BOS
20 Feb 2025

Maa Shakumbhari University, SAHARANPUR U.P.

माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर,

Syllabus of

Botany

Four Year Under-Graduate (UG) Programme with Honours

&

Honours with research

&

Apprentice Embedded Course

(As per guidelines of U.P. Government according to National Education Policy-2020 w.e.f. the session 2025-2026)

20 Feb 2025

Members from the Board of Studies (BOS):

S.No.	Name	Signature
1.	**Prof. Sanjeev Kumar,** Department of Botany, D.A.V. (P.G.) College, Muzaffarnagar **(Convener)**	
2.	**Prof. Ritu Agarwal,** Department of Botany, M.S. College, Saharanpur **(Member)**	
3.	**Dr. Rakesh Kumar,** Department of Botany, VSP Govt. (P.G.) College, Kairana, Shamli **(Member)**	
4.	**Dr. Yogendra Kumar,** Department of Botany, Govt. Degree College Nanauta, Saharanpur **(Member)**	
5	**Prof. Rup Narayan,** Department of Botany, CCSU, Meerut **(External Expert)**	On-line
6	**Prof. Alok Srivastava,** Department of Plant Science, MJPRU, Bareilly **(External Expert)**	On-line

on-line: https://meet.google.com/csc-irhd-ies

20/2/25

(Prof. Garima Jain)
Dean of Science.

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

Year	Sem.	Course Code	Paper Title	Theory/ Practical	Credits
			Certificate Course in Microbial Technology & Applied Botany		
FIRST YEAR	I	120401	Microbiology & Plant Pathology	Theory	4
		120480	Techniques in Microbiology &Plant Pathology	Practical	2
	II	220401	Archegoniates &Plant Architecture	Theory	4
		220480	Land Plants Architecture	Practical	2
			Diploma in Plant Identification, Utilization & Ethnomedicine		
SECOND YEAR	III	320401	Flowering Plants Identification &Aesthetic Characteristics	Theory	4
		320480	Plant Identification technology	Practical	2
	IV	420401	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4
		420480	Commercial Botany & Phytochemical Analysis	Practical	2
			Bachelor of Science		
THIRD YEAR	V	520401	Plant Physiology, Metabolism & Biochemistry	Theory	4
		520402	Molecular Biology & Bioinformatics	Theory	4
		520480	Experiments in physiology, Biochemistry & molecular biology	Practical	2
			*Project-I	Practical	3
	VI	620401	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4
		620402	Ecology & Environment	Theory	4
		620480	Cytogenetics, Conservation & Environment management	Practical	2
			*Project-II	Practical	3
			Four Year Degree Programme with Honours		
FOURTH TEAR	VII	720401	Diversity of Algae & Bryophytes	Theory	4
		720402	Diversity of Pteridophytes, Gymnosperm & Paleobotany	Theory	4
		720403	Morphology & Taxonomy of Angiosperms	Theory	4
		720404	Biology & Diversity of Microbes	Theory	4
		720480	Practical	Practical	2
	VIII	820401	Genetics & Plant Breeding	Theory	4
		820402	Cell& Molecular Biology	Theory	4
		820403	Ecology & Phytogeography	Theory	4
		820404	Fungi & Plant Pathology	Theory	4
		820480	Practical	Practical	2

- Students can opt 3- year UG Degree program (B.Sc.)
- Students who want to opt 4- year UG Degree program with Honours (VII & VIII Semester) (B.Sc. with Honours).
- *Students who want to opt 4- year UG Degree (Honours with research) will choose the above given 3 theory papers (4 credits each) along with research project (4 credits each) in both VII & VIII Semester.
- *Under the Apprenticeship/Internship embedded UG degree programme The Student Should Complete training Programme in both VII & VIII Semester (1200 hrs./ 1 year, 40 credits) through NATS or from Equivalent organisation. The Degree Holder have to do 2 year PG Programme. It is purely optional for Universities, to run and give this degree. Training may be in the area such as ; seed technology, tissue culture, mushroom cultivation, herbal technology , medecinal plant cultivation , organic farming from institutions.

Programme outcomes (POs):

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

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

Programme specific outcomes (PSOs):

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

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

1. Diversity of plants and microbes, their habitat, morphology, architecture and reproduction.

2. Plant disease causing microbes, symptoms & control.

3. Economic value of plants and their use in Human Welfare.

Programme specific outcomes (PSOs):

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

This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for

	III						molecular biology				
		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 *** Botanical Excursion/ Lab Visits/Industrial training Is compulsory**	25		75

Practicals in VII & VIII Semester (4th year of B.Sc) will be from syllabus of Theory papers (related Experiments)

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

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

Programme: *Certificate Course in Microbial Technology & Classical Botany*	Year: I	Semester: I/Paper-I
Subject: **Botany**		
Course Code: B040101T | Paper Code : 120401	Course Title: **Microbiology & Plant Pathology**	

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

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

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

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

Unit	Topic	No. of Lectures (60 hrs)

I	**A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists (in 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).** **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.	8
II	**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.	8
III	**Phycology** Range of thallus organization in Algae, Pigments, Flagella, Reserve food, Types of Reproduction, Classification and comparative life cycle of – *Nostoc, Chlorella, Volvox, Oedogonium, Chara; Ectocarpus, Sargassum, Polysiphonia.* Phycoviruses, Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation-Symbiosis; Commercialproducts of algae –biofuel, Agar, Diatomite.	7
IV	**Mycology** Comparative study of general characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishingcharacters of **Myxomycota:** General characters of **True Fungi (Eumycota):** Mastigomycotina *Synchytrium*: **Zygomycotina:** *Rhizopus,* **Ascomycotina:** *Saccharomyces, Penicillium, Peziza.* **Basidiomycotina:** *Ustilago, Puccinia, Agaricus;* **Deuteromycotina:** *Fusarium,Alternaria.* Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality,	7
V	**Mushroom Cultivation, Lichenology & Mycorrhiza** Mushroom cultivation. General account of lichens, reproduction and significance; *Mycorrhiza: ectomycorrhiza* and *endomycorrhiza* and their significance.	7
VI	**Plant Pathology** Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil	7
VII	**Diseases and Control** Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late Blight of Potato, Black Stem Rust of Wheat, *Alternaria* 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	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, blue green algae, *Azolla* and *mycorrhiza*. Plant growth promoting rhizobacteria & biopesticides— *Trichoderma sp.* and *Pseudomonas*, Single cell proteins (*Spirulina)*, Organic farming inputs, Microbiology of water, Biopolymers, Bioindicators, Biosensors, Bioremediation, Production of biofuels, Biodegradation of pollutants and Biodeterioration of materials & Cultural Property. Microbial Biofactories (*E.coli* and Yeast) for production of recombinant proteins	8

ıggested Readings:

ब्नतेम ठववो चनइसपीमक पद म्पदकप उंल इम चतमेबतपइमक इल जीम न्दपअमतेपजपमेण

1. वनस्पति विज्ञान (सम्पूर्ण) भंवाल, कवक, लाइकेन, जीवाण, वि ाणु, ब्रायोफाइटा, टॅरडोफाइटा, जिम्नांस्पर्म तथा पुा वनस्पति विज्ञान रू लेखकद् सिंह, पांडे व जेन पकी ान रू रस्तोगी प्रका ान, मेरठ।
2. सूक्ष्म जैविकी कवक एव पादप रोग विज्ञान त्रिवेदी भार्मा एवं धनकर तइक चनइसपीमत 2019
3. परिचायात्मक पादप रांग विज्ञान डॉ आ ी । कमार त्रिपाठी, डॉ सनत कुमार त्रिपाठी 2018 एग्रबॅयोस इंडिया पब्लि ार।
4. पादप रोग विज्ञान रू जिया लाल यादव 2012
5. डॉ आ ाश कमार त्रिपाठी डाफ सनद कमार त्रिपाठी 2018 परिचायत्मक पादप रांग विज्ञान एगाबायोस्त इंडिया पब्लि ार।
6. श्रीश वर्मा 2020. स्पूक्ष्म जैविकी, कवक एव पादप रोग विज्ञान
7. प्रांजल आर्य 2020. पादप रोग रू उत्पत्ति प्रसार एवं नियंत्रण
8. डपवतवइपवसवहल थ्नदकंउमदजंस दक ।चचसपवंजपवदे ;ीपदकपद्ध ;चइद्ध
9. प्ैठछरू 9788188826230 म्कपजपवदरू 03ल्मंत रू 2016 ।नजीवत रू क्तण् च्नतवीपज' ए क्तण् क्मव च्नइसपीमत रू'जनकमदज म्कपजपवद संदहनंहम रू भ्पदकप
10. पादप रांग विज्ञान परिभाशाद् को ारू क्मपिदपजपवदंस क्पवजपवदंतल व िच्संदज च्ंजीवसवहल' च्नइसपीमत ब्वउचपेपवद वित 'बपमदजपपिब दक जमबीदपबंस ज्मतउपदवसवहलण
11. डवकमतद डपवतवइपवसवहल ;ीपदकपद्ध ;ीइद्ध 'प्ैठछरू 9788177543599म्कपजपवद रू 1ल्मंत रू 2018 ।नजीवत रू क्तण् च्नतवीपज' ए क्तण् 'पदही ज च्नइसपीमत रू ।हतवइपवे ;प्दकपंद्ध
12. 'नहहमेजमक इववो भ्च्संदज चंजीवसवहल इल त्ैण् डमीतवजतंए ज्ंजं डवळतं.भ्पसस म्कनबंजपवद तम पदवसनकमक पद तमंकपदह तमेवनतबमे सपेज
13. 'नहहमेजमक इववाःम्उपदमदज प्दकपंद ठवजंदपेजेरू र्ैंज दक च्तमेमदज ;ठपवहतंचीपमे दक बवदजतपइनजपवदेद्ध ए च्' नतमौ Narayan and T. Pullaiah, Regency Publications, (2011)

Unit-I A:

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

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

iii. 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*

iv. *https://www.scribd.com/presentation/81269920/Botany-of-Ancient-India*

v. *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 2015by 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-I B.

. 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.
. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Aggarwal, S. K. 2009. Foundation Course in Biology, A one books Pvt. Ltd., New Delhi.
. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, NewDelhi.
6. Annie Ragland, 2012. Algae and Bryophytes, Saras Publication, Kanyakumari, India.
. 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.
. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
10. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., NewDelhi.
1. 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.
3. 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.
5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
16. Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
7. 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..
9. Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt.Ltd, New Delhi.
20. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
21. Pelczar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
22. Rangaswamy, G. 2009, Disease of Crop Plants in India, Prientice Hall of India, New Delhi.
23. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
24. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
25. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
26. Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
27. Sundar Rajan. S. 2010.College Botany Volume I, Himalaya Publications, Mumbai.
28. Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

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

Programme: *Certificate Course in Microbial Technology & Classical Botany*	Year: I	Semester: I/Paper-II
Subject: Botany		
Course Code: B040102P, Papercode: 120480	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)
1.	**INSTRUMENTS & TECHNIQUES** 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 3. Cleaning and Sterilization of glasswares 4. Preparation of media- Nutrient Agar and Broth 5. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 6. Preparation of agar slant, stab, agar plate 7. Phenol Coefficient method to test the efficacy of disinfectants	7
II	**BACTERIAL IDENTIFICATION** 1. Isolation of bacteria. 2. 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. *Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria.* 3. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus.* 4. Lichens: crustose, foliose and fruticose specimens.	8
IV	**PHYCOLOGY:** 1. Type study of algae and Cyanobacteria –*Spirulina, Nostoc.* Chlorophyceae - *Chlorella, Volvox, Oedogonium, Cladophora,*and *Chara;* Xanthophyceae – *Vaucheria;* Bacillariophyceae – *Pinnularia* Phaeophyceae – *Sargassum* Rhodophyceae - *Polysiphonia*	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 ofwheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of*Puccinia*, Few viral and bacterial plant diseases.	8
VI	**PRACTICALS IN APPLIED MICROBIOLOGY-1** 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of rhizosphere to non- rhizosphere population of bacteria. 3. Isolation of antagonistic Pseudomonas from soil. 4. Microscopic observations of root colonization by VAM fungi. 5. Isolation of *Azospirillum* sp. from the roots of grasses. 6. Isolation of phyllosphere microflora. 7. Isolation of P solubilizing microorganisms.	8
VII	**PRACTICALS IN APPLIED MICROBIOLOGY-2** 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay – cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.	8

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

Suggested Readings:

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

1॰ प्रयंगात्मक वनस्पति विज्ञान भागदृ1 लेवक अ ंक बंदे तथा अ ंक कुमार प्रका न रस्तोगी प्रका न मेरठ।

2॰ प्रायोगिक वनस्पति विज्ञान॰ वींदांत .ैंाउं दृ ज्तपअमकप ष्ठछ व्वकमरू 978.81.8142.697.0 65ए त्व्य
ष्ट्रइसपीपदह भ्वनेम ेपअंरप छंहंत ब्यअपस स्पदमेएश्रंपचनत . 302006 ; त्ंरंेजींद द्ध

3. प्रायोगिक वनस्पति विज्ञान वी.एससी.दृ1 एस बी अग्रवाल प्रका क रू ि विलाल अग्रवाल एण्ड कम्पनी प्रकाि त वर्श : 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 : 9788177545180Edition : 01Year : 2017Author : Singh Riti , Singh UCPublisher : Agrobios (India)

6. Biofertilizer Production Manual (hindi) (hb) ISBN : 9788177541274Edition : 01Year : 2014Author : Gehlot D Publisher : Agrobios (India)Language : Hindi

1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
5. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
5. Sambamurty. A.V.S.S. 2006, A Textbook of Algae, I. K. International Publishing House, Pvt. Ltd.,
7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
8. https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf
9. http://nhb.gov.in/pdf/Cultivation.pdf
10. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
11. Sen, Surjit,Acharya, Krishnendu, Rai, Manjula 2019 IBSN - 978-93-88347-23-5 - Biofertilizers and Biopesticides .Technoworld, Kolkata
12. http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf
13. http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf
14. Hochman,Gal,Zilberman,David 2014 IBSN-1461493285- Algae Farming and Its Bio-Products Springer
18. Gokare A. Ravishankar , Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
19. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898

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

Suggested Continuous Evaluation Methods:

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

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	7
Minor field work/excursion/lab visit/technology dissemination etc.	8
Internal Assessment in Practicals	is scrapped by U.P. Govt.

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Microbiology/biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts
Lab Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balances, Fermenter, Anaerobic jar and Spectrophotometer.

Suggested equivalent online courses:
https://community.plantae.org/tags/mooc
futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html
https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
http://allaboutalgae.com/benefits/
https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdf
https://www.mooc-list.com/tags/microbiology
http://www.agrifs.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%7D%20%5B8171339239%5D%20%281984%29.pdf
https://www.coursera.org/courses?query=plants
http://egyankosh.ac.in/handle/123456789/53530
https://www.classcentral.com/tag/microbiology
https://www.edx.org/learn/microbiology
https://www.mooc-list.com/tags/microbiology
https://www.udemy.com/topic/microbiology/

Programme /Class: B.Sc.-I/ ***Certificate Course In Microbial Technology & Classical Botany***	Year: **I**	Semester: **II** Paper-I
Subject: **Botany** Paper Code: 120401		
Course Code: B040201T	Course Title: **Archegoniates and Plant Architecture**	

Course outcomes:
After the completion of the course the students will be able to:
1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants
4. Understand the details of external and internal structures of flowering plants.

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

Unit	Topic	Lectures (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 *Riccia, Marchantia , Anthoceros, Sphagnum and Funaria.* (Developmental details not tobe included). economic importance of bryophytes	7
II	**Pteridophytes** General characteristics, Early (fossil)land plants (*Rhynia*). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes. Comparative study of morphology, anatomy and reproduction of *Selaginella, Equisetum and Azolla.*	8
III	**Gymnosperms** Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples with special reference to *Cycas, Ginkgo,Pinus, Ephedra*, 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 modifications of roots; stem, leaf and bud. Types of inflorescences;flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	7
VI	**Plant Anatomy:** Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization. Secondary growth - Root and stem- cambium (structure and function) annual rings, Periderm, Anomalous secondary growth - *Bignonia, Boerhaavia, Dracaena, Nyctanthes*	7
VII	**Reproductive Botany** Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte,Types of pollination, Methods of pollination, Germination of pollen grain, Structure of male gametophyte, Fertilization, Structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and Polyembryony.	8
VIII	**Palynology:** Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomicevidences.	7

Suggested Readings:

Course Books published in Hindi/English

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1. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
4. Rashid A (1999) An Introduction to Pteridophyta, Vikas Publishing House Pvt. Ltd. New Delhi.
5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
12. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.
13. Bhojwani, S.S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,.
14. P.K.K. Nair- A textbook of Palynology.
15. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
16. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
17. E.J.Eames. Morphology of Vascular Plants, Standard University Press.
18. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
19. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
20. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. 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.mobot.org/MOBOT/research/APweb/
https://milneorchid.weebly.com/plant-id-for-beginners.html
https://www.botany.org/PlantImages/PlantAnatomy.php
http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print
https://palynology.org/
http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html
https://www.sciencelearn.org.nz/resources/100-plant-reproduction
https://palaeobotany.org/

Programme/Class: *Certificate Course in Microbial Technology & Classical Botany*	Year: I	Semester: II Paper-II (Practical)
Subject: **Botany**		
Course Code: B040202P Paper code: 22080	Course Title: **Land Plants Architecture**	

Course outcomes:

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

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

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

Unit	Topic (Any three from each unit)	No. of Lectures
I	**Bryophytes:** *Marchantia*- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). *Sphagnum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8
II	**Pteridophytes:** *Lycopodium*: Habit, stem T. S. strobilus V. S., *Selaginella*: Habit, rhizophore T. S, stem T . S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. *Equisetum* - Habit, rhizome and stem T.S. and V. S. of strobilus. *Azolla* – Habitat & its structure	7
III	**Gymnosperms** 1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. *Ephedra* & *Thuja*: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed.	8
IV	**Palaeobotany** 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	6
V	**Angiosperm Morphology** 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots, stems, leaves and inflorescences	8

VI	**Plant Anatomy:** Normal & Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes* Study of primary and secondary growth in the root and stem of monocots 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 –*Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea* by microscopic observation. 7. Calculation of pollen viability percentage using in vitro 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 *Pteris*, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine ,Taxol and *Thuja* oil.	7

Suggested Readings:

Course Books published in Hindi/English

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

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

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

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

Kumar, S and Kashyap, A.S.. 2003. Manual of Practical Algae. Campus Books International, New Delhi

Bendre, A.M. and Kumar A text book of Practical Botany. Vol I,II., Rastogi Pub. Meerut.

Suresh Kumar , Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet , New Delhi.

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

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

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

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

https://www.easybiologyclass.com/topic-botany
http://www3.botany.ubc.ca/bryophyte/index.html
http://ecflora.cavehill.uwi.edu/bio_courses/bl14apl/practical_3.1.ht
m http://mydunotes.blogspot.com/p/botany.html
http://www.fao.org/3/a-v92?.e.pdf
https://iinrg.icar.gov.in/library/nrg/nrg.pdf
https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model_project_on_Azolla_cultivation.pdf
http://arnoldia.arboretum.harvard.edu/pdf/articles/1977-37-1-propagation-manual-of-selected-gymnosperms.pdf
https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730/wo_AgricHandbook727_153_175.pdf

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

Diploma in Plant Identification, Utilization & Ethnomedicine

Programme /Class: *Diploma in Plant Identification, Utilization & Ethnomedicine*	Year: II	Semester: III Paper-I
Subject: Botany Paper Code: 32040		
Course Code: B040301T	Course Title: **Flowering Plants Identification & Aesthetic Characteristics**	

Course outcomes:

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

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

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

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

Unit	Topic	No. of Lectures (60hrs)
I	**Taxonomic Resources & Nomenclature** Components of taxonomy (identification, nomenclature, classification) ; Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Artificial Keys. Binomial Nomenclature:Principles and rûles 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), Takhtajaan, Angiosperm Phylogeny Group (APG IV) 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 peculiaritiesand 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 peculiaritiesand 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:** Brief idea on Phenetics, Biometrics (Neighbour joining), Cladistics: Basics and Methodology; Supraspecific taxa (Monophyletic, polyphyletic and paraphyletic groups); Plesiomorphy and Apomorphy).	8-7
VII	**TOOLS & SOFTWARES IN PLANT IDENTIFICATION-** GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities Free Phylogenetic Software: PAUP and MESQUITE Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for Botany.	78
VII	**Computer usage, Android Applications & Character Analysis** MS Office: PPT, Microsoft Excel, data entry, graphs,. GPS tagging, Plant Identification Apps. Concept of Character, Selection of characters, Character coding, Character step matrix, Character x Taxon Matrix	7
VIII	**Aesthetic Characteristics of Plants:** Elementary knowledge of Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai.	8

Suggested Readings:

Course Books published in Hindi/English

1- vko'rchth ouLifr foKku ¼VSDlksukWeh] ,ukVkWeh] ,afcz;ksyWth rFkk bdksukWfed cktVuh½ ys[kd– flag ikaMs o tSu izdk'ku : jLrksxh izdk"ku] esjBA

2- Hkkjr dh lainkj foKku lapkj Hkou M&-d-l- d".ku ekxZ iwlk dSail

3- Propagation And Nursery Management (hindi) (hb) ISBN : 9788177546200Edition : 01Year : 2016Author : Pandey S.K. , Soni N.Publisher : Agrobios (India)

4. Dr. Amar Singh. पादपवर्गिकी- Plant Taxonomy (An Old and Rare Book) from the category Ayurveda in our Books collection. Uttar Pradesh Hindi Sansthan, Lucknow

1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House.
2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of I ndia. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. http://delta-intkey.com
5. https://www.naace.co.uk/school-improvement/ict-mark/
6. https://www.socitm.gov.uk, (2002) Learning in the 21st century Executive briefing A Socitm Insight publication, July 2002 Socitm.
7. K. B. Anjaria, (2015)"Electronic Herbarium and Digital Database Preparation of Common Trees of Anand District, Gujarat" MRP submitted to UGC, WRO, Pune 2015 (unpublished)
8. Lizeron Eremias and R. Subash.(2013) "E-Content Development: A Milestone In The Dynamic Progress Of E-Learning" International Journal of Teacher Educational Research (IJTER) Vol.2 No.1 January, 2013 ISSN: 2319- 4642
9. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd,New Delhi.
10. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
11. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
12. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
13. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd,London.
14. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
15. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons.
16. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscape designer. Upper Saddle River, NJ: Pearson Prentice Hall.
17. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group.
18. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed plantings. New York: John Wiley & Sons.
19. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

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

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

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

Programme/Class: : *Diploma in Plant Identification, Utilization & Ethnomedicine*	Year: II	Semester: III Paper-II (Practical)
Paper Code : 320480	Subject: Botany	
Course Code: B040302P	Course Title: **Plant Identification technology**	

Course outcomes:

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

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

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

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

Unit	Topic* *(Perform Any three experiments from each unit as per facility)	No. of Lecture (60Hrs)
I	**Herbarium: Plant collection, Preservation and Documentation:** 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 NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, Floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	8
IV	**COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGI BRYOPHYTES, PTERIDOPHYTES (Two each)**	7
V	**Botanical Nomenclature & reporting Method:** a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI **b. Author Citation, Effective Publication and Principle of Priority:** To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic Journal	7
VI	**COMPUTER APPLICATION AND CHARACTER CODING** 1. Learning to use EXCEL Microsoft PowerPoint and Word., working with folder and windows utility., create and manage files and folder tree, Selection of Character, Coding and Preparation of Data Matrix in MS Office or MS Excel.	7

		2. Practice browsing different sites using search engines. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails. 3. Create and Participate in virtual conferencing in an interactive Zoom Meeting	
	VII	**Computer Application in taxonomy** 1. Use Taxonomic Softwares (Dichotomous Key) 2 . Practicals on Phylogenetic analysis 3. Make line drawing of Plants for description 4.Using of plant identification apps on android phones	8
	VIII	1. Create a Bonsai of any plant 2. Develop a miniature garden 3. Draw Layouts of various types of gardens 4. Plant Propagation methods practice	8

Suggested Readings:

Course Books published in Hindi/English

1- i;ksxkRed ouLifr foKku Hkkx -2 ys[kd v"kksd cksFkjk rFkk v"kksd dqekj izdk"ku : jLrksxh izdk"ku] esjB
iz;ksxkRed ouLifr foKku Hkkx -3 ys[kd : v"kksd cksFkjk rFkk v"kksd dqekj izdk"ku : jLrksxh izdk"ku] esjB
izk;ksfxd ouLifr foKku ch,llh – I,II,III ,l ch vxzoky izdk"kd : f"koyky vxzoky ,.M dEiuh
izk;ksfxd ouLifr foKku 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 : R K Sinha ISBN : 9789386768520 I.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.- NiraliPrakashan, Pune. India.
6. PramilaMehra 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 PublishingCo., 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; DehraDu
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 McGrow-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 Commemoratory Taxonomy. Blakie, Academic and Professional, London
20. Singh, G (2004) Plant Systematics:Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New

Delhi.
21. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens,Kew (Reprinted 1999).
22. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.
23. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom.,Regnum Vegetabile Vol. 39. Utrecht.
24. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printer and Publishers, New Delhi.
25. Victor, J.E., M. Koekemoer, L. Fish, S.J. Smithies, M. Mossmer. 2004. Herbarium essentials:the South African Herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria.

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

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

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

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts
Lab Requisites: Microscopes (Compound, Stereo) Dissection box, stain, Herbarium, Herbarium press, Dryers, Grinder, Reference Flora

Suggested equivalent online courses:

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

Any Other :

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

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

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

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

Programme /Class: *Diploma in Plant Identification, Utilization & Ethnomedicine*	Year: II	Semester: IV Paper-I
Paper Code : 420401	Subject: Botany	
Course Code: B040401T	Course Title: **Economic Botany, Ethnomedicine and Phytochemistry**	

Course outcomes:

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

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

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

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

Unit	Topic	No. of Lectures (60hrs)
I	**Origin and domestication of cultivated plants** Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages.	7
II	**Botany of oils, Fibers, timber yielding plants & dyes** Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumigatories & Masticatories, Rubber, Dyes, Timber,biofuel crops.	7
III	**Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise)** Commercial greenhouse cultivation of rose, *Gerbera, Gladiolus, Anthurium*/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics.	7
IV	**IPR & Traditional Knowledge** IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.	8
V	**Ethnobotany** Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	8
VI	**Medicinal aspects** Study of common plants used by tribes (*Aegle marmelos, Ficus religiosa, Emblica officinalis, Eclipta alba, Rauvolfia serpentina, Oxalis and Ocimum sanctum)* 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

	Plants in primary health care: common medicinal plants: *Tinospora, Acorus, Ocimum, Turmeric* and *Aloe*. 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 *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Catharanthus roseus* and *Zingiber officinale.*	8
VIII	**Herbal Preparations & Phytochemistry :** Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products , general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids, Alkaloids and pharmacological activities.	7

Suggested Readings:

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

1- vko`rchth ouLifr foKku ¼VSDlksukWeh] ,ukVkWeh] ,afcz;ksyWth rFkk bdksukfed cksVuh½ ys[kd- flag ikaMs o tSu idk'ku : jLrksxh izdk"ku] esjBA

2- Hkkjr dh lainkj foKku lapkj Hkou M°-d-l- d".ku ekxZ iwlk dSail

3- ikfjfLFkfrdh ,oa vkfFkZd ouLifr foKku- 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, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
11. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
12. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
13. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
14. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
15. Jain, S. K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh,Dehradun.
16. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.London.
17. Joshi, S. G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
18. Kokate, C. and Gokeale- Pharmocognacy- Nirali Prakashan, NewDelhi.
19. Lad, V. 1984. Ayurveda – The Science of Self-healing. Motilal Banarasidass, New Delhi.
20. Lewis, W. H. and M. P. F. Elwin Lewis. 1976. Medical Botany. Plants Affecting Man's Health. A

a. Wiley Inter science Publication. John Wiley and Sons, New York.

21. Farooqui, A. A. and Sreeraman, B. S. 2001. Cultvation of medicinal and aromatic crops. Universities Press.
22. Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
23. Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai.1. Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I. Himalaya Publishing house.
24. Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.
25. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.

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

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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 resourses:

https://www.pnas.org/content/104/suppl_1/8641
https://www.journals.uchicago.edu/doi/pdfplus/10.1086/659998
https://bsi.gov.in/page/en/ethnobotany
http://www.legalserviceindia.com/article/l98-Intellectual-Property-and-Traditional-knowledge.html
https://www.brainkart.com/article/Economic-importance-Plants—Food,-Rice,-Oil,-Fibre,-Timber-yielding-plant_1095/
https://www.loc.gov/rr/scitech/tracer-bullets/economic-botanytb.html
http://nsdl.niscair.res.in/bitstream/123456789/127/1/Fibre%20crops%2C%20bamboo%2C%20timber%20-%20Final.pdf
https://www2.palomar.edu/users/warmstrong/econpls.htm
https://www.longdom.org/proceedings/phytochemistry-and-phytoconstituents-of-herbal-drugs-and-formulations-1668.htm

Programme: *Diploma in Plant Identification, Utilization & Ethnomedicine*	Year: II	Semester: IV Paper-II
Paper code: 420480	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 ground nut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea- tea leaves, tests for tannin Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance mentioned in Unit I-& II	8
II	**Commercial Cultivation** Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrient solutions & running models for cultivation of vegetables Development of hydroponics nutrient solutions & running models for cultivation of fodder	8
III	**Cultivating Medicinal and aromatic plants & Essential oil extraction** a. Lemon grass/ Neem/ Zinger /Rose/Mint	7
IV	**Documentation from** Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand –Nakshtra Vatika, Navgrah vatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi	7
V	**Ethnobotany** Study of common plants used by tribes. *Aegle marmelos, Ficus religiosa, Cynodon dactylon.* Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital	7

VI	**Instrumentation and herbal Preparations** Develop Capsules of herbs/ Develop Herbal oils/ Develop Poultice/cream Analyse some active ingredients using chromatography /Spectrophotometry	8
VII	**Pharmacognosy** Organoleptic studies of plants mentioned in the theory : 1. Morphological studies of vegetative and floral parts. 2. Microscopic preparations of root, stem and leaf. 3. Stomatal number and stomatal index. 4. Vein islet number. 5. Palisade ratio. 6. Fibres and vessels (maceration). 7. Starch test 8. Proteins and lipid test	8
VIII	**Phytochemistry:** Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins & resins. Any 5 herbal preparations.	7

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

1. Plant Ecology And Economic Botany by Dhankar - Sharma - Trivedi, RBD Publication
2. QkekZdksXukWlh Shiva Kant, Pankaj Kumar Brahmiya : Thakur Publication
3. PHARMACOGNOSY ...Hindi Edition (Paperback, Hindi, Dr. Akancha Rashi, KHUSHAL JASWANI), RM Publication
4. iz;ksxkRed ouLifr foKku Hkkx 2 ys[kd v"kksd cansz rFkk v"kksd dqekj i.dk"ku jLrksxh izdk"ku esjB
5. Wallis, T. E. 1946. Textbook of Pharmacognosy, J & A Churchill Ltd.
6. Roseline, A. 2011. Pharmacognosy. MJP 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. Pharma, B.A. (Curators), B.A. Arch,. BAMS

Suggested Continuous Evaluation Methods:

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

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

	Course prerequisites: **Qualification:** To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry). **Facilities: Smart and Interactive Class** **Other Requisites:** Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts **Lab requisites:** Repository of economic products, Microscopes/ Botanical /Herbal Garden, TLC, Spectrophotometer.
	Suggested equivalent online courses: https://www.entrepreneurindia.co/Document/Download/pdfanddoc-144615-.pdf http://nopr.niscair.res.in/handle/123456789/45825 https://www.wipo.int/export/sites/www/tk/en/resources/pdf/medical_tk.pdf https://www.bentoli.com/commercial-farming-agriculture/

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

BACHELOR OF SCIENCE (BOTANY)

Programme/Class: *Bachelor of Science*	Year: III	Semester: V Paper-I
Paper Code : 520401	Subject: BOTANY	
Course Code: B040501T	Course Title: **Plant Physiology, Metabolism & Biochemistry**	

Course outcomes:

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

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

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

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

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

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

Suggested Readings:

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

1- lkni "kjhj fØ;k foKku rFkk tSo jlk;u ys[kd : MkW ,p ,l JhokLro izdk"ku : jLrksxh izdk"ku] esjBA

2- ikni "kjhj fØ;k foKku rFkk tSo jlk;u ys[kd : flag] ikaMs rFkk tSo izdk"ku : jLrksxh izdk"ku] esjBA

3- ikni dkf;Zdh ,oa tUu foKku. Madan Kumar. 2020.

4- Plant Physiology and BiochemistryISBN #:81-301-0035-5Sunil D Purohit, K. Ahmed & Gotam K Kukda Edition: 2013Pages: 368 + VIII Text Book (Hindi)

5- ikni dkf;Zdh ,oa tUu jlk;u Dhankar - Sharma – Trivedi RBD Publishing

Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.

1. A Handbook On Mineral Nutrition And Diagnostic Techniques For Nutritional Disorders Of Crops (pb)ISBN : 9788177543377Edition : 01Year : 2011Author : Pathmanabhan G , Vanangamudi M , Chandrasekaran CN , Sathyamoorthi K , Babu CR , Babu RC , Boopathi PNPublisher : Agrobios (India)
2. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
3. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
4. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
5. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
6. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pthways 2008, New Central Book. Agencies.
7. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
8. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
9. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
10. Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
11. Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
12. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
13. Ramesh Gupta. Efficacy, Safety and Toxicity brings together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
14. Harborne,J.B.1973 .Phytochemical Methods. John Wiley & Sons, New York.
15. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
16. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017

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

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

Internal Assessment	Marks
Class Interaction	5
Quiz	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 Ski Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ /Gardening)

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

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

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

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

Programme/Class: *Bachelor of Science*	Year: III	Semester: V Paper-II
Paper Code: 520402	Subject: BOTANY	
Course Code: B040502T	Course Title: **Molecular Biology & Bioinformatics**	

Course outcomes:

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

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

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

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

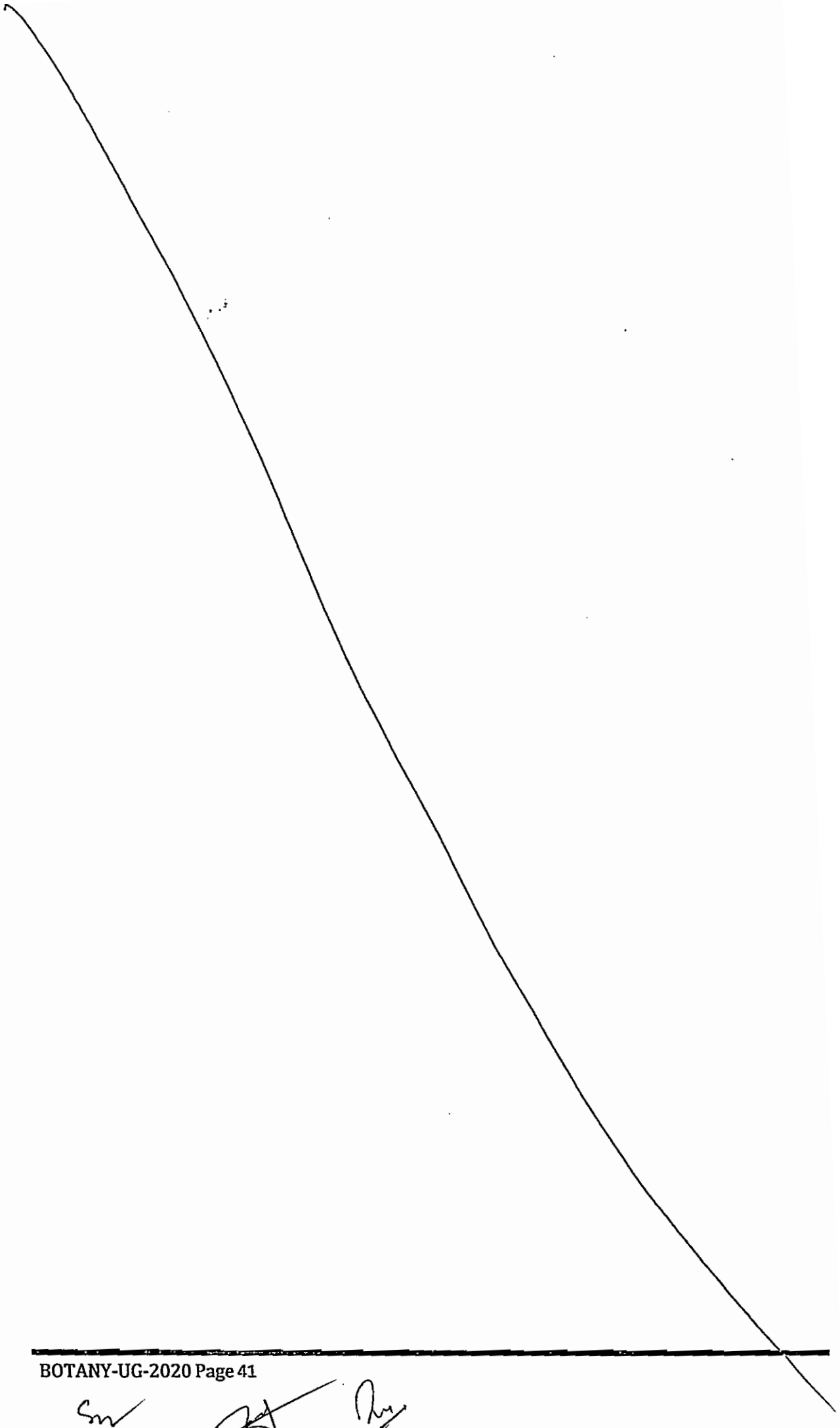
Unit	Topic	No. of Lectures(60hrs)
I	**Genetic material** Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi-conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, Ø (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes.	7

II	**Transcription & Regulation of gene expression** Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes, RNAi, Gene editing	7
I II	**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 (Moondust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns..	7
V	**Bioinformatics & its applications** Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics. 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. vkf.od tho foKku ,oat So rduhdh, Bhopal
2. **Sharma - Trivedi Molecular Biology And Biotechnology**
3. **by RBD Publisher**
4. Plant Physiology and Biochemistry ISBN #: 81-301-0035-5Author: Sunil D Purohit, K. Ahmed & Gotam K KukdaEdition: 2013Pages: 368 + VIIIType: Text Book (Hindi)
2. Molecular Biology Biotechnology ISBN #: 81-301-0033-9Author: Sunil D Purohit & Gotam K Kukda Edition: 2013Pages: 366 + XType: Text Book (Hindi) Apex Publishing House, Udaipur, Rajasthan
5. Bioinformatics Paperback – 1 January 2015 by Dr Archana Pandeya (Author), Santosh Choubey (Editor), & 2 More Hindi AISECT Ltd.
6. BIOTECHNOLOGY AND GENETIC ENGINEERING (Hindi, Hardcover, Dr. Archna Nigam)



1. Primrose, SB. 1995. Principles of Genome Analysis. Blackwell Science Ltd.Oxford, UK..
2. E.J. Gardner and D.P. Snustad. PRINCIPAL OF GENETICS (1984), John Wiley & Sons, Ney 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 : 9788188826193Edition : 01Year : 2018Author : 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 Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

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

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech)
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
https://www.edx.org/learn/molecular-biology
https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering
https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090
https://www.coursera.org/courses?query=genetics
https://www.coursera.org/courses?query=molecular%20biology
https://www.edx.org/learn/genetic-engineering
https://www.mooc-list.com/tags/genetic-engineering
https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907
https://nptel.ac.in/courses/102/103/102103013/

Programme/Class: *Bachelor of Science*	Year: III	Semester: V Paper-III
Paper Code: 520480	Subject: Botany	
Course Code: B040503P	Course Title: ***Experiments in physiology, Biochemistry & molecular biology***	

Course outcomes:

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

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

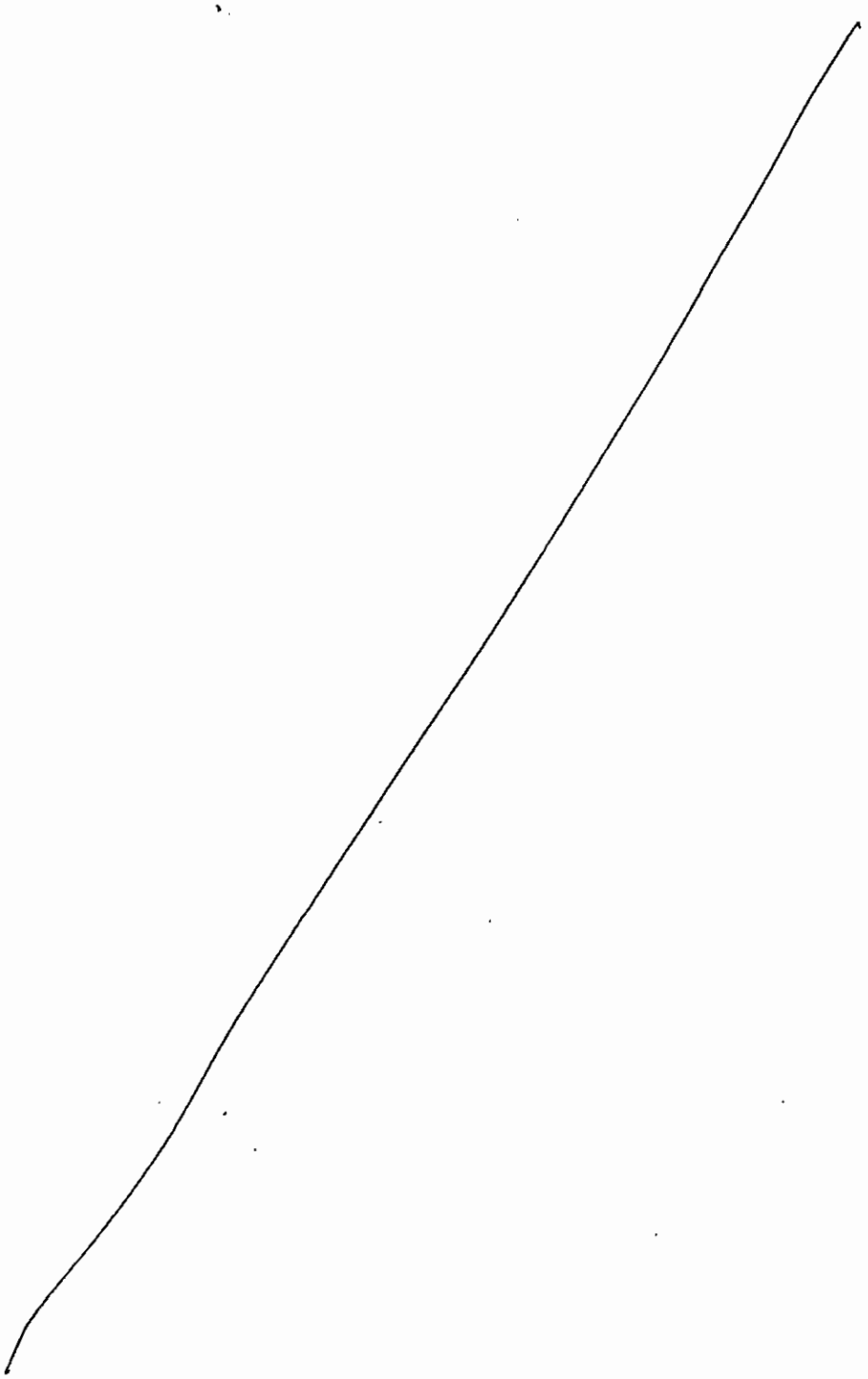
Credits: 2	**Core Compulsory**
Max. Marks: 25+75	Min. Passing Marks:

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

Unit	Topic* *(Perform any three from each unit based on facility)*	No. of Lectures(60 hrs)
I	**Plant water relation, Mineral Nutrition and translocation in phloem** 1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of *Rhoeo / Tradescantia.* 2. Osmosis – by potato osmoscope experiment 3. Effect of temperature on absorption of water by storage tissue and determination of Q10. 4. Experiment to demonstrate the transpiration phenomenon with the bell jar method 5. Experiment for demonstration of Transpiration by Four-Leaf Experiment: 6. Structure of stomata (dicot & monocot) 7. Determination of rate of transpiration using cobalt chloride method. 8. Experiment to measure the rate of transpiration by using Farmer's Potometer 9. Experiment to measure the rate of transpiration by using Ganong's potometer 10. Effect of Temperature on membrane permeability by colorimetric method. 11. Study of mineral deficiency symptoms using plant material/photographs.	8
II	**Nitrogen Metabolism, Photo Synthesis & Respiration** 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of 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 (per g/hr.) 6.Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble	8
III	**Plant Development, Movements, Dormancy & Responses** 1. Geotropism and phototropism — Klinostat 2. Hydrotropism a. Measurement of growth — Arc and Liver Auxenometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains.	8

	5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA bioassay)	
IV	**Techniques for biochemical analysis** 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items. 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	**Genetic material** 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating *E.coli* on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method.	7
VI	**Preparation of models/ charts:** 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments) through photographs 2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves) 3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous; Semiconservative model of replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA 4. Study of structures of : tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing 6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs. 7. Understanding the mechanism of RNAi by photographs	7

VII	**Genetic Engineering** 1. Isolation of protoplasts. 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph). 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.	7



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

Suggested Readings:

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

1. iz;ksxkRed ouLifr foKku Hkkx 3 ys[kd v"ksd cansa rFkk v"ksd dqekj i:dk"ku jLrksxh i:dk"kuj esjB

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 : 9788177544589Edition : 01Year : 2012Author : Akhtar InamPublisher : Agrobios (India)
3. Advanced Methods In Physiology And Biochemistry (pb)ISBN : 9789381191132Edition : 01Year : 2016Author : 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 Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

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

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ /Gardening)
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts
Lab requisites: Electrophoresis units, Gelrocker, UV-transilluminator, Vortex Mixer, Shaker, CVT,

HiMedia Biotechnology &Molecular biology Kits/Chemicals, Micropipettes, Elisa reader/Microtitre Reader
Suggested equivalent online courses: https://www.edx.org/learn/molecular-biology https://krishikosh.egranth.ac.in/handle/1/5810039999 https://www.classcentral.com/course/swayam-genetic-engineering-theory-and-application-14090 https://www.coursera.org/courses?query=genetics https://www.coursera.org/courses?query=molecular%20biology https://www.edx.org/learn/genetic-engineering https://www.mooc-list.com/tags/genetic-engineering https://www.classcentral.com/course/edx-molecular-biology-part-1-dna-replication-and-repair-2907

Programme/Class: Bachelor of Science	Year: III	Semester: V Paper-IV

Subject: BOTANY

Course Code: - B040504R	Course Title: **Project in Botany for Pre-graduation**

Course outcomes:

- Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
- project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes.
- It will promote creativity and the spirit of enquiry in learners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing.
- It will enhance their abilities, enthusiasm, and interest.

Credits: 03	Core: **Compulsory**
Max. Marks: 25+75	Min. Passing Marks: .....

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

Suggestive List Of PROJECTS

1. Rural Areas: Flora of a city/ village, Biodiversity of Village, Soil & seed testing service provision to farmers,
2. Industrial waste management
3. water pollution status of rural water & promotion of WASH in villages
4. Plant Disease identification in farms, nurseries and orchards.
5. Digital portal for plants: Campus, city or particular area
6. Rare and endangered plants & their conservation & domestication
7. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area
8. Science Communication by Creating science documentaries of innovators , Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.)
9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public.
10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties
11. Study of pollen grains in different flowers
12. Study of stomata in different plants
13. Study of various types of secretory and special tissues in plants.

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-QhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

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

http://www.ulib.org/

http://www.tkdl.res.in/

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

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

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

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

Programme/Class: *Bachelor of Science*	Year: III	Semester: VI Paper-I
Paper Code: 620401	Subject: Botany	
Course Code: B040601T	Course Title: **Cytogenetics, Plant Breeding & Nanotechnology**	

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

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

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

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

Unit	Topic	No. of Lectures (60hrs)
I	**Cell biology** Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram.Cell cycle:– 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, inter generic, 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

	Elementary knowledge of Principles, components and techniques of *in vitro* plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	
VI	**Nanotechnology** Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particle synthesis: Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	7
VII	**Artificial Intelligence in Plant Sciences** 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 Database management, IoT platforms, IoT Graphical user interface • IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture	7

Suggested Readings:

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

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2. dksf"kdk tSfodh] vkuqokn"kdh] tSo izkS4ksfxdh Sharma and Trivedi byRBD Publisher
3. **Cell Biology And Genetics (Hindi) 2/e PB ...Gupta P K (Hindi) rastogi Publications**
4. **PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct PublishingISBN: ISBN: 9781698665283 Authors:H. R. Dagla Jai Narain Vyas University**
5. **Biotechnology: Fundamentals And Application (hindi) (hb) ISBN : 9788177544732Edition : 03Year : 2018Author : Dr. Purohit SS , Mathur S**
6. **Biotechnology (Hindi) (Hindi, Paperback, B.D.Singh) Hindi Publisher: Kalyani Pubishers ISBN: 9789327246070, 9327246071**
7. **Cytogenetics, Plant Breeding, Evolution and Biostatistics ISBN #: 978-81-301-0066-1Sunil 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. dksf"kdk rFkk v.kqtSfodh "kēn–laxgCommission for Scientific and Technical Terminology (CSTT)

12.ikni vkuqokn"kdh ifjHkk'kk dks"k Commission for Scientific and TechnicalTerminology (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 e
11. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India.5th edition.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A..
13. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
14. M K Raxdan An Introduction to Plant Tissue Culture –; Oxford & IBH Publishing Co.Pvt. Ltd.,New Delhi
15. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
16. Allard RW (1960) Principles of Plant Breeding. John willey and Sons. Inc. New York
17. BD Singh (2003) Plant Breeding. Kalyani Publishers
18. Cohn, N.S. (1964) Elements of Cytology. Brace and World Inc, New Delhi
19. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
20. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology Scientific American books.
21. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York
22. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
23. Gerald Karp (1985) Cell biology, Mc Graw Hill company..
24. Lewin, B, (1994) Genes, Oxford University Press, New York.
25. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
26. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
27. Roy S.C. and Kalayan kumar De (1997) Cell biology. New central Boos Calcutta
28. Sandhya Mitra,(1998) Elements of molecular biology. Macmillan, India Ltd.
29. Sharma JR (1994) Principles and Practices of Plant Breeding. Tata McGraw-Hill Pub. Co. New Delhi
30. Sharma, A.K and Sharma A (1980) Chromosome technique Theory and practice, Aditya Books, New York
31. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
32. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
33. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
34. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd
35. A. J. Nair . Basics of Biotechnology- Laxmi Publications, New Delhi.
36. S S Purohit and S K Mathur; Biotechnology-Fundamentals and Application- Agrobotanica, India.
37. A. J. Nair Introduction to Genetic Engineering & Biotechnology.Jones & Bartlett Publishers, Boston,USA.
38. H S Chawla Introduction to Plant Biotechnology-; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
39. H D Kumar Modern concept of Biotechnology, Vikas Publishing House, Pvt. Ltd., New Delhi.
40. P C Trivedi ,Plant biotechnology, Recent Advances 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 Hll.
47. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
48. Bass, Joel,E and et. al., Allyn & Bacon, 2009 .Methods for Teaching Science as Inquiry, The truth of science, Newton R.G.,
49. R. Rangaswami (2009) A Text book of Agriculture Statistics .New Age International (P) Limited, Hyderabad.
50. Nageshwar Rao G.(2007)Statistics for Agriculture Sciences BS Publications. New Delhi
51. NigamA.K. andGupta,V.K.(1979)Hand book on Analysis of Agricultural Experiments.. IASRI Publication, New Delhi.

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

This course can be opted as an elective by the students of following subjects:
Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	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.aspx
https://www.mooc-list.com/tags/genetics
https://www.coursera.org/learn/genetics-evolution
https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/

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

Programme/Class: *Bachelor of Science*	Year: III	Semester: VI Paper-II
Paper code: 620402	Subject: Botany	
Course Code: B040602T	Course Title: Ecology & Environment	

Course outcomes:

1. acquaint the students with complex interrelationship between organisms and environment;
2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

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

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

Unit	Topic	No. of Lectures (60 hrs)
I	**Natural resources & Sustainable utilization:** 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 Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation	7
IV	**Biodiversity and its conservation:** Definition -genetic, species, and ecosystem diversity. Value of biodiversity: Indian socio-cultural,ethical and aesthetic values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecade, ecotypes, ecological indicators. Conservation of Biodiversity: *Ex-situ* and *in-situ* 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	**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.	7
VI	**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.	8
VII	**Pollution, Waste management & Circular Economy** Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution 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.	8
VIII	**Environmental ethics, Carbon Credits & Role of GIS** Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.	8

Suggested Readings:

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

1. Environmental Studies (Hindi)ISBN 81-301-0004-5B. L. Chaudhary & Jitendra Pandey Edition: 2013Pages: 340 + XII Apex Publishing House
2. Soil and Water Conservation ISBN #: 978-81-301-0071-5S. C. Mahnot & P. K. Singh Apex Publishing House
4. Ecology And Environmental Biology (ikfjfLFkfrdh ,oa i;kZoj.k tSfodh½ by RBD Publisher Author: Bhatia - Jain - Kohli - Shrivastava - Singh – Verma
5. i;kZoj.kh; ouLikfr ,oa ikni O;kf/kdh ys[kd : MkW ih Mh "kekZ izdk"ku : jLrksxh izdk"ku] esjB
6. Shrimad Bhagvadgeeta, 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 #: 978-81-301-0064-7B. L. Chaudhary, Gotam K Kukda& Jitendra Kumar Joshi
10. UGC Unified: Environmental Sciences (Hindi) (pb) ISBN: 9788177545814 Edition : 01Year : 2015Author : Dr. Purohit SS , Dr. Deo PP , Dr. Agrawal Ashok KPublisher : Agrobios (India)
11. Chapman and Ris--: 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., 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

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

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

Suggested Continuous Evaluation Methods:

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

Internal Assessment	Marks
Class Interaction	5
Quiz	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
uturelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
https://www.coursera.org/courses?query=plants
http://egyankosh.ac.in/handle/123456789/53530

Programme/Class: *Bachelor of Science*	Year: III	Semester: VI Paper-III
Paper Code: 620480	Subject: Botany	
Course Code: B040603P	Course Title: **Lab on Cytogenetics, Conservation & Environment management**	

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

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

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

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

Unit	Topic (Any three from each unit)	No. of Lectures(60hrs)
I	**Cell biology** 1. Study of plant cell structure with the help of epidermal peal mount of Onion/*Rhoeo/Crinum* 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa.*	7

II	**Genetics** 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: I c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5.Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.	8
III	**Biostatistics:** 1.Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2.Calculation of correlation coefficient values and finding out the probability. 3.Determination of goodness of fit in 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** 1. Familiarization of instruments and special equipments used in the plant tissue culture experiments 2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3. Surface sterilization of plant materials for inoculation (implantation in the medium) 4. Micropropagation of potato/tomato/ - Demonstration 5.Protoplast isolation and culturing – Demonstration	8
V	**Ecology & Environment** 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites	8
VI	**Soil Formation, Properties & Conservation** 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map	8
VII	**Biodiversity and Phytogeography:** 1. Study of plant community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density, abundance and IVI of ~~components~~ species (~~to be done during~~ excursion/field ~~visit~~ exercise). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps	7

	3. Phytogeographical areas of India	
VIII	Pollution &Waste management 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter 2. Estimation of chloride and dissolved oxygen content in water sample 3. Comparative anatomical studies of leaves form polluted and less polluted areas. 4. Measurement of dissolved O_2 by azide modification of Winkler's method. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water 7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. **Climate Change, Carbon Credits & Role of GIS** 1. Conducting Waste Audit of your Institution -Demo 2. Green auditing of the College/University -Demo	7

Suggested Readings: as in papers above:

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. iz;ksxkRed ouLifr foKku Hkkx 3 ys[kd v"kksd cansz rFkk v"kksd dqekj izdk"ku jLrksxh izdk"ku esjB
4. A Handbook Of Soil, Fertilizer And Manure (2nd Ed.) (pb) ISBN : 9788177544152Edition : 02Year : 2017Author : Gupta PKPublisher : Agrobios (India)
5. Green Technology: An Approach For Sustainable Environment ISBN : 9788177543438Edition : 01Year : 2021Author : Dr. Purohit SSPublisher : Agrobios (India)
6. Laboratory Manual Of Chemical And Bacterial Analysis Of Water And SewageISBN : 9788177540802Edition : 01Year : 2011Author : Theroux FR , Eldridge EF , Mallmann WLPublisher : Agrobios (India)
7. Methods In Environmental Analysis: Water Soil And Air (2nd Ed.) ISBN : 9788177543087Edition : 02Year : 2021Author : Gupta PKPublisher : Agrobios (India)
8. Water Treatment And Purification Technology ISBN : 9788177540024Edition : 01Year : 2009Author : Ryan WJPublisher : Agrobios (India

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

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

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

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

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts
Lab requisites: Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:
https://www.cytology-iac.org/educational-resources/virtual-slide-library
https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx
https://www.mooc-list.com/tags/genetics
https://www.coursera.org/learn/genetics-evolution
https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/

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

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**	

Course outcomes:
After completing this course a student will have:

- Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
- project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes
- It will promote creativity and the spirit of enquiry in learners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing
- It will enhance their abilities, enthusiasm, and interest.

Credits: **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

	Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing) Bio composting 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

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/

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

(http://epathshala.nic.in/, http://epathshala.gov.in/)

nptel.iitm.ac.in

https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r3_yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE

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

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

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

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

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

Programme/Class: M.Sc./ B.Sc. 4th year	Year: First	Semester: First/ VII Semester
	Subject: Botany	
Course Code: : 0720401	Course Title: Diversity of Algae & Bryophytes	

Objectives: To study structure, reproduction, phylogeny and inter-relationships of Algae, Bryophyta.

Course Outcomes:

1. Students will have clear idea of the characteristics of the lower plant groups (Algae and Bryophytes).
2. Concepts in the evolution of plants and application will be clear to students.

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks:

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers, research developments, opportunities, institutions and journals.	8
II	Classification and salient features of different classes of Algae. Algal pigments, food reserves, flagellation and their importance in classification. Thallus organization, reproduction and life cycle patterns. Economic importance of algae as food, feed, source of chemicals and drugs, Algal biofertilizers, uses in industry and Algal blooms.	12
III	Comparative study of classes of Chlorophyceae, Xanthophyceae and Bacillariophyceae, with reference to: a. Range of structure of plant body including ultrastructure. b. Methods of reproduction. c. Variation in life cycles.	12
IV	Comparative study of Phaeophyceae and Rhodophyceae with reference to: a. Range of structure of plant body. b. Range of mode of reproduction. c. Variation in life cycles.	12
V	Classification of Bryophytes and their distribution in India. Range of thallus structure (plant body) and anatomy in Bryophytes (with suitable examples) A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.	8
VI	Evolutionary tendencies in sporophytes of Bryophytes (Progressive sterilization of sporogenous tissue) Reproduction, life history, Inter-relationship, affinities of various groups of Bryophytes. Ecology and economic importance of Bryophytes.	8

Suggested Readings:

1. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey. 16
2. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.
3. Chapman, V.J. and Chapman D.J. (1975). The algae. 2nd Edition, Mac. Millan Publ. Inc. New York.
4. Chopra, R. N., and Kumar, P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York (NY).
5. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.
6. Hoek, C. van den, Mann, D. G. and Jahns, H. M. (1995). Algae: An introduction to Phycology. Cambridge University Press, UK.
7. Kashyap, S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part1, Chronica Botanica, New Delhi.
8. Kashyap, S. R. (1932). Liverworts of the western Himalayas and the panjab plain (illustrated). Part 2, the Chronica Botanica, New Delhi.
9. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta.VolI,Bryophyta, Central Book Depot.
10. Puri, P. (1981). Bryophytes: Morphology, Growth and Differentiation. Atmaram and Sons, New Delhi.
11. Prescott, G. W. (1969). The algae: A review. Nelson, London.
12. Round, F.E. (1981). The Ecology of Algae. Cambridge University Press, Cambridge.

Programme/Class: M.Sc.	Year: First	Semester: First
B Sc. 4th year	Subject: Botany	VII Sem.
Course Code: : 0720402	Course Title: **Diversity of Pteridophytes, Gymnosperms & Palaeobotany**	

Objectives: To study phylogeny and inter-relationships of Pteridophytes and Gymnosperms

Course Outcomes: 1. Students will have clear idea of the characteristics of the lower plant groups.
2. Concepts in the evolution, morphology, reproduction & application of plants will be clear to students.

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers, research developments, opportunities, institutions and journals.	12
II	Classification of Pteridophytes; specific characters of important classes. a. Psilopsida: Psilophytales and Psilotales. b. Lycopsida: Protolepidodendrales, Lepidodendrales, Lepidospermales and Isoetales. c. Sphenopsida: Hyeniales, Sphenophyllales and Calamitales. d. Pteropsida: Coenopteridales, Ophioglossales, Marattiales, Osmundales, Filicales, Marsileales, Salviniales and Indian Fossils.	12
III	Telome concept. Stelar system and evolutionary tendencies. Heterospory and evolution of seed habit. Apogamy, apospory, parthenogenesis. Soral evolution in Pteridophytes. Alternation of generations. .	8

IV	Classification and distribution of gymnosperms with special reference to India Study of morphology, structure and life history as illustrated by the following: Pteridospermales, Bennettitales, Cycadales, Pentoxylales, Cordaitales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.	12
V	Evolution and Economic importance of Gymnosperms. Geological Eras and distribution of plants in geological time scale. Types of Fossils, Process of fossilization and fossil preservation methods. Techniques of study of fossils. Distribution of fossils in India	16

Suggested Readings:

1. Agashe, S. N. (1995). Paleobotany. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
2. Arnold, A. C. (2005). An Introduction to Paleobotany. Agrobios (India), Jodhpur.
3. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
4. Biswas, C. and Johri, B. M. (1997). Gymnosperms. 4 Narosa Publishers, NewDelhi.
5. Parihar, N.S. (1976). Biology and morphology of the Pteidophytes. Central Book Depot.
6. Rashid, A. (1999). An Introduction to Pteridophyta. Vikas Publishing House Pvt. Ltd., New Delhi.
7. Ramanujan, C.K.G. (1970). Indian Gymnosperms in time and space. Today &Tomorrow 's Printers & Publishers
8. Sporne, K.R. (1965). Morphology of Gymnosperms. Hutchinson University Library.
9. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.

Programme/Class: M.Sc.	Year: First	Semester: First
BSc 4th year	Subject: Botany	VII Sem.
Course Code: 0720403	Course Title: Morphology and Taxonomy of Angiosperms	

Course Objectives: To acquaint the students about the morphology and taxonomy of angiosperms

Course Outcomes: On successful completion of this course, students will be able to:

- Understand the distinctive features of different angiosperms plants.
- Learn about various approaches to classify the angiosperms.
- Learn the practical applications, techniques to preserve the plants.

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

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

Unit	Topics	No. of Lectures
I	Morphology: Morphology of flower, Stamen and Carpel, Floral characteristics, structure of the pistil, pollen stigma interactions, Plant adaptation–physiological and their morphological nature (xerophyte, hydrophyte and halophyte)..	12
II	Contribution of Plant Taxonomist, Phylogeny, and research developments, opportunities, institutions and journals. e-Herbarium, Plant identifications through internet applications.	12

III	Need for scientific names, development of botanical code, contents of botanical code, Ranks and endings provided by the ICN, Typification (Holotype, Isotype, Paratype, Syntype, Lectotype, Neotype), Author citation, Publication of Names, Principle of Priority, PhyloCode. Outline of classification of Angiosperms as proposed by Bentham and Hooker. APG classification system: Basal living angiosperm, Monocots and Eudicots. Phylogenetic relationships of major angiosperm clades.	12
IV	Special features of important families: Monocots (Commelinaceae, Cyperaceae, Poaceae, Orchidaceae), Eudicots (Magnoliaceae, Ranunculaceae, Papaveraceae, Brassicaceae, Malvaceae, Oxalidaceae, Rutaceae, Fabaceae, Rosaceae, Lythraceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Convolvulaceae, Solanaceae, Acanthaceae, Scrophulariaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Cannabaceae, Moraceae).	12
V	Herbarium preparation and use, Virtual Herbarium, Roles of a Botanical Garden, Floras, Journals, Taxonomic Keys, DNA Barcoding. Chemotaxonomy, Embryology and Palynology Sieve-tube plastids in relation to taxonomy. Possible ancestors of Angiosperms.	12

Suggested Readings:

1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition. 29
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi. 5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York

Programme/Class: M.Sc.	Year: First	Semester: First
B.Sc. 4th year	Subject: Botany	VII Sem.
Course Code: : 0720404	Course Title: Biology and Diversity of Microbes	

Course Objectives: The objective of this course is to make students aware about microbial world and its diversity along with their skill enhancement in microbial application for human welfare and development.

Course Outcomes: By the end of the course, the students should be able to:

1. Address the concepts of microbes and their diversity.
2. Evaluate methods for isolation, purification and cultivation of microorganisms from different sources.
3. Understand classification and growth patterns of bacterial cell.
4. Differentiate between virus, viroids, virusoids and prions.

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

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		
Unit	**Topics**	**No. of Lectures**

I	Pioneer microbiologists; golden era of microbiology. Research developments opportunities, institutions and journals. Microbes' identifications through internet applications.	6
II	Introduction and general characteristics of Viruses, Classification of plant viruses. Isolation, purification and characterization of viruses. Replication, transmission of viruses, economic importance, symptomatology of plant viruses. Virus-induced cell transformation, virus-induced cancer. Cyanobacteria, Viroids, Prions. Archaebacteria and Eubacteria: General account, ultrastructure, nutrition and reproduction, economic importance. Plasmids and their characteristics. 16s r-DNA sequencing. Agricultural Microbiology: Agriculturally important microorganisms, biological nitrogen fixation, Mycorrhizae, Plant diseases and their biocontrol. Plant growth promoting rhizobacteria (PGPR). Weed and Pest Biocontrol.	12
III	Environmental Microbiology: Microbes and quality of environment. Microbial degradation of pesticides and hydrocarbons. Biodegradation of the agricultural residues. Bioremediation of contaminated soils and water. Microbes in nanotechnology. Biosensors, Biogas Production.	6
IV	Food and Industrial Microbiology: Fermentation, fermenter design and growth processes. Food spoilage. Microbes in recovery of metal (bioleaching) and oil. Cell and enzyme immobilization. Microbial enzymes of industrial interest. Single Cell Protein. Vaccines.	7
V	10. Host-parasite interaction: a brief idea of recognition and entry process of bacteria, viruses into animal & plant-host cells, alteration of host cell. Virus induced cancer; bacteria and plant two- component signaling systems; bacterial chemotaxis and quorum sensing. Hormones and their receptors, signaling through G–protein coupled receptors, regulation of signaling pathways.	7
VI	11. Innate and adaptive immune system: Types of Immunity, antigens, antigenicity, structure and function of antibody molecules, monoclonal antibodies, Antigen-antibody interactions (serology), activation & differentiation of B and T Cell, B & T cells receptors, MHC molecules compliment system, immune response during bacterial (tuberculosis), parasitic (malaria) and Viral (HIV) infections, vaccine.	10
VII	2. Isolation, purification and cultivation of microbes. 3. Important criteria used for classifications of microorganisms (morphological, ecological, biochemical, molecular and numerical). 4. Classification of bacteria based on Bergey's manual of determinative bacteriology. 5. Archaeobacteria and Eubacteria: Characters, Ultrastructure, nutrition genetic recombination (Transformation, Transduction, Conjugation), and economic importance. 6. Cyanobacteria: salient features and biological importance.	12

Suggested Readings:

1. Salyers, A. A., Whitt, D. D. (2000). Microbiology: Diversityand the Environment. 1st Edition.

2. Pommerville, J. C. (2018). Fundamentals of Microbiology. 11th Edition.

3. Pelczar (Jr.), M. J., Chan, E.C.S. and Krieg, N. R. (2016). Microbiology. 5th Edition.

4. Tortora, F. (2017). Microbiology an introduction. 12th edition.

5. Willey, J., Sandman, K., Wood, D. (2020). Prescott's Microbiology. 11th Edition.

Programme/Class: M.Sc.	Year: First	Semester: Second
B Sc 4th year	Subject: Botany	VIII Sem
Course Code: : 0820401	Course Title: Genetics & Plant Breeding	

Course Objectives: The paper will deal with Mendelian and non-Mendelian inheritance

Course Outcome:

1. This course will provide an understanding of - inheritance of qualitative and quantitative traits.
2. The course will provide an understanding of – fine structure of genes and biochemical genetics
3. The students will be able to learn about – mutations and extra chromosomal inheritance

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Contribution of pioneer workers and recent developments, opportunities, institutions and journals.	8
II	Mendel's Laws of inheritance and modified ratios. Allelic and non-allelic interaction of genes. Multiple alleles: alleles, coat color in rodents, blood groups in Humans, self-incompatibility.	8
III	Linkage and crossing over: chromosome mapping, linkage groups, mechanism of chromosome pairing and synaptonemal complex. Sex determination in man, Drosophila and plants. Maternal effects and Extra- nuclear inheritance.	8
IV	Biochemical genetics, concept of gene. Structural changes in chromosomes: Deficiency, duplication (meiotic pairing & phenotypic effects), Inversions, translocations, (meiotic pairing, Chromosome disjunction), multiple translocations. Numerical changes in chromosomes and Haploidy: a) Euploidy/Polyploidy : Classification, production, role in evolution, utility in crop improvement. b) Aneuploidy : Trisomics, tetrasomics, monosomy, multisomy-Meiotic behaviors, breeding behavior. c) Apomixis: Cytogenetic basis and types of Apomictic reproduction	12
V	Mutation: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens, gene mutations, induction and detection of mutation, mutation by transposons. Concept of gene: gene structure and expression; gene fine structure, cis-trans test, Biochemical genetics, introns.	12
VI	Methods of plant breeding. Genetic basis of inbreeding, hybridization and heterosis, exploitation of hybrid vigor. Plant breeding work done in India with special reference to potato, maize, rice, wheat, sugarcane and cotton.	12

Suggested Readings:

1. Gupta P K (2009). Genetics, 4/e. Rastogi Publications, Meerut.
2. Gupta P K (2007). Genetics:Classical to modern. Rastogi Publications, Meerut.
3. Griffith et *al* (2008). An introduction to Genetic Analysis. Freeman & Co.
4. Hartl DL and Jones EW (1997). Genetics: Principles and Analysis 4th Ed. Jones & Bartlett Publishers, Inc

5. Hartwell L *et al* (2000). Genetics: From genes to genomics. McGraw Hill, New Delhi.
6. Lewin B. (2007). Genes IX. Wiley Eastern Ltd., New Delhi.
7. Pierce, B. (2005). Genetics: A conceptual Approach 2nd Ed. WH Freeman
8. Snustad D P , Simmons NJ and Jenkins JB (2003). Principles of Genetics. John Wiely& Sons, New York.
9. Strickberger, N.W. (1985). Genetics 3rd Ed. Macmillan Co. New York.
10. Allard, R.W. (1960). Principles of Plant Breeding. John Wiley, New York
11. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
12. Frey, K. J. (1966). Plant Breeding. The Iowa State University Press, Ames.
13. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
14. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
15. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science. Amsterdam. The Netherlands.

Programme/Class: M.Sc.	Year: First	Semester: Second

B.Sc. 4th year	Subject: Botany	VIII Semester
Course Code: : 0820402	Course Title: Cell and Molecular Biology	

Objectives:

1. To understand the structures and purposes of basic components of the cell.
2. To understand how these cellular components to generate and utilize energy in cells.
3. To understand the cellular components underlying mitotic and meiotic cell division.
4. To relate the cell cycle to the health, wellbeing and biology of all organisms.
5. The course further deals with plant secondary metabolites and plant-plant interaction.

Course Outcomes:

1. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function.
2. Application of the studies in accordance with responses to environmental or physiological changes.
3. Student will have better understanding of the alternation of cell function brought about by mutation.
4. Impart an insight into the various biochemical and molecular mechanism of plant biology.
5. Take students to higher levels of biochemical and molecular learning about plant system.
6. Understand the biochemical and molecular role of various biomolecules.

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

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

Unit	Topics	No. of Lectures
I	Introduction of Cell and molecular biologist. Research developments, opportunities, institutions and journals.	6
II	The Dynamic cell: Structural organization of plant cell, specialized plant cell. Microscopy: Principle, parts and functioning of electron microscopes including stereoscopic binocular, dark field illumination, confocal, phase contrast, fluorescence and polarizing microscopes, camera Lucida, SEM, TEM. STEM. Cell envelopes: Ultra-structure, chemical foundation and functions of cell wall, Biological membranes with special emphasis on plasma membrane and tonoplast membrane.	12

III	Plant Cell inclusions, their structure and function; Mitochondria and Chloroplast. Nucleus & Nucleolus: Structure, nuclear pores, nucleosome concept. Chromatin Organisation: Chromosome structure and composition, Centromere, Telomere, Euchromatin and Heterochromatin, Karyotypes, Polytene, Lamp brush chromosomes and Sex chromosomes.	6
IV	Ribosomes, Dictyosomes, Lysosomes, ER, Microbodies and Plasmodesmata. Cell cycle & Apoptosis: Biochemical and genetic mechanism– a) Mitosis, spindle formation mechanism, cytokinesis, cell plate formation, Cytoskeleton with emphasis on spindle apparatus, motor movements. b) Meiosis and its significance c) Programmed Cell Death (PCD).	7
V	Nucleic Acids: Nature, Structure, types of DNA (A, B, Z-DNA) and RNA, (t-RNA, micro-RNA) difference between DNA & RNA; DNA replication (Origin and fork) and its biosynthesis, extra chromosomal replications, DNA damage and repair, transposons and mechanisms of transposition. Genetic Code: Discovery, Properties and cracking of genetic code.	12
VI	Protein Synthesis: Basics, mechanism of protein synthesis in prokaryotes and eukaryotes, transcription, RNA processing, reverse transcription, translation and regulation of protein synthesis in prokaryotes (Structural, regulatory genes and operon model). Control of gene expression at transcription and translation level: Regulation of gene expression in phages, viruses, prokaryotes and eukaryotes, role of chromatin in regulating gene expression and gene silencing.	17

Suggested Readings:

1. Alberts, B., et. al. (1983). Molecular Biology of The Cell. W. W. Norton & co., 1464pp, Sixth edition, United states.
2. Cooper, G. (2000). The Cell, A molecular approach. Second edition.
3. Lodish, H., et. al. (2021). Molecular Cell Biology. Ninth edition.
4. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
5. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering. 2nd Edition, CAB International, U.K.
6. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.). W.H. Freeman & Co., New York.
7. Taiz, L. and Zeiger, E. (2010). Plant Physiology. 5th Edition. Sinauer Associates, USA.

Programme/Class: M.Sc.	Year: First	Semester: Second
BSc 4th year	Subject: Botany	VIII Semester
Course Code: : 0820403	Course Title: Ecology and Phytogeography	

Course Objectives: To provide the students the ability to understand the environment and distribution of plants.

Course Outcomes: On successful completion of this course the students will be able to

- Understand the concepts of ecology.
- Know about the environment and learn the way to conserve the environment.

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

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

Unit	Topics	No. of Lectures
I	Introduction of ecologist, recent developments, opportunities, institutions and journals	8
II	Ecological factors (light, air, water, topographic, edaphic, biotic), climate change. Ecological concepts of species: Genecology and Ecological niche. Population Ecology: Basic concepts, characteristics of population and population structure. Community Ecology: Composition, characters, structure, origin and development of community: methods of study of structure of community.	12
III	Ecological succession: Process concept and trends. Climax. (Xerosere, hydrosere) Ecosystem Ecology: Structure and functions, with example of a natural and artificial ecosystem, Energy flow in ecosystem. Production Ecology: Measurement methods and productivity in different ecosystems.	12
IV	Preliminary Knowledge of I.B.P. (International Biological Programme), M.A.B (Man and Biosphere Programme). Pollution: Kinds of pollution (Air, Water, Soil and Noise) and greenhouse gases, Ozone hole, and global warming.	8
V	Recycling of waste: Biogas, utilization and disposal of organic wastes and inorganic wastes, Biodiversity and its conservation. Biogeochemical cycles of C, N, P, S, and Hydrological cycle, Nutrient sources, Nutrient budgets in terrestrial communities and aquatic communities. Soil erosion and conservation, rainwater harvesting, Chipko movement, Van Mahotsav, Afforestation, reforestation.	12
VI	Principles of phytogeography, vegetation types and Phytogeographical regions of India. Age and area hypothesis, continental drift, endemism, Hot spots, Plant exploration. Invasion and introduction. Remote sensing: Concepts, principles, processes, tools, techniques in acquisition of R.S. data. Application in ecological and meteorological research	8

Suggested Readings:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Ambast, R.S. & Ambast N.K. (2022). A Textbook of Plant Ecology. CBS Publisher & Distributors Pvt Ltd. 1t6th Ed.
4. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
5. Pratima Kapur and S. R. Govil (2004). Experimental Plant Ecology. CBS Publishers & Distributors Pvt Ltd, India
6. Govil S. R. & Tripathi, B. D. (2001). Water Pollution: An Experimental Approach. CBS Publishers & Distributors Pvt Ltd, India
7. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
8. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
9. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.

Programme/Class: M.Sc.	Year: First	Semester: Second
BSc 4th year	Subject: Botany	VIII Semester
Course Code: : 0820404	Course Title: Fungi and Plant Pathology	

Objectives:

1. To understand the detailed structure of fungus
2. To study the evolution of fungi.
3. To study the economic importance of fungi

Course Outcomes:

1. Students will understand every aspect of fungi.
2. Students will able to endeavour the arena of mushroom cultivation and be the future entrepreneur.
3. Students will able to use locally available strains of fungi as biocontrol agents.

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Contribution of Mycologist and Plant Pathologist, Research developments, Opportunities, Institutions and journals.	8
II	General characters of fungi, cell structure and nutrition. Range of Thallus organization in fungi. Unique aspects of (i) fungal cells, (ii) molecular biology of fungi Types of reproduction in fungi. Classification of fungi as proposed by Ainsworth (1973) Alexopoulus, Mims& Blackwell (1996). Recognition of Fungi as a separate kingdom; splitting of the fungi (Fungi and allied organisms into three kingdoms- Protista, Chromista and Fungi. Nutrition and growth in Fungi including factors affecting fungal growth. Differentiation in fungi: control of i) Dimorphism. ii) conidiation. iii) mating (with the help of Sex hormones). Heterothallism, Heterokaryosis, parasexuality and physiological specialization in Fungi.	12

III	A general account and affinities of the following groups with special reference to systematic position, structure and reproduction of organisms mentioned hereunder: I. The Fungi belonging to kingdom Protozoa: a. Myxomycota (myxomycetes): Stemonites, Ceratiomyxa, b. Plasmodiophoromycota (Plasmodiophorales) Plasmodiophora. II. The Fungi belonging to Kingdom Chromista: a. Oomycota: Saprolegnia, Phythium, Phytopthora, Albugo, III. The Kingdom Fungi: a. Chytridiomycota: Synchytrium, b. Blastocladiomycota: Allomyces, Coelomomyces c. Zygomycota: Saksanaea, Pilobolus, Entomophthora d. Ascomycota : Taphrina, Phyllactinia, Erysiphae, Neurospora, Peziza e. Basidiomycota: Puccinia, Uromyces, Hemiliea, Melampsora, Tilletia, Ustilago f. Anamorphic fungi (Deuteromycotina): With reference to their telomorph, also wherever possible; Cercospora, Helminthosporium, Curvularia, Alternaria, Fusarium, Colletotrichum, Aspergillus, Penicillium.	12
IV	Fungal interactions: I. Role of antibiotics, hyphal interference,II. Mycoparasitism, III. Commensalism, Mycorrihizae, Lichens (Structure, types, reproduction, importance), Fungi as biocontrol agents. Symptoms of fungal, bacterial and viral plant diseases. Causes of plant diseases. Host-parasite relationship, role of enzymes and toxins in disease development. Effect of infection on physiology of host. Effect of environment on disease development-epiphytotics.	12
V	Disease control by Physical methods, chemical methods, crop rotation, plant quarantines, resistance Integrated pest management mechanism, its advantages, disadvantages and future prospects. Principles of biological control of air- borne and soil-borne plant diseases. Etiology and control of the following crop diseases: Paddy: Paddy blast, Bacterial leaf blight. Wheat : Black Stem rust, Bunt of wheat, Flag smut. Jowar: Grain Smut. Sugarcane: Smut, Red rot. Cotton: Wilt Grape : Downy and powdery mildew Apple : Apple scab Groundnut: Tikka disease. Fibre: Rust of Linum. Coriander: Gall of coriander.	16

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (2007). Introductory Mycology. Fourth Edition, Wiley IndiaPvt. Limited.
2. Mehrotra, R.S. (2017). Plant Pathology. 3rd Edition, McGraw-Hill Education, New Delhi.
3. Okafor, N. and Okeke, B.C. (2018). Modern Industrial Microbiology and Biotechnology. 2nd Edition, CRC Press,Boca Raton
4. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi & Their Allies, Second Edition. MacMillan PublishersPvt. Ltd., Delhi, India
5. Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition, Cambridge University Press, Cambridgeand New York.
7. Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 10th Edition, Mc Graw-Hill.

USA
8. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
9. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia)Singapore. 4th edition.
10. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
11. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
12. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Programme/Class: M.Sc.	Year: First	Semester: Second
B.Sc 4th year	Subject: Botany	VIII - Semester
Course Code: : 0820405	Course Title: Anatomy and Embryology of Angiosperms	

Course Objectives: To study the external and internal structures of root stem and leaf.

Course Outcomes: On successful completion of this course, students will be able to:

- Understand the morphology of plants.
- Understand the basic concepts of anatomy of plants.

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Recent Research developments, Opportunities, Institutions and journals. Shoot development: organization of shoot apical meristem (SAM), Cytological and molecular analysis, Leaf (Marginal meristem). Root development: organization of root apical meristem (RAM), Cell fates and lineage differentiation of vascular tissue, regulation of root growth. Epidermal structures, ontogeny and classification of stomata, trichomes and secretory glands Phloem: Structure and development of sieve elements, P-Proteins Xylem: Structure and development of tracheary elements Vascular cambium: normal and abnormal functioning Nodal Anatomy: evolution of nodal vasculature	12
II	Plant Tissues: Classification; Simple and complex tissues; cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.	8
III	Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Leaf: Structure of dicot and monocot leaf, Kranz anatomy. Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent center; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.	8
IV	Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; dendrochronology. Periderm: Development and composition of periderm, rhytidome and lenticels.	12

VI	Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes. Secretory System: Hydathodes, cavities, lithocysts and laticifers.	8
VII	Stamen and Carpel evolution. Microsporogenesis and Megasporogenesis. Embryo sac and its types. Pollination and Fertilization. Embryo and Endosperm development. Placentation and its types. Types of fruits. Seed germination. Dormancy.	12

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
6. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
7. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
8. Johri, B.M. (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.