will promote creativity and the spirit of enquiry in learners. • They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing. • It will enhance their abilities, enthusiasm, and interest. 		
Credits: 03	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.		
Suggestive List of PROJECTS		
<ol style="list-style-type: none"> 1. Rural Areas: Flora of faculty/ village, Biodiversity of Village, Soil & seed testing service provision to farmers, 2. Industrial waste management 3. water pollution status of rural water & promotion of WASH in villages 4. Plant Disease identification in farms, nurseries and orchards. 5. Digital portal for plants: Campus, city or particular area 6. Rare and endangered plants & their conservation & domestication 7. Air pollution tolerance index (APTI): Screening of sensitive/tolerant plant species at various locations in particular area 8. Science Communication by Creating science documentaries of innovators, Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.) 9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public. 10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties 11. Study of pollen grains in different flowers 12. Study of stomata in different plants 13. Study of various types of secretory and special tissues in plants. 		
Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.		
This course can be opted as an elective by the students of following subjects:		Open to all
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
Seminar		10
Thesis/dissertation		10
		25
Course prerequisites:		

Qualification: To study this course, a student must have qualified 10+2 with Biology/NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: All listed under all papers of the course.

Suggested equivalent online courses:

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

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

[OhBITSyPnvi3r8yeio-](#)

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

[/http://www.vigyanprasar.gov.in/digilib](http://www.vigyanprasar.gov.in/digilib)

Directory of Open Access Repositories

(DOAR) <http://www.opendoar.org> Registry of Open

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

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

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Programme/Class: Bachelor of Science		Year: III	Semester: VI Paper- I
Subject: Botany			
Course Code: B040601T		Course Title: Cytogenetics, Plant Breeding & Nanotechnology	
Course outcomes: After the completion of the course the students will be able: <ol style="list-style-type: none"> 1. Acquire knowledge on cell ultrastructure. 2. Understand the structure and chemical composition of chromatin and concept of cell division. 3. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance. 4. Understand the concept of one gene one enzyme hypothesis along with the molecular mechanism of mutation. 			
Credits: 4		Core Compulsory	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60hrs)	
I	Cell biology Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions -Organization of nucleus: nucleare envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes -Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: -mitosis: open and closed mitosis - amitosis- meiosis. Variation in Chromosome number (Numerical aberrations) -aneuploidy and Euploidy- haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	8	
II	Genetics Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants	7	
III	Plant breeding Plant introduction. Agencies of plant introduction in India, Procedure of introduction- Acclimatization - Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, intergeneric, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	8	
IV	Biostatistics: Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency - Arithmetic Mean, Mode and Median; Measurement of dispersion - Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi-square test for goodness of fit. Computer application in biostatistics- MS Excel and SPSS	7	

v	Plant tissue culture	8
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	Elementary knowledge of Principles, components and techniques of <i>in vitro</i> plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast-principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	
VI	Nanotechnology Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nanoparticles synthesis: Biological synthesis of nanoparticles, Advantages and applications of biological synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	7
VII	Artificial Intelligence in Plant Sciences Elementary idea of Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic, Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis; Applications of Artificial Neural Networks in Plant Science.	8
VIII	Introduction to use of Digital technologies – AI, IoT & ICT in Botany Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository- google scholar, science direct. resource management, weather forecasting. IoT Databasemanagement, IoT platforms, IoT Graphical user interface • IoT Application development for Android Mobile phones, ICT Applications for different crops and horticulture	7

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Suggested Readings:

Course Books published in ^{English} Hindi may be prescribed by the Universities.

1. कोशिकाविज्ञान अनुवांशिकी, विकास एवं पारिस्थितिकी लेखक : पीके गुप्ता प्रकाशन : रस्तोगी प्रकाशन, मेरठ
 2. कोशिका जैविकी, आनुवांशिकी, जैवप्रौद्योगिकी Sharma and Trivedi by RBD Publisher
 3. Cell Biology And Genetics (Hindi) 2/e PB Gupta PK (Hindi) Rastogi Publications
 4. PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct Publishing ISBN: ISBN: 9781698665283 Authors: H.R. Daga, Jai Narain Vyas University
 5. Biotechnology: Fundamentals And Application (Hindi) (hb) ISBN : 9788177544732 Edition : 03 Year : 2018 Author: Dr. Purohit SS, Mathur S
 6. Biotechnology (Hindi) (Hindi, Paperback, B.D. Singh) Hindi Publisher: Kalyani Publishers ISBN : 9789327246070, 9327246071
 7. Cytogenetics, Plant Breeding, Evolution and Biostatistics ISBN#: 978-81-301-0066-1 Sunil D Purohit & Gotam K Kukda, Apex Publishing House
 8. Genetics and Biotechnology Sunil D Purohit, K. Ahmed & Gotam K Kukda Apex Publishing House
 9. Padap Prajanan (Hindi) Hardcover – 1 January 2016 by Chandra Prakash Shukl (Author) Pointer Publishers, Jaipur
 10. PLANT BREEDING: PRINCIPLE AND METHODS B D SINGH - IN HINDI
 11. कोशिका तथा अणु जैविकी शब्द-संग्रह Commission for Scientific and Technical Terminology (CSTT)
 12. पादप आनुवांशिकी परिभाषाकोश Commission for Scientific and Technical Terminology (CSTT)
1. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
 2. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. 6th Edition. WW. Norton & Co.
 3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
 4. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
 5. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H. Freeman.
 6. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company

7. Nelson, D.L. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*, 5th Ed., W.H. Freeman and Company.
8. Karp, G. (2010). *Cell Biology*, John Wiley & Sons, U.S.A. 6th edition.
9. Hardin, J., Becker, G., Skliensmith, L.J. (2012). *Becker's World of the Cell*. 8th edition. Pearson Education Inc. U.S.A.)
10. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). *Principles of Genetics*, John Wiley & Sons, India. 8th edition.
11. Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*, John Wiley & Sons Inc., India. 5th edition.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). *Concepts of Genetics*. Benjamin Cummings, U.S.A..
13. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). *Introduction to Genetic Analysis*. W.H. Freeman and Co., U.S.A. 10th edition.
14. MKRaxdan *An Introduction to Plant Tissue Culture*—; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
15. Aggarwal SK (2009) *Foundation Course in Biology*, 2nd Edition, Ane Books Pvt. Ltd
16. Allard RW (1960) *Principles of Plant Breeding*. John Wiley and Sons. Inc. New York
17. BDSingh (2003) *Plant Breeding*. Kalyani Publishers
18. Cohn, N.S. (1964) *Elements of Cytology*. Brace and World Inc, New Delhi
19. Darnel, J. Lodish, Hand Baltimore, D. (1991) *Cell and molecular biology*. Lea and Fibiger, Washington.
20. DeRobertis, E.D.P and Robertis, E.M.P (1991) *Cell and molecular biology* Scientific American books.
21. Dobzhansky, B (1961) *Genetic and origin of species*, Columbia university Press New York
22. Durbin (2007) *Biological Sequence Analysis*. Cambridge University Press India Pvt. Ltd
23. Gerald Karp (1985) *Cell biology*, McGraw Hill company..
24. Lewin, B. (1994) *Genes*, Oxford University Press, New York.
25. Lewis, W.H (1980) *Polyploidy*. Plenum Press, New York.
26. Nichol IT (2007) *An Introduction to Genetic Engineering*, Cambridge University Press India Pvt. Ltd
27. Roy S.C. and Kalayankumar De (1997) *Cell biology*. New central Boos Calcutta
28. Sandhya Mitra, (1998) *Elements of molecular biology*. Macmillan, India Ltd.
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30. Sharma, A. K and Sharma A (1980) *Chromosome technique Theory and practice*, Aditya Books, New York
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32. Taylor (2008) *Biological Sciences*. Cambridge University Press India Pvt. Ltd
33. Twyman, R.M. (1998) *Advanced molecular biology* Vivabooks New Delhi.
34. Veer Bala Rastogi (2008), *Fundamentals of Molecular Biology* Ane Books Pvt. Ltd
35. A. J. Nair. *Basics of Biotechnology*-Laxmi Publications, New Delhi.
36. SSPurohit and SK Mathur; *Biotechnology-Fundamentals and Application-Agrobotanica*, India.
37. A.J. Nair *Introduction to Genetic Engineering & Biotechnology*. Jones & Bartlett Publishers, Boston, USA.
38. HS Chawla *Introduction to Plant Biotechnology*—; Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
39. HD Kumar *Modern concept of Biotechnology*, Vikas Publishing House, Pvt. Ltd., New Delhi.
40. P C Trivedi, *Plant biotechnology*, Recent Advances Panima Publishing Corporation, New Delhi.
41. Du, C., and S.A. Jackson. 2019. *Machine learning and complex biological data*. *Genome Biology* 20:76. <https://doi.org/10.1186/s13059-019-1689-0>
42. Alexis and Mathew Leon., *Fundamentals of Information Technology* Leon Vikas
43. Plant R. E., Stone N. D. (1991). *Knowledge-based systems in agriculture*. McGraw-Hill, Inc. 1221 Avenue of the Americas, New York, NY 10020.
44. Han S., Steward B.L., Tang L. (2016). *Intelligent agricultural machinery and field robots*. In Zhang Q. *Precision agriculture technology for crop farming* (pp. 133-176). CRC Press, Taylor & Francis Group, New York.
45. Lucci S., Kopec D. (2013). *Artificial intelligence in the 21st century*. 22841 Quicksilver Drive Dulles, VA 20166.
46. V. Rajaraman *Introduction to Information Technology*, Prentice Hall.
47. Ramesh Bangia *Learning Computer Fundamentals*, Khanna Book Publishers
48. Bass, Joel, Eand et. al., Allyn & Bacon, 2009. *Methods for Teaching Sciences as Inquiry*, The truth of science, Newton R. G.,
49. R. Rangaswami (2009) *A Textbook of Agriculture Statistics*. New Age International (P) Limited, Hyderabad.
50. Nageshwar Rao G. (2007) *Statistics for Agriculture Sciences* BS Publications. New Delhi
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58. Yubing Xie. 2012. Nanotechnology. CRC Press. The Nanobiotechnology Handbook. CRC Press.
59. Sulabha K. Kulkarni. 2014 Nanotechnology: Principles and Practices. CP publishing, New Delhi.
60. BSMurty, PShankar, BaldevRaj, BBRath, JamesMurday. 2012. Textbook of Nanoscience and Nanotechnology. Springer
61. K.K. Chattopadhyay and A.N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
62. Sharma A.K. 2003. Text Book of Biostatistics I, Discovery Publishing House.
63. Annadurai, B. 2007. Text Book of Biostatistics. New Age International.
64. Gurumani, N. 2010. An Introduction to Biostatistics (2nd Edn). MJ Publishers.
65. David S. Goodshell. 2004. Bionanotechnology - Lessons from nature. John Wiley Publications.
66. R. Stephen Crespi, Tibtech, Patenting in Biotechnology - Part I, Vol. 9, 117-122, 1991.
67. Pattnaik, P.K., Kumar, R., Pal, S., Panda, S.N. (Eds.) IoT and Analytics for Agriculture, 2020
68. <https://www.springer.com/gp/book/9789811391767>
69. <https://www.springer.com/gp/book/9789811550720>
70. Petersen Roger G. (1994) Agricultural Field Experiments Design and Analysis by Marcel Dekker, New York.

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.Pharm, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

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

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

Course pre-requisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

- <https://www.cytology-iac.org/educational-resources/virtual-slide-library>
<https://www.asct.com/ASCTWeb/Content/Cytopreparation> Online Course.as
<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:			
<ol style="list-style-type: none"> 1. acquaint the students with complex interrelationship between organisms and environment; 2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. 3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation. 			
Credits: 4		Core Compulsory/Elective	
Max. Marks: 25+75		Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0			
Unit	Topic	No. of Lectures (60 hrs)	
I	Natural resources & Sustainable utilization: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.	7	
II	Ecology & Ecosystem Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem – structure and function of an ecosystem. Abiotic and biotic components and their interrelationship – Biogeochemical and hydrological cycles, and Energy flow in an ecosystem Ecological Succession – Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Concept of Ecological perturbations and balance, Ecological pyramids, Primary and Secondary Production and Productivity; Types of ecosystems: Natural and Man-made – Forest Grassland, Aquatic and Agro- Ecosystems. Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	8	
III	Soil Formation, Properties & Conservation Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological – Contour farming, Mulching, Strip cropping, Terracing and Croprotation. Mechanical – Basin Listing, Construction of dams, Watershed Management, Soil reclamation	7	
IV	Biodiversity and its conservation: Definition – genetic, species, and ecosystem diversity. Value of biodiversity: Indian socio-cultural, ethical and aesthetic values; hotspots of Biodiversity threat to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecade, ecotypes, ecological indicators. Conservation of Biodiversity: <i>Ex-situ</i> and <i>in-situ</i> conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Biosphere reserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI, Indian value system	7	

V	<p>Phytogeography Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.</p>	7
VI	<p>Environmental audit & Sustainability Elementary knowledge: Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.</p>	8
VII	<p>Pollution, Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) - Trickling Filters - oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, upflow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG; Waste- Types, collection and disposal, Recycling of solid wastes (hazardous & non-hazardous)-classification, collection and segregation, Incineration, Pyrolysis and gasification, Sanitary landfilling; composting, Biogas production, Circular Economy & sustainability.</p>	8
VIII	<p>Environmental ethics, Carbon Credits & Role of GIS Carbon credit: concept, exchange of carbon credits, Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation, Consumerism and waste products, Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.</p>	8

Suggested Readings:

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

1. Environmental Studies (Hindi) ISBN 81-301-0004-5 B.L. Chaudhary & Jitendra Pandey Edition: 2013 Pages: 340 + XII Apex Publishing House
2. Soil and Water Conservation ISBN#: 978-81-301-0071-5 S.C. Mahnot & P.K. Singh Apex Publishing House
4. Ecology and Environmental Biology (पारिस्थितिकी एवं पर्यावरण जैविकी) by RBD
Publisher Author: Bhatia - Jain - Kohli - Shrivastava - Singh - Verma
5. पर्यावरणीय वनस्पति एवं पादपव्याधिकी लेखक : डॉ पी डी शर्मा प्रकाशन : रस्तोगी प्रकाशन, मेरठ
6. Shrimad Bhagvadgita, Geeta Press, Gorakhpur
7. Garud Puran, Geeta Press, Gorakhpur
8. Paryavaran Evam Paristhitiki 5e (Hindi) Paperback - 20 February 2020 Majid Husain
9. Environmental Biology and Phytogeography ISBN#: 978-81-301-0064-7 B.L. Chaudhary, Gotam K Kukda & Jitendra Kumar Joshi
10. UGC Unified: Environmental Sciences (Hindi) (pb) ISBN: 9788177545814 Edition: 01 Year: 2015 Author: Dr. Purohit SS, Dr. Deo PP, Dr. Agrawal Ashok K Publisher: Agrobios (India)
11. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
12. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
13. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
14. Begon, M., Harper, J.L. and Townsend, C.R. Ecology - Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
15. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company



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

This course can be opted as a selective 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/mooc>
futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
<https://www.coursera.org/courses?query=plants>
<http://egyankosh.ac.in/handle/123456789/53530>

Programme/Class: 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 to: <ol style="list-style-type: none"> 1. To perform all experiments related to the semester - i.e. Plant tissue cultured plants, conducting breeding in 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 (60hrs)	
I	Cell biology 1. Study of plant cell structure with the help of epidermal peel mount of Onion/ <i>Rhoeo</i> / <i>Crinum</i> 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 <i>Allium cepa</i> .	7	

II	Genetics <ol style="list-style-type: none"> 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) <ol style="list-style-type: none"> a. Recessive epistasis 9:3:1. b. Dominant epistasis 12:3:1 c. Complementary genes 9:7 d. Duplicate genes with cumulative effect 9:6:1 e. Inhibitory genes 13:3 4. Observe the genetic variations among inter and intraspecific plants. 5. Demonstration of Breeding techniques - Hybridization, case studies of mutation, polyploidy, emasculation experiment. 	8
III	Biostatistics: <ol style="list-style-type: none"> 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. 3. Computer application in biostatistics - MS Excel and SPSS 	7
IV	Plant tissue culture <ol style="list-style-type: none"> 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5. Protoplast isolation and culturing - Demonstration 	8
V	Ecology & Environment <ol style="list-style-type: none"> 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (<i>Cuscuta</i>), Root parasite (<i>Orobanche</i>) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with the ecology of different sites 	8
VI	Soil Formation, Properties & Conservation <ol style="list-style-type: none"> 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India - Map 	8
VII	Biodiversity and Phytogeography: <ol style="list-style-type: none"> 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) 	7

	2. Marking of vegetation types of India, World & Uttar Pradesh on maps	
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[Handwritten initials]

3. Phytogeographical areas of India		
VIII	<p>Pollution & Waste management</p> <ol style="list-style-type: none"> 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter 2. Estimation of chloride and dissolved oxygen content in water sample 3. Comparative anatomical studies of leaves from polluted and less polluted areas. 4. Measurement of dissolved O₂ by azide modification of Winkler's method. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water 7. Making kitchen waste from compost/vermicompost by Enzymes/Biodecomposer/ Whey with dung. <p>Climate Change, Carbon Credits & Role of GIS</p> <ol style="list-style-type: none"> 1. Conducting Waste Audit of your Institution-Demo 2. Green auditing of the College/University-Demo 	7

Suggested Readings: as in papers above:

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

1. Practical Botany (Part III) Author: Sunil D Purohit, Anamika Singhvi & Kiran Tak 2013 Apex Publishing House, Raj.
2. Practical Botany (Part II) Author: N. C. Aery, Sunil D Purohit & Gotam K Kukda 2013 Apex Publishing House, Raj.
3. प्रयोगात्मक वनस्पति विज्ञान भाग 3 लेखक अशोक बेंद्रे तथा अशोक कुमार प्रकाशन रस्तोगी प्रकाशन मेरठ
4. A Handbook Of Soil, Fertilizer And Manure (2nd Ed.) (pb) ISBN : 9788177544152 Edition : 02 Year: 2017 Author : Gupta PK Publisher: Agrobios (India)
5. Green Technology: An Approach For Sustainable Environment ISBN: 9788177543438 Edition: 01 Year: 2021 Author : Dr. Purohit SS Publisher : Agrobios (India)
6. Laboratory Manual Of Chemical And Bacterial Analysis Of Water And Sewage ISBN : 9788177540802 Edition : 01 Year : 2011 Author : Theroux FR , Eldridge EF , Mallmann WL Publisher: Agrobios (India)
7. Methods In Environmental Analysis: Water Soil And Air (2nd Ed.) ISBN : 9788177543087 Edition: 02 Year: 2021 Author: Gupta PK Publisher: Agrobios (India)
8. Water Treatment And Purification Technology ISBN : 9788177540024 Edition : 01 Year : 2009 Author: Ryan WJ Publisher : Agrobios (India)

<http://vidyamitra.in/flibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany><http://eecontent.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.Pharm, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluations 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

Coursepre-requisites:

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

Facilities: Smart and Interactive Class

Other Requisites: Videocollection, Books, CDs, Access to Online resources, Display Charts Labrequisites: Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:

[https://www.cytology-iac.org/educational-resources/virtual-slide-](https://www.cytology-iac.org/educational-resources/virtual-slide-library)

[libraryhttps://www.asct.com/ASCTWeb/Content/Cytopreparation Online Course.as](https://www.asct.com/ASCTWeb/Content/CytopreparationOnlineCourse.aspx)

[pxhttps://www.mooc-list.com/tags/genetics](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 / Project-II / Paper-IV
Subject: BOTANY		
Course Code: -B040604R	Course Title: Project in Botany for Graduation	
<p>Course outcomes: After completing this course a student will have:</p> <ul style="list-style-type: none"> • Project work will supplement field experimental learning and deviations from classroom and laboratory transactions. • project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes • It will promote creativity and the spirit of enquiry in learners. • They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing • It will enhance their abilities, enthusiasm, and interest. 		
Credits: 03	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.		
SUGGESTIVE LIST OF PROJECTS		
Prepare beds for growing nursery for herbs, shrubs and trees. Develop Green house facility in college and grow plants. Develop hydroponics facility in college and grow plants. Develop botanical garden in the college with labelling. Vertical gardens, roof gardens. Culture & art of making bonsai. Phytochemical Analysis of Medicinal plants		

1

Computer Aided Designing (CAD) for outdoor and indoor landscaping Exposure to CAD (Computer Aided Designing) Biocomposting and Vermicomposting. Performing Aromatherapy by essential Oils	
Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.	
This course can be opted as an elective by the students of following subjects: This course can be opted as an elective by the students of following subjects: Open to all	
Suggested Continuous Evaluation Methods:	
Internal Assessment	Marks
Class Interaction	5
Seminar	10
Thesis/dissertation	10
	25
<p>Course prerequisites: Qualification: To study this course, a student must have qualified 10+2 with Biology/NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/Microbiology/Gardening/biomedical Science. Facilities: Smart and Interactive Class Other Requisites: All listed under all papers of the course.</p> <p>Suggested equivalent online courses: https://ndl.iitkcp.ac.in/http://heecontent.upsdc.gov.i n/Home.aspx(http://epathshala.nic.in/, http://epathshala.gov.in/nptel.iitm.ac.in https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r8yeio- L9f5uTy1a6oEoALCLa9Ebu0pyz858yOZxoC5wkQAvD_BwEhttp://www.dli.ernet.in/,http://www.wilib.org/ http://www.tkdl.res.in/,http://www.vigyanprasar.gov.in/digilib Directory of Open Access Repositories (DOAR) http://www.opendoar.org Registry of Open Access Repositories (ROAR) http://roar.eprints.org/ http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf</p>	