Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Two Year Degree Programme

Postgraduate Programme of Science& Technology

M.Sc. in Botany

Board of Studies in

Botany

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

w.e.f. June, 2023

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. (Research /Degree) in Botany** Programme to be effective from the **Academic Year 2023-24.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 09/08/2023

Place: Latur

NEP Cell

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of M.Sc. in Botany Programme to be effective from the Academic Year 2023-24.

Date:

Place: Latur

(S. N. Shinde)
Chairperson
Board of Studies in Botany
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Members of Board of Studies in the Subject Botany

Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	**Shri S. N. Shinde**, Head, Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Chairman	HoD
2	**Dr. B. S. Survase**, Director, School of Life Sciences, S. R. T. M. U. Nanded	Member	V.C. Nominee
3	**Prof. Dr. A. S. Dhabe**, Head, Department of Botany, Dr. Babasaheb Ambedkar M. University, Aurangabad	Member	Expert from outside for Special Course
4	**Prof. Dr. A. B. Ade**, Head, Department of Botany, Savitribai Phule Pune University, Pune	Member	Academic Council Nominee
5	**Dr. V. S. Maske**, Head, Department of Botany, Bahirji Smarak Mahavidyalaya, Vasmat, Dist. Hingoli	Member	Academic Council Nominee
6	**Shri Laxman Done**, Done's Mushrooms, Kumbhari, Dist. Latur	Member	Expert from Industry
7	**Prof. Dr. N. B. Gaikwad,** Department of Botany, Shivaji University, Kolhapur	Member	P.G. Alumni
8	**Dr. S.H. Nile,** Senior Scientist, Zhejiang Chinese Medical University, Hanzhou Zhejans	Member	Expert from outside for Special Course
9	**Dr. K. D. Savant,** Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
10	**Shri D. R. Awad**, Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
11	**Ms. D.S. Chavan**, Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
12	**Ms. P. V. Kumbhar**, Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
13	**Ms. R.L. Shaikh,** Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
14	**Ms. P. S. Maskepatil**, Department of Botany, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Department
15	**Dr. D. V. Vedpathak**, Department of Microbiology, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Faculty
16	**Dr. D.G. Palke**, Head, Department of Chemistry, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Member from same Faculty

From the Desk of the Chairperson…

The Department of Botany is established in 1971. It is one of the leading departments in the field of teaching and student centric activities. After Autonomy, in keeping pace with the advances in various aspects of plant sciences, the department has introduced the courses like Molecular Biology, Cell Biology, Plant Biotechnology, Bioinformatics, Genetics, Instrumentation in Botany, Pharmacognosy, Gardening and Landscaping, Plant Breeding, Biostatistics, Forensic Botany etc. The Department has academic autonomy and has been revising its curriculum regularly. The department has successfully implemented the choice based credit system for grading the students. The department is known for the teaching, learning and the results. It is also known for strict implementation of rules and regulations formulated time to time by the administration of Autonomous College. The Curriculum of the M.Sc. has been designed by considering NET, SET, GATE and others competitive examinations.

The Higher Education system in India and all over the world has undergone paradigm shift in both qualitative and quantitative aspects. Its best example is National Education Policy (NEP-2020). The National Education Policy 2020 emphasizes on developing overall personality of students by incorporating Humanitarian and Constitutional values, creativity and critical thinking, harnessing innovation, use of modern technology and interaction with various stakeholders. It recognizes that the pedagogy should evolve to make education more experiential, holistic, integrated, learner-centric, flexible and developing skill etc. to shape the student that can face the challenges of the future, the new policy also envisages the refinement and improvement in the Learning Outcome based Curriculum Framework.

Botany is one of the most fundamental branches of Life Sciences. It is the broad subject encompassing classical and modern systemic aspects of plant diversity as well as contemporary subjects like Molecular Biology, Bioinformatics, Biotechnology, etc. to foster comprehensive understanding about various aspects of plant sciences. The present learning outcome based curriculum framework for M. Sc. in Botany is designed to provide a focused leering outcome based syllabus at the PG level providing structured teaching-learning experiences catering to needs of the students. The courses in Botany will prepare the students both academically and in terms of employability. This program also inculcates various attributes like Problem solving, Research skills, Critical thinking etc. These attributes encompass values related to emotional stability, social justice, creative and critical thinking, well-being and various skills required for employability, thus preparing students for continuous learning and sustainability.

The course is upgraded keeping in mind the aspirations of the students, changing nature of the subject as well as the learning environment. Courses of Botany have been designed to incorporate recent advancements, techniques to upgrade the skills of students. The new structure is expected to

enhance the level of understanding among students and maintain the standard of Master Degree in Botany across the country. The efforts have been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process. This framework offers flexibility and innovation in syllabi designing and in methods adopted for teaching-learning process and learning assessment.

The new curriculum offers knowledge of wide areas in Botany including Diversity, Plant Systematics, Plant Biotechnology, Cell Biology, Genetics, Plant Physiology, Bioinformatics, Medicinal Plants. Plant disease management etc. This new syllabus has been prepared keeping in view the unique requirement of M.Sc. Botany students. The contents of the syllabi have been drawn to accommodate the widening horizons of the Botany discipline and reflect the changing needs of the students. The semester wise course distribution and detailed syllabus for each course is appended with a list of suggested references.

The present structure comprises Discipline specific courses (DSC), MMC Electives Course (MEC), Generic/Open Electives (GE/OE), etc. The discipline specific courses (DSC) are compulsory and the elective courses can be chosen from the given Basket. The project work is specially emphasized in this structure. The project will mainly involve experimental work. The students will be asked their choice for project. The Generic Electives will be offered to the students of other departments of the college. The students will have the option to choose one generic elective from the given Basket. The generic elective comprises theory as well as practical.

These courses offer skills to pursue research and teaching in the field of Botany and thus would produce best minds to meet the demands of society. This curriculum framework for M. Sc.in Botany is developed keeping in view of the students centric learning Pedagogy, which is entirely outcome oriented. The curriculum framework focuses on the pragmas approach whereby practical application of theoretical concepts is covered through Laboratory and Field works.

The MMC objective of this curriculum is to elevate the subject knowledge of the students, making them critical thinkers and able to solve problems and issues related to Botany logically and efficiently.

(S. N. Shinde)
Chairperson
Board of Studies in Botany
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Contents

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

PG Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Year M.Sc. Degree

Year Level	Sem	MMC 24-28 (22-26) per Sem 46-56 for two years		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	**Elective**		RMC 4Cr	NA	NA	20Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	**PG Diploma (After 03 Year B.Sc. Degree)**
I 6.0	**I**	MMC I 3Cr MMC II 3Cr MMC III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr						
	II	MMC IV 3Cr MMC V 3Cr MMC VI 3Cr	MEC II 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	OJT-I 4Cr /FPI 4Cr	NA	20Cr	OJT/FP: 1Cr=25M	
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**NA**	**40Cr**		
Exit Option: PG Diploma with 40 Credits After 03 Year B.Sc. Degree										
II 6.5	**III**	MMC VII 3Cr MMC VIII 3Cr MMC IX 3Cr	MEC III 3Cr	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr LC-XII 1Cr	NA	NA	RP-I 4Cr	**20Cr**	RPI & RPII: 1Cr=25M	**PG Degree (After 03 Year UG Degree)**
	IV	MMC X 3Cr MMC XI 3Cr MMC XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**MMC 36Cr**	**MEC 12Cr**	**LC-16Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**RP 10Cr**	**40+42 =82 Cr**		**82 Credits**
	Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree									

Abbreviations:

1. **MMC : Major Mandatory Course**
2. **MEC : Major Elective Course**
3. **RMC : Research Methodology Course**
4. **OJT : On Job Training (Internship/Apprenticeship)**
5. **FP : Field Project**
6. **RP : Research Project**
7. **Cum. Cr : Cumulative Credit**

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Department of Botany

M.Sc. Botany Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Years/One Year PG (M.Sc.)

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
I 6.0	I	601BOT1101 (MMC I)	Cell Biology Signaling and Communication	03	45
			Lab Course-I	01	30
		601BOT1102 (MMC II)	Diversity of Microbes and Cryptogams.	03	45
			Lab Course-II	01	30
		601BOT1103 (MMCIII)	Biochemistry and Metabolism of Biomolecules	03	45
			Lab Course-III	01	30
		601BOT1201 MEC-I (A) Or MEC-I(B)	Instrumentation and Biostatistics OR Plant Physiology	03	45
			Lab Course-IV	01	30
		601BOT1301 (RMC)	Research Methodology Course	04	100
	Total Credits			**20**	
	II	601BOT2101 (MMC IV)	Diversity of Pteridophytes, Gymnosperms	03	45
			Lab Course-V	01	30
		601BOT2102 (MMCV)	Plant Physiology and Metabolism	03	45
			Lab Course-VI	01	30
		601BOT2103 (MMC VI)	Plant Structure Development & Reproduction in Angiosperms	03	45
			Lab Course-VII	01	30
		MEC-I (A) Or MEC-I(B)	Plant Ecology and Evolution OR Angiosperms Systematics	03	45
			Lab Course-VIII	01	30
		OJT-I/Field Project (FP) 601BOT2401	OJT/ Field Project	04	120
	Total Credits			**20**	
Total Credits (Semester I & II)				**40**	

PG Program Outcomes:

PO-1 Academic Competence:

All-inclusive knowledge of biochemical process, Cell Biology, Diversity of Microbes, Pteridophytes, fossil plants and Cryptogams, Instrumentation and Biostatistics, plant physiology, reproduction in Angiosperms, Molecular biology, plant Biotechnology, Genetics Engineering, Cytogentics and plant breeding and plant nanotechnology.

PO-2 Scientific Outlook:

Scientific temperament with the help of experiments, and practicals in botany such as plant morphology, physiology, anatomy and application of economic botany, bioengineering, biotechnology and Genetic Engineering.

PO-3 Personal and Professional Competence:

Competency to analyse samples and data obtained from experiments, field visits, projects, survey and will make scientific draft/report for solving problems. They will exhibit self-learning, discipline and logical approach.

PO-4 Entrepreneurial Competence:

Applied knowledge of Botany to enter in start-up of mushroom cultivation, fruit and vegetable processing, plant pathology or work for the probable solutions for challenges in botanical and environmental issues.

PO-5 Research Competence:

An ability to assess and identify research problem and botanical techniques and instrumentation and with the help of integrated knowledge do the experiments, interpret the data and findings and provide valid conclusion.

Programme Specific Outcomes:

After completion of Programme, the students will

PSO1. Academic Competence:

After successful completion of the course, a student is able to understand different fields of Botany like systematics, Cell Biology, Diversity of Microbes, Pteridophytes, fossil plants and Cryptogams, Instrumentation and Biostatistics, plant physiology, reproduction in Angiosperms, plant Biotechnology, Genetics Engineering, plant breeding and plant nanotechnology, evolution, ecology, physiology, biochemistry, plant interactions with microbes and insects, anatomy, morphology, reproduction, genetics and molecular biology of various life-forms. She/he even has an edge over other students as they will be trained in skill enhancement courses like tissue culture and breeding technology.

PSO2. Scientific Outlook:

Scientific temperament with the help of experiments, and practicals in botany such as plant morphology, physiology, anatomy and application of economic botany, bioengineering, biotechnology and Genetic Engineering, also classify various life forms of plants, design and execute experiments related to basic studies on ecology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology etc.

PSO3. Personal and Professional Competence:

Competency to analyse samples and data obtained from experiments, field visits, projects, survey and will make scientific draft/report for solving problems. They will exhibit self-learning, discipline and logical approach.

PSO-4. Research Competence:

An ability to assess and identify research problem and botanical techniques and instrumentation term research projects/dissertations using tools and techniques in any of the basic specializations of Botany under supervision and with the help of integrated knowledge do the experiments, interpret the data and findings and provide valid conclusion.

PSO5: Entrepreneurial Competence:

Applied knowledge of Botany to enter in start-up of mushroom cultivation, fruit and vegetable processing, plant pathology or work for the probable solutions for challenges in botanical and environmental issues.

PSO6: Practical skills:

Learn about practical technique in lab for detail study of plant cell structure, reproduction, anatomy, breeding procedures for hybridization. Maintain a high level of scientific excellence in botanical research with specific emphasis on the role of plants. Create, select and apply appropriate techniques, resources and modern technology in multidisciplinary way. Practice of subject with knowledge to design experiments, analyze and interpret data to reach to an effective conclusion.

PSO7: Problem analysis:

They would identify, formulate and analyze the complex problems with reaching a substantiated conclusion. Logical thinking with application of biological, physical and chemical sciences. Learning that develops analytical and integrative problem-solving approaches.

PSO8: Personal and Professional Competence:

Students would perform functions that demand higher competence in national/international organizations with sporty and helping spirits. Prepare the students for many competitive exams like MPSC, UPSC NET SET GATE.

Competency to analyse samples and data obtained from experiments, field visits, projects, survey and will make scientific draft/report for solving problems. They will exhibit self-learning, discipline and logical approach.

PSO9: Ethics:

Knowledgeable, disciplined students with good values, ethics, and kind heart will help in nation building globally. Student should be aware of ethical issues and regulatory considerations while addressing society needs for growth with honesty

Semester - I

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MSC-I

Course Title: Cell Biology Signaling and Communication

Course Code: 601BOT1101

Credits: 03 **Lectures: 45 Hrs.**

Learning Objectives:

LO-1 Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

LO-2 Students will understand how these cellular components are used to generate and utilizeenergy in cells

LO-3 Students will understand the cellular components underlying mitotic cell division.

LO-4 Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Examine the basic aspects of cell biology, Genetics and evolution.

CO-2 Apply and integrate the basic concepts of cell biology including structure and functions of organisms.

CO-3 Correlate cell structure using compound microscope and elucidation of Ultra structurefrom electron microphotographs.

CO-4 Examine the mitosis and meiosis by smear/ squash method and from prepared slides.

Unit No.	Title of Unit & Contents	Hrs.
I	**Cell Organelles-I**	**12**
	1. Introduction 2. Cell wall - biogenesis, Ultra structure and functions. Growth-	

	primary and secondary wall. 3. Cell membranes - Molecular organization, Fluid mosaic model, membrane protein diffusion, transport across membranes-facilitated diffusion, carrier & channel proteins, transporters, active transport, transport of ions and solutes 4. Biogenesis of chloroplasts and mitochondria. 5. Molecular organization of chloroplast and mitochondrial membranes. 6. Plasmodesmata –Structure and role in movement of molecules. 7. Vacuoles –Tonoplast membrane biogenesis, transporters, role as storage organelle,transport across vacuolar membrane. 8. Correlate significance of bacteria, algae and fungi with human welfare.	
	Unit Outcomes: UO-1 Correlate cell structure using compound microscope and elucidation of Ultra structurefrom electron microphotographs.	
II	**Cell Organelles-II**	**11**
	1. Nucleus- Structure, organization and regulation of nuclear pore complex.Transport across nuclear membrane. 2. Endoplasmic Reticulum-Role in synthesis and transport of secretary proteins 3. Golgi complex –Role in sorting, storage and secretion, 4. Lysosomes, membrane integrity and role Glyoxysomes and Peroxisomes structureand functions. 5. Ribosome –Structure, assembly and dissociation of subunits, functions. 6. Structure and function of Cytoskeleton**:** Composition and organization of microtubules,microfilaments. Tread milling, role in cell division, signaling and intracellular traffic. Role in motility. Flagella-Structure and organization.	
	Unit Outcome: UO-1 Apply and integrate the basic concepts of cell biology including structure andfunctions of organisms	
III	**Cell Signaling and Communication.**	**11**
	Cell signaling: 1. Hormones and their receptors, cell surface receptor, signaling through G-proteincoupled receptors.	

	2. Signal transduction pathways, secondary Messengers. 3. Regulation of signaling pathways, 4. Bacterial and plant two component systems. 5. Light signaling in plants. **Cellular communication:** 1. Regulation of hematopoiesis. 2. General principles of cell communication. 3. Cell adhesion and roles of different adhesion molecules. 4. Gap junctions. 5. Extracellular matrix and integrin's. 6. Neurotransmission and its regulation	
	Unit Outcome: UO-1. Justify the basic aspects of cell signaling and cellular communication.	
IV	**Cell Cycle**	**11**
	Cell Cycle 1. Phases of Cell Cycle. 2. Functional importance of each phase. 3. Molecular events during cell cycle. 4. Regulation of cell cycle. 5. Cyclins and protein kinases. 6. MPF (maturation promoting factor) **A) Cell aging and cell senescence:** 1. Programmed cell death and its molecular aspects. 2. Regulation of cell death. 3. PCD in response to stress. **B) Apoptosis:** 1. Role of different genes. 2. Cell organelles during apoptosis. 3. Genetic control of apoptosis	
	Unit Outcomes: UO-1. Examine the mitosis and meiosis by smear/ squash method and from prepared slides	

Learning Resources:

1. Albert's B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989
2. Molecular biology of the Cell (2ndedition)-Garland Pub. Inc., New York.

3. Cells and Molecular Biology: Concepts & Experiments- Karp, G. 1999.. John Wileyand Sons, Inc., USA.
4. Molecular Cell Biology- Lodish S, Baltimore B, Berk, C and Lawrence K,1995, ,3rd editions, Scientific American Books, N.Y
5. Cell and Molecular Biology-De Robertis and De Robertis, 1988, 8 edition, Info-Med, Hongkong.
6. Biochemistry and Molecular Biology of Plants-Buchanan, Grissom and Jones, 2000, ,American Soc. Plant Biologists, Waldorf
7. The Cell: Molecular Approach-Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA Cooper G M and Hausman R E,2007, 4thEdn, Sinauer Associates,USA. Johnson Lewys – 2004: Cell Biology; Sarup and sons, New Delhi.
8. Cell and Molecular Biology-E.J. Dupraw – 1970; Academic Press, London
9. Cell and Molecular Biology (VIII)-De Robertis and De Robertis – 1997; B.I. Waverly Pvt. Ltd., New Delhi
10. Cytogenetics -C. P. Swanson, T. Merz, and W.J. Young – 1982 Prentice – Hall of India Pvt. Ltd., New Delhi India
11. Cell Biology-C. B. Powar – 1992; Himalaya Publishing House.
12. Cell Biology and Genetics-Dr. Veer Bala Rastogi.
13. Cell and Molecular Biology-P. K. Gupta 4th revised edition.
14. Cell Biology Fundamental and Applications-Gupta, Jangir.
15. Cell Biology-S.C. Rastogi New Age International Publisher 3rd edition.
16. Cell Biology and Molecular Biology-N. Arumugam Saras Publication.

e-Journals:

1. https://onlinelibrary.wiley.com/journal/15824934
2. https://juniperpublishers.com/ijcsmb/images/fraction-slider/IJCSMB_.jpg
3. https://www.sciencedirect.com/journal/journal-of-molecular-biology
4. https://www.springer.com/journal/18/
5. https://www.mdpi.com/journal/cimb
6. https://www.peerreviewcentral.com/ads/image/AJBGMB.png

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: Lab Course

Course Title: Lab Course –I (Based on MSC-I)

Course Code: 601BOT1104

Credits: 01

Hours – 30 Hrs. **Maximum Marks – 50**

Learning Objectives:

LO-1 To familiarize the students with techniques of cell biology.

LO-2 To study the cancerous cells.

LO-3 To provide the students hands on experience in selected techniques cell biology

Course outcomes:

After completion of course, Students are able to:

CO-1 Understand karyotype and Ideogram and their significance.

CO-2 Distinguish between mitotic and meiosis.

CO-3 Justify structural aspect of DNA and RNA.

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1. Demonstration of SEM and TEM (Photocopy)
2. Isolation of mitochondria
3. Comparative study of normal and banded karyotype
4. Determination of mitotic index in any plant species
5. Differential centrifugation for isolation of cell fractions –Nuclear fraction
6. Determination of permeability of living cells to acids and bases

7-10. Study of different stages of mitosis from Onion root tip.

11-12. Study of different stages of meiosis from suitable plant material

13. Study of karyotype from suitable plant material.
14. Study of chiasmata frequency from suitable plant material.

15-17. Study of electron micrographs of cell organelles

N.B: 1) Any ten Practicals from above list

2) Several Short Excursions, field visit and at least one Long Excursion.

Shiv Chhatrapati Shikshan Sanstha's

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(Autonomous)

Department of Botany

Course Type: MSC-II

Course Title: Diversity of Microbes and Cryptogams

Course Code: 601BOT1102

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To support and promote research development.

LO-2 To investigate the ecological impact of antibiotic administration on the cultivable indigenous microbiota.

LO-3 To provide training in scientific and transferable skills through modular lecture courses, research projects.

LO-4 To understand and competence that will serve as a lasting and practical basis for a career.

LO-5 To study morphology, reproductive structure and anatomy of cryptogams.

Course Outcomes:

After completion of course Students are enable to:

CO-1 Investigate the ecological impact of Bryophytes as pollution indicators.

CO-2 Identify the microbes on the basis of their morphology.

CO-3 Correlate distinguish algal species on the basis morphology and pigmentation.

CO-4 Justify the fungal diversity.

Unit No.	Title of Unit & Contents	Hrs.
I	**Viruses, Bacteria and Mycoplasma**	**10**
	1. Viruses: General characters, Ultra structure of plant viruses (TMV), Transmission of plant viruses and Economic importance of viruses. 2. **Bacteria:** General characters, Ultra Structure, Nutrition (Autotrophic, Heterotrophic and Symbiotic), Reproduction (Binary fission, Transformation and Transduction), Economic Importance of Bacteria. **3. Mycoplasma:**	

	General characters, Ultra structure, Economic importance of Mycoplasma	
	Unit Outcomes: UO-1 Identify the microbes on the basis of their morphology	
II	**FUNGI**	**10**
	1. General characters of Fungi 2. Biodiversity and Taxonomy of the Phyla Zygomycota (Rhizopus), Ascomycota 3. (Aspergillus), Basidiomycota (Polyporus), Oomycota (Saprolgniea), Dueteromycota 4. (Alternaria) 5. Economic importance of Fungi	
	Unit Outcome: UO-1 Justify the fungal diversity	
III	**ALGAE**	**12**
	1. Thallus organization 2. Cell structure, Reproduction, Pigments, Reserve food, Flagella 3. Salient Features of Chlorophyta *(Volvox)*, Bacillariophya (*Pillularia*), Pheophyta (*Sargasum*) and Rhodophyta *(Batrachospermum*) 4. Economic importance of Algae	
	Unit Outcome: 1. UO-1. Correlate distinguish algal species on the basis morphology and pigmentation.	
IV	**BRYOPHYTES**	**13**
	4. Introduction and Origin of Bryophytes. 5. Distribution, Habit, Morphology,Reproduction,Phylogeny,andInter - relationship of the orders Marchentiales (Riccia), Anthocerotales (Antheceros), Jungermanniales (Porella), Sphagnales (Sphagnum) 6. Economic importance of Bryophytes 7. Bryophytes as indicators of pollution.	
	Unit Outcomes: UO-1. Investigate the ecological impact of Bryophytes as pollution indicators	

Learning Resources:

1. Textbook of Algae Kumar, H.D. and H. N. Singh (1971)

2. Textbook of Algae Sharma, O.P. (1986)
3. Textbook of Botany – Algae Pandey, B. P. (1994)
4. Botany for degree Students-Algae Vashista, B. R. (1995)
5. College Botany Vol. III Gangulee, H.C. and A. K Kar (1992)
6. Taxonomy and Biology of Blue green algae Desikachary, T.V. (1)
7. Structure and Reproduction of Algae Fritsch, F. E. (1965)
8. Algae-Form and Function Venkataraman et al. (1974)
9. Textbook of Fungi Sharma, O.P. (1989)
10. Morphology and Taxonomy of Fungi Bessey, E. A. (1967)
11. College Botany Vol. I. Gangulee, H.S. and A.K Kar (1992)
12. The Myxomycetes of India. Thind K. S. (1977)
13. Aquatic Fungi of India Dayal (1995):
14. Inter-relationship of Bryophytes Cavers, R. (1964):
15. Liverworts of Western Himalayas and the Punjab Plains Part-I
16. An introduction to Embryophyta. Vol-I Bryophyta Parihar
17. Bryology in India Ram Udar (1976):
18. Cryptogamic Botany Bol. II. Smith, G. M. (1955)
19. The Structure and life of Bryophytes. Watson, E.V, (1964)
20. Botany for degree students -Bryophyta.Vashista, B.R (1996):
21. Biology of Bryophytes Chopra, R.N. and P. K. Kumra (1988).
22. Virology by P. Saravanan
23. Text book of Fungi, Bacteria and Viruses by H.C. Dubey
24. Principles of Virology by S. J. Flint and Others
25. Plant Bacteriology by D.P. Tripathi

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Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: Lab Course

Course Title: Lab Course II (Based on MSC-II)

Course Code: 601BOT1105

Credits: 01 **Hours: 30**

Learning Objectives:

LO-1 To practically expose the students with divers life forms.

LO-2 To study the lifecycles of cryptogams.

LO-3 To provide the students hands on experience with morphological and reproductive.

LO-4 To learn the economic importance of Algae, Bryophyte and Fungi.

Course outcomes:

After completion of course, Students are able to:

CO-1 Correlate the Life cycles of Algae, Bryophyte and Fungi.

CO-2 Examine the morphological and reproductive features of cryptogams.

CO-3 Learn the Distinguishing affinities of cryptogams.

CO-4 To learn the practical skill for preparation of Slide.

CO-5 Justify structural aspect of plants.

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1. Isolation of Algae from soil and water
2. Study of thallus and reproductive structures of *Chara*
3. Study of thallus and reproductive structures of *Sargasum*
4. Study of thallus and reproductive structures of *Pillularia*
5. Study of thallus and reproductive structures of *Batrachospermum*
6. Study of thallus, internal and reproductive structures of *Riccia*
7. Study of thallus, internal and reproductive structures of *Anthoceros*
8. Study of thallus, internal and reproductive structures of *Polytricum*
9. Study of thallus, internal and reproductive structures of *Porella*
10. Study of thallus, internal and reproductive structures of *Sphagnum*
11. Study of thallus and reproductive structures of *Rhizopus*
12. Study of thallus and reproductive structures of *Aspergillus*
13. Study of thallus and reproductive structures of *Polyporus*

14. Study of thallus and reproductive structures of *Saprolegniea*
15. Study of thallus and reproductive structures of *Steminitis*
16. Preparation of culture media: PDA, Czapek, Dox Agar medium
17. Isolation of Fungi from soil, air, water, and host, their inoculation on culture media

N.B: 1) Any ten Practicals from above list

2) Several Short Excursions, field visit and at least one Long Excursion.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MSC-III

Course Title: Biochemistry and Metabolism of Biomolecules

Course Code: 601BOT1103

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To study biomolecules and their interaction with living organism.

LO-2 To study biomolecules and energetics.

LO-3 To provide basic principles of the molecular architecture of cells.

LO-4 To understandthe biochemical nature of macromolecules and their construction.

LO-5 To learn the metabolism of dietary and endogenous carbohydrate, lipid, and Protein.

LO-6 To study the principles and MMC mechanisms of metabolic control and of molecular signaling by Hormones.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Examine the Biochemical and Metabolic processes of cell.

CO-2 Justify the Biomolecules and their interactions.

CO-3 Correlate the molecular architecture of Biomolecules.

CO-4 Examine the role of enzymes in control of metabolism

Unit No.	Title of Unit & Contents	Hrs.
I	**Molecules and their Interaction**	**11**
	1. Structure of atoms, molecules and chemical bonds. (Covalent and Non - covalent bonds) Stabilizing interactions (H- bonding, hydrophobic interactions, electrostatic interactions Van - Der Waals interactions etc.) 2. Principles of biophysical chemistry Solutions (Percentage, Molar, Normal, PPM and PPB) pH Buffer, Reaction kinetics 3. Thermodynamics laws (Concept of entropy, Enthalpy, standard free energy, Colligative properties (Osmotic pressure freezing point and boiling point).	

	4. Gibb's free Energy	
	Unit Outcomes: UO-1 Justify the Biomolecules and their interactions	
II	**Structure and Functions of Biomolecules**	**11**
	1. Composition, structure, types and function of biomolecules: a. Carbohydrates b. Lipids c. Amino acids d. Peptide Bonds 2. Proteins (Primary, Secondary tertiary and quaternary structure) Conformation of Protein (Ramachandran plot, secondary structure, domains, motif and folds) 3. Nucleic acids. Nucleotides Conformation of nucleic acids (A B, Z DNA), RNA	
	Unit Outcome: UO-1 Correlate the molecular architecture of Biomolecules	
III	**Enzymology**	**12**
	1. Introduction, Properties, Enzymes classification, vitamins as co-enzymes, Principles of catalysis and Enzyme kinetics (MM equation,) 2. Types of Enzymes (Alloenzymes, isoenzymes, Apo enzymes, Ribozymes) 3. Types of Enzyme inhibition, (Competitive, noncompetitive and uncompetitive) 4. Allosteric enzyme regulation.	
	Unit Outcome: **1)** UO-1. Examine the role of enzymes in control of metabolism.	
IV	**Metabolism**	**11**
	1. Metabolism of carbohydrates (Gluconeogenesis), nucleotides Biosynthesis (De novo and salvage pathway) 2. General pathway of Lipid metabolism 3. General pathway of Amino acid metabolism\	
	Unit Outcomes: UO-1. Examine the Biochemical and Metabolic processes of cell	

Learning Resources:

1. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologism Maryland, USA Buchanan B.B, Gruissem W. and Jones R.L 2000.
2. Plant Metabolism (Second Edition) Longman, Essex, England. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Lay Zell D.B. (eds)1997.
3. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA. Gallstone A.W. 1989.
4. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA. Moore T.C.1989.
5. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA. Nobel P. S1999.
6. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA. Salesbury F.B and Ross C.W 1992.
7. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA. Taiz L. and Zeiger E. 1998.
8. A.T. B of Plant Physiology, Biochemistry and Biotechnology, Chand Publications. Verma S.K. and Verma Mohit 2007.
9. Principles of Biochemistry, CBS Publishers and Distributers (Indian Reprint) Leininger.
10. Fundamentals of Biochemistry, Dr. J. L Jain Dr. Sanjay Jain Nitin Jain S Chand Publication revised edition.
11. Textbook of Plant Physiology, Biochemistry and Biotechnology Dr. S.K. Verma, Mohit Verma S Chand publication.
12. Plant Physiology and Biochemistry by H. S. Srivastava.
13. Plant Biochemistry- Dr.V. Arunkumar Dr. N. Senthilkumar Dr. K. Sivakumar.
14. Plant Biochemistry -G. Nagaraj.
15. Biochemistry -U. Satyanarayana U. Chakrapani.
16. Biochemistry -C.B. Powar, G.R. Chatwal Himalaya Publishing House.
17. Fundametals of Plant Biochemistry and Biotechnology -N. K. Gupta, Sunita Gupta.
18. Plant Biochemistry -Dr. J.P. Kilkar.
19. Biochemistry -Pankaja Naik 4th edition.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: Lab Course

Course Title: Lab Course III (Based on MSC-III)

Course Code: 601BOT1106

Credit: 01 **Hours: 30**

Learning Objectives:

LO-1 To familiarize the students with techniques of biochemistry.

LO-2 To study the estimation methods of biomolecules.

LO-3 To provide the students hands on isolation of DNA, RAN and Proteins.

Course outcomes:

After completion of course, Students are able to:

LO-1 Find out the various biomolecules.

LO-2 Distinguish DNA, RNA and Proteins.

LO-3 Justify structural aspect of Biomolecules.

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1. Quantitative estimation of protein by Foline -Lowry method.
2. Quantitative estimation of protein by Bradford reagent method.
3. Isolation of DNA from various sources.
4. Isolation of RNA from yeast tablets.
5. Estimation of DNA using Diphenyl Amine reagent.
6. Estimation of RNA by orcinol reagent.
7. Estimation of total Amino acid in Germinating and Non-germinating seeds.
8. Qualitative detection of Amino acid.
9. Estimation of total soluble sugars.
10. Effect of substrate concentration pH on enzyme activity.
11. Effect of pH on enzyme activity.
12. Estimation of Ascorbic acid in ripe and unripe fruits.

N.B: 1) Any ten Practicals from above list

2) Several Short Excursions, field visit and at least one Long Excursion.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MEC-I (A)

Course Title: Instrumentation and Biostatistics

Course Code: 601BOT1201

Credits: 03 **Hours: 45**

Learning Objectives

LO-1 To focus on application of instruments in research.

LO-2 To understand the complex optical devices, key concept and application.

LO-3 To obtain most conclusive results.

LO-4 To know that mixtures are composed of constituents which are not combined.

LO-5 To apply methods of distillation, filtration, evaporation, sieving to separate mixture.

LO-6 To store and process biological data.

LO-7 To provide platform to develop computational biological methods.

LO-8 To use the exact methods used to calculate the relation between biological data

Course Outcomes:

After completion of course, Students are able to:

CO-1 Examine principal, working and functions of different bio- instruments.

CO-2 Examine principal, working and functions of different laboratory techniques

CO-3 Justify the methods of biostatistics.

CO-3 Explain the applications of biostatistics in biological research.

Unit No.	Title of Unit & Contents	Hrs.
I	**Microscopy and Spectroscopy**	**10**
	1. Microscopy: a. Light microscope, Introduction, Principle and working b. Compound microscope, Stereo microscope, Phase contrast microscope c. Electron microscope: TEM, SEM, (image processing method and staining technique) d. Flow cytometry 2. Spectroscopy: UV-visible and IR spectrophotometry, NMR & mass	

	spectrometry	
	Unit Outcomes: UO-1 Examine principal, working and functions of different bio-instruments.	
II	**Laboratory Techniques-I**	**12**
	1. **Separation Techniques:** Centrifugation Basic principles of centrifugation, types, care and safety aspects of centrifuges, preparative and analytical centrifugation 2. **Chromatographic Techniques:** Principles, paper, Thin layer chromatography (TLC), HPLC, GC. 3. **Electrophoretic Techniques:** General principles Support media, Electrophoresis of Proteins (SDS PAGE) and nucleic acids (PAGE), 4. **Agarose electrophoresis Culture Techniques:** Principles, types (bacterial, fungal) media preparation, Sterilization and Inoculation.	
	Unit Outcome: UO-1 Examine principal, working and functions of different laboratory techniques.	
III	**Laboratory Techniques-II**	**12**
	1. **Biochemistry Laboratory:** Laboratory discipline, safety and care, experimental report, SI unit, pH and Buffers 2. **Microtomy:** Principle of tissue fixation for microtomy, types of microtome's, Serial sectioning and staining 3. **Radioactive Techniques:** Isotopes and their half-life and biological half-life Specific activity of radioisotopes, making radioisotope solutions	
	Unit Outcome: UO-1. Examine principal, working and functions of Microtomy and radioactive techniques	
IV	**Laboratory Techniques-III**	**11**
	1. Computers in Biology: Modern computers, tissue in biological	

	science, Internet **2. Biostatistics:** a. Measures of central tendency and dispersal b. Probability distributions (Binomial, Poisson and normal) c. Regression and Correlation d. t-test; Analysis of variance; X	
	Unit Outcomes: **1.** UO-1. Explain the applications of biostatistics in biological research	

References Book:

1. Instruments of chemical analysis by H. Kaure
2. Fundamentals of Biochemistry by J L Jain and Nitin Jain
3. Textbook of Biochemistry by N. Jeya Shanthi
4. Instrumental methods of chemical analysis by Tatwal Anand
5. Fundamentals of Biochemistry by AC Deb
6. Bioinstrumentation by Veera Kumari
7. Biological instrumentations and methodology by P.K.Bajpai
8. Fundamentals of Biochemistry for Medical Students by Ambika Shanmugam.
9. Practical Biochemistry: Principles and Techniques. Ed. E. Wilson and J.Walker (2000) Cambridge Publ.
11. Biomedical instrumentation and measurements -by Leslie Cromwell and others
12. Methods in Experimental Biology. - Ralph, R. (1975). Blakie, London
13. An Introduction to Biometry- Mungikar, A. M. (1997), Saraswati Printing Press Aurangabad.
14. Biostatistics by khan and Khanum
15. Analytical quantitative methods in microscopy – G. A. Meek and H. Y. Elder
16. Microscope photometry – Horst Piller
17. Biological Ultrastructure – A. Engstrom and J. B. Finean
18. Techniques in Photomicrography – Brain and Ten Cate
19. Photomicrography: A comprehensive treatise – Roger P. Loveland.
20. Laboratory techniques in Botany – M. J. Purvis and D. C. Collier and D. Walli
21. Techniques and methods in biology by Ghatak K.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MEC-I (B)

Course Title: Plant Physiology

Course Code: 601BOT1202

Credits: 03 **Hours: 60**

Learning Objectives:

LO-1 To study different mechanism used for water transport**.**

LO-2 To study the role of secondary metabolites in plant defense.

LO-3 To learn the various physiological processes of plant.

LO-4 To study the Photoperiodism, biological clocks and stress biology

Course Outcomes:

After completion of course, Students are able to:

CO-1 Explain the different mechanism used for water transport.

CO-2 Correlate the plant defense and secondary metabolites.

CO-3 Justify the various physiological processes of plant.

CO-4 Examine the Photoperiodism, biological clocks and stress biology.

Unit No.	Title of Unit & Contents	Hrs.
I	**Plant Water Relation**	**13**
	1. Soil and plant water uptake, water and its role in plants, properties and functions of water in the cell water relations,water potential of plant cells. 2. Mechanism of water uptake by root, transport in root, aquaporins, movements of water in plants, Micorrhizal association on water uptake. 3. Water loss from plants: Evapo-transpiration. Transpiration, driving force for transpiration, Plant factors influencing transpiration rate. 4. Stomata: Structure and function, mechanism of stomatal movement and antitranspirants. 5. The role of mineral nutrition in plant metabolism:Essential elements,	

	classification based on functions of elements in plants.	
	Unit Outcome: UO-1. Explain the different mechanism used for water transport	
II	**Nitrogen Metabolism and Respiration**	**10**
	1. Nitrate and ammonium assimilation; amino acid biosynthesis. 2. Nif gene, nod gene-Structure, function and regulation. 3. Enzymes-Structure, function and kinetics. 4. Glycolysis, Citric acid cycle; electron transport and ATP synthesis; alternate oxidase	
	Unit Outcome: UO-1. Justify the various physiological processes of plant	
III	**Plant Hormones**	**11**
	1. Biosynthesis, storage, breakdown and transport; physiological effect and mechanisms (Mode) of action. 2. Post-Harvest Technology: Physiological changes during ripening, fruit preservation and role of Ethylene in post-harvest technology. 3. Senescence: Factors influencing senescence, ripening and post life of flower, vegetables and seeds. Molecular mechanism of senescence and ageing, senescence associated genes. 4. Importance of seed, seed structure and function, physiological and biochemical changes during seed and fruit development and abortion. 5. Defense mechanism and secondary metabolites 6. Structure, function and mechanisms of action of a. Phytochromes. b. Crypotchromes. c. Phototropins.	
	Unit Outcome: UO-1. Correlate the plant defense and secondary metabolites	
IV	**Sensory and Stress Biology**	**11**
	1. Stomatal movement. 2. Photoperiodism and biological clocks. 3. Vernalization 4. Drought- characteristic features, water potential in the soil- Plant air continuum, Development of water deficits, energy balance concept. 5. Molecular response to water deficit: stress perception, Expression of regulatory genes and significance of gene products.	

	6. Stress and hormones: ABA as a signaling molecule, Cytokinin as a negative signal. 7. Oxidative stress: Oxidative stress- ROS, Role of scavenging system	
	Unit Outcome: UO-1 Examine the Photoperiodism, biological clocks and stress biology.	

Learning Resources:

1. Chopra, V.L. & Paroda, R.S. 1988. Approaches for incorporating drought and salinity resistance in crop plants, Oxford & IBH Publishing Co. Pvt. Ltd., ND
2. Treshow, M. 1970. Environment and plant response, Mc Graw Hill, NY
3. Taiz, L. and E. Zeiger. 2002. Plant Physiology, 3rd ed. Sinauer Associates Inc Publishers Massachusetts.
4. Nilsen, L. & Orcutt, 1998. Physiology of plants under stress : Abiotic factors, John Wiley & Sons, Inc., USA
5. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins (Paperback),~ Nicholas C. ,Price,Nicholas C. Price (Author), Oxford 1999.

Course Type: Laboratory Course (A)

Course Title: Laboratory Course-IV (Based on MEC-I)

Course Code: 601BOT1203

Credit: 01 **Hours: 30**

Learning Objectives:

LO-1 To practically expose the students with Microscopy, spectroscopy and chromatography.

LO-2 To study the principles and working of bioinstrumentation.

LO-3 To provide the students hands on experience with separation of biomolecules.

Course outcomes:

After completion of course, Students are able to:

CO-1 Explain the use of bioinstrumentation.

CO-2 Describe Molarity, Normality, Percentile solutions.

CO-3 Justify structural aspect of Proteins & Nucleic acids.

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1. Preparation of Standard solutions, %, M, N, PPM, PPB
2. Determination of Absorption spectra using UV-VIS spectrophotometer. (Protein / Nucleic acid)
3. Separation of Nucleic acid using Agarose gel Electrophoresis
4. Separation of Amino acid using paper Chromatography
5. Separation of plant pigments using thin layer chromatography
6. Separation of proteins using SDS-PAGE (Demonstration)
7. Demonstration and working of HPTLC
8. Study the principle and working of compound Microscope
9. Study the principle and working of pH meter / colorimeter / spectrophotometer and centrifuge
10. Preparation of permanent double stained slides of plant material with the help of microtomy
11. Problems based on X^2 – Test
12. ANOVA use of computers
13. pH – measurements and preparation of buffers
14. Verification of Beer and Lamberts law
15. Micrometry

16. Study of instruments – Radioactive counters, X-ray diffraction, NMR, GC, HPLC, SEM, TEM, Fluorescence microscopy

17. Accessing biological data bases / Email operation

N.B: 1) Any Ten Practicals from above list.

2) Several Short Excursions, Field visits and at least one Long Excursion

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: Laboratory Course (B)

Course Title: Laboratory Course-IV (Based on MEC-I)

Course Code: 601BOT1203

Credit: 01 **Hours: 30**

Learning Objectives:

LO-1 To learn the concepts of seed viability and Methods of seed dormancy.

LO-2 To study the effect of photosynthetic rate using various wavelengths of light.

LO-3 To quarried knowledge of effect of light intensity on oxygen evolution in photosynthesis.

LO-4 To know the practical applications of growth regulators.

Course outcomes:

After completion of course, Students are able to:

LO-1 Explain the concepts of seed viability and dormancy.

LO-2 Correlate the effect of photosynthetic rate using various wavelengths of light.

LO-3 Justify the effect of light intensity on oxygen evolution in photosynthesis.

LO-4 Examine the role of growth regulators on development of plant.

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1. Preparation of stock solutions
2. Measurement of transpiration by Ganong's photometer.
3. Measurement of transpiration by Cobalt chloride method
4. Measurement of photosynthetic rate using various wavelengths of light.
4. Determination of stomatal index and stomatal frequency in leaves.
5. Determination of seed viability and vigour test
6. Study of methods of breaking seed dormancy.
7. Demonstration of the effect of auxins on rooting.
8. Demonstration of Hills reaction.
9. Demonstration of root respiration
10. Determination the osmotic potential of cell sap by plasmolysis method
11. Study of effect of light intensity and bicarbonate concentration on oxygen evolution in photosynthesis.

N.B: 1) Any Ten Practicals from above list.

2) Several Short Excursions, Field visits and at least one Long Excursion

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: RMC

Course Title: Research Methodology

Course Code: 601BOT1301

Credits: 04 **Max. Marks: 100** **Lectures: 60 Hrs.**

Learning Objectives:

LO1. To enable to student to understand and work methods and concepts related Research.

LO2. To enable the student to develop research proposal and to work with research problem.

LO3. To develop broad comprehension of research area.

Course Outcomes:

After completion of course, the student will be able to-

CO1. Examine the basic aspects of Research methods

CO2. Apply and integrate the basic concepts Collection and analysis of data.

CO3. Know the of report writing and evaluation methods.

CO4. Examine the plagiarism by using various apps.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Methods of Research**	**15**
	1. Meaning of Research, Objectives of Research, Types of Research, 2. Research Approaches, Significance of Research, Research Methods Versus Methodology, Research and Scientific Methods, 3. Research Processes, Criteria for Good Research 4. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques Involved in Defining a Problem	
	Unit Outcome: UO1. Examine the basic aspects of Research methods	
II	**Research Design and Sampling**	**15**
	1. Meaning and Need for Research Design, Features of A Good Design. 2. Important Concepts Relating to Research Design: Dependent and Independent Variables, Extraneous Variables, Control, Research Hypothesis, Experimental and Non-Experimental Hypothesis –Testing Research, Experimental and Control Group	

	3. Different Research Designs: Research Design in Case of Exploratory Research Studies, Research Design in Case of Hypothesis- Testing Research Studies, Basic Principles of Experimental Designs, Important Experimental Designs 4. Sampling Design, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of A Good Sample Design, Different Types of Sample Design	
	Unit Outcome: UO1. Apply and integrate the basic concepts Collection and analysis of data.	
III	**Data Collection and Data Processing**	**15**
	1. Measurements in Research, Measurement Scales, Sources of Errors in Measurement. 2. Collection of Primary Data: Observation Method, Interview Method, Through Questionnaires, Through Schedules, Difference Between Questionnaire and Schedule 3. Collection of Secondary Data, Selection of Appropriate Methods for Data Collection, Case Study Method 4. Data Processing, Processing Operations: Editing, Coding, Classification, Tabulation, Graphical Representation, Types of Analysis, Statistical Tools and Techniques Of Data Analysis-Measures Of Central Tendency, Dispersion.	
	Unit Outcome: UO1. Know the of report writing and evaluation methods	
IV	**Report Writing and Evaluations**	**15**
	1. Principles of Report Writing and Guide Lines According to Style Manuals. 2. Writing and Presentation of Preliminary, Main Body and Reference Section of Report. 3. Evaluation of Research Report. 4. Methods to Search Required Information Effectively, Reference Management Software Like Zotero/ Mendeley, Software for Paper Formatting Like Latex/ MS Office. 5. Software for Detection of Plagiarism.	
	Unit Outcome: UO1. Examine the plagiarism by using various apps.	

Learning Recourses: -

1. Bajpai S. R. (1975) Methods of Social Survey and Research, Kitabghar, Kanpur.
2. Hans Raj (1988) Theory and Practice in Social Research, Surjeet Publication, Kolhapur.
3. Krishnaswami O. R. (1988) Methodology of Research in Social Science, Himalaya Pub. House.
4. Sadhu, Singh, Research Methodology in Social Science Bhandarkar, Research Methodology
5. Kothari, C. R. (2005) Quantitative Technique, New Delhi, Vikas Publication House.
6. Gautam, N. C. (2004) Development of Research tools, New Delhi, Shree Publishers.
7. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
8. Chandera A. and Sexena T. P. (2000) Style Manual, New Delhi, Metropolitan Book Comp. Ltd.
9. Shukla, J. J. (1999) Theories of Knowledge, Ahmadabad, Karnavati Publication.
10. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.
11. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
12. Best J. W. and Khan J. V. (2005) Research in Education New Delhi, Prentice Hall India.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: DSC-IV

Course Title: Diversity of Pteridophytes, Gymnosperms, and Fossil Plants

Course Code: 601BOT2101

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To study evolutionary trends of cryptogams and Gymnosperms.

LO-2 To study the connecting links between Pteridophytes and Gymnosperms

LO-3 To study the morphology, anatomy and of Pteridophytes & gymnosperms.

LO-4 To provide the of the conceptual knowledge about fossil plants to the students.

LO-5 To aware the students about importance Pteridophytes & gymnosperms

Course Outcomes:

After completion of course, Students are able to:

CO-1 Differentiate between the characteristics of Pteridophytes & Gymnosperms living forms.

CO-2 Examine the stellar evolution, heterospory and seed habit.

CO-3 Compare the life form, structure, reproduction and significance of Pteridophyte, Gymnosperm and Fossil Plants etc.

CO-4 Explain the Principles of Paleobotany and Paleopalynological techniques.

Unit No.	Title of Unit & Contents	Hrs.
I	**Pteridophytes-I**	**10**
	1. Introduction and characteristic features. Diversity of Pteridophytes in India and their migration to land. Affinities of Pteridophyte with Bryophyte and Algae **2.** Recent systems of classification of Pteridophytes **3.** Comparative morphology, reproduction and phylogeny of following orders with reference to the forms mentioned against each**:** Psilotales (*Tmesipteris*), Lycopodiales (*Lycopodium*), Filicales (*Adiantum*), Equisitales (*Equisetum*), Salviniales (*Salvinia*)	
	Unit Outcome:	

	UO-1 Differentiate between the characteristics of Pteridophytes & Gymnosperms living forms	
II	**Pteridophytes -II**	**12**
	1. Apogamy and Apospory **2.** Telome concept **3.** Stelar evolution **4.** Soral evolution **5.** Gametophyte evolution **6.** Heterospory and seed habit **7.** Economic importance of Pteridophytes	
	Unit Outcome: UO-1 Examine the stellar evolution, heterospory and seed habit	
III	**Gymnosperms**	**11**
	1. Characteristic features of Gymnosperms **2.** Recent system of classification (S.P. Bhatnagar and Alok Moitra) **3.** Study of morphology and reproduction Cycadales (*Zamia*), Coniferales (*Pinus*), Gnetales (*Gnetum*), Ephedrales (*Ephedra*) **4.** Gymnosperms as prospective ancestor of Angiosperms **5.** Economic importance of gymnosperms	
	Unit Outcome: **1.** UO-1. Compare the life form, structure, reproduction and significance of Pteridophyte, Gymnosperm and Fossil Plants etc.	
IV	**Paleobotany**	**12**
	1. Introduction Evolution time scale **2.** Principles of Paleobotany: Petrification, Impression and Compression **3.** Indian fossil flora –Glossopteris flora, Rajmahal hill flora and Deccan Intertrappean flora **4.** Paleopalynological techniques- Coal maceration and Lignite maceration **5.** Study of morphology and evolutionary trends of: • Bennettitales • Cycadales • Coniferales **6.** Economic importance	
	Unit Outcome: UO-1. Explain the Principles of Paleobotany and Paleopalynological	

	techniques	

Learning Recourses:

1. Advances in Pteridology- Trivedi, A. N. (2002)
2. Morphology of Vascular plants- Bierhorst, D.W. (1971)
3. Comparative morphology of vascular plants- Eames, A. J. and E. M. Giffard (1950)
4. An introduction to Pteridophytes- Rashid, A. (1978)
5. Morphology of Pteridophytes- Sporne, K.R. (1966)
6. The Ferns- Bower, F. O. (1963)
7. The Phylogeny and Classification of ferns- Jermy, A. G. (1973)
8. Botany for degree students – Pteridophytes- Vashishta, B.R. (1996)
9. An Introduction to Pteridophyte- Parihar, N.S. (1959)
10. An introduction to paleobotany- Arnold, C.A. (1972)
11. Principles of paleobotany- Darah, W.C. (1968)
12. Indian Fossil Pteridophytes- Surange, K.R. (1968)
13. Introduction to palaeobotany, Mc-Graw Hill, Arnold, C.A. (1947)
    Book Co. Inc., New York and London.
14. Pteridophytes and Gymnosperms, springer Verlag, New York Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.
15. The Gymnosperms, Narosa Biswas, C & Johri, B.N. (2004), Publishing House, New Delhi.Coulter J.M. & Chamberlain C. J..(1978)
16. Morphology of Gymnosperms-Central Book Depot, Allahabad. Kakkar, R.K. and Kakkar, B.R. (1995)
17. The Gymnosperms (Fossils& Living), Central Publishing House, Allahabad.Sharma O.P. (2002)
18. Gymnosperms, Pragati Prakashan, Meerut.
19. Gymnosperms. S Chand. Vashishta P.C., A.R. Sinha, Anil Kumar. 2006
20. Pteridophytes. S. Chand Vashishta P.C. 2006.
21. Biology and Morphology of Pteridophytes. Central Book Depot Allahabad Parihar N.S. 1996.
22. A Textbook of Bryophytes, Pteridophytes, Gymnosperm and Paleobotany Chittaranjan Mohanty
23. Diversity of Pteridophytes, Gymnosperms and Elementary Paleobotany by Satish Kumar

Journals

1. American Fern Journal.
2. International Journal of plant sciences.
3. Morphology of vascular plants- Bierhorst, D.W. (1971)
4. Gymnosperms, Structure and Evolution-Chamberlein, C.J. (1966)

5. Morphology of Gymnosperms-Coulter and Chumberlein, J. M.
6. Comparative morphology of vascular plants -Foster, A. S. and Gifford, E. M. (1959)
7. Indian Gymnosperms in Time and Space- Ramanujan, C.G.K. (1979)
8. Morphology of Gymnosperms-Sporne, K.R. (1967)
9. The Gymnosperms-Vasishta, P.C. (1976) Bhatnagar, S.P. and MoitraAlok (1996)- The Gymnosperms.
10. - An Introduction to Paleobotany-Arnold, C. A. (1972)
11. Studies in Paleobotany.-Andrews, H.N. (1961)
12. - Principles of Paleobotany- Darroh, W.C. (1960) Surange, K. R. (1968) - Indian Fossil Pteridophytes.
13. Essentials of Paleobotany. Shukla, A.C. and Mishra, S.D. (1975) Bhatnagar, S.P. and MoitraAlok (1975) - The Gymnosperms.

Course Type: Laboratory Course

Course Title: Laboratory Course-V (Based on DSC-IV)

Course Code: 601BOT2104

Credits: 01 **Hours: 30**

Learning Objectives:

LO-1 To study the evolution of stele in Pteridophytes.

LO-2 To study the heterospory and seed habit.

LO-3 To study the maceration techniques.

Course outcomes of laboratory course:

After completion of course, Students are able to:

CO-1 Classify Pteridophytes and Gymnosperms on the basis of external feature.

CO-2 Distinguish between reproductive stages of Pteridophytes and Gymnosperms.

CO-3 Arrange systematic position of Pteridophytes and Gymnosperms.

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1. Study of morphological, anatomical (double stained slide permanent slide) and reproductive structures of *Tmesipteris*
2. Study of morphological, anatomical (double stained slide permanent slide) and reproductive structures of *Lycopodium*
3. Study of morphological, anatomical (double stained slide permanent slide) and reproductive structures of *Adianntum*
4. Study of morphological, anatomical (double stained slide permanent slide) and reproductive structures of *Equisetum*
5. Study of morphological, anatomical (double stained slide permanent slide) and reproductive structures of *Salvinia*
6. Study of the morphology and anatomy (double stained slide permanent slide) of the vegetative and reproductive structures of *Gnetum*
7. Study of the morphology and anatomy (double stained slide permanent slide) of the vegetative and reproductive structures of *Zamia*.
8. Study of the morphology and anatomy of the vegetative and reproductive structures of *Pinus.*
9. Study of the morphology and anatomy (double stained slide permanent slide) of the vegetative and reproductive structures of *Ephedra*.

10. Study of Maceration Techniques.
11. Study of Fossils specimens (Any two as per available material)

N.B: 1) Any Ten Practicals

2) Several Short Excursions and at least one Long Excursion.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MSC-V

Course Title: Plant Physiology and Metabolism

Course Code: 601BOT2102

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To increase awareness and appreciation for plants in your environment, as well as to understand their diverse physiological functions.

LO-2 To help you understand the role of plant physiology in the botanical sciences.

LO-3 To introduce you to some methods and techniques used in plant physiological research.

LO-4 To help you develop the knowledge and confidence to pursue advanced courses in plant biology, and to conduct your own plant physiology research.

LO-5 Demonstrate ways to measure environmental services accomplished by plants.

LO-6 Propose ways of using plants to preserve and improve urban, agricultural, rural, and wilderness environments.

LO-7 Explain and provide examples of how plants interact with light, water, soil and Other organisms and how humans can optimize those interactions.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Explain the various metabolic, physiological paths in plants.

CO-2 Justify the regulation of growth, development and influence of environment.

CO-3 Examine the soil plant relationship with reference to environmental factors and plant physiology.

CO-4 Correlate the function of secondary metabolite and plant hormones

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Unit No.	Title of Unit & Contents	Hrs.
I	**Transport and Translocation Mechanism**	**11**
	1. Solute transport and photo assimilates translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes,	

	through xylem and phloem, nutrient uptake through root microbe interaction; membrane transport proteins **2. Nitrogen metabolism:** i Root nodulation and nitrogen fixation ii Nitrogen uptake iii NOD factor	
	Unit Outcome: UO-1 Explain the various physiological paths in plants.	
II	**Stress Physiology and Senescence**	**11**
	1. Stress physiology: – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses **2. Senescence: Mechanism**, physiology of senescence; role of hormones, biochemical aspects, significance in fruit ripening	
	Unit Outcome: UO-1 Examine the soil plant relationship with reference to environmental factors and plant physiology	
III	**Photosynthesis**	**12**
	1. **Photosynthesis**: Evolution of photosynthetic apparatus, photooxidation of water, Hills reaction, two-pigment system, mechanism of electron and proton H+ transport 2. **Carbon assimilation pathways** in C3, C4 and CAM plants. Photosynthetic productivity in these plants, and significance **Photorespiration:** Glycolate pathway, Glyoxylate pathway, biochemical basis of photorespiration, significance	
	Unit Outcome: UO-1. Explain the various metabolic paths in plants.	
IV	**Plant Metabolism**	**10**
	1. **Secondary metabolites:** Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles 2. **Phytohormones:** Biosynthesis and mechanism of action of Phytohormones auxin, gibberellin, cytokinin, ethylene and ABA. Brassinosteriods, Jasmoic acids, Polyamines, salicylic acid.	
	Unit Outcome: UO-1. Correlate the function of secondary metabolite and plant hormones	

Learning Recourses:

1. Biochemistry and Molecular Biology of Plants: Buchanan B.B., Gruissem, W. and Jones, R.L. 2000. American Society of Plant Physiologists, Maryland, USA.
2. Life Processes in Plants: Galston, A.W. 1989. Scientific American Library, Springer-Verlag, New York, USA.
3. Biochemistry and Molecular Biology of Plant Hormones, Hookahs, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999. Elsevier, Amsterdam, The Netherlands.
4. Introduction to Plant Physiology: Hopkins, W.G. 1995. John Wiley& Sons, Inc., New York, USA.
5. Molecular Cell Biology (fourth edition): Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, Dand Darnell, J. 2000. W.H. Freeman and Company, New York, USA.
6. Biochemistry and Physiology of Plant Hormones (second edition). Moore, T.C. 1989. Springer-Verlag, New York, USA.
7. Physiochemical and Environmental Plant Physiology (second edition), Nobel, P.S., 1999. Academic Press, San Diego, USA.
8. Plant Physiology (4th edition), Wadsworth Publishing Co., California, USA, Salisbury, F.B. and Ross, C.W. 1992.
9. Concepts in Photobiology. Photosynthesis and Photomorphogenesis, Singhal, G.S., Renger, G., Sopory. S.K., Irrgang, K.D. and Govindejee 1999. Narosa Publishing House, New Delhi.
10. Plant Physiology (2nd edition): Taiz, L. and Zeiger, E. 1998. Academic Press, San Diego, U.S.A. Westhoff, P. (1998) Molecular Plant Development: from Gene to Plant. Oxford University Press, Oxford, UK.
11. Plummer, D.T. 1988. An Introduction to practical Biochemistry. Tata McGraw Hill Publishing Co. Ltd. New Delhi.
12. A Biologist Guide to Principles and Techniques: Wilson, K. and Goulding, K.H. (Eds), 1992. Practical Biochemistry (3rd Edition). Manas Saikia for Foundation Books, New Delhi.
13. Biochemical methods (2^{nd} Edition): Sadasivam, S. and Manickam A., 1996. New Age International Publishers New Delhi.
14. Modern Plant Physiology R. K. Sinha 2^{nd} edition.
15. Plant Physiology Kumar /Purohit 2^{nd} edition.
16. Plant Physiology and Metabolism Dr. K. N. Dhumal, V. K. Kadam, Dr. Sayyad Iliyas, Dr. R.N. Deshmukh.
17. Basics of Plant Physiology and Metabolism Dr. Arun Joshi 4^{th} edition.

Course Type: Laboratory Course

Course Title: Laboratory Course-VI (Based on MMC-V)

Course Code: 601BOT2104

Credit: 01 **Hours: 30**

Learning Objective:

LO-1 To study biochemical changes during leaf senescence.

LO-2 To study the role of growth hormone in plant physiology.

LO-3 To study the importance of secondary metabolites

Course outcomes:

After completion of course, Students are able to:

CO-1 Analyse the energy flow in plants.

CO-2 Interpret the different physiological phenomenon of plants.

CO-3 Recognize need of mineral nutrients by plants.

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1. Estimation of soluble proteins in germinating and non-germinating seeds by Lowry /Bradford's method
2. Estimation of total amino acids in germinating and non-germinating seeds
3. The identification of sugar in Fruit juices by TLC
4. Isolation of Chloroplast from spinach leaves
5. To study biochemical changes during leaf senescence
6. Effect of time and enzyme concentration on the rate of enzyme action(Any one)
7. Estimation of stress induced amino acid (Proline)
8. Estimation of total fats in fatty seeds
9. Separation of Alkaloids/Phenols by TLC
10. Estimation of Phenols by chemical method
11. Qualitative analysis of secondary metabolites
12. Sugar/ amino acids analysis with paper chromatography
13. Estimation of Chlorophylls

N.B: 1) Any Ten Practicals

2) Several Short Excursions and at least one Long Excursion

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Department of Botany

Course Type: DSC-VI

Course Title: Plant Structure, Development & Reproduction in Angiosperms

Course Code: 601BOT2103

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To describe reproductive structure of a plant and compare male and female gametophytes and explain how they form in Angiosperms.

LO-2 To describe the components of a complete flower.

LO-3 To compare and contrast life cycles of angiosperms, gymnosperms.

LO-4 To describe the structure and function of the flower within the angiosperm life cycle.

LO-5 To list and explain significance of steps in angiosperm gametogenesis and fertilization, including double fertilization.

LO-6 To explain significance of features or steps of seed maturation, dormancy, and germination.

LO-7 To predict mechanisms of pollination or dispersal based on flower or fruit characteristics.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Examine anatomy in relation to basic structure of plants and their developmental structure.

CO-2 Acquire knowledge about leaf, shoot and root development.

CO-3 Justify basic anatomical concept of primary structure of root stem and flower.

CO-4 Explain the principles of Palynology and its branches.

Unit No.	Title of Unit & Contents	Hrs.
I	**Process of Plant Development**	**10**
	1. Plant development- concept, definitions and unique features **2.** Processes of development, cell growth, organization of cells, tissues and tissue system to whole plant. Cell- cell interaction **3.** Factors for development- intrinsic and extrinsic	

	4. Vegetative development – structure and organization of seed embryo **5.** Seed formation and germination – Embryonal axis- meristems, establishment of seedling organ **6.** Phenomenon of development, meristems as dynamic centers of cell regeneration, organ development, primordium to organ, juvenility – characteristics, transition to adult phase.	
	Unit Outcome: UO-1 Acquire knowledge about leaf, shoot and root development.	
II	**Embryological aspects of Development**	**12**
	1. Transition - vegetative to reproductive phase, morphological and histochemical changes in vegetative plant body **2.** Gametophyte development, microsporogenesis and male gametophyte megasporogenesis and female gametophyte **3.** Fertilization – process and its significance abnormalities in fertilization **4.** Embryo development - Development of embryo in dicots and monocot, unclassified or abnormal embryos, unorganized or reduced embryo **5.** Polyembryony – concept and classification of polyembryony, special cases and causes of polyembryony, apomixes- concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis.	
	Unit Outcome: UO-1 Examine anatomy in relation to basic structure of plants and their developmental structure.	
III	**Molecular Basis of Plant Development**	**11**
	1. Plant hormones– Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action **2.** Organization of shoot and root apical meristem, shoot and root development, leaf development and Phyllotaxy **3.** Molecular basis of plant development - Embryogenesis and seedling development, root, shoot and leaf development, gene expression during transition to flowering and flower development molecular genetics of gametophytes development, expression of cell incompatibility **4.** Transition to flowering and flower development-ABC Model	
	Unit Outcome: UO-1. Justify basic anatomical concept of primary structure of root stem and	

	flower.	
IV	**Palynology**	**12**
	1. Palynology: Scope and branches with special suggested readings **2. Palynotaxonomy:** Pollen morphology and plant taxonomy with suggested readings: to Gymnosperms and Angiosperms **3. Paleopalynology:** Principles, microfossil recovery theory and techniques, microfossil groups and oil exploration **4. Aeropalynology:** Principles, techniques, pollen analysis, pollen and spore allergy, allergic properties of pollen, pollen calendar and importance **5. Aeropalynology:** Pollen viability, pollen germination, pollen storage and them Significance **6. Melitopalynology:** Bee colony, foraging behavior of bees Unfloral multifloral honey, application in crop productivity	
	Unit Outcome: UO-1. Explain the principles of Palynology and its branches	

Learning Recourses:

1. Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. Vikas Pub. House.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms.
3. Kluwer Academic Publishers.
4. Fahn A (1989) plant anatomy (Third edition) Pergamon Press.
5. Gilbert (2006). Developmental biology (8thEdition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
6. Graham C.F. and Wareing P.F. (1984). Developmental Controls in Animals and Plants.
7. Blackwell Scientific Publications.
8. Jermy Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press.
9. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
10. Krishnamurthy. (1988) Methods in Plant Histochemistry.
11. Lewis Wolpert (2002), Principles of Development (2nd edition). Oxford University Press.
12. Lyndon R.F. (1990) Plant Development the Cellular Basis. UNWIN HYMAN.

13. Raghavan V. (2000) Developmental Biology of Flowering Plants. Springer Verlag.
14. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.
15. Wareing P. F. and Philips I. D. J. (1981) Growth and Differentiation in plants. Pergamon Press.
16. Wada M., Shimazaki K., Iino M. (2005). Light sensing in plants. Springer.
17. Davies P. J. (2004) Plant hormones. Kluwer.
18. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. Americal Society of Plant Physiology, Marylan

Shiv Chhatrapati Shikshan Sanstha's

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Department of Botany

Course Type: Laboratory Course

Course Title: Laboratory Course-VII (Based on MMC-VI)

Course Code: 601BOT2106

Credit: 01 **Hours: 30**

Learning Objective:

LO-1 To study the reproductive structures of Angiosperms.

LO-2 To study the growth pattern in reproductive structure.

LO-3 To study the nutritive tissue and its types.

Course outcomes of laboratory course:

After completion of course, Students are able to:

CO-1 Differentiate various tissues.

CO-2 Perform sectioning of various ovules.

CO-3 Develop approach for embryology study

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1. Isolation of vegetative and reproductive apical meristem
2. Tracing the course of stomatal development and observations on stomatal types
3. Anatomical studies on secondary growth (wood)
4. Origin and development of epidermal structures (Trichomes, glands and lenticels) and study of secretary structures (nectarines and laticifers)
5. Histochemical comparison between vegetative SA and reproductively induced SA
6. Observations on Microsporogenesis and development of male gametophyte (pollen)
7. Observations on. Megasporogenesis and development of female gametophyte
8. Observations on types of endosperm, dissection and isolation of endosperm
9. Observations on stages of embryo development, dissection and isolation of developing embryo (3 stages)
10. In vitro germination of spore/pollen, Correlation between fertility (stain ability), viability (TTC and FDA staining) and germinability (in vitro) of pollen grains
11. Histological analysis of secondary growth (Primary or secondary axis)
12. Dissection of haustorial endosperm
13. Dissection of an embryo of dicot and monocot

N.B: 1) Any ten Practicals form the above list.

2) Several Short Excursions, field visits and at least one Long Excursion.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MSE-II

Course Title: Plant Ecology and Evolution

Course Code: 601BOT2201

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To create awareness among students about bio resource conservation.

LO-2 To provide scientific basis for aims of environmentalism.

LO-3 To understand dynamics of our surrounding and conserve it.

LO-4 To understand trend of evolution among living organisms.

LO-5 To provide students with an understanding of the basics of plant-environment and their interaction with other organisms.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Justify the concept if niche and species interaction.

CO-2 Explain the mechanism of genetic drift, adaptive radiation and species isolation.

CO-3 Correlate the Characteristics of population, Community and ecological succession.

CO-4 Examine the trend of evolution among living organisms.

Unit No.	Title of Unit & Contents	Hrs.
I	**Environmental Ecology**	**12**
	1. **Habitat and Niche:** Concept of habitat and niche; (niche width and overlap; fundamental and realized niche; resource partitioning; character displacement) 2. **Interaction types:** Plant interaction with abiotic factors such as climatic, edaphic, and topographic factors Plant-plant interaction concept of allelopathy. Species interaction: mutualism, commensalism, competition, parasitism and predation 3. **Conservation Biology:**	

	i. Principles of conservation, MMC approach to management ii. Organisms of conservation concern: Rare, endangered species	
	Unit Outcome: UO-1 Justify the concept if niche and species interaction.	
II	**Population and Community Ecology**	**10**
	1. **Population Ecology:** Characteristics of a population; population growth curves; population regulation, life history strategies (r and K selection); concept of metapopulation-demes and dispersal, age structure populations 2. **Community Ecology:** Nature of communities; community structure and attributes; level of species diversity and its measurement 3. **Diversity types and levels:** Alpha, Beta, Gamma 4. **Ecological Succession:** Types; mechanisms; changes involved in succession, concept of climax.	
	Unit Outcome: UO-1 Correlate the Characteristics of population, Community and ecological succession.	
III	**Evolutionary Biology**	**11**
	1. **Emergence of evolutionary thoughts:** Lamarck; Darwin-concepts of variation, adaptation struggle, fitness and natural selection; Spontaneity of mutations; the evolutionary synthesis 2. **Origin of cells and unicellular revolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparone and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes 3. **Paleontology and Evolutionary History:** The evolutionary time scale; Eras, Lectures and epoch; MMC events in the evolutionary time scale	
	Unit Outcome: UO-1. Examine the trend of evolution among living organisms	
IV	**Molecular Evolutionary Biology**	**12**
	1. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; origin of new genes and proteins 2. **The Mechanisms:** Population genetics- Populations, Gene pool, Gene frequency; Hardy- Weinberg Law; concepts and rate of change in gene	

	frequency through natural selection, Migration and random genetic drift, Adaptive radiation. 3. Isolating mechanisms; Speciation, Allopatric and Sympatric; Convergent evolution; Sexual selection, Co-evolution	
	Unit Outcome: UO-1. Explain the mechanism of genetic drift, adaptive radiation and species isolation.	

Learning resources:

1. Patterns of primary production in the biosphere. H.F.W. Lieth (1978).
2. Fundamentals of Ecology. Agarwal S. K. (1992).
3. The Biosphere. Bradbury I. K. (1990)
4. Handbook of Limnology and water pollution with practical methodology Das S. M. (1989).
5. Environment and Plant Ecology. Etherington J. R. (1975).
6. Deterministic mathematical models in population ecology. Freedman H. I.(1980).
7. Quantitative Plant Ecology. Greig Smith P. (1983).
8. Comparative Plant Ecology. Grisms J. P. et .al (1988).
9. Quantitative and dynamic ecology. Kershaw K. S. (1964).
10. Concept of ecology. Kormondy E. J. (1966).
11. Ecology. Krebs C. J. (1978).
12. Manual of plant Ecology. Misra K. C. (1989).
13. Proceedings of the school of plant ecology. Misra R. and Das R. R. (1971).
14. Ecology. Odum E. P. (1971).
15. Fundamentals of Ecology. Odum E. P. (3rd ed. 1996).
16. Fundamentals of Ecology. Odum E. P. and Gary W. Barrett (6th ed. 2010).
17. Principles of Environment Sciences. Pandeya S. C. et.al (1963).
18. On the Origin of Species. London: John Murray (always seek out the first edition, facsimile version, and avoid later editions). Darwin, C. 1859
19. Genetics and the Origin of Species. New York: Columbia Univ. Press (there are several later editions, and the title changed in the last). Dobzhansky, T. 1937.
20. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press (there is a later edition). Fisher, R. A. 1930.
21. Phylogenetic Systematics. Urbana: Univ. Illinois Press (an English translation of a book published earlier in German). Hennig, W. 1966.
22. Systematics and the Origin of Species. New York: Columbia Univ. Press (there is a later edition, with a different title). Mayr, E. 1942.

23. Factors of Evolution. Philadelphia: Blakiston (publication of this book, written in the early 1940's, was delayed because of war, and then the translation from Russian to English was also delayed; it has been reprinted by Univ. Chicago Press). Schmalhausen, I. I. 1949

24. Tempo and Mode of Evolution. New York: Columbia Univ. Press (again, there is a later edition, with a different title). Simpson, G. G. 1944.

25. A Textbook of Plant Ecology Including Ethnobotany and Soil Science by Dr. R.S.Shukla, Dr.P.S.Chandel S Chand Publication.

26. A Textbook of Plant Ecology by R.S.Ambasht , N.K.Ambasht 15th edition

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: MSE-II

Course Title: Taxonomy of Angiosperms

Course Code: 601BOT2102

Credits: 03 **Hours: 45**

Learning Objectives:

LO-1 To study the Principles and tools of Taxonomy

LO-2 To study the different classification systems.

LO-3 To learn Origin, evolution of agriculture and Plant domestication.

LO-4 To know the characteristic, classification and economic importance of some families of Angiosperms.

Course Outcomes:

After completion of course, Students are able to:

CO-1 Examine the principles and tools of Angiosperms

CO-2 Correlate the different classification systems.

CO-3 Explain Origin, evolution of agriculture and Plant domestication.

CO-4 Justify the characteristic, interrelationships, classification and economic importance of some families of Angiosperms.

Unit No.	Title of Unit & Contents	Hrs.
I	**Principles and tools of Taxonomy**	**12**
	1. Introduction, Botanical Nomenclature: Brief history, Scientific names, ICN, Principles 2. Adaptation and morphological peculiarities in Angiosperms 3. Tools of taxonomy: Floras, monographs, Herbarium and botanical gardens, their role in research and conservation. Important herbaria and botanic gardens of the World.	

	4. Floristics: Need and significance. History of botanical exploration in India and recent works with special emphasis on Maharashtra. 5. Morphological features used in identification. Artificial dichotomous keys Biodiversity, Types, Importance and methods of conservation	
	Unit Outcome: UO-1 Examine the principles and tools of Angiosperms	
II	**Classification Systems**	**10**
	1. Importance and need for classification. Criteria used for classification; phases of plant classification. Overview on pre and post-Darwinian systems of classification. 2. Artificial systems of classification –Theophrastus. 3. System of classification: Engler and Prantl's system, Hutchinson's system 4. Phylogenetic systems of classification - Cronquist 5. APG system of classification	
	Unit Outcome: UO-1 Correlate the different classification systems.	
III	**Evolution**	**11**
	1. Origin and evolution of agriculture: Introduction, food crops, centers of plant domestication of MMC crops, crop dispersal and distribution. 2. Plant domestication: Introduction, Evolution of farming, changes during domestication, genetic regulation of domestication syndromes. 3. Evolution of weeds, genetic diversity and domestication. Centers and threats to diversity. 4. Crop plants and their wild relatives: Cereal grains, legumes, starch plants, fruits, vegetables, fibers, cordage, medicinal plants, poisonous plants.	
	Unit Outcome: UO-1. Explain Origin, evolution of agriculture and Plant domestication.	
IV	**Families of Angiosperms**	**12**
	1. MMC clades in APG-IV: characteristic features, interrelationships, classification (APG-IV) and economic importance of families of angiosperms: Anagrade: Amborellaceae, Nymphaeaceae Magnoliids: Magnoliaceae	

	Monocots: Araceae Commelinoids: Arecaceae Probable Sister of Eudicots: Ceratophyllaceae Eudicots: Ranunculaceae Core Eudicots: Amaranthaceae Eurosids-I: Leguminosae Euasterids-I: Apocynaceae Euasterid-II: Asteraceae	
	Unit Outcome: UO-1. Justify the characteristic, interrelationships, classification and economic importance of some families of Angiosperms	

Learning Resources:

1. Briggs, David. 2009. Plant microevolution and Conservation in Human-influenced Ecosystems.Cambridge University Press.
2. Cooke, T. 1903-1908. The Flora of Presidency of Bombay, Vol. I-III.
3. Cronquist, A. 1981.An Integrated System of Classification of Flowering Plants. ColumbiaUniversity Press, New York.
4. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press,U.S.A.
5. Hickey, M. and King, C. 2000. The Cambridge Illustrated Glossary of BotanicalTerms. Cambridge University Press, UK.
6. Hutchinson, J. 1959. Families of Flowering plants. Clarendon Press, Oxford.
7. Jain S.K. and Rao R.R. 1976.Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.
8. Jones, S. B. and Luchinger A.E. 1986. Plant Systematics 2ndedn, McGraw Hill Book Co.
9. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. 2008.Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
10. Kubitzki, K. 1977. Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics – Evolution Supplement I.
11. Kuijt J. 1969. The biology of parasitic flowering plants.California University Press.
12. Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants.Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
13. Mabberly, T. J.2009. The Plant Book 2ndedn Cambridge University Press,Cambridge.
14. Manilal, K. S. and M. S. Muktesh Kumar [ed.] 1998.A Handbook of Taxonomic Training. DST, New Delhi.

15. Naik, V. N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
16. Nair, P.K.K. 1966. Pollen morphology of Angiosperms.Periodical Expert Book Agency, New Delhi.
17. Paech, K. and M.V. Tracey. 1956. Modern Methods of Plant Analysis. Vol-I & II.Springer-Verlag.
18. Quicke, Donald L. J. 1993. Principles and Techniques of Contemporary Taxonomy. BlakieAcademic & Professional, London.
19. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
20. Sharma A.K. and A. Sharma. 1980. Chromosome Technique: Theory and Practices (3rded.)Butterworths, London.
21. Shivanna, K.R. and N.S. Rangaswamy. 1992. Pollen Biology- A Laboratory Manual.Springer-Verlag.
22. Simpson, M.G. 2010.Plant Systematics. Elsevier, Amsterdam.
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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Botany

Course Type: Lab Course

Course Title: Lab Course VIII (Based on MSC-II)

Course Code: 601BOT2203

Credits: 01 **Hours: 30**

Learning Objective:

LO-1 To determination the of frequency, Density, Abundance and Dominance of the plant community.

LO-2 To evaluate of abiotic and biotic components of ecosystem.

LO-3 To study the importance of Phytoplankton

Course outcomes:

After completion of course, Students are able to:

CO-1 Interpret the biotic and abiotic components of ecosystem.

CO-2 Analyze the of BOD and DO.

CO-3 Recognize need of mineral nutrients flow in food chain.

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1. Study of Phytoplankton
2. Evaluation of Abiotic components of Aquatic ecosystem (pH, temperature and Transparency).
3. Determination of Phytomass
4. Study of species diversity index
5. Study of Population dynamics
6. Determination of field capacity of Soil
7. Estimation of primary productivity of an Aquatic ecosystem
8. Determination of residual chlorine from water sample
9. Determination of frequency, Density, Abundance, Dominance and IVI of the Plant Community
10. Estimation of DO and free CO_2
11. Study of morphological and anatomical characteristics of plants under pollution stages
12. Allelopathic analysis of the plants

13. Determination of Palmers algal index
14. Ecological reports based on tour or analysis

N.B: 1) Any Ten Practicals.

2) Several Short Excursions and at least one Long Excursion

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

PG First Year

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken Tutorial Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
Research Methodology	100	10	10	20	10	-	-	40	60	100
DSC/DSE	75	05	10	15	10	-	-	30	45	75
Lab Course	50	-	-	-	-	05	20	-	25	50
Field Project	100	10	10	20	10	-	-	40	60	100

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.