B. Sc. (Botany)

Programme Code: SCW03(B)BSC

SYLLABUS

(As per NEP 2020 Guidelines)

Sunbeam College for Women
Autonomous Post Graduate College | Accredited 'A' Grade by NAAC
BHAGWANPUR, VARANASI-221005 (U.P.)

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

Subject prerequisites:

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

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany program covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

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

Programme outcomes (POs):

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

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

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

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

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

2. Plant disease causing microbes, symptoms &control.

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

Programme specific outcomes (PSOs):
B.Sc. II Year/ (Diploma in Plant Identification, Utilization & Ethnomedicine)

This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromising on academic rigor and our rich wealth of knowledge inherited over generations.

1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity of Plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to Important Families of Flowering Plants, Field Data Collection & Herbarium Techniques.

2. The course is designed to become a commercial crop grower, florist, protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.

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

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

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.

2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.

3. Understanding of various analytical techniques of plant sciences, use of plants as industrial

resources or as human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants. 4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data. **5.** Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values, 6. Strengthen mathematical and computational skills. Enable students to use ICT&AI effectively. 7. Develop good skills in laboratory such as observation and evaluation by the use of modern tools and technology.	
PSO 1	Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and environment and the importance of conserving it. Hands on training in various fields will develop practical skills, handling equipments and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology.
PSO 2	Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: •Microbiologist, plant pathologist, Taxonomist • Plant Physiologist • Plant Biochemist • Researcher • Mycologist • Ecologist • Weed Scientist • Paleobotanist • Conservationist • Fruit Grower • Morphologist • Cytologist • Ethnobotanist • Plant geneticists etc.
PSO 3	Inculcate strong fundamentals on modern and classical aspects of Botany, Understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.
PSO 4	Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

	Proposed Year wise Structure of B.Sc. in Botany (CORE / ELECTIVE COURSES & PROJECTS)										
	Subject: **Botany**										Total Credits /hrs/
Course/ Entry – Exit levels	Year	Sem.	Paper 1	Credit/ hrs.	Paper 2	Credit/ hrs	Paper 3	Credits /hrs	Research Project	Credit/	
Certificate Course In Microbial Technology & Applied Botany	I	I	**Microbiology & Plant Pathology**	4/60	**Techniques in Microbiology & Plant Pathology**	2/60	--		Nil	Nil	6/120
		II	**Archegoniates & Plant Architecture**	4/60	**Land Plants Architecture**	2/60	--		Nil	Nil	6/120
Diploma in Plant Identification, Utilization & Ethnomedicine	II	III	**Flowering Plants Identification & Aesthetic Characteristics**	4/60	**Plant Identification technology**	2/60	--		Nil	Nil	6/120
		IV	**Economic Botany, Ethnomedicine & Phytochemistry**	4/60	**Commercial Botany & Phytochemical Analysis**	2/60	-		Nil	Nil	6/120
Bachelor of Science	III	V	**Plant Physiology, Metabolism & Biochemistry**	4/60	**Molecular Biology & Bioinformatics**	4/60	**Experiments in physiology, Biochemistry & molecular biology**	2/60	***Project-I**	3/45	13/205
		VI	**Cytogenetics, Plant Breeding & nanotechnology**	4/60	**Ecology & Environment**	4/60	**Cytogenetics, Conservation & Environment management**	2/60	***Project- II**	3/45	13/205
Comments	**Total Credits/Hrs. / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/ Virtual/ ICT based as per choice of the Institution)** *** Suggestive List of Projects mentioned in Detailed Paper Syllabus**										**50/890**

Botany Course is One of the Major Subjects for Biology Students and Minor or Elective for students of other faculties

Second Major Subject Can be Zoology/ Biotechnology /Microbiology

Third Major Subject can be from Science or Any other faculty of UGC /AICTE – (Arts/ Agriculture/ Education/ law/ Commerce)

Fourth Subject is Minor or Elective to be selected from any one of other Faculties as per student's own interest

One Vocational Course has to be opted from the list given in Syllabus as per NSDC guidelines

One Co-curricular Course is compulsory

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

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

CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I		
Programme: ***Certificate Course in Microbial Technology & Classical Botany***	Year: **I**	Semester: **I/Paper-I**
Subject: **Botany**		
Course Code: BS2440101T	Course Title: **Microbiology & Plant Pathology**	

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

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

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

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

Unit	Topic	No. of Lectures (60 hrs.)
I	Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be practiced and assessed via class interaction/ assignments / self-study mentioned under Continuous Internal Evaluation (CIE). **Microbial Techniques & Instrumentation** Microscopy – Light, Phase Contrast and Electron (scanning and transmission) microscopy. Staining techniques for light microscopy. Common equipment of microbiology lab and principle of their working – Autoclave, Oven, Laminar air flow, Centrifuge. Colorimetry and Spectrophotometry and pH meter	8
II	**Microbial world** General classification of bacteria, Structure of bacterial cell, Gram-positive and Gram-negative bacteria (characteristic feature), Types of bacterial nutrition. Bacterial Growth curve, factors affecting growth of microbes; Batch culture techniques; Bacterial Chemotaxis and Quorum sensing; Sporulation, reproduction and recombination in bacteria; Plasmids and their economic importance Viruses, general characteristics, Structure of viruses -Tobacco Mosaic Viruses (TMV). Bacteriophages- Structure of T4 &, λ-phage; Multiplication of phages by Lytic and Lysogenic cycles. General characters of - Viroids, Prions, Mycoplasmas, phytoplasmas and Actinomycetes	8
III	**Phycology** Range of thallus organization in Algae. Pigments, Reserve food materials and methods of reproduction in Algae. Classification of Algae by F E Fritsch (upto orders). Life cycles of – *Nostoc, Chlorella, Volvox, Chara, Vaucheria, Ectocarpus* and *Polysiphonia.* Economic importance of algae - Role of algae in soil fertility- as biofertilizer (biological Nitrogen fixation). Commercial products of algae –Biofuel and Agar.	7
IV	**Mycology** Fungi and its general characteristics, mode of nutrition and economic importance of Fungi. Classification up to class (Ainsworth/Alexopoulous and Mims). Distinguishing characters of Myxomycotina. Zygomycotina – *Rhizopus,* Ascomycotina -*Saccharomyces* and *Peziza,* Basidiomycota- *Ustilago, Puccinia, Agaricus,* Deuteromycotina –*Alternaria.* Heterothallism, Heterokaryosis & Parasexuality	7

Ektashukla

V	**Mushroom Cultivation, Lichenology & Mycorrhiza** Tools and techniques of Mushroom cultivation General account of lichens, reproduction and economic importance. 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). Defense mechanism with special reference to Phytoalexin. Resistance- Systemic acquired and induced systemic. Fungicides-Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil.	7
VII	**Diseases and Control** Symptoms, Causal organism, Disease cycle and Control measures of – Early & Late blight of Potato, Black rust of wheat, Red rot of Sugarcane, Mosaic diseases on tobacco, Citrus canker, Little leaf of brinjal. Disease management: - Quarantine, Chemical, Biological and Integrated pest disease management.	8
VIII	**Applied Microbiology** Food fermentations and food produced by microbes, Production of antibiotics, enzymes and alcoholic beverages. Microbes in genetic recombinant vaccines production. Plant growth promoting rhizobacteria. Biopesticides—*Trichoderma* sp. and *Pseudomonas*. Single cell proteins (SCP). Role of microbes in biopolymers, bioindicators and bioremediation. Production of biofuels, biodegradation of pollutants and biodeterioration (cultural property).	8

Suggested Readings:

Unit-I A:

i. https://indianculture.gov.in/rarebooks/economic-botany-india
https://www.infinityfoundation.com/mandala/t_es/t_es_tiwar_botany_frameset.htm
ii. https://www.researchgate.net/publication/335715457_Ancient_Indian_rishi's_Sages_knowledge_of_botany_and_medicinal_plants_since_Vedic_period_was_much_older_than_the_period_of_Theophrastus_A_case_study-_who_was_the_actual_father_of_botany
iii. https://www.scribd.com/presentation/81269920/Botany-of-Ancient-India
iv. https://insa.nic.in/writereaddata/UpLoadedFiles/IJHS/Vol17_2_17_PKBhattacharyya.pdf
v. http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri/wgbis_info/botany_history.pdf

Suggested Reading

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A.
3. Agarwal, S. K. 2009. Foundation Course in Biology, A one books Pvt. Ltd., New Delhi.
4. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
5. Chopra. G. L. 1984. A text book of Algae, Rastogi publications, Meerut, India.
6. Desikachari, T. V. 1959. Cyanophyta, ICAR, New Delhi.
7. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
8. Dorothy Wood, Joanne Willey, Kathleen Sandman. 2022. Prescott's Microbiology 12ED. McGraw-Hill Education
9. Fritsch, F. E. 1956. Structure and Reproduction of Algae, Cambridge University Press, London.
10. Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
11. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, Singapore: John Wiley & Sons.
12. Roger Y Stanier, John L Ingraham, Mark L Wheelis Pager Stanier. (1999). General Microbiology 5e MacMillan.
13. Robert Edward Lee (2008). Phycology. Cambridge University Press.
14. Morris Ian (1968). An Introduction to Algae. London, Hutchinson
15. Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
16. Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press.
17. Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt.Ltd, New Delhi.
18. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
19. Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi

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20. Sambamurty. A.V.S.S. 2006, A Text book of Algae, I. K. International Publishing House, Pvt. Ltd., New Delhi.
21. Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
22. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
23. Harjinder Singh *et al.*, Text book of Microbiology and Plant Pathology, Krishna Publication Meerut.
24. Singh, Jain and Pandey A text book of Botany Rastogi Publication, Meerut.

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

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

Ekta Shukla M. R

Programme: ***Certificate Course in Microbial Technology & Classical Botany***	Year: **I**	Semester: **I/Paper-II**
Subject: **Botany**		
Course Code: BS2440102P	Course Title: **Techniques in Microbiology &Plant Pathology**	

Course outcomes: After the completion of the course the students will be able:
Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
Practical skills in the field and laboratory experiments in Microbiology &Pathology.
learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations.
Can initiate her own Plant & Seed Diagnostic Clinic
Can start own enterprise on microbial products

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

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

Unit	Topic	No. of Lectures (60 hrs.)
1.	INSTRUMENTS & TECHNIQUES 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, filtration unit, pH meter. 3. Cleaning and Sterilization methods of glassware and media 4. Preparation of media- Nutrient Agar and Broth	7
II	BACTERIAL IDENTIFICATION 1. Techniques for the Identification of bacteria. 2. Staining techniques: Gram's, Staining, Endospore, 3. Pure culture techniques (Types of streaking, Serial dilution) (Demonstration)	8
III	MYCOLOGICAL STUDY: 1. Identification of fungi by lactophenol cotton blue method- *Rhizopus, Saccharomyces, Peziza, Ustilago, Puccinia Alternaria.* 2. Permanent slides of uredial, telial, pycnial & aecial stages of *Puccinia.* 3. *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus* through permanent slide. 4. Lichens: crustose, foliose and fruticose specimens.	8
IV	PHYCOLOGY: 1. To study the thallus structure of the following Algal taxa of different classes with temporary mounting and staining – *Spirulina, Nostoc, Chlorella, Volvox, Chara, Vaucheria, Ectocarpus* and *Polysiphonia*	8
V	EXPERIMENTAL PLANT PATHOLOGY 1. Preparation of fungal media (PDA). 2. To prepare temporary slide of fungal pathogen from diseased parts of the plant. 3. Identification: of diseases with the help of pathological specimens- White Rust of Crucifers, Bacterial blight of rice, Loose smut of wheat, Red rot of Sugarcane, Late blight of potato, Citrus Canker and Curling leaf of Papaya.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY-1 1. To study the isolation techniques of nitrogen fixing bacteria from root nodules of legumes. 2. To study the isolation techniques of Rhizosphere and Phyllosphere microflora.	7
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 1. Wine production. (Demonstration) 2. Isolation of lactic acid bacteria from curd. 3. To study the techniques Enzyme production and Assay- Cellulase, and Amylase	8
VIII	1. To study the mass culture techniques of *Spirulina, & Chlorella* for biofuel production 2. Visit to NBAIM, Mau, to view Microbial Culture Repository. 3. Visit to Mushroom cultivation unit (Mau).	6

Suggested Readings:

Course Books published.

1. 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)
2. Modern Mushroom Cultivation and Recipes (hindi) (hb)ISBN: 9788177545180Edition: 01Year: 2017Author: Singh Riti, Singh UC Publisher: Agrobios (India)
3. Biofertilizer Production Manual (hindi) (hb) ISBN: 9788177541274Edition: 01Year: 2014Author: Gehlot D Publisher: Agrobios (India)Language: Hindi
4. Botany Practical Part 1 Ashok Bendre & Ashok Kumar Rastogi Publication, Meerut
5. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
6. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
8. https://agrimoon.com/wp-content/uploads/Mashroom-culture.pdf
9. http://nhb.gov.in/pdf/Cultivation.pdf
10. https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf

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Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

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

Suggested equivalent online courses:

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

Programme /Class: B.Sc.-I/ *Certificate Course In Microbial Technology & Classical Botany*	Year: **I**	Semester: **II** **Paper-I**
Subject: **Botany**		
Course Code: BS2440201T	Course Title: **Archegoniate and Plant Architecture**	

Course outcomes:

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

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

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

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

Unit	Topic	Lectures (60hrs)
I	**Introduction to Archegoniates & Bryophytes** General characteristics of Bryophytes. Adaptations to land habit, Range of thallus organization. Classification of Bryophytes (up to order). Morphology, anatomy, reproduction and Life cycle in -*Riccia*, *Marchantia, Anthoceros* and *Sphagnum*. (Developmental details not to be included). Economic importance of bryophytes.	7
II	**Pteridophytes** General characteristics, Early land plants (*Rhynia*). Classification (up to order) with examples. Morphology, anatomy, reproduction and Life cycle in – *Lycopodium, Sellaginela, Equisetum* and *Pteris*. Heterospory and seed habit. Stelar System- origin and Evolution. Economic importance of Pteridophytes.	8
III	**Gymnosperms** General characteristics. Classification (upto order) and distribution of gymnosperms in India; Salient features, structure and reproduction of *Cycas*, *Pinus*, *Ephedra* and *Gnetum*. Economic importance of Gymnosperms.	8
IV	**Paleobotany** General account of Cycadofilicales, Bennettitales and Cordaitales. Geological time scale. Brief account of process of fossilization & types of fossils. Contribution of Birbal Sahni in the field of Paleobotany.	8
V	**Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence)** Morphology and modifications of roots, stem, leaf. Types of inflorescences; flowers, floral parts, fruits and types of placentation. Definition and types of seeds.	7
VI	**Plant Anatomy:** Meristematic and permanent tissues. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Types of Vascular bundles. Secondary growth in dicot root and stem. Structure and Function of cambium. Anomalous secondary growth - *Boerhaavia, Dracaena, Nyctanthus*	7
VII	**Reproductive Botany** Plant Embryology- Structure of microsporangium and microsporogenesis. Structure of megasporangium and its types, megasporogenesis. Structure and types of female gametophyte, Methods of pollination, Germination of pollen grain. Structure of male gametophyte. Fertilization, Double fertilization. Structure of dicot and monocot embryo, Endosperm, Apomixis and Polyembryony.	8
VIII	**Palynology:** Pollen structure, pollen morphology, pollen allergy, Applied Palynology: Basic concepts, Paleopalynology, Aeropalynology, Forensic palynology.	7

Basta Shukla

M.B.Mishra

Suggested Readings:

Course Books published

1. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
2. Sporne.R.K. (1967). The Morphology of Gymnosperms. Hutchinson
3. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
8. Parihar NS (1976) Biology and Morphology of Pteridophytes. Central Book Depot.
9. Bhatnagar SP (1996) Gymnosperms, New Age International Publisher.
10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
12. Bhojwani, S.S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House,.
13. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verlag, Berlin.
14. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.

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

Suggested Continuous Evaluation Methods:

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class, WIFI facility

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

Suggested equivalent online courses:

https://www.anbg.gov.au/bryophyte/what-is-bryophyte.html
https://pteridoportal.org/portal/index.php
https://www.conifers.org/zz/gymnosperms.php
http://www.mobot.org/MOBOT/research/APweb/
https://milneorchid.weebly.com/plant-id-for-beginners.html
https://www.botany.org/PlantImages/PlantAnatomy.php
http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print
https://palynology.org/ http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html
https://www.sciencelearn.org.nz/resources/100-plant-reproduction https://palaeobotany.org/

Programme/Class: ***Certificate Course in Microbial Technology & Classical Botany***	Year: **I**	Semester: **II** **Paper-II (Practical)**
Subject: **Botany**		
Course Code: BS2440202P	Course Title: **Land Plants Architecture**	

Course outcomes:

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

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

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

Unit	Topic	No. of Lectures
I	**Bryophytes:** *Marchantia*- morphology of dorsiventral thallus, V.T. S. thallus of *Marchantia*, W.M. gemmae (all temporary slides), V.S. Gemma, antheridiophore, archegoniophore and L.S. Sporophyte (with the help of permanent slides). *Anthoceros*- Morphology and V.T.S thallus *Sphagnum*- Morphology, W.M. leaf (temporary slides); permanent slides showing operculum, peristome, annulus, spores, and L.S. capsule.	**8**
II	**Pteridophytes:** *Lycopodium:* Habit (sporophyte), T. S stem and V. S. strobilus. *Selaginella:* Habit (sporophyte), T. S stem and V. S. strobilus. *Equisetum* – Habit (sporophyte), T.S of rhizome and stem. and V. S. of strobilus (permanent slide). *Azolla* – Habitat & its structure	**7**
III	**Gymnosperms** 1. *Cycas*- Habit (sporophyte), T.S. of coralloid root, Leaflet and Rachis. V. S. male cone, Megasporophyll with ovule (Specimen). 2. Pinus – Dwarf and Long shoot (Habit), T. S of dwarf shoot and needle. R. L. S and T. L. S. of stem (permanent slide) male and female cone (Specimens), 3. *Ephedra* - Habit (Sporophyte), T. S stem (young), Male and Female strobilus (Specimen).	**8**
IV	**Paleobotany & Palynology** 1. Morphology of *Rhynia* sporophyte. 2. Visit to Birbal Sahni Institute of Paleobotany or virtual conference with their scientists to learn fossilization 3. Mark and know about Indian geographical sites rich in plant fossils (Raj Mahal Hills, Bihar and Salkhan U.P.)	**6**

V	**Angiosperm Morphology** 1. To study of diversity in leaf shape, size and other foliar features. 2. To study the phyllotaxy in plants 3. Fruits- study from different types from fresh/preserved specimens 4. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 5. Modifications in Roots, stems, and leaves.	8
VI	**Plant Anatomy:** 1. Normal & Anomalous secondary growth - *Dracaena, Boerhaavia Nyctanthus* 2. Study of primary and secondary growth in root and stem of monocots and dicots by section cutting and permanent slides. 3. Study of internal structure of dicot and monocot leaves (permanent slides).	8
VII	**Reproductive Botany** 1. Structure (internal) of anther and pollen grains 2. Structure (internal) of ovule (through permanent slides). 3. Study of pollen morphology of the locally available flowering plants by microscopic observation. 4. To study *in vitro* pollen germination techniques.	8
VIII	**Commercial Uses and Production technology** 1. Visit to nearby *Azolla* producing ponds 2. Production and propagation of Ornamental *Pteris*, *Cycas*, *Thuja* for landscaping (Demonstrative) 3. Lab method for extraction of Thuja oil (Demonstrative)	7

Suggested Readings:

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

1. Misra; Trivedi, P.S. 1997. Botany Vol. II. Vikas Publishing House.
2. Pandey, BP and Chadha. 1997. Botany Vol. III. Vikas Publishing House.
3. Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.
4. Kumar, S and Kashyap. 2003. Manual of Practical Algae. Campus Books International, New Delhi
5. Bendre and Kumar A text book of Practical Botany. Vol I, II., Rastogi Pub. Meerut.
6. Suresh Kumar, Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet , New Delhi.
7. Santra, SC. 2005. College Botany Practical Vol. II. New Central Book Agency (P) Ltd.

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

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

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

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

Course prerequisites:

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

Facilities: Smart and Interactive Class

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

Suggested equivalent online courses:

https://www.easybiologyclass.com/topic-botany

http://www3.botany.ubc.ca/bryophyte/index.html

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

http://mydunotes.blogspot.com/p/botany.html

http://www.fao.org/3/a-v9236e.pdf

https://iinrg.icar.gov.in/library/nrg/nrg.pdf

https://agritech.tnau.ac.in/banking/nabard_pdf/Azolla%20Cultivation/Model_projct_on_Azolla_cultivation.pdf

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

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