MAA Pateshwari University, Balarampur, U.P

To,

Date: 18/08/2025

The Registrar,
MAA Pateshwari University,
Balarampur, U.P

Subject: Discussion on approval of unified syllabus of Botany regarding to New Education Policy (NEP)

Respected Sir,

The virtual meeting of Board of Studies (BOS) was organized on **09/04/2025, 20/06/2025 31/07/2025, 01/08/2025 and 17/08/2025** for preparing the unified syllabus of UG (Four Year) with respect to NEP.

Following members participated in the discussion.

Sr.No.	Name of Expert/BOS Member	Designation	Department	College/ University
1.	Dr. Rekha Sharma	Convener	Department of Botany	S.L.B.S. Degree College, Gonda
2.	Dr. Shiv Mahendra Singh	Member	Department of Botany	M.L.K P. G College, Balrampur
3.	Dr. Deepak Kumar Singh	Member	Department of Botany	A.N.D Kisan P.G College, Babhnan, Gonda
4.	Prof. Anil Kumar Dwivedi	Member	Department of Botany	D. D. U University, Gorakhpur
5.	Prof. N.K Singh *(Ret. Principal)*	Member	Department of Botany	M.L.K P. G College, Balrampur
6	Dr. Ashutosh Kumar Verma	Member	Department of Botany	Siddharth University, Kapilvastu, Siddharth Nagar

After discussion and amendment, the committee reached on a common platform. The unanimously accepted unified syllabus is enclosed as pdf for your kind approval.

With Regards

Rekha

Dr. Rekha Sharma (Convener)
Department of Botany
S.L.B.S. Degree College, Gonda

PROPOSED STRUCTURE OF CBCS (NEP)
U.G BOTANY SYLLABUS
DEPARTMENT OF BOTANY
FACULTY OF SCIENCE
MAA Pateshwari University, Balarampur, U.P

Syllabus Developed/Proposed by				
Sr.No.	**Name of Expert/BOS Member**	**Designation**	**Department**	**College/ University**
1.	Dr. Rekha Sharma	Convener	Department of Botany	S.L.B.S. Degree College, Gonda
2.	Dr. Shiv Mahendra Singh	Member	Department of Botany	M.L.K P. G College, Balrampur
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4.	Prof. Anil Kumar Dwivedi	Member	Department of Botany	D. D. U. University, Gorakhpur
5.	Prof. N.K Singh *(Ret. Principal)*	Member	Department of Botany	M.L.K P. G College, Balrampur
6	Dr. Ashutosh Kumar Verma	Member	Department of Botany	Siddharth University, Kapilvastu, Siddharth Nagar

Dr. Rekha Sharma (Convener)

Dr. Shiv Mahendra Singh

Dr. Deepak Kumar Singh

Prof. Anil Kumar Dwivedi

Prof. N.K Singh (Ret. Principal)

Dr. Ashutosh Kumar Verma

Outline of semester-wise papers with titles in B.Sc. (Botany) Four Year Program					
Year	**Semester**	**Course Code**	**Paper Title**	**Theory/ Practical**	**Credits**
FIRST YEAR	I	B040101T	Microbiology & Plant Pathology	Theory	4+0
		B040102P	Techniques in Microbiology & Plant Pathology	Practical	0+2
	II	B040201T	Archegoniates & Plant Architecture	Theory	4+0
		B040202P	Land Plants Architecture	Practical	0+2
SECOND YEAR	III	B040301T	Flowering Plants Identification & Aesthetic Characteristics	Theory	4+0
		B040302P	Plant Identification Technology	Practical	0+2
	IV	B040401T	Economic Botany, Ethnomedicine & Phytochemistry	Theory	4+0
		B040402P	Commercial Botany & Phytochemical Analysis	Practical	0+2
THIRD YEAR	V	B040501T	Plant Physiology, Metabolism & Biochemistry	Theory	4+0
		B040502T	Molecular Biology & Bioinformatics	Theory	4+0
		B040503P	Experiments in Physiology, Biochemistry & Molecular Biology	Practical	0+2
	VI	B040601T	Cytogenetics, Plant Breeding & Nanotechnology	Theory	4+0
		B040602T	Ecology and Conservation Biology	Theory	4+0
		B040603P	Cytogenetics, Conservation & Environment Management	Practical	0+2
		B040604R	Minor Project	Practical (Research)	0+4
FOURTH YEAR **B.Sc. Honours** **Or** **B.Sc. Honours with research**	**BOTANY HONOURS COURSE**				
	VII	B040701T	Applied Microbiology	Theory	4+0
		B040702T	Trends in Plant Sciences	Theory	4+0
		B040703T	Techniques and Instrumentation	Theory	4+0
		B040704P	Applications & Techniques in Microbial and Plant Sciences	Practical	0+4
		*B040705Ta	Environmental Awareness and Ethics	Theory	4+0
		*B040705Tb	Plant Systematics	Theory	4+0
		*B040705Tc	Conservation Biology	Theory	4+0
	VIII	B040801T	Biofertilizers and Biopesticides	Theory	4+0
		B040802T	Nursery and Gardening	Theory	4+0
		B040803T	Mushroom Cultivation	Theory	4+0
		B040804T	Landscaping Floriculture	Theory	4+0
		B040805P	Practical based on B040801T to B040804T	Practical	0+4
	BOTANY HONOURS COURSE WITH RESEARCH (For Students who secured 75% or above marks in first six semesters)				
	VII	B040701T	Applied Microbiology	Theory	4+0
		B040702T	Trends in Plant Sciences	Theory	4+0
		B040703T	Techniques and Instrumentation	Theory	4+0
		B040704P	Applications & Techniques in Microbial and Plant Sciences	Practical	0+4
		*B040705Ta	Environmental Awareness and Ethics	Theory	4+0
		*B040705Tb	Plant Systematics	Theory	4+0
		*B040705Tc	Conservation Biology	Theory	4+0
	VIII	B040801RM	Research Methodology	Theory	4+0
		B040802R	Major Research Project/Dissertation	Practical (Research)	16

*Elective paper: Choose any one among B040705Ta, B040705Tb and UBOT705Tc

Internal & External Assessment			
Internal Assessment	**Marks**	**External Assessment**	**Marks**
Class interaction	5	Viva Voce on Practical	10
Quiz & Seminar	5	Report on Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models	10
Assignments (Charts/ Flora/ Rural Service/ Technology Dissemination/ micro research work/Botanical Excursion/ Lab Visits/Industrial & laboratory training)	15	Table work / Experiments	45
		Practical Record File	10
TOTAL *Botanical Excursion/ Micro research work/ Lab Visits/Industrial training is compulsory for semester I & III	**25**		**75**

PROPOSED STRUCTURE OF CBCS (NEP)
U.G (Ist Year) BOTANY SYLLABUS
DEPARTMENT OF BOTANY
FACULTY OF SCIENCE
MAA Pateshwari University, Balarampur, U.P

Programme/Class: **Bachelor of Science**	Year: **I**	**Course Code:** B040101T	**Semester: I** **Paper-I**
Course Title: **Microbiology & Plant Pathology**		**Course Credits: 4+0, Marks 25+75**	

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 & Lichen & their economic importance. 2. Develop conceptual skill in identifying microbes, pathogens, biofertilizers & lichen 3. Gain knowledge about developing commercial enterprises 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 lichen 8. Gain Knowledge about the economic values of this lower group of plant community.

Unit	Topic	No. of Lecture (60 Hrs.)
I.	Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists.	7
II.	**Microbial world:** Cell structure of eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria; 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. Mycoplasma & phytoplasma, Actinomycetes.	8
III.	**Virology:** Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 &, λ-phage; Lytic and Lysogenic cycles, viroid, Prions.	8
IV.	**Mycology:** General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification up to class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: *Rhizopus*, Ascomycota: *Saccharomyces*, *Penicillium*, *Peziza*. Basidiomycotina: *Ustilago*, *Puccinia*, *Agaricus*; Deuteromycotina: *Fusarium*, *Alternaria*. Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality.	8
V.	**Lichenology & Mycorrhiza:** General account, reproduction and significance of lichen; 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, False Smut of Rice, Black Rust of Wheat, *Alternaria* spot' and White rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on Tobacco, yellow vein mosaic of bhindi; Citrus Canker, Little leaf of brinjal; Damping off of seedlings, Disease management: Quarantine, Chemical, Biological, Integrated pest disease management	7
VIII.	**Phycology:** Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – *Nostoc*, *Chlorella*, *Volvox*, *Hydrodictyon*, *Oedogonium*, *Chara*; *Sargassum*, *Ectocarpus*, *Polysiphonia*. Economic importance of algae - Role of algae in soil fertility-biofertilizer – Nitrogen fixation- Symbiosis; Commercial products of algae –biofuel, Agar.	8

Suggested readings:

- Willey, Joanne M., Sherwood, Linda M., and Christopher J. Woolverton. Prescott's Microbiology. 10th ed. New York: McGraw-Hill Education, 2017.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- 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.
- 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, New Delhi.
- 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.
- Chopra. G. L. 1984. A text book of Algae, Rastogi publications, Meerut, India.
- Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
- Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
- Fritsch, R. E. 1977. Structure and Reproduction of Algae, Cambridge University Press, London.
- Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
- Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies. Noida, U.P.: Macmillan Publishers India Ltd.
- Reven, F.H., Evert, R. F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H. Freeman and Company.
- Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
- Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press.
- Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt. Ltd, New Delhi.
- Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
- Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
- Rangaswamy, G. 2009, Disease of Crop Plants in India, Prientice Hall of India, New Delhi.
- Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
- Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
- Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
- Smith. G. M. 1996. Cryptogamic Botany Volume I, Tata Mc Graw Hill, New Delhi.
- Sundar Rajan. S. 2010. College Botany Volume I, Himalaya Publications, Mumbai.
- Vashishta, B.R. Sinha, A.K. and Singh, V. P. 1991. Algae, S. Chand and Company, Pvt. Ltd., New Delhi

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

Programme/Class: **Bachelor of Science**	Year: **I**	**Course Code:** B040102P	**Semester: I** **Paper-II**
Course Title: **Techniques in Microbiology & Plant Pathology**		**Course Credits: 0+2, Marks 25+75**	

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

Unit	Topic * (Minimum Any three from each unit depending on facilities)	No. of Lectures (60 Hrs.)
I.	**INSTRUMENTS & TECHNIQUES** 1. Laboratory safety and good laboratory practices 2. Principles and applications 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.	8
II.	**BACTERIAL IDENTIFICATION** 1. Isolation of bacteria. 2. Identification of bacteria. 3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall. 4. Cultural characteristics of bacteria on NA. 5. Pure culture techniques (Types of streaking). 6. Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.	8
III.	**MYCOLOGICAL STUDY** 1. 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.	7
IV.	**PHYCOLOGY:** Type study of algae and Cyanobacteria –*Spirullina, 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. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia, Few viral and bacterial plant diseases.	7
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.	7
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
VIII.	1. Cultivation of *Spirulina*, & *Chlorella* in lab for Protein and 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.Visit to near Sugar Mill Unit	8

Suggested Readings:

- Practical Botany (Part I) ISBN #:81-301-0008-8 Sunil D Purohit, Gotam K Kukda & Anamika Singhvi Edition:2013 Apex Publishing House Durga Nursery Road, Udaipur, Rajasthan (bilingual).
- Modern Mushroom Cultivation and Recipes (hindi) (hb) ISBN: 9788177545180 Edition: 01 Year : 2017 Author: Singh Riti, Singh UC Publisher: Agrobios (India)
- Biofertilizer Production Manual (hindi) (hb) ISBN: 9788177541274 Edition : 01 Year : 2014 Author : Gehlot D Publisher: Agrobios (India) Language: Hindi.
- Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
- Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
- Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
- Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
- Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
- Sambamurty. A.V.S.S. 2006, A Textbook of Algae, I. K. International Publishing House, Pvt. Ltd.,
- Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
- Sen, Surjit,Acharya, Krishnendu, Rai, Manjula 2019 ISBN - 978-93-88347-23-5 - Biofertilizers and Biopesticides. Technoworld, Kolkata
- Hochman,Gal,Zilberman,David 2014 IBSN-1461493285- Algae Farming and Its Bio-Products Springer
- Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
- Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013.
- Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898.
- https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf
- http://nhb.gov.in/pdf/Cultivation.pdf
- https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
- http://www.kvkkendrapara.org/pdf/Bio%20Fertilizer%20Production%20and%20marketing.pdf
- http://www.gbv.de/dms/tib-ub-hannover/751302945.pdf

Programme/Class: **Bachelor of Science**	Year: **I**	**Course Code:** B040201T	**Semester: II** **Paper-I**
Course Title: Archegoniates & Plant Architecture			**Course Credits: 4+0** **Marks 25+75**

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 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.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Introduction to Archegoniates & Bryophytes, Unique features of Archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), Morphology, Anatomy and Reproduction of *Riccia*, *Marchantia*, *Anthoceros* and *Sphagnum* (Developmental details not to be included). Economic Importance of Bryophytes.	8
II.	**Pteridophytes:** General characteristics, Early land plants (*Rhynia*). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.	7
III.	**Gymnosperms**: Classification and distribution of gymnosperms; Salient features of Cycadales (*Cycas*), Ginkgoales (*Ginkgo*), Coniferales (*Pinus*) and Gnetales (*Ephedra*), structure and reproduction; Economic Importance.	7
IV.	**Palaeobotany**: General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Prof. Birbal Sahni.	7
V.	Angiosperm Morphology (Roots, Stem, Leaves, Flowers & Inflorescence), Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences; flowers, flower parts, fruits and types of placentation; Definition and types of seeds.	8
VI.	**Plant Anatomy:** Meristematic and permanent tissues, Organs (root, stem and leaf). Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica Corpus theory. Secondary growth - Root and stem- cambium (structure and function) annular rings, Anomalous secondary growth - *Bignonia, Boerhavia, Dracaena, Nyctanthes.*	8
VII.	**Reproductive Botany**: Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polyembryony.	8
VIII.	**Palynology:** Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic palynology, Role in taxonomic evidences.	7

Suggested Readings:

- Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency).
- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- 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.
- Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company.
- Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand
- Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
- Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
- Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
- Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
- Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.

- Bhojwani, S.S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House
- P.K.K. Nair- A textbook of Palynology.
- Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
- Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
- E.J.Eames . Morphology of Vascular Plants, Standard University Press.
- Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
- Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
- 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.

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: **Bachelor of Science**	Year: **I**	**Course Code:** B040202P	**Semester: II Paper-II**
Course Title: Land Plants Architecture			**Course Credits: 0+2, Marks 25+75**

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 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 can 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 groups of plants 5. Understand the composition, modifications, internal structure &architecture of flowering plants for becoming a Botanist.

Unit	Topic * (Minimum Any three from each unit depending on facilities)	No. of Lectures (60 Hrs.)
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	8
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. 2. *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. 3. *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.	7
IV.	**Palaeobotany & Palynology**: 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	7
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.	7
VI.	**Plant Anatomy:** Normal & Anomalous secondary thickening - *Bignonia, Dracaena, Boerhavia, 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.	7
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
VIII.	**Commercial Uses and Production technology**: 1. *Azolla* production 2. Production technology of Resins 3. Production and propagation of Ornamental Pteris, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, *Taxol* and *Thuja* oil.	8

Suggested Readings:

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

Suggested equivalent online courses:

- https://www.easybiologyclass.com/topic-botany
- http://www3.botany.ubc.ca/bryophyte/index.html
- http://ecflora.cavehill.uwi.edu/bio_courses/bl14apl/practical_3.1.htm
- http://mydunotes.blogspot.com/p/botany.html
- http://www.fao.org/3/a-v9236e.pdf
- https://iinrg.icar.gov.in/library/nrg/nrg.pdf
- https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model_projct_on_*Azolla*_cultivation.pdf
- http://arnoldia.arboretum.harvard.edu/pdf/articles/1977-37-1-propagation-manual-of-selected gymnosperms.pdf
- https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730/wo_AgricHandbook727_153_175.pdf

PROPOSED STRUCTURE OF CBCS (NEP)
U.G (IInd Year) BOTANY SYLLABUS
DEPARTMENT OF BOTANY
FACULTY OF SCIENCE
MAA Pateshwari University, Balarampur, U.P

Programme/Class: **Bachelor of Science**	Year: **II**	**Course Code:** B040301T	**Semester: III** **Paper-I**
Course Title: **Flowering Plants Identification & Aesthetic Characteristics**		**Course Credits: 4+0, Marks 25+75**	

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

Unit	Topic	No. of Lecture (60 Hrs.)
I.	Taxonomic Resources & Nomenclature Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid publication).	8
II.	Types of classification & Evidences Artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantl (up to series) angiosperm phylogeny group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).	8
III.	Identification of Angiospermic families -I: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae.	7
IV.	Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora) A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system) Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae.	7
V.	Modern trends in Plant taxonomy: Brief idea on Phenetics, Cladistics (Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy).	7
VI.	Tools & softwares in plant identification- GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for botany.	7
VII.	Computer usage & Android Applications MS Office: PPT, Microsoft Excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media. GPS tagging, Plant Identification Apps.	8
VIII.	Aesthetic Characteristics of Plants: Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water Garden). Some Famous gardens of India. Conservatory, green houses, Indoor Garden, Roof Garden, Topiary, Bonsai.	8

Suggested Readings

1. Plant Systematics. Arun K. Pandey & Shruti Kansana. 2020. Jaya Publishing House.
2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys.
5. 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)
6. 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
7. 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.
8. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
9. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
10. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
11. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
12. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
13. Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons.
14. Bertauski, T. 2005. Designing the landscape: An introductory guide for the landscape designer. Upper Saddle River, NJ: Pearson Prentice Hall.
15. Thomas, H., and S. Wooster. 2008. The complete planting design course: Plans and styles for every garden. London: Octopus Publishing Group.
16. Scarfone, S. 2007. Professional planting design: An architectural and horticultural approach for creating mixed bed plantings. New York: John Wiley & Sons.
17. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

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: **Bachelor of Science**	Year: **II**	**Course Code:** B040302P	**Semester: III Paper-II**
Course Title: Plant Identification technology		**Course Credits: 0+2, Marks 25+75**	

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.

Unit	Topic * (Minimum Any three from each unit depending on facilities)	No. of Lecture (60 Hrs.)
I.	Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: a. Field equipments, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number	8
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 natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.	8
III.	Identification during excursions a.Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India. b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	7
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.	**Computers:** 1. Learning to use EXCEL Microsoft PowerPoint and Word., working with folder and windows utility., create and manage files and folder tree,2. Practice browsing different sites using search engines. practice and understand different E-Mail services – Outlook, Yahoo mail, Rediff mail etc. Practice Creating E-Mail accounts, Sending, Receiving & Storing of mails. 3. Create and participate in virtual conferencing in an interactive Zoom Meeting	7
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

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. 1. Day, S.C. (2003) Complete Home Gardening. (2003) Agrobios, Jodhpur, India.
3. Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios, Jodhpur, India.
4. Khan, M.R. (1995) Horticulture and Gardening. – Nirali Prakashan, Pune. India.
5. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH PublishingCo., New Delhi.
6. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
7. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
8. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
9. Womersley, J. S. 1981. Plant collecting and herbarium development: A manual.
10. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehradun.
11. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys.
12. Manilal, K. S. and M. S. Muktesh Kumar (ed.) (1998) A Hand book of Taxonomy Training, DST, N. Delhi
13. Naik, V. N. (1984) Taxonomy of Angiosperms Tata McGrow-Hill Publication Com. Ltd., New Delhi
14. Primak, R. B. (2004) A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers
15. Quicke, Donald, L. J. (1993) Principles and Techniques of Commemoratory Taxonomy. Blakie, Academic and Professional, London
16. Singh, G (2004) Plant Systematics: Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
17. Bridson, D. & L. Forman. eds. 1998. The Herbarium Handbook. 3rd ed. Royal Botanic Gardens, Kew (Reprinted 1999).
18. De Vogel, E.F. 1987. Manual of Herbarium Taxonomy: Theory and Practice. UNESCO, Jakarta.
19. Fosberg, F.R. & M.-H. Sachet. 1965. Manual for tropical herbaria. Int. Bur. Pl. Tax. & Nom., Regnum Vegetabile Vol. 39. Utrecht.
20. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printers and Publishers, New Delhi.

Suggested equivalent online courses:

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

Programme/Class: **Bachelor of Science**	Year: **II**	**Course Code:** B040401T	**Semester: IV** **Paper-I**
Course Title: **Economic Botany, Ethnomedicine & Phytochemistry**		**Course Credits: 4+0, Marks 25+75**	

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.

Unit	Topic	No. of Lecture (60 Hrs.)
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.	8
II.	Botany of oils, Fibers, timber yielding plants & dyes Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.	8
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.	**Ethnobotany**: Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	7
V.	**Medicinal aspects:** Study of common plants used by tribes (*Aegle marmelos, Ficus religiosa, Cynodon dactylon, Eclipta alba, Oxalis, Ocimum sanctum* and *Trichopus zeylanicus*). Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics.	7
VI.	Plants in primary health care: common medicinal plants: Tinospora, Acorus, Ocimum, Turmeric and Aloe. Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration	7
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.	8
VIII.	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*, *Vinca rosea* and *Zingiber officinale*.	8

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.
4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. Amit Deogirikar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. Rajlaxmi Prakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
9. Krishnamurthy, K.V. (2004). An Advanced Text book 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).
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, New Delhi.
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.
22. Harborne, J. B. 1998. Phytochemical methods – a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
27. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
34. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
35. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
36. k. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn Edward Arnold, London.

Suggested equivalent online resources:

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

Programme/Class: **Bachelor of Science**	Year: **II**	**Course Code:** B040402P	**Semester: IV** **Paper-II**
Course Title: **Commercial Botany & Phytochemical Analysis**		**Course Credits: 0+2, Marks 25+75**	

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.

Unit	Topic *(Perform any three from each unit based on facility)	No. of Lecture (60 Hrs.)
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	7
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.	8

Suggested Readings

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

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/

PROPOSED STRUCTURE OF U.G (IIIrd Year) BOTANY SYLLABUS

DEPARTMENT OF BOTANY

FACULTY OF SCIENCE

MAA Pateshwari University, Balarampur, U.P

Programme/Class: **Bachelor of Science**	Year: **III**	**Course Code:** B040501T	**Semester: V** **Paper-I**
Course Title: **Plant Physiology, Metabolism & Biochemistry**			**Course Credits: 4+0, Marks 25+75**

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.

Unit	Topics	No. of Lectures (60 Hrs.)
I.	Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.	8
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.	8
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.	7
IV.	Lipid Metabolism & Photosynthesis Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation.; Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C3 & C4 photosynthesis, CAM- Reaction and Significance	7
V.	Plant Development, Movements, Dormancy & Responses Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence	7
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	7
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	8
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.	8

Suggested Readings:

1. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.
2. A Handbook on Mineral Nutrition and Diagnostic Techniques for Nutritional Disorders of Crops (pb) ISBN: 9788177543377 Edition: 01Year: 2011 Author: Pathmanabhan G, Vanangamudi M, Chandrasekaran CN, Sathyamoorthi K, Babu CR, Babu RC, Boopathi PNPublisher : Agrobios (India).
3. Jain, V.K. Fundamental of Plant Physiology (7th ed.) 2004. S. Chand and Company.
4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.
5. Panday, S.N. & Sinha, B.K. Plant Physiology (4th ed.), 2006, Vikas Publishing House Pvt. Ltd.
6. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
7. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pathways 2008, New Central Book. Agencies.
8. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
9. Mathews, C.K., Van Holder, K.E. & Ahren, K.G. Bio-Chemistry (3rd ed.), 2000, Pearson Education.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
11. Srivastava, HN. 2006. Pradeep's Botany Vol. V. Pradeep Publications, Jalandhar.
12. Verma, SK. Plant Physiology and Biochemistry. S. Chand & Sons, New Delhi.
13. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.
14. Ramesh Gupta. Efficacy, Safety and Toxicity brings together all current knowledge regarding nutraceuticals and their potential toxic effects. 2016. Elsevier.
15. Harborne, J.B. 1973. Phytochemical Methods. John Wiley & Sons, New York.
16. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008 Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.
17. P.K. Gupta. BIOTECHNOLOGY AND GENOMICS. Rastogi Publications, 7th Reprint (1st Edition): 2016-2017.
18. Singh, D.K., Pathak, J. (2024). "A text book of plant physiology, metabolism and biochemistry". Discount group of publication, Gorakhpur. ISBN:978-93-9350 978-9.

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**	**Course Code:** B040502T	**Semester: V** **Paper-II**
Course Title: **Molecular Biology & Bioinformatics**			**Course Credits: 4+0, Marks 25+75**

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.

Unit	Topics	No. of Lectures (60 Hrs.)
I.	Genetic material Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material.	7
II.	DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi conservative, semi discontinuous RNA priming, Ǿ (theta) mode of replication, replication of linear, dsDNA, replicating the 5′end of linear chromosome including replication enzymes.	8
III.	Transcription: Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase-function and types.	7
IV.	**Regulation of gene expression:** Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.	8
V.	**Applications of Genetic engineering-I:** Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice).	8
VI.	**Applications of Genetic engineering- II:** Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns.	7
VII.	**History and Scope of Bioinformatics:** Historical background and scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics. Computer fundamentals - programming languages in bioinformatics, biological databases (Protein, nucleic acids and metabolites), Construction of phylogenetic tree.	8
VIII.	Applications and Limitations of bioinformatics	7

Suggested Readings

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 : 9788188826193 Edition : 01Year : 2018Author : Dr. Parihar.

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**	**Course Code:** B040503P	**Semester: V Paper-III**
Course Title: Experiments in physiology, Biochemistry & molecular biology		**Course Credits: 0+2, Marks 25+75**	

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.

Units	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.	7
II	**Nitrogen Metabolism, Photo Synthesis & Respiration** 1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography. 2. Separation of plastidial pigments by solvent and paper chromatography. 3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method. 4. Effect of HCO3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting). 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble.	8
III	**Plant Development, Movements, Dormancy & Responses** 1. Geotropism and phototropism — Klinostàt 2. Hydrotropism a. Measurement of growth — Arc and Liver Auxonometer 3. To study the phenomenon of seed germination (effect of light). 4. To study the induction of amylase activity in germinating grains. 5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA bioassay)	7
IV	**Techniques for biochemical analysis** 1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc. 2. Separation of amino acids by paper chromatography. 3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples., 4. Qualitative Analysis of carbohydrates, 5. Estimation of reducing sugar by anthrone method, 6. Qualitative Analysis of Lipids 7. Qualitative analysis of Amino acids and Proteins 8. Quantitative Analysis of Nucleic Acids, 9. Analysis of dietary supplements, nutraceuticals & antioxidants 10. Testing of adulterants in food items.	8
V	**Genetic material** 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivating *E. coli* on it. 3. Isolation of Genomic DNA 4. Isolation of DNA from plants 5. Examination of the purity of DNA by agarose gel electrophoresis. 6. Quantification of DNA by UV-spectrophotometer 7. Estimation of DNA by diphenylamine method.	8
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.	8
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	7

	between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.6. Agarose gel analysis of plasmid DNA 7. Restriction digestion of plasmid DNA - Demonstration of PCR.	
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

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Suggested Readings:

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

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**	**Course Code:** B040601T	**Semester: VI Paper-I**
Course Title: Cytogenetics, Plant Breeding & Nanotechnology			**Course Credits: 4+0, Marks 25+75**

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. Acquire knowledge on Nanotechnology.

Unit	Topics	No. of Lectures (60 Hrs.)
I	**Cell biology** Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: G0, G1, S and G2 phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical and Structural aberrations).	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.	8
III	**Plant breeding-I:** 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.	7
IV	**Plant breeding-II:** 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**.**	7
V	**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
VI	**Plant tissue culture:** Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	7
VII	**Nanotechnology:** Nano-particles synthesis, biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials.	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.	8

Suggested Readings:

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.

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/

Programme/Class: **Bachelor of Science**	Year: **III**	**Course Code: B040602T**	**Semester: VI Paper-II**
Course Title: Ecology and Conservation Biology			**Course Credits: 4+0, Marks 25+75**

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.

Unit	Topics	No. of Lectures (60 Hrs.)
I.	**Natural resources & Sustainable utilization:** Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.	8
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 com-Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems, Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	8
III.	**Soil Formation, Properties & Conservation** Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation.	7
IV.	**Biodiversity-I:** Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity.	7
V.	**Biodiversity-II:** Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators.	7
VI.	**Conservation of Biodiversity-I:** Ex-situ and in-situ conservation, Red data book, botanical gardens, National Park, Sanctuaries, hot & hottest spots and Bioreserves.	7
VII.	**Conservation of Biodiversity-II:** Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.	8
VIII.	**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.	8

Suggestive readings

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company
6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications

8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
10. Mackenzie et al. Ecology, Latest Ed., Viva Books.
11. Gurevitch, J. (et al.)., The Ecology of plants, 2002, Sinauer Associates.
12. Kimar, U. & Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.
16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.
17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates
19. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

Suggested equivalent online courses:

- https://community.plantae.org/tags/mooc
- https://www.coursera.org/courses?query=plants
- http://egyankosh.ac.in/handle/123456789/53530

Programme/Class: **Bachelor of Science**	Year: **III**	**Course Code: B040603P**	**Semester: VI Paper-III**
Course Title: Lab on Cytogenetics, Conservation & Environment Management			**Course Credits: 0+2, Marks 25+75**

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.

Unit	Topic* *(Perform any three from each unit based on facility)	No. of Lectures (60 Hrs.)
I.	**Cell biology** 1. Study of plant cell structure with the help of epidermal peal mount of Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa.*	8
II.	**Genetics** 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) (a.) Recessive epistasis 9: 3: 1. (b.) Dominant epistasis 12: 3: 1 (c.) Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding Techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.	8
III.	**Biostatistics:** 1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2.Calculation of correlation coefficient values and finding out the probability. 3.Determination of goodness of fit in 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	7
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	7
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-I: a**. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit).	7
VIII.	**Biodiversity and Phytogeography-II:** a. Marking of vegetation types of India, World & Uttar Pradesh on maps **b**. Phytogeographical areas of India	8

Suggested Readings:

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

Suggested equivalent online courses:

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

Programme/Class: **Bachelor of Science**	Year: **III**	**Course Code: B040604R**	**Semester: VI/ Minor Project Paper-IV**
Course Title: Minor Project			**Course Credits: 0+4, Marks 25+75**

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.

Unit

SUGGESTIVE LIST OF PROJECTS

- ☞ Prepare beds for growing nursery for herbs, shrubs and trees.
- ☞ Develop Green house facility in college and grow plants Develop hydroponics facility in college and grow plants.
- ☞ Develop botanical garden in the college with labelling Vertical gardens, roof gardens.
- ☞ Microbial culture and their metabolomic study.
- ☞ Biobased nanoparticles synthesis
- ☞ Computer Aided Designing (CAD) for outdoor and indoor scaping
- ☞ Exposure to CAD (Computer Aided Designing)
- ☞ Phytochemical Analysis of Medicinal plants
- ☞ Bio composting and Vermicomposting.
- ☞ Performing Aromatherapy by essential Oils.

Suggested equivalent online courses:

- https://ndl.iitkgp.ac.in/
- http://heecontent.upsdc.gov.in/Home.aspx
- (http://epathshala.nic.in/, http://epathshala.gov.in/)
- https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J
- 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

PROPOSED STRUCTURE OF U.G (IVth Year) BOTANY SYLLABUS
DEPARTMENT OF BOTANY
FACULTY OF SCIENCE
MAA Pateshwari University, Balarampur, U.P

Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code:** B040701T	**Semester: VII Paper-I**
Course Title: **Applied Microbiology**			**Course Credits: 4+0 Marks 25+75**

Course outcomes: After the completion of the course the students will be able to: 1. Understand the impact and significance of microbes in maintaining a healthy ecosystem 2. Gain knowledge about microbial formulations used as biopesticides or biofertilizers 3. Gain knowledge about uses of microbes for plant growth promotion and as biocontrol agents.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Polyphasic approach of microbial classification (Phenetic, Phylogenetic, and Genotypic), The three domains of life (Archaea – Bacteria –Eukaryotes), Endosymbiosis theory and the role of horizontal gene transfer in shaping of domains, Importance of microbial classification, Microbial symbiosis and their significance.	15
II.	Microbiology of water, Biopolymers, Bioindicators, Biosensors, Bioremediation, Biodegradation of pollutants, Biodeterioration of materials.	15
III.	Introduction to soil microorganisms – bacteria (cyanobacteria and actinobacteria), algae, fungi, protozoans, nematodes and viruses – Role of microbes in soil fertility. Mass production of bacterial biofertilizers, blue green algae, *Azolla* and mycorrhiza. Plant growth promoting rhizobacteria (PGPR) & biopesticides— *Trichoderma* sp. and *Pseudomonas*, Organic farming inputs. Biological control and IPM.	15
IV.	General concepts of industrial microbiology, principles of exploitation of microorganisms of their products, Food fermentations and food produced by microbes: amino acids, antibiotics, enzymes, vitamins, alcoholic beverages, organic acid & genetic recombinant vaccines. Microbial cells as food – single cell proteins. Production of biofuels.	15

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

Suggested Reading:

1. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
2. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
3. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
4. Kodo, C.I. and Agarwal, H.O.1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
5. MadhaveeLatha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi
6. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
7. Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192
8. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898.
9. Trigiano Robert N. 2007. Plant Pathology Concepts and Laboratory Exercises. 2nd Edition, CRC Press. U.K.

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- 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.jnkvv.org/PDF/11042020102651plant_pathology.pdf
- https://www.apsnet.org/edcenter/disimpactmngmnt/topc/EpidemiologyTemporal/Pages/ManagementStrategies.aspx

Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code:** B040702T	**Semester: VII** **Paper-II**
Course Title: **Trends in Plant Sciences**			**Course Credits: 4+0** **Marks 25+75**

Course outcomes: After the completion of the course the students will be able to: 1. Gain insight into new methods, techniques and protocols that advance our ability to study and understand the biology of plants 2. Utilize their knowledge for human welfare 3. Gain knowledge about the chemistry of plants and herbal preparations 4. Learn about the responses of plants to various abiotic stresses 4. Understand the applications of nanotechnology in various spheres.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	**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. **Herbal Technology:** Brief idea about processing, extraction and analysis of herbal drugs. Role of Indian Government in herbal Research & Marketing - CIMAP, AYUSH & TAMPCOL.	15
II.	**Nanotechnology:** Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Nano-particles synthesis, biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials, Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	15
III.	**Stress Physiology**: Plant responses to various types of abiotic stresses: drought, salinity, flooding, extreme temperature (low and high), metal toxicity, ozone and UV-B radiations. Oxidative stress and redox metabolism in plants, Site of generation and biological effect of ROS- oxidative damage, oxidation of lipids, proteins and nucleic acids. Antioxidant defense mechanisms.	15
IV.	**Bioinformatics**: Basics of Bioinformatics, Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, Applications of bioinformatics; biological databases - NCBI, nucleic acid databases (GenBank, EMBL), protein databases (Swiss-Prot, PDB), metabolic pathway database (KEGG); Phylogenetic analysis: Similarity, identity and homology, Alignment – local and global, pairwise and multiple sequence, Methods of Alignment (BLAST and FASTA); Construction of phylogenetic tree.	15

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1. Hopkins and Hunner. 2011. Introduction to plant physiology. Willey Publication. UK.
4. Taiz and Zeigar 2010. Plant Physiology.
2. YubingXie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
3. Sulabha K. Kulkarni. 2014 Nanotechnology: Principles and Practices. CP publishing, New Delhi.
4. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer.
5. Ghosh Z, Mallick B (2012) Bioinformatics: Principles and Applications. Oxford University Press. ISBN-13: 978-0-19-569230-3.
6. Rastogi SC, Mendiratta N, Rastogi P (2011) Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors Pvt. Ltd. ISBN: 81-239-1482-2.
7. Singh, D.K., Ahmed H., Pathak, J. (2023). "Economic Botany, Ethnomedicine and Phytochemistry". Pragati Prakashan, Meerut. ISBN:978-93-5531-762-9.

Suggested Reading:

1. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication
2. David S. Goodshell. 2004. Bionanotechnology-Lessons from nature. John Wiley Publications
3. Abiotic Stress Adaptation in Plants: Physiological, Molecular and Genomic Foundation (2010), Ashwani Pareek, S.K. Sopory, Hans J. Bohnert and Govindjee; Springer Publication.
4. Buchanan, Greessam and Jones .2002. Biochemistry and Molecular Biology of plants. American society of plant biology. USA.

Internet:

- https://www.springer.com/gp/book/9789811391767
- https://www.springer.com/gp/book/9789811550720

Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code:** B040703T	**Semester: VII Paper-III**
Course Title: **Techniques and instrumentation**			**Course Credits: 4+0 Marks 25+75**

Course outcomes: After the completion of the course the students will be able to: 1. Investigate natural metabolic products of plants using various techniques 2. Understand growth and development in plant cells through various techniques 3. Use knowledge in diverse applications such as detection of adulterants in food items, purification of proteins and enzymes 4. Use these techniques in metabolomic studies.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Sand culture/water culture and controlled soil culture techniques, Tracer techniques: Detection and measurement of isotopes and applications, Microscopy: Bright field, phase contrast, fluorescence, confocal, transmission electron microscopy, scanning electron microscopy Microtomy	15
II.	Centrifugation and ultracentrifugation techniques and their applications. Chromatography-Paper, TLC, Column, Gel Filtration, Affinity, Ion Exchange, HPLC, GC Flow cytometry: Principles and Applications	15
III.	Photometry: Colorimetry and Spectrophotometry (UV-visible). Fluorescence spectrometry, Chemiluminescence Spectrometry, Atomic Absorption/emission spectrometry, Basic features and principles of IR, Raman, Mass, NMR, ESR	15
IV.	Molecular DNA markers (RAPD, RFLP, SNPs); DNA sequencing, PCR and Reverse Transcriptase-PCR, Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Electrophoretic techniques and their applications. Applications and detection of proteins and nucleic acids (Western Transfers and Immuno blots and Southern blot), DNA chip technology and Microarray.	15

REFERENCES

Books:

1. Simon Roe, ed. (2001), Protein purification techniques: A practical approach, 2nd edition, Oxford University Press
2. K. Wilson, J. Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh Edition, Cambridge University Press, NewYork, USA.

Suggested Readings:

1. E.J. Hewitt (1966). Sand and water culture methods used in the study of plant nutrition. Commonwealth Agricultural Bureaux, Farnham Royl. Bucks, England.
2. G. Hegyi, J. Kardos, M. Kovács, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L.Radnai, A.Reményi, I. Venekei (2013). Introduction to Practical Biochemistry, ELTE Faculty of Natural Sciences, Institute of Biology.
3. K. Wilson, J. Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology, Seventh Edition, Cambridge University Press, NewYork, USA.
4. Phillip Sheeler and Donald E Bianchi (2006). Cell and Molecular Biology, John Wiley and Sons, Inc. U.K.
5. R. Boyer (2000). Modern Experimental Biochemistry, Pearson Education, Asia.
6. S.E. Ruzin (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York.
7. S.K. Sawhney, Randhir Singh (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.

Internet:

- http://ecoursesonline.iasri.res.in/course/view.php?id=282
- https://www.docsity.com/en/subjects/biochemistry-and-instrumentation/
- https://www.longdom.org/scholarly/biochemistry-techniques-journals-articles-ppts-list-3172.html

Programme/Class: **Bachelor of Science**	Year: IV	**Course Code:** B040704P	**Semester: VII Paper-IV**
Course title: Applications & Techniques in Microbial and Plant Sciences			**Course Credits: 0+4 Marks 25+75**

Course outcomes: After the completion of the course the students will be able to: 1. Isolate and study plant pathogens in order to correctly identify them 2. Learn to devise methods of controlling plant pathogens based on the nature of propagules and mode of transmission 3. Practice biological control of pests instead of depending on harmful chemical pesticides 4. Learn to mitigate the use of chemical fertilizers, and increase the use of biofertilizer 5. Understand techniques that are useful in the study of plant pathogens and biomolecules 6. Learn about the host responses to stress, and its quantification.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	**Isolation and characterization of Microbes:** Study of fermentative diversity of bacteria, Isolation and characterization of soil bacteria, Morphology and staining of nitrogen fixing bacteria, Enumeration of rhizosphere to non-rhizosphere population of bacteria, Isolation of antagonistic bacterial sp. from the rhizosphere, Isolation of Phosphate solubilizing microorganisms, microscopic observations of root colonization by VAM fungi, Isolation of phyllosphere microflora.	15
II.	**Practicals in Applied Microbiology:** Study of diseased plant specimens and materials, Preparation of media for isolation of the pathogen: bacteria (NA) and fungi (PDA), Isolation of pathogens from infected material, Study of the hypersensitive response during virus infection, Insect transmission of plant virus, Purification of plant virus, Serological detection of plant viruses.	15
III.	**Stress physiology:** Quantitative estimation of proline in water stressed leaf tissues, Quantitative estimation of hydrogen peroxide content in leaf tissues, Qualitative visualization of superoxide anions in stressed leaf tissues, Quantitative estimation of ascorbic acid in plant tissue.	15
IV.	**Techniques and Instrumentation:** Chromatographic procedures (gel filtration) for separation of low molecular and high molecular weight leaf extract components, Thin layer chromatography for detection of amino acids, Isolation of proteins from leaf sap through precipitation and centrifugation, Separation of proteins by electrophoresis.	15

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1. Matthew's Plant Virology, R. Hull, 4th edition, 2003, Elsevier.
2. Prescott's Microbiology, J. Willey, L. Sherwood, 10th edition, 2017, McGraw-Hill Education.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology,
4. Edited by A. Hofmann, S. Clokie, 8th edition, 2018, Cambridge University Press.
5. Plant Pathology, G.N. Agrios, 5th edition, 2005, Elsevier.
6. Alcamo's Fundamentals of Microbiology, J.C. Pommerville, 2nd edition, 2013, Jones and
7. Bartlett Learning.
8. Microbiology: An Introduction, G.J. Tortora, B.R. Funke, C.L. Case, 11th edition, 2016,
9. Pearson India Education Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition.
Cambridge, U.K.: Cambridge University Press.
10. Text Book of Mycology by A.K. Sarbhoy; ICAR Publications, New Delhi, 2006.

Suggested Reading:

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
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8. Amos Richmond Ph.D., Prof. Emeritus, Qiang Hu Ph.D 2013. Handbook of Microalgal Culture: Applied Phycology and Biotechnology, Second Edition Print ISBN:9780470673898.
9. Trigiano Robert N. 2007. Plant Pathology Concepts and Laboratory Exercises. 2nd Edition, CRC Press. U.K.

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- 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
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- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=11293
- http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%201%20%20Introduction
- http://www.jnkvv.org/PDF/11042020102651plant_pathology.pdf

Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code:** *B040705Ta	**Semester: VII Elective Paper**
Course title: Environmental awareness and ethics			**Course Credits: 4+0 Marks 25+75**

Course outcomes: After the completion of the course the students will be able to: 1. Understand the relationship of humans and environment and their moral obligation to protect the environment 2. Promote sustainable development of the planet 3. Generate environment consciousness in themselves and the community.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	**Pollution and Waste management:** Environmental pollution, Environmental protection laws, Regulatory framework for pollution monitoring and control; 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.	15
II.	**Types of waste & Circular Economy:** 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.	15
III.	**Environmental audit & Sustainability:** Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Sustainability indices; 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; Urbanization; Concept and characteristics of smart city; Urban resources and environmental problems; Carrying capacity analysis; Concept of ecological footprints.	15
IV.	**Environmental ethics, Carbon Credits and Role of GIS:** Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources& agriculture studies.	15

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Books:

Green Technology: An Approach for Sustainable Environment ISBN: 9788177543438 Edition: 01Year: 2021Author: Dr. Purohit SS Publisher: Agrobios (India).

Suggested Reading:

Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries Policy and Science Considerations. Martinus Nijh off Publishers.

Internet:

- http://vidyamitra.inflibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany
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Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code:** *B040705Tb	**Semester: VII Elective Paper**
Course title: Plant systematics			**Course Credits: 4+0 Marks 25+75**

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

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Principles of systematics, Relevance and role of Systematics; Approaches to classification, Phenetic, Phylogenetic and cladistics; Relative merits and demerits of major systems of classification viz. Bentham and Hooker, Engler and Prantl, Hutchinson, Cronquist, Dahlgen and Thorne; APG system, Origin and Evolution of Angiosperms.	15
II.	Herbarium & Botanical Gardens. ICN (History, Principles and Applications), Protologue and Botanic literature (Monographs, Icones, Floras and Taxonomic literature); Species Concept: Various models; Speciation and Variation Phytogeography with special reference to discontinuous areas, endemism, hotspots and hottest hotspots GIS.	15
III.	Modern tools and evidence of taxonomy viz: Morphology and Anatomy: Epidermis and other structures associated with it, Node, Leaf, Flower Embryology, Palynology, Reproductive Biology, Ovular morphology and Seed Coat; Cytotaxonomy, Phytochemistry, Sieve Elements Plastids.	15
IV.	Sexual dioecism; Interesting taxonomic features and interrelationships of following Dicot families: Acanthaceae, Amaranathaceae, Asclepiadaceae, Asteraceae, Caesalpiniaceae, Capparaceae, Caryophyllaceae, Cucurbitaceae, Ericaceae, Euphorbiaceae, Malvaceae, Mimosaceae, Nelumbonaceae, Nymphaeaceae, Papaveraceae, Paplionaceae, Polygonaceae, Ranunculaceae, Rosaceae, Rubiaceae, Scrophulariaceae, Tiliaceae and, Trochodendraceae. Special features of Insectivorous/Parasitic and Saprophytic families, Interesting taxonomic features and inter-relationships of following Monocot families and treatment of monocots in evolutionary systems of classification: Alismataceae, Commelinaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae, and Zingiberaceae.	15

REFERENCES

Books:

1. Davis, P. H. and V. H. Heywood. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
2. Eames, A.J. 1961. Morphology of Angiosperms. McGraw Hill, NY.
3. Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGrow-Hill Publication Com
4. Pandey, B.P. 2007. Taxonomy of Angiosperms. S. Chand and Company Limited. New Delhi
5. Harborne, Turner and Boulter- Chemotaxonomy of Leguminosae, Academic Press, London, 1971.
6. John Firminger Duthie- Flora of Upper Gangetic Plants, Shiva offset Press, vol.I, 1903, vol.II, 1911.
7. John Hutchinson- The families of flowering plants, Clorendon Press, 1959.
8. Arthur John Cronquist- The evolution and classification of flowering plants, Shiva offset Press, 1981.
9. Alfred Barton Randle- The classification of flowering plants, Harvard University, 1904.
10. Gurcharan Singh- Plant systematic, Oxford & IBH Publishing Company Pvt. Ltd., 1999.
11. Tod F. Stuessy-Plant taxonomy, Shiva offset Press, 2002.
12. Peter H.A. Sneath and Robert R. Sokal- Numerical taxonomy, Wayne State University Press, 1973.
13. T. Pullaiah- Taxonomy of angiosperms, Regency Publications, New Delhi, 1998.

Suggested Readings:

1. Sharma, O.P. 2009. Plant Taxonomy. Tata McGraw-Hill. Mumbai.
2. Singh Gurcharan. 2004. Plant Systematics: Theory and practice Oxford and YBH, Publishing Co. Pvt. Ltd., New Delhi
3. Singh G. 2004. Plant Systematics. Science Publishers. New Delhi.
4. Woodland, D.W. 1991. Contemporary Plant Systematics. Prentice Hall. New Jersey

Internet:

- 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://libguides.rutgers.edu/c.php?g=336690&p=2267037
- https://www.delta-intkey.com/

Programme/Class: **Bachelor of Science**	Year: **IV**	**Course Code: *B040705Tc**	**Semester: VII Elective Paper**
Course title: Conservation of Biodiversity			**Course Credits: 4+0 Marks 25+75**

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

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Plant diversity concepts, importance of Species diversity in Ecosystems, Ecosystem functions and services, Levels of Biodiversity - Ecosystem diversity, Species diversity and its measure, Species - richness, evenness, abundance and genetic diversity, Abiotic and biotic factors affecting biodiversity, causes of biodiversity loss (viz. ecosystem, degradation, land-use change, fragmentation, invasive species, climate change, pollution, overexploitation and co-extinctions).	15
II.	Need for biodiversity conservation, Types of conservation (preventive, remedial and restoration), Current status of biodiversity conservation and Red list index, Conservation status by IUCN red list categorized criteria (DD, LC, NT, VU, EN, CR, EW and EX), Community based conservation strategies, Indigenous and traditional knowledge in biodiversity.	15
III.	In situ conservation - Protected areas and its types, Biosphere reserves, National parks, Wildlife sanctuaries and Sacred groves, Ex situ conservation- Botanical gardens, Seed banks, In-vitro storage of germplasm and cryopreservation, Concept of diversity hot spots, Biodiversity hotspots in India.	15
IV.	International and National conservation policies, Role of government agencies and NGOs in plant conservation, General account of important authorities and institutions - UNEP, DST, MoEF, BSI, NBPGR, CPCB, NMPB, AYUSH.	15

Suggested Readings:

1. Plant Conservation and Biodiversity Editors: Hawksworth, David L., Bull, Alan T. (Springer)
2. Biological Diversity and Its Conservation, Sharma Dushyant Kumar, Daya Publishing House
3. A Handbook of Plant Resource Utilization and Conservation, Bijan Bihari Dutta.
4. Biodiversity: Concepts and Conservation, B.B. Hosetti, S. Ramkrishna, Aavishkar Publishers, Distributors, Jaipur

Programme/Class: **Bachelor of Science (Honours)**	Year: **IV**	**Course Code:** B040801T	**Semester: VIII**
Course title: Biofertilizer and Biopesticides			**Course Credits: 4+0 Marks 25+75**

Course Outcome:
After the completion of the course the students will be able to:
• Know about biofertilizers and their application in crop fields.
• Know about practical application of PGPR (plant growth promoting rhizobacteria).

Unit	Topic	No. of Lectures (60 Hrs.)
I.	General account of microbes used as biofertilizers-PGPR, nitrogen fixing bacteria, algae and mycorrhizae.	15
II.	Isolation of PGPR and mass multiplication, *Azospirillum, Azotobacter*-classification and characteristics, crop response to Azotobacter inoculums etc. Cyanobacteria, *Azolla* and *Anabaena azollae* association, biological nitrogen fixation, *Azolla* in rice cultivation.	15
III.	Mycorrhizal association, types of mycorrhizal association, phosphorus nutrition, Bio compost making methods from agricultural and industrial wastes, types and methods of vermicomposting.	15
IV.	Biopesticides: basic concepts, bacterial and fungal biopesticides, botanical pesticides and their application.	15

Programme/Class: **Bachelor of Science (Honours)**	Year: **IV**	**Course Code: B040802T**	**Semester: VIII**
Course title: Nursery and Gardening			**Course Credits: 4+0 Marks 25+75**

Course Outcome:
After the completion of the course the students will be able to:
• Understand scope of Nursery and gardening
• Know about vegetative propagation

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Scope and objectives of nursery, infrastructure for nursery. Planning and seasonal activities. Planting-direct seeding and transplants.	15
II.	Structure and types of seeds, seed dormancy-causes and methods of breaking dormancy, seed storage.	15
III.	Vegetative propagation-cutting, selection of cutting, treatment of cutting. Rooting medium and planting of cuttings. Hardening of plants-green house, mist chamber, shade house and glass house.	15
IV.	Gardening-objectives and scope, different types of gardening landscape and home gardening, parks and its components-plant materials and design. Gardening operations-soil laying, manuring, watering, management of pests and diseases and harvesting.	15

Programme/Class: **Bachelor of Science (Honours)**	Year: **IV**	**Course Code: B040803T**	**Semester: VIII**
Course title: Mushroom Cultivation			**Course Credits: 4+0 Marks 25+75**

Course Outcome:
After the completion of the course the students will be able to:
• Basics of mushroom cultivation.
• Cultivation of Button, Oyster and Straw Mushrooms.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Cultivation system, farm design, Compost and composting fundamentals of cultivation system, principles of mushroom farm layout-location of building plot, design of farm, bulk chamber, composting platform, equipments and facilities.	15
II.	Machinery required for compost making, materials for compost preparation. Methods of composting-long method of composting and short method of composting.	15
III.	Spawn and Spawning-Facilities required for spawn preparation, preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, storage of spawn.	15
IV.	Cultivation of Button, Oyster and Straw Mushrooms-collection of raw materials, compost and composting, spawn and spawning, cropping and crop management, picking and packing. Nutrient Profile of Mushroom-protein, amino acids, calorific values, carbohydrates, fats, vitamins and minerals.	15

Programme/Class: **Bachelor of Science (Honours)**	Year: **IV**	**Course Code: B040804T**	**Semester: VIII**
Course title: Landscaping Floriculture			**Course Credits: 4+0 Marks 25+75**

Course Outcome:
After the completion of the course the students will be able to:
• Understand basic concept of floriculture.
• Initiate commercial floriculture- a start-up.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	Ornamental plants-flowering annuals, herbaceous perennials, divine vines, shade and ornamental trees, ornamental bulbous and foliage plants, cacti and succulents, palms and cycads, ferns and selaginellas. Cultivation of plants in pots, indoor gardening and bonsai.	15
II.	Principles of garden design-English, Italian, French, Persian, Mughal and Japanese gardens, features of garden (garden wall, fencing, steps, hedge, edging, lawn, flower, beds, shrubbery, borders, water garden), some famous gardens of India.	15
III.	Landscaping places of public importance-landscaping highways and educational institutions.	15
IV.	Commercial floriculture- factors affecting flower production, production and packaging of cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium and Orchids). Diseases and pests of ornamental plants.	15

Programme/Class: **Bachelor of Science (Honours)**	Year: **IV**	**Course Code: B040805P**	**Semester: VIII**
Course title: Practical based on UBOT801T to UBOT804T			**Course Credits: 4+0 Marks 25+75**

Topic

- Collection of biofertilizers, field application of biofertilizers.
- Isolation and inoculums production of VAM.
- Cultivation of different vegetables.
- Field visit of green houses, parks and glass houses.
- Visit to relevant Labs and field visit (involved in mushroom cultivation).
- Visit to Nurseries and cultivation of different plants in pots.

Programme/Class: **Bachelor of Science (Honours with research)**	**Year:** IV	**Course Code:** B040801RM	**Semester: VIII Paper-I**
Course title: Research methodology			**Course Credits: 4+0 Marks 25+75**

Course outcomes: The undergraduate students will develop a research orientation and become acquainted with the fundamentals of research methods. 1. Understand the basic concepts and techniques used in research viz. sampling techniques, research designs and techniques of analysis. 2. Develop understanding of the basic framework of research process. 3. Learn how to review literature and collect data 4. Develop an understanding of the ethical dimensions of conducting applied research. 5. Appreciate the components of scholarly writing and evaluate its quality.

Unit	Topic	No. of Lectures (60 Hrs.)
I.	**Basic Concepts of Research:** Meaning of research in biological sciences; Research methods vs Research methodology; Motivation and objectives of research problem Selecting and formulating a research problem. Types of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.	15
II.	**Research Design and Survey of Literature:** Concept and need, Identification of Research problem, defining and delimiting Research problem. Basic principles of research design-objectives, introduction, rationale of work, material and methods, designing experiments. Necessity and importance of review of literature in defining a research problem; Primary and secondary sources of literature- reviews, treatise, monographs, web as a source for searching literature. Identifying the gap areas from literature review.	15
III.	**Data Collection, Analysis and Scientific Writing:** Observation and collection of data. Data processing, analysis, interpretation and their applications. Format of writing research paper, popular scientific articles for general awareness, review and reports- layout, structure, language, illustrations and tables; Procedure of reference citation. Principles of biostatistics. Computer application: Operating systems, software, molecular modelling using computer.	15
IV.	**Application of Results and Ethics:** Environmental impacts; Ethical issues; Ethical committees; Commercialization; Copy right; Royalty: Intellectual property rights and patent law; Trade related aspects of intellectual property rights; Reproduction of published material; Impact factor and citation index; Plagiarisms; Reference citation and acknowledgement; Reproducibility and accountability.	15

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Books:

Chawla, Deepak & Sondhi, Neena (2011). Research methodology: Concepts and cases, Vikas Publishing House Pvt. Ltd. Delhi.

Pawar, B.S. (2009). Theory building for hypothesis specification in organizational studies, Response Books, New Delhi.

Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher

Suggested Reading:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual.

2. Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches,Pearson Education

3. Best and Kahn, Research Methodology, PHI Limited.

4. Rand R.Wilcox Fundamentals of modern statistical methods

5. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.

Programme/Class: **Bachelor of Science (Honours with research)**	Year: **IV**	**Course Code: B040802R**	**Semester: VIII/ Paper-II**
Course Title: **Major research project/dissertation**			**Course Credits: 16, Marks 25+75**

Course outcomes: The full semester External Project/Dissertation is designed to ensure that the student is able to apply the knowledge gained in the previous semesters in specific areas of interest in a problem-solving environment, gaining bench-experience, to serve as a springboard for a professional future.

External Project/Dissertation

External Project/Dissertation for Semester VIII will be carried out by the students in various recognized/established labs of Parent/Other Universities, of Institutes under CSIR, ICMR, IIT, ICAR, DST, DBT, Industry, Government Departments etc. (to be arranged by the students themselves, including whatever expenses become due in this regard).

Dr. Rekha Sharma (Convener) Dr. Shiv Mahendra Singh Dr. Deepak Kumar Singh Prof. Anil Kumar Dwivedi

Prof. N.K Singh (Ret. Principal) Dr. Ashutosh Kumar Verma

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