

**Sant Gadge Baba Amravati University, Amravati**

**FACULTY: Science and Technology**

**Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (M. Sc.) following Three Years UG Programme w.e.f. 2023-24**

**(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option**

**M. Sc. (Herbal Science) First Year Semester- I**

S. N.	Subject	Type Course	Subject Code	Teaching and learning scheme							Duration of Exam	Examination & Evaluation Scheme							
				Teaching periods per week				Credits				Maximum marks		Practical		Total Marks	Minimum Marks for passing		
				L	T	P	Total	L/T	Pract	Total		Theory Internal	Theory+ MCQ External	Internal	External		Internal	External	Grade
<b>0</b>	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively If students wish to opt Minor Course of UG as Major for PG, balance 12 Credits Course will have to be completed (As and when applicable)	<b>Th-Prq</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	Additional Credits to be earned = (1) minus (2) (1). Credits from Major DSC Courses in UG (minus) (2). The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG			<b>2</b>	<b>15</b>	<b>35</b>			<b>50</b>	<b>6</b>	<b>14</b>	<b>P</b>
<b>1</b>	<b>Research Methodology and IPR</b>	Th-Major		4			<b>4</b>	4		<b>4</b>	<b>3</b>	30	70			<b>100</b>	<b>12</b>	<b>28</b>	<b>P</b>
<b>2</b>	DSC I.1 Introduction to Herbal Science	Th-Major		4			<b>4</b>	4		<b>4</b>	<b>3</b>	30	70			<b>100</b>	<b>12</b>	<b>28</b>	<b>P</b>
<b>3</b>	DSC II.1 Taxonomy of Medicinal Plants	Th-Major		4			<b>4</b>	4		<b>4</b>	<b>3</b>	30	70			<b>100</b>	<b>12</b>	<b>28</b>	<b>P</b>
<b>4</b>	DSC III.1 Medicinal Plants Cultivation	Th-Major		3			<b>3</b>	3		<b>3</b>	<b>3</b>	30	70			<b>100</b>	<b>12</b>	<b>28</b>	<b>P</b>
<b>5</b>	DSE I 1. Phytochemistry and Pharmacognosy -I 2. Herbal Drug Technology- I	Th-Major Elective		3			<b>3</b>	3		<b>3</b>	<b>3</b>	30	70			<b>100</b>	<b>12</b>	<b>28</b>	<b>P</b>
<b>6</b>	DSC I.1 Lab- I	Pr-Major				2	<b>2</b>		1	<b>1</b>	<b>3</b>			25	25	<b>50</b>	<b>25</b>		<b>P</b>
<b>7</b>	DSC II.1 Lab- II	Pr-Major				2	<b>2</b>		1	<b>1</b>	<b>3</b>			25	25	<b>50</b>	<b>25</b>		<b>P</b>
<b>8</b>	DSC III.1 Lab- III	Pr-Major				2	<b>2</b>		1	<b>1</b>	<b>3</b>			25	25	<b>50</b>	<b>25</b>		<b>P</b>

9	DSE I Lab- IV (Basket of 2 elective)	Pr- Major			2	2		1	1	3			25	25	50	25	P
10	# On Job Training, Internship/ Apprenticeship; Field projects Related to Major @ during vacations cumulatively	Related to DSC		120 Hours cumulatively during vacations of Semester I and Semester II					4*								P*
11	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semesters I, II, III and IV	Generic Option		90 Hours Cumulatively From Sem I to Sem IV													
<b>Total</b>								22							700+50		

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/  
Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report. Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.



	Fine/Applied/Visual/Performing Arts During Semesters I, II, III and IV																
	<b>Total</b>								<b>18+4*</b>							<b>600+50</b>	

**L: Lecture, T: Tutorial, P: Practical/Practicum**

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in the Semester II credit grade report. Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.



	Fine/Applied/Visual/Performing Arts During Semesters I, II, III and IV																	
	<b>Total</b>								<b>22</b>									<b>650</b>

**L: Lecture, T: Tutorial, P: Practical/Practicum**

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

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## M. Sc. (Herbal Science) First Year Semester- IV

S. N.	Subject	Type Course	Subject Code	Teaching and learning scheme							Duration of Exam	Examination & Evaluation Scheme								
				Teaching periods per week				Credits				Maximum marks		Practical		Total Marks	Minimum Marks for passing			
				L	T	P	Total	L/T	Pract	Total		Theory Internal	Theory+ MCQ External	Internal	External		Internal	External	Grade	
1	DSC I.4 Plant Nutraceuticals	Th-Major		4			4	4		4	3	30	70			100	12	28	P	
2	DSC II.4 Indian Systems of Medicine: Siddha, Unani and Tibetan	Th-Major		4			4	4		4	3	30	70			100	12	28	P	
3	DSC III.4 Medicinal plants case studies	Th-Major		3			3	3		3	3	30	70			100	12	28	P	
4	DSE IV 1. Phytochemistry and Pharmacognosy -IV 2. Herbal Drug Technology-IV	Th-Major Elective		3			3	3		3	3	30	70			100	12	28	P	
5	DSC I.3 Lab- XIII	Pr-Major				2	2		1	1	3			25	25	50	25		P	
6	DSC II.3 Lab- XIV	Pr-Major				2	2		1	1	3			25	25	50	25		P	
7	DSC III.3 Lab – XV	Pr-Major				2	2		1	1	3			25	25	50	25		P	
8	DSE II Lab- XVI (Basket of 2 electives)	Pr-Major				2	2		1	1	3			25	25	50	25		P	
9	Research Project Pase- II	Major			2	8	10	2	4	6	3			75	75	150	75		P	
10	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semesters I, II, III and IV	Generic Option		90 Hours Cumulatively From Sem I to Sem IV																
	<b>Total</b>									24						750				

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training; Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in the Semester II credit grade report. Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semesters I, II, III and IV. Its credits and grades will be reflected in the semester IV credit grade report.

### Comprehensive credit scheme:

#### Paper/ Course-wise splits of Credit.

Sr. No.	Type of Course	Maximum Credits offered	Minimum Credits require to pass
1	DSC	56	56
2	DSE	16	16
		<b>72</b>	<b>72</b>
3	RM and IPR	4	4
4	Research Projects (Sem- III & IV)	10	10
5	OJT/ Internship	4 (for 120 Hrs.)	2 (For 60 Hrs.)
6	Co-curricular course	Limited to max. 3 only (At least 90 Hrs.)	00
		<b>93</b>	<b>88</b>

#### Semester-wise splits of Credit (without OJT& Co-curricular course).

Semester- I	Semester- II	Semester- III	Semester- IV	Total Credits
22	18	22	24	86



**Sant Gadge Baba Amravati University, Amravati**  
**Part A**  
**Faculty – Science and Technology**  
**Programme- M. Sc. (Herbal Science) (NEPv23)**

**POs**

1. To equip students with strong fundamentals in subject domain knowledge.
2. To train students in all the areas of emerging herbal science with unique combination of core, elective papers.
3. Students can explore the cutting-edge technologies and skills currently used in Herbal science and technology.
4. Students are made aware of social, environmental issues and significance of subject for natural societal benefit.
5. To create interest and awareness about natural herbal products so that students can save the natural resources.
6. Focus is equally given on theoretical work as well as field work and experimentation.
7. To develop scientific temperament and research attitude among the students for better society.

**PSOs 1**

1. To equip the students with the fundamental concepts of herbal sciences and developing technologies.
2. To understand the basics of plant science required for the study of herbal science.
3. To understand various cultivation practices to cultivate medicinal plants
4. To study primary secondary metabolites of medicinal plants used in herbal drugs.
5. To execute expertise in Chromatographic analysis as an important technique.

**PSOs 2**

1. To study various plant authentication techniques.
2. To study and be skilled in various modern analytical techniques.
3. To study plant propagation, transgenics, and secondary metabolite production.
4. To study the fundamentals of pharmacognosy and herbal drug technology.

**M.Sc. Herbal Science – Potential Course Benefits:**

- The degree course serves as a basis for further higher studies in this field such as Doctoral and Post Doctoral research.

- Herbal Science also helps to know such as product registration, laboratory testing including microbiology and heavy metals testing, product knowledge training, nutritional analysis, and design of brochures and other promotional materials.
- This degree holders have plenty of opportunities in some of its specialized fields such as Herbal Medicine, Anthropology, Naturopathy, Health Sciences, Botanical medicine, and the Agricultural sector.
- They can also go for further research studies and join teaching fields (as teachers/instructors).

### **Employability Potential:**

Herbal Science is an applied branch of plants science. Sant Gadge Baba Amravati University offers M.Sc. Herbal Science, a master's Program which deals with study of utility plants with respect to medicine, cosmetics etc., their characteristics, cultivation, technological developments and various other related aspects in detail. The main aims and objectives of this M.Sc. program are:

- To prepare students for a carrier as scientists, who can deal with current research lines in plant science using modern techniques.
- To help them represent this emerging discipline in research and development and socio-economic benefits.
- To encourage multidisciplinary collaboration.
- To equip and help the students in all aspects of herbal science with a view that they can take up teaching at different levels, research in institute/university, Self entrepreneurship, and in production and quality control sectors of various plant science, pharma, and agriculture.
- To bridge the knowledge gap of fundamental concepts of herbalism and modern innovations.
- To generate skilled manpower having a clear subject base and experimental expertise.

### **M. Sc. Herbal Science: Employment Areas**

Healthcare/Cosmetic Industry

Food Industry/ Nutraceutical/ Cosmetic Industry

Biopharmaceutical Industry

Quality Control/Analysis in the pharma sector

Medicinal Plant Production

Herbal industry representative, consultant, formulator, manufacturer or manager Production, and processing

Specialist Researcher / Teacher/ Instructor

Herb cultivator or wildcrafter

Work in the health/wellness/supplements industry

### **Eligibility for M. Sc. Herbal Science:**

The duration of this program is two years. There are 20 seats and admission is on a merit basis. Candidates who wish to opt M. Sc. in Herbal Science should have completed **B. Sc. with at least any one life science subject (Botany, Biotechnology, Biochemistry, Microbiology, Chemistry, Life Sciences), B. Sc. in agriculture, B. Sc. Horticulture, B. Sc. Forestry, B. Sc. Agriculture Biotechnology, B. Pharm., B. voc. Horticulture and B. Voc. Nutrition and cosmetics.**

The Syllabi of M. Sc. Herbal Science is designed as per NEP- 2020 v2023 pattern and is very rich so that students can opt two specializations as per their choices and interest. The major focus is on abilities and skills within core course subjects. The whole post-graduate program is of 4 semesters, during which students are imparted deep knowledge about fundamentals of Herbal Science, Basic Plant Science, Cultivation practices, Modern Plant authentication techniques, Plant propagation and Secondary metabolite analysis, Pharmacognosy, Basic Herbal Technology, Crude drugs and Nutraceuticals, Ancient systems of medicine, Herbal technology and drug development, Herbal cosmetics, Drug standardization along with expertise in various analytical techniques with job profiles in teaching sector, self entrepreneurship, production and quality control of biological and pharma industries. It would also provide a highly skilled human resource for incubation centers and start-ups in the field of plant-related industrial units as well as Research and Development sectors.

Education is not only to gain knowledge and understand things but it must be able to enhance one's ability and skills for better employability. Employability skills are those which help one to stand separately from others for the same jobs. These skills are vital in order to secure a role where employability, skill matches your job profile. These skills come naturally or can be acquired through work experience, practice or education.

Employability skills are transferable and students can use these at workplace. Teachers seek all these sets of diverse skills in students in addition to academic qualifications, in order to stay relevant and improve their efficiency. Teachers should focus on building employability skills. Various skills can be developed after completion of this program. These are as follows.

- 1. Communication Skills:** It is one of the important personality traits which is sought after employment. It generally consists of five elements sender, receiver, message, medium, and feedback. It can be verbal, non-verbal, visual, or written. Good communication skills help any institution/organization to avoid unnecessary misunderstanding, waste of time, and increase output. To be an effective communicator one has to understand colleagues through ideas and thoughts to achieve the goal. Practices like positive expression, body language, careful listening, thinking before you speak, debate, group discussion, elocution completion, seminars, etc. can improve the skills.
- 2. Leadership Skills:** The flourishing of any organization requires good leaders with excellent leadership skills. They look for such people. Good leaders can manage people/teams well, convince them, motivate them, and train them so as to improve the workplace's practices as per the set objectives. Students are given various responsibilities of organizing and conducting of events, arrangements, and coordination of various activities in the team to develop these qualities.
- 3. Problem-Solving Skills:** This quality helps to remove obstacles by resolving complex issues. They are an asset to any organization for increasing efficiency. It is an act to determine the issue, identify the cause, select the best possible solution, and implement it. Complex problems can be broken into smaller parts and then the issue can be addressed. In other way, it can be solved by research, and analyses and then a decision can be made. Undertaking research projects, Assignments, brainstorming sessions, solving puzzles etc. can enhance this skill.
- 4. Team Work Skills:** To know the role in the team and work amicably with teammates. Healthy, cordial relationship with colleagues and a better work environment increases job satisfaction. It has a direct impact on organizational stability, innovation, and output. In practicals, groups of 4-5 students are made and they perform the experiment efficiently, group assignments, group activities, etc. develop these skills.
- 5. Reliability Skills:** This is a very important employability skill to build trust with the employer. Consistency is the key to reliability. Meetings, daily tasks, responding to queries, acknowledging mistakes, and taking lessons from it are the thing to develop reliability. Mentor –mentee meets often, counseling, etc.
- 6. Self-Management Skills:** It is the ability to organise and manage own work without guide. It saves time and enhances efficiency. Students' project work, Botanical Excursions, tours management, preparations for exams, performing experiments in 3 hrs etc.
- 7. Learning Skills:** It enables to improve the knowledge about the subject. Tend to change to adapt to new concepts and methods. Such persons can acquire challenging positions and save time. It ensures quick implementations of new systems, process, and technology.

Students are asked to refer to good books of the subject, seminars on recent topics are given, standard protocols are used in practicals etc.

- 8. Technology skills:** In the present scenario it is a must to know how to use the updated technology. It is one of the leading skills for any institution. Helps to stay relevant and ahead of the competition. These skills are valued as one can grasp the technology-based concept and learn how to use them effectively. Students are using this technology for learning and research purpose.
- 9. Planning and Organisation skills:** Important to achieve goals, manage time, money, and effort and increase efficiency. Should be resourceful, manage priorities, be timely and take decisions.
- 10. Technical and Analytical skills:** Make them skilled in practicals, and laboratory equipment and interpret the data on biological material.

The course is designed in such a way that after completion it is expected that students will develop and nurture these employability skill for employment or entrepreneurship development.

**SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI**

**Credit system per semester as per university norms/ NEP v2023  
M. Sc. Herbal Science**

Course	Credits				Total
	Sem- I	Sem- II	Sem- III	Sem- IV	
<b>Core (DSC) Theory + Practical</b>	11+ 3 = 14	11+ 3 = 14	11+ 3 = 14	11+ 3 = 14	56
<b>Elective (DSE) Theory + Practical</b>	03+1 = 04	03+1 = 04	03+1 = 04	03+1 = 04	16
<b>On-Job Training (OJT)</b>	04				04
<b>Co-curricular activities</b>	Maximum 03				03
<b>Research Project</b>	--	--	04	06	10
<b>Total</b>					93

**Notes:-**

- (1) Minimum pass marks for theory and practical examination including internal assessment shall be 36% separately.
- (2) Project work guidelines-
  - (a) Topic of project work shall be given by the concerned supervisor with prior approval of the Head of Department. There shall be no duplication of the topic of the project work. The project shall be based on research in the laboratory and/or fieldwork. Project work shall be allotted at the beginning of the third semester and the student shall have to submit it at least 15 days before the commencement of the practical examination of the fourth semester. Project work will be evaluated by external and internal examiners. The first phase of Research project will be completed at the end

- of 3<sup>rd</sup> Semester and evaluated internally while the 2<sup>nd</sup> phase must have to be completed before end of 4<sup>th</sup> semester and evaluated by external examiner.
- (b) There should be at least 2 to 3 external examiners for a batch of 10 students or 3 to 5 external examiner for a batch more than 10 students.
- (3) There shall be separate exemption in theory and / or practical on getting minimum pass marks.
- (4) Internal Assessment marks for all semesters shall be granted on the basis of - performance of students in any of the following activities:- (i) Study tour, (ii) Seminar, (iii) field visits, (iv) Industrial visits, (v) visit to research institute / organization, (vi) Assignments, (vii) Unit test and any other co-curricular activities.
- (5) The concerned Department or College shall have to maintain the record of award of internal assessment marks.

#### **PATTERN OF QUESTION PAPER ON THE UNIT SYSTEM**

**The pattern of question paper as per unit system will be broadly based on the following pattern –**

1. Syllabus has been divided into six units. The question paper will have 07 questions of 10 marks each. Each question will carry 10 marks. On the prescribed six units there will be a question both a long answer type and a short answer type (Long answer question =07 marks, short answer question =03 marks).
2. There will be options of long answer to long answer and short answer to short answer.
3. There will be equal division of marks.
4. Theory paper will be of 70 marks and the Theory internal will be of 30 marks. Both will have separate passing.
5. Each practical/ lab course will be of 25 marks internal and 25 marks external, total 50 Marks.

**M. Sc. Herbal Science (As per NEP 2020)**

<b>Syllabus Prescribed for the year 2023-24</b>		
<b>Programme</b>	<b>PG Programme</b>	
<b>M. Sc. Herbal Science</b>	<b>Semester-I</b>	
<b>Code of the Course Subject</b> <b>RMI-1</b>	<b>Title of the Course/ Subject</b> <b>Research Methodology and IPR</b>	<b>No. of Periods/week</b> <b>04</b> <b>Credits = 04</b>
<b>COs :</b>		
<ol style="list-style-type: none"> <li>1. Students will understand the fundamentals of research, its types, significance and publications.</li> <li>2. Students will be able to define and design the research problem.</li> <li>3. Students will gain an understanding of sample design and data collection.</li> <li>4. Students can develop a hypothesis and test it independently.</li> <li>5. Students get acquainted with various tools and techniques used in scientific research &amp; IPR in the subject.</li> </ol>		
<b>Unit: I:</b>	<b>Research, Types, and Strategies</b>	
	<ol style="list-style-type: none"> <li>1.1 Basics of research</li> <li>1.2 Various research terminologies: (Primary research, Secondary research, Qualitative research, Quantitative research, Peer review, Literature review, systemic review)</li> <li>1.3 Types of Research: Basic research, Applied research, Correlational research, Descriptive research, Ethnographic research, Experimental research, Exploratory research, Grounded theory, Historical research, and Phenomenological research.</li> <li>1.4 Research Process, Significance of Research and Characteristics of good research.</li> </ol>	
<b>Unit- II:</b>	<b>Research Problem, Sample Design, and Hypothesis</b>	
	<ol style="list-style-type: none"> <li>2.1 What is a Research Problem?</li> <li>2.2 Technique Involved in Defining a Problem.</li> <li>2.3 Research Design; Features of a Good Research Design: Important Concepts Relating to Research Design: Different Research Designs.</li> <li>2.4 Basic Principles of Experimental Designs</li> </ol>	
<b>Unit- III:</b>	<b>Sample Design and Data Collection:</b>	
	<ol style="list-style-type: none"> <li>3.1 Sample design, Steps involved, procedure, and characters of good sample design. Types of sample design. Determination of sample size.</li> <li>3.2 Data Collection, Data types (Primary and secondary data); methods of data collection; case studies.</li> </ol>	
<b>Unit- IV:</b>	<b>Various Statistical Tools for Biological Analysis and IPR</b>	
	<ol style="list-style-type: none"> <li>4.1 Mean, mode, median, standard deviation, and correlation.</li> <li>4.2 Modern statistical tools- STATA, R, GraphPad Prism, MATLAB.</li> <li>4.3 Introduction to Intellectual Property Rights</li> <li>4.4 Introduction to IPR and Types of IPR</li> </ol>	
<b>Unit- V:</b>	<b>Microscopic techniques for crude drug analysis</b>	
	<ol style="list-style-type: none"> <li>5.1 Visual observations of crude drugs</li> <li>5.2 Microscopic observations of crude drugs               <ol style="list-style-type: none"> <li>5.2.1 Pallisade ratio</li> <li>5.2.2 Stomatal index</li> </ol> </li> </ol>	



	5.2.3 Trichomes 5.3 Preliminary evaluation of crude drug samples
<b>Unit- VI</b>	<b>Chromatography technique</b> 6.1 Principle, working and applications 6.2 Paper Chromatography 6.3 Thin layer chromatography
<b>Suggested Reading:</b>	
<p>Arunmurthy, T. V. S. and Padmaja, T. V. S. (2018) A textbook of Research Methodology, Scitech publishing.</p> <p>Fernandez, V. (2020) Fundamentals of Research methodology, Omniscience scholars publishing.</p> <p>Kelly, A. E. and Lesh, R. A. (2000) Handbook of Research Design in Mathematics and Science. Routledge, Taylor and Francis Group, New York.</p> <p>Kothari, C. R. (2004) Research Methodology, 2<sup>nd</sup> Edition, New Age International Publisher, India</p> <p>Kothari, C. R. and Garg, G. (2015) Research Methodology: Methods and techniques. New Age International Publisher, India.</p> <p>Mishra, S. B. and Shashi Alok (2017) Handbook of Research Methodology: A compendium for scholars and researchers. Educreation Publishing, New Delhi, India.</p> <p>Singh, Y. K. (2016) Fundamentals of research methodology and statistics. New Age International Publisher, India</p> <p>Thomas, C. G. (2021) Research Methodology and Scientific Writings. Springer Cham. Publisher.</p> <p>Walia, A. M. and Uppal, M. (2020) Fundamentals of Research, Notion Press, India</p>	
<b>Learning Outcomes:</b>	
<ol style="list-style-type: none"> <li>1. Students will be able to evaluate the research presentations on the basis of its characteristics.</li> <li>2. Students will develop the skill to write research articles and scientific reports.</li> </ol>	

<b>Syllabus Prescribed for year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSC I.1</b>	<b>Introduction to Herbal Science</b>	<b>04 Credits = 04</b>
<b>COs :</b>		
<ol style="list-style-type: none"> <li>1. To understand the fundamentals of herbal science.</li> <li>2. To understand the basics of various ancient systems of medicine.</li> <li>3. To understand the role of plants in the development of herbal science.</li> <li>4. To understand the role of major pharmacopoeias across the globe.</li> </ol>		
<b>Unit: I:</b>	<b>Introduction to Herbal Sciences</b>	
	<ol style="list-style-type: none"> <li>1.1 Historical Background, Present Status, and Scope of Herbal Science</li> <li>1.2 Medicinal Botany and Folklore Medicine</li> <li>1.3 Need to preserve the ancient knowledge</li> <li>1.4 Role of tribals in conserving traditional herbal treasure</li> </ol>	
<b>Unit- II:</b>	<b>Indigenous Knowledge systems</b>	
	<ul style="list-style-type: none"> <li>• Fundamental concepts and updates of-               <ol style="list-style-type: none"> <li>2.1 Introduction, History and Basic Doctrine of Ayurveda</li> <li>2.2 Introduction, History and Basic Doctrine of Siddha</li> </ol> </li> </ul>	
<b>Unit- III:</b>	<b>Indigenous Knowledge systems</b>	
	<ul style="list-style-type: none"> <li>• Fundamental concepts and updates of-               <ol style="list-style-type: none"> <li>3.1 Introduction, History and Basic Doctrine of Unani Medicine</li> <li>3.2 Introduction, History and Basic Doctrine of Homeopathy</li> <li>3.3 Introduction, History and Basic Doctrine of the Tibetan system of Medicine</li> </ol> </li> </ul>	
<b>Unit- IV:</b>	<b>Rediscovery of Natural Herbal Medicine</b>	
	<ul style="list-style-type: none"> <li>• Reasons for the popularity of Natural herbal remedies</li> <li>• Overview with suitable examples-               <ol style="list-style-type: none"> <li>4.1 Pharmacognosy</li> <li>4.2 Aromatherapy</li> <li>4.3 Cosmetology</li> </ol> </li> </ul>	
<b>Unit- V:</b>	<b>Introduction to Pharmacopoeia</b>	
	<ul style="list-style-type: none"> <li>• <b>Introduction to major pharmacopoeia across the globe</b> <ol style="list-style-type: none"> <li>5.1 Indian Pharmacopoeia</li> <li>5.2 USA Pharmacopoeia</li> <li>5.3 European Pharmacopoeia</li> </ol> </li> </ul>	
<b>Unit- VI</b>	<b>Introduction to Pharmacopoeia</b>	
	<ul style="list-style-type: none"> <li>• <b>Introduction to major pharmacopoeia across the globe</b> <ol style="list-style-type: none"> <li>6.1 British Pharmacopoeia</li> <li>6.2 African Herbal Pharmacopoeia</li> <li>6.3 WHO's International Pharmacopoeia</li> </ol> </li> </ul>	
<b>Laboratory Exercise: Introduction to Herbal Science</b>		
<ol style="list-style-type: none"> <li>1. Identification of the following medicinal plants and chemical tests for their active constituents:           <ul style="list-style-type: none"> <li>• Medicinal Plants: <i>Datura</i> (tropane alkaloids), <i>Andrographis</i> (diterpene lactose), <i>Curcuma</i> (curcuminoids), <i>Boerhaavia</i> (glycosides), <i>Ricinus</i> (fatty acids), <i>Terminalia bellerica</i> (tannins), <i>Allium sativum</i> (sulphur compounds).</li> </ul> </li> <li>2. Identification of the following plants used in cosmetics and aromatherapy and chemical tests for their active constituents:</li> </ol>		

<ul style="list-style-type: none"> <li>• Cosmetics and Aromatherapy: <i>Vetiveria zizanoidis</i>, <i>Rosa sinensis</i>, <i>Jasminum</i> spp., <i>Pogostemon patchouli</i>.</li> </ul> <p>3. Identification of the following Food additives and chemical tests for their active constituents:</p> <ul style="list-style-type: none"> <li>• Food additives: <i>Bixa Orellana</i>, <i>Beta vulgaris</i>, <i>Cinamom umtamala</i>, <i>Zingiber officinalis</i>, <i>Allium sativum</i>, <i>Curcuma longa</i>.</li> </ul>
<p><b>Suggested Reading:</b></p> <p>Indian Pharmacopeia Commission (2018) Indian Pharmacopeia (8<sup>th</sup>Edn), Published by Indian Pharmacopeia Commission.</p> <p>Irene B. Murimi-Worstell, Jeromie M. Ballreich, Marissa J. Seamans, G. Caleb Alexander (2019) Association between US Pharmacopeia (USP) monograph standards, generic entry and prescription drug costs. Plos One, November 12, 2019.</p> <p>Joshi, M. C. (2019) Handbook of Indian Medicinal Plants, Scientific Publisher, India</p> <p>Kochhar, S. L. (2016) Economic Botany: A comprehensive approach, Cambridge Publication.</p> <p>Lewis Walter H. (2010) Medical Botany: Plants affecting human health, John Wiley &amp; Sons Inc.</p> <p>Maheshwari, J. K. (2003) Ethno- Botany and Medicinal plants of Indian subcontinent. Scientific Publisher, India</p> <p>Murthy K. R. S. (2016) Sushruta Samhita Vol.I to IV, Chaukhambha Orientalia.</p> <p>Rastogi Ram and Mehrotra B. N. (1990) Indian Medicinal Plants Vol. 1 to 4</p> <p>Saraf, S and Shukla, S. S. (2011) Fundamental aspects and Basic concepts of Siddha Medicine. Systematic Review of Pharmacy, 2(1): 48</p> <p>Seth Ashok (2007) The herbs of Ayurveda Vol. I to IV, Dattani Book Agency.</p> <p>Sharma P. V. (2005) Charaka Samhita Vol. I to IV, Chaukhambha Orientalia.</p> <p>Shiva, M.P., Lehri, Alok., Shiva, Alka (2007) Aromatic and Medicinal Plants. International Book Distributor, Deharadun.</p> <p>Staff, E. (2007) Handbook of mushroom cultivation, processing and packaging. Engineers India Research Institute.</p> <p>TrivediPravin Chandra (2006) Ethnobotany, Published by Agrobios, Jodhpur</p> <p>WHO (2020) The International Pharmacopeia</p> <p>WHO (2013) Review of World Pharmacopeias, International Meeting of World Pharmacopoeias World Health Organization, Geneva, Executive Board Room 29 February–2 March 2012.</p> <p>ZoharaYaniv and Uriel, B. (2005) Handbook of Medicinal Plants, CRC Press</p> <p>Jaiswal, Y.S., Williams, L.L. (2016) A glimpse of Ayurveda - The forgotten history and principles of Indian traditional medicine. J Tradit Complement Med. 7(1):50-53.</p>
<p><b>Learning Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. The students will be able to understand the basic concept of herbal science.</li> <li>2. They will have information regarding the ancient systems of medicine in India</li> <li>3. They will learn about the major pharmacopoeia across the world.</li> <li>4. They can critically think over the safety aspects of herbal products.</li> </ol>

<b>Syllabus Prescribed for the year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
<b>Code of the Course Subject</b> <b>DSC II.1</b>	<b>Title of the Course/ Subject</b> <b>Taxonomy of Medicinal Plants</b>	<b>No. of Periods/week</b> <b>04</b> <b>Credits = 04</b>
<b>COs :</b>		
1. The students will understand the general outline of plant classification. 2. The students will understand the characteristic features of different plant groups. 3. They will learn and understand the importance of locally available medicinal plants. 4. The students will be able to characterize and identify different plant species.		
<b>Unit- I:</b>	<b>Taxonomic groups of plants and their medicinal importance</b>	
	<ul style="list-style-type: none"> <li>• Major taxonomic groups of Plants               <ul style="list-style-type: none"> <li>○ General Characteristics features and Medicinal importance –                   <ul style="list-style-type: none"> <li>1.1 Algae,</li> <li>1.2 Fungi,</li> <li>1.3 Bryophytes,</li> <li>1.4 Pteridophytes and</li> <li>1.5 Gymnosperms</li> </ul> </li> </ul> </li> </ul>	
<b>Unit- II:</b>	<b>Nomenclature, Taxonomic Hierarchy, and Classification:</b>	
	2.1 Binomial Nomenclature 2.2 Taxonomic hierarchy 2.3 Bentham and Hooker’s system of classification up to the family level	
<b>Unit- III:</b>	<b>Angiospermic medicinal plants:</b>	
	3.1 General Characteristic Features of Angiosperms; 3.2 Taxonomic description of locally available plants with respect to the following families (at least two plants of each family) with medicinal importance: <ul style="list-style-type: none"> <li>3.2.1 Annonaceae,</li> <li>3.2.2 Malvaceae,</li> </ul>	
<b>Unit- IV:</b>	<b>Angiospermic medicinal plants:</b>	
	4.1 Taxonomic description of locally available plants with respect to the following families (at least two plants of each family) with medicinal importance: <ul style="list-style-type: none"> <li>4.1.1 Leguminosae,</li> <li>4.1.2 Anacardiaceae</li> <li>4.1.3 Myrtaceae</li> </ul>	
<b>Unit- V:</b>	<b>Angiospermic medicinal plants:</b>	
	5.1 Taxonomic description of locally available plants with respect to the following families (at least two plants of each family) with medicinal importance: <ul style="list-style-type: none"> <li>5.1.1 Rubiaceae,</li> <li>5.1.2 Apocyanaceae,</li> <li>5.1.3 Solanaceae,</li> </ul>	
<b>Unit- VI</b>	<b>Angiospermic medicinal plants:</b>	

	<p>6.1 Taxonomic description of locally available plants with respect to the following families (at least two plants of each family) with medicinal importance:</p> <p>6.1.1 Lamiaceae,  6.1.2 Euphorbiaceae,  6.1.3 Liliaceae,  6.1.4 Scitaminae.</p>
<b>Laboratory Exercise: Basics of Plant Science</b>	
<ol style="list-style-type: none"> <li>1. Identification of given algal material.</li> <li>2. Identification of given fungal material.</li> <li>3. Identification of given bryophytic material.</li> <li>4. Identification of given pteridophytic material.</li> <li>5. Identification of given gymnospermic material.</li> <li>6. Exomorphic features of four medicinal plants each, from the families prescribed for theory.</li> <li>7. Physico-chemical studies of any two medicinal plant (available in the area) leaf with respect to ash content and extractive value (Water, Methyl alcohol, Acetone)</li> </ol>	
<b>Suggested Readings:</b>	
<p>Bhatnagar, S. P. and Moitra, A. (1996) Gymnosperms. New Age Publishers.</p> <p>Ganguli, H. C., Das, K. S., Datta, C. (2011) College Botany Vol. I, New Central Book Agency.</p> <p>Ganguli, H. C., Das, K. S., Datta, C. (2011) College Botany Vol. II, New Central Book Agency.</p> <p>Jain, D. K. and Singh.V. (2009) Taxonomy of Angiosperms. Rastogi Publication</p> <p>Joshi, S. G. (2018) Medicinal Plants. Oxford and IBH Publishing</p> <p>Kaur, Inderdeep and Uniyal, PremLal (2019) Text Book of Gymnosperms. Daya Publication House</p> <p>Kumar, Anil (2006) Medicinal Plants. Kalyani Publication</p> <p>Naik, V. N. (1984) Taxonomy, Tata McGraw Hill Publication</p> <p>Pandey, B. P. (2001) Text Book of Botany- Angiosperms. S. Chand and Company</p> <p>Pandey, S. N. (2009) Taxonomy of Angiosperms.</p> <p>Saxena, N. B. and Saxena, S. (2019) Plant Taxonomy. Pragati Prakashan</p> <p>Shiva, M. P. and Shreenath, K. P. (2013) Taxonomy of some selected Medicinal Plants. LAP Lambert Publishing.</p> <p>Singh, Gurucharan (2017) Plant systematics: an integrated approach. CRC Press</p> <p>Sinha, R. K. (2013) Practical Taxonomy of Angiosperms. IK International Publishing House</p> <p>Smith G. M. (2019) Cryptogamic Botany, Algae and Fungi, 2<sup>nd</sup>Edn. Surjeet Publication.</p> <p>Smith G. M. (2019) Cryptogamic Botany, Bryophytes and Pteridophytes, 2<sup>nd</sup>Edn. Surjeet Publication.</p> <p>Vashista, P. C., Sinha, A. K. and Kumar, A. (2010) Botany for Degree students: Gymnosperms. S. Chand and Company.</p>	
<b>Learning Outcomes:</b>	
<ol style="list-style-type: none"> <li>1. The students will be able to understand the classification of plant kingdoms.</li> <li>2. The students will learn about the characteristics of angiosperms and various angiospermic medicinal plants available in the region.</li> <li>3. The students will be able to characterize medicinal plants on the basis of exomorphic, endomorphic, and physico-chemical characters</li> </ol>	

<b>Syllabus Prescribed for year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
<b>Code of the Course Subject</b> <b>DSC III.1</b>	<b>Title of the Course/ Subject</b> <b>Medicinal Plant Cultivation</b>	<b>No. of Periods/week</b> <b>03</b> <b>Credits = 03</b>
<b>COs :</b>		
<p>1. The students will learn and understand various methods of vegetative and sexual reproduction in plants.</p> <p>2. The students get acquainted with the fundamentals aspect of soil-less production i.e. hydroponics technology</p> <p>3. The students will have a better understanding of polyhouse technology.</p>		
<b>Unit: I:</b>	<b>Natural Methods Vegetative Reproduction (by Specialized vegetative structures):</b>	
	<p>1.1.1 Tuberous roots, 1.1.2 stem tubers, 1.1.3 rhizome, 1.1.4 bulb, 1.1.5 corm, 1.1.6 runner, 1.1.7 stolon, 1.1.8 sucker, 1.1.9 bulbils</p>	
<b>Unit- II:</b>	<b>Artificial methods of vegetative reproduction :</b>	
	<p>2.1 Cutting (stem and leaf), 2.2 Grafting, 2.3 Budding, and 2.4 Layering 2.5 Micropropagation</p>	
<b>Unit- III:</b>	<b>Sexual Reproduction in Angiosperms</b>	
	<p>3.1 Microsporogenesis and Microgametogenesis 3.2 Megasporogenesis and Megagametogenesis 3.3 Fertilization 3.4 Embryo and Endosperm development 3.5 Seed Germination and seed dormancy</p>	
<b>Unit- IV:</b>	<b>Hydroponics- I</b>	
	<p>3.1 Origin and historical account of Hydroponics 3.1.1 Scope of hydroponics 3.2 Techniques in Hydroponics – 3.2.1 Static solution culture, 3.2.2 Continuous-flow solution culture, 3.2.3 Aeroponics, Passive sub-irrigation, 3.2.4 Bubbleponics.</p>	
<b>Unit- V:</b>	<b>Hydroponics- II</b>	
	<p>5.1 Media used for Hydroponics: 5.1.1 Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fiber.</p>	

	<p>5.2 Nutrient Solutions – Major and Minor nutrients, role of nutrients.</p> <p>5.3 Commercial Utility of Hydroponics</p>
<b>Unit- VI</b>	<p><b>Polyhouse Technology and modern agriculture</b></p> <p>6.1 Introduction to Polyhouse Technology</p> <p>6.2 Type of polyhouses, construction, additional facilities maintenance of polyhouses,</p> <p>6.3 Applications of Polyhouse Technology</p> <p>6.4 Role of Agricultural Sensors and Artificial Intelligence in crop production.</p>
<b>Laboratory Exercise: Cultivation Practices:</b>	
<ol style="list-style-type: none"> <li>1) Demonstration of natural vegetative reproduction (As you studied in the theory syllabus)</li> <li>2) Perform any two types of artificial vegetative reproduction (As you studied in the theory syllabus)</li> <li>3) Demonstrate megasporogenesis in angiosperms</li> <li>4) Demonstrate microsporogenesis in angiosperms</li> <li>5) Growing crop plants using the hydroponic method (Anyone plants as per regional suitability)</li> </ol>	
<b>Suggested Readings:</b>	
<p>Dumas, C. and Russell, S. (1992) Sexual Reproduction in flowering plants. Academic Press</p> <p>Godfrey- Sam-Aggrey, W. and Norman, J. C. (1996) Handbook of common vegetative propagation methods for food crops and ornamental Plants. Vantage Publisher</p> <p>Gosh, A. (2018) Greenhouse Technology, New India Publishing Agency</p> <p>Johari, B. M. and Shrivastava, P. S. (2001) Reproductive Biology of Plants. Springer Publishing</p> <p>Jones, J. B. Jr. (2004) Hydroponics: a practical guide for soilless growers, 2<sup>nd</sup>Edn. CRC Press</p> <p>Madhuri, G. and Bharad, A. V. (2014) Carnation under Polyhouse. LAP Lambert Academic Press</p> <p>Mogie, M. (1992) Evolution of Asexual Reproduction in Plants. Springer Publication.</p> <p>Ramawat, K. G., Merillon, J-M, Shivanna, K. R. (2014) Reproductive Biology of Plants. CRC Press.</p> <p>Raviv, M., Lieth, H. and Bar- Tal., A. (2019) Soilless cultures: Theory and Practice 2<sup>nd</sup>Edn, Academic Press.</p> <p>Resh, H. M. (2012) Hydronic Food Production: A definitive guide book for the advanced home gardener and the commercial hydroponic grower, 7<sup>th</sup>Edn. CRC Press.</p> <p>Resh, H. M. (2015) Hydroponics for home growers. CRC Press.</p> <p>Shivanna, K. R., Tondon, R. and Kaul, M. (2020) Reproductive ecology of flowering plants: Pattern and Processes. Springer Publication</p> <p>Singh, B. (2014) Advances in Protected cultivation. Nipa Books.</p> <p>Tiwari, G. N. (2009) Greenhouse technology for controlled environment. Narosa Publication,</p> <p>USAID (2007) Vegetative Propagation Techniques. Alternative Livelihood Program.</p>	
<b>Learning Outcomes:</b>	
<ol style="list-style-type: none"> <li>1. The students will be able to learn the vegetative reproduction techniques in Angiospermic plants and its performance skills.</li> <li>2. The students will learn about sexual reproduction in angiosperms plants and seed dormancy.</li> <li>3. The students will get acquainted with the emerging hydroponics methods of growing soilless crops.</li> <li>4. The students will well verse with the theoretic and practical aspects of polyhouse technology.</li> </ol>	

<b>Syllabus Prescribed for year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
<b>Code of the Course Subject</b> DSE I	<b>Title of the Course/ Subject</b> Phytochemistry and Pharmacognosy- I	<b>No. of Periods/week</b> 03 <b>Credits = 03</b>
<b>COs :</b>		
1. To expose the students to the fundamentals of phytochemistry and pharmacognosy. 2. To impart basic analytical skills to students. 3. To make the students expert in analyzing and interpreting the results with accuracy.		
<b>Unit- I:</b>	1.1 History and Scope of Phytochemistry 1.2 Importance of Phytochemistry 1.3 Classification of Phytochemicals 1.4 General uses of phytochemicals	
<b>Unit- II:</b>	2.1 Biosynthesis, classification, types, and Uses of Carbohydrates 2.2 Biosynthesis, classification, types, and uses of Lipids	
<b>Unit- III:</b>	3.1 Biosynthesis, classification, types, and uses of Volatile oil 3.2 Biosynthesis, classification, types, and Uses of resin	
<b>Unit- IV:</b>	4.1 Phytochemical extract methods 4.2 Solvent extraction method 4.3 Factors to be considered while solvent extraction 4.4 Common methods of extraction of medicinal plants Maceration, Infusion, Digestion, Decoction Percolation, Soxhlet extraction Microwave-assisted extraction Ultrasound-assisted extraction	
<b>Unit- V:</b>	<b>Qualitative Phytochemical screening</b>  5.1 Qualitative chemical tests for phytochemicals- Alkaloids, phenolics, flavonoids, glycosides, tannins, terpenoids, steroids and saponins 5.2 Preparative Paper chromatography and Thin layer chromatography	
<b>Unit- VI:</b>	<b>Basics of Pharmacognosy</b>  6.1 History and Scope of Pharmacognosy 6.2 Various sources of drugs 6.3 Various types of crude drugs 6.4 Exomorphic and endophoric characters 6.5 Physico-chemical screening	
<b>Laboratory Exercises:</b>		
1. Separation of Phytochemicals using different methods of Chromatography  - Paper Chromatography  - Thin Layer Chromatograph,		



<p>2. Qualitative tests for- Alkaloids, phenolics, flavonoids, glycosides, tannins, terpenoids, steroids, and saponins</p> <p>3. Exomorphic and endomorphic characters of drug material (Any 3)</p> <p>4. Physico-chemical screening of given drug sample (any 3)</p>
<p><b>Suggested Reading:</b></p> <p>Coskun, O. (2016) Separation techniques: Chromatography. North Clinic.Instamb. 3(2): 156- 160</p> <p>Heinz- Helmut, P. (1992) UV- Visible spectroscopy and its applications. Springer Ltd.</p> <p>Kafle, B. P. (2019) Chemical analysis and material characterization by spectrophotometry, Elsevier Inc.</p> <p>Mark, F. Vitha (2016) Chromatography: Principles and Instrumentation, Wiley Publication.</p> <p>Mark, F. Vitha (2018) Spectroscopy: Principles and Instrumentation. John Wiley &amp; Sons Inc.</p> <p>McNair, H. M. and Miller, J. M. (2009) Basic Gas Chromatography, Wiley- Blackwell Publisher.</p> <p>Mitchell, G. H. (2017) Gel electrophoresis: Types, Applications and Research, Nova Science Publishers Inc.</p> <p>Nikalje, A. P. and Bhosale, D. (2017) A Handbook of Chromatography, Scholars Press, Germany.</p> <p>Robards, K., Haddad, P. R. and Jackson, P. E. (1994) Principles and Practice of Modern Chromatographic Methods. Elsevier Ltd.</p> <p>Scott, R. P. W. (1995) Techniques and Practice of Chromatography, CRC Press</p> <p>Sharma, J. and Fried, B. (2003) Edn. Handbook of Thin-Layer Chromatography Third Edition, Revised and Expanded. Marcel Decker, Inc.</p> <p>Treese, G. E. and Evans, W. C., Text book of Pharmacognosy, 15<sup>th</sup> Edn. W. B. Saunders, Edenberge, New York.</p>
<p><b>Learning Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. The student will acquire the basic skills in phytochemistry and pharmacognosy.</li> <li>2. The students could analyze the samples and interpret the results with accuracy.</li> </ol>

<b>Syllabus Prescribed for year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
<b>Code of the Course Subject</b> DSE I	<b>Title of the Course/ Subject</b> Herbal Drug Technology- I	<b>No. of Periods/week</b> 03 <b>Credits = 03</b>
<b>COs :</b>		
1. To expose the students to the fundamentals of phytochemistry and pharmacognosy. 2. To impart basic analytical skills to students. 3. To make the students analyze and interpret the results with accuracy.		
<b>Unit- I:</b>	<b>Introduction to Herbal Drug:</b> 1.1 Herbal drug- Definition 1.2 Importance of herbal drugs and herbal therapies 1.3 Herbal versus conventional drugs 1.4 Safety of herbal drugs 1.5 Toxicity of herbal drugs	
<b>Unit- II:</b>	<b>Medicinal and Aromatic plants:</b> 2.1 Definition, history, importance, and scope 2.2 Status of medicinal plants in the world and India 2.3 Medicinal plant diversity and local healthcare	
<b>Unit- III:</b>	<b>Conservation and promotion of Medicinal plants:</b> 3.1 Conservation of medicinal plants- issues and approaches 3.2 Medicinal plants conservation areas 3.3 National medicinal plant board and State medicinal plant boards- objectives and functions.	
<b>Unit- IV:</b>	<b>Important Indian medicinal plants:</b> Systematics, geographic distribution and uses of- <i>Acorus calamus, Adathoda vasica, Abrus precatorius, Aloe vera, Phyllanthus amarus, Stevia rebaudiana, Withania somnifera.</i>	
<b>Unit- V:</b>	<b>Important Aromatic medicinal plants- I</b> 5.1 Introduction and historical background of Aromatic plants 5.2 Aromatic and cosmetic products 5.3 Raw material for perfumes and cosmetic industries 5.4 Aromatic spices	
<b>Unit- VI:</b>	<b>Important Aromatic medicinal plants- II</b> Taxonomic description and uses of important medicinal plants- Citronella, Davana, Damask Rose, Geranium, Khus Grass, Lavender, Lemon grass, Mentha, Holi Basil Eucalyptus, Thyme, Marjoram, Oregano.	
<b>Laboratory Exercises:</b>		
1. Description of locally available medicinal plants with uses (any 3) 2. Description of locally available aromatic plants with uses (any 3) 3. Extraction of essential oil from aromatic plants (any 2) 4. Qualitative phytochemical tests of medicinal plants (any 3)		
<b>Suggested Reading:</b>		
Bhattacharya, S. K. (2004) Handbook of Aromatic plants Bhattacharya, S. K. (2009) Handbook of Medicinal and Aromatic Plants.		

Jose, J. and Rajalaxmi, R. (2017) Medicinal and Aromatic plants: Essential oils and Pharmaceutical uses.

Kirtikar, K. R. and Basu, B. D. (1935) Indian Medicinal plants. Lalit Mohan Basu Alahabd.

Mathe, A. and Ali, I. A. (2022) Medicinal and Aromatic Plants Vol- 1 (Edited vol). Springer link.

Naik, V. N. (2005) Identification of common Indian medicinal plants. Amrut Prakashan.

Trivedi, P. C. (2009) Indian medicinal plants

Warrier, P. K., Nambiar, V. P. K. and Ramankutty, C. (2010) Indian Medicinal Plants: A compendium of 500 species. Universities Press.

Zafar, S. (2012) Medicinal Plants of India. CBS Publisher and Distributor.

**Learning Outcomes:**

1. The student will acquire the basic knowledge and understanding of medicinal and aromatic plants.
2. The students could test and primarily analyze the crude drug samples

**M. Sc. I, Semester- I (Herbal Science)**  
**Practical: I / Lab- I**  
**Introduction to Herbal Science (DSC I.1)**  
**(2 Practicals/ week; Credits= 01)**

**Time: 3.00 Hrs]**

**[ Total Marks: 50**  
**(Internal: 25 Marks and External: 25 marks)**

**Internal Practical Examination:**

1. Photographic collection of traditional medicinal plants (at least 10 each).	10 M
2. Visit to recognized laboratory/ institute.	10 M
3. Formative assessments	05 M
<b>Total</b>	<b>25 M</b>

**External Practical Examination:**

1. Description of any one traditional medicinal plant	05 M
2. Qualitative chemical tests for given sample	05 M
5. <i>Viva- voce</i>	10 M
6. Practical record submission	05 M
<b>Total</b>	<b>25 M</b>

**M. Sc. I, Semester- I (Herbal Science)**  
**Practical: II / Lab- II**  
**Taxonomy of Medicinal plants (DSC II.1)**  
**(2 Practicals/ week; Credits= 01)**

**Time: 3.00 Hrs]**

**[ Total Marks: 50**  
**(Internal: 25 Marks and External: 25 marks)**

**Internal Practical Examination:**

1. Photographic collection of traditional medicinal plants (at least 10 each).	10 M
2. Field report.	10 M
3. Formative assessments	05 M
<b>Total</b>	<b>25 M</b>

**External Practical Examination:**

1. Taxonomic Description of any one traditional medicinal plant	05 M
2. Give systematic description and medicinal uses of given medicinal plant	05 M
5. <i>Viva- voce</i>	10 M
6. Practical record submission	05 M
<b>Total</b>	<b>25 M</b>

**M. Sc. I, Semester- I (Herbal Science)**  
**Practical: III / Lab- III**  
**Medicinal Plants Cultivation (DSC III.1)**  
**(2 Practicals/week; Credits= 01)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25 Marks and External: 25 marks)**

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**Internal Practical Examination:**

- |  |                    |
|--|--------------------|
| 1. A brief report on cultivation techniques performed by student<br>(Anyone from Cutting, budding, grafting, and layering) | 10 M               |
| 2. Photographic collection of medicinal crop plants growing in the region.   | 10 M               |
| 3. Formative assignments   | 05 M               |
|  | <b>Total: 25 M</b> |

**External Practical Examination:**

- |  |                     |
|--|---------------------|
| 1. Microsporogenesis/ megasporogenesis (Slide preparation) | 05 M                |
| 2. Performance of any one cultivation technique            | 05 M                |
| 3 Viva- voce   | 10 M                |
| 4. Practical record submission                             | 05M                 |
|  | <b>Total : 25 M</b> |

**M. Sc. I, Semester- I (Herbal Science)**  
**Practical: IV / Lab- IV**  
**Phytochemistry and Pharmacognosy- I (DSE IV.1) Elective**  
**(2 Practicals/week; Credits= 01)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25 Marks and External: 25 marks)**

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**Internal Practical Examination:**

- |  |                    |
|--|--------------------|
| 1. Submission of the photographic collection of local medicinal plants with uses | 10 M               |
| 2. Visit to any National Institute/ Laboratory.                                  | 10 M               |
| 3. Formative assignments   | 05 M               |
|  | <b>Total: 25 M</b> |

**External Practical Examination:**

- |  |                     |
|--|---------------------|
| 1. Qualitative phytochemical tests (any two) | 05 M                |
| 2. Pharmacognostic evaluation of crude drug  | 05 M                |
| 3 Viva- voce                                 | 10 M                |
| 4. Practical record submission               | 05M                 |
|  | <b>Total : 25 M</b> |

**M. Sc. I, Semester- I (Herbal Science)**  
**Practical: III / Lab- III**  
**Herbal Drug Technology (DSE- I) Elective**  
**(2 Practicals/week; Credits= 01)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25 Marks and External: 25 marks)**

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**Internal Practical Examination:**

- |  |                    |
|--|--------------------|
| 1. A survey for crude herbal drugs in local market | 10 M               |
| 2. Photographic collection of medicinal plants.    | 10 M               |
| 3. Formative assignments                           | 05 M               |
|  | <b>Total: 25 M</b> |

**External Practical Examination:**

- |   |                     |
|---|---------------------|
| 1. Taxonomic Description of Medicinal plants          | 05 M                |
| 2. Medicinal uses of given medicinal plants (Any two) | 05 M                |
| 3 Viva- voce  | 10 M                |
| 4. Practical record submission                        | 05M                 |
|   | <b>Total : 25 M</b> |

**Syllabus M. Sc. I, Sem- II (Herbal Science)**

<b>Syllabus Prescribed for the year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSC I.2</b>	<b>Bioactive Principles from Plants</b>	<b>04</b> <b>Credits = 04</b>
<b>COs :</b>		
<ol style="list-style-type: none"> <li>To understand various primary metabolites, their types, roles, and applications.</li> <li>To analyze various aspects of secondary metabolites, synthesis, structure, and applications.</li> <li>To exercise the screening methods of primary and secondary metabolites.</li> </ol>		
<b>Unit- I:</b>	<b>Primary Metabolites:</b>	
	<ol style="list-style-type: none"> <li>1.1 Carbohydrates- Biosynthesis and Biodegradation</li> <li>1.2 Classification of Carbohydrates and Types</li> <li>1.3 Uses, nutrition, and health benefits</li> <li>1.4 Sucrose, Starch, Cellulose.</li> </ol>	
<b>Unit- II:</b>	<b>Primary Metabolites:</b>	
	<ol style="list-style-type: none"> <li>2.1 Lipids, types, and properties of lipids</li> <li>2.2 Biosynthesis and Degradation of fatty acids and Glycerol,</li> <li>2.3 Respiratory metabolism in germinating seeds, <math>\beta</math>-oxidation &amp; energetics of <math>\beta</math>oxidation.</li> <li>2.4 Biological Importance of Lipids, fats and wax</li> </ol>	
<b>Unit- III:</b>	<b>Nitrogen Metabolism:</b>	
	<ol style="list-style-type: none"> <li>3.1 Nitrogen Nutrition,</li> <li>3.2 Asymbiotic and Symbiotic N fixation,</li> <li>3.3 Synthesis of Amino acids and Amides, Proteins.</li> <li>3.4 Genetics of Nitrogen fixation</li> </ol>	
<b>Unit- IV:</b>	<b>Secondary Metabolites:</b>	
	<ol style="list-style-type: none"> <li>4.1 History, Classification, Properties, Distribution in Nature, Biosynthesis, Extraction, Biological Role and Applications of-               <ol style="list-style-type: none"> <li>4.1.1 Alkaloids and</li> <li>4.1.2 Glycosides</li> <li>4.1.3 Phenolic compounds including flavonoids</li> </ol> </li> </ol>	
<b>Unit- V</b>	<b>Secondary Metabolites:</b>	
	<ol style="list-style-type: none"> <li>5.1 History, Classification, Properties, Distribution in Nature, Biosynthesis, Extraction, Biological role and applications of-               <ol style="list-style-type: none"> <li>5.1.1 Tannins and Other Phenolic Compounds.</li> <li>5.1.2 Terpenes</li> <li>5.1.3 Steroids</li> </ol> </li> </ol>	
<b>Unit- VI</b>	<b>Secondary Metabolites:</b>	

	<p style="text-align: center;"><b>6.1</b> History, Classification, Properties, Distribution in Nature, Biosynthesis, Extraction, Biological role and applications of-</p> <p style="text-align: center;">6.1.1 Volatile oils</p> <p style="text-align: center;">6.1.2 Resins</p> <p style="text-align: center;">6.1.3 Saponins</p>
<b>Laboratory Exercise: Plant Metabolism</b>	
<p>1) Screening of primary metabolite from given plant materials -</p> <ul style="list-style-type: none"> <li>- Amino acids</li> <li>- Vitamins</li> <li>- Carbohydrates</li> <li>- Lipids</li> </ul> <p>2) Screening of secondary metabolites from given plant materials –</p> <ul style="list-style-type: none"> <li>- Alkaloids</li> <li>- Phenolics</li> <li>- Flavonoids</li> <li>- Steroids</li> <li>- Glycosides</li> <li>- Tannins</li> <li>- Saponins</li> </ul>	
<b>Suggested Readings:</b>	
<p>Bhat, G. A., and Raise Ul- Haq, M. and Bhat, M. I. (2020) Secondary Metabolites from Plants. Books Enclave.</p> <p>Buchanan, B. B., Gruissem, W. and Jones, R. (2015) Biochemistry and Molecular Biology of Plants., 2<sup>nd</sup>Edn. Wiley Publication.</p> <p>Cooper, R., and Nicola, G. (2014) Natural Products Chemistry: Sources, separation and structure. CRC Press.</p> <p>Cseke, L. J., Kirakosyan, A., Kaufman, P. B., Warber, S., Duke, J. A., and Brielmann H.L. (2006) Natural Products from Plants. CRC Press.</p> <p>Daniel, M. (2006) Medicinal Plants: Chemistry and Properties. Science Publishers</p> <p>Day, P. M. (1989) Methods in Plant Biochemistry. Academic Press.</p> <p>Gleason, F., and Chollat, R. (2011) Plant Biochemistry. Jones and Bartlett Publishers, Inc</p> <p>Goyal, M. R., Joy, P. P. and Suleriya, H. A. R. (2019) Plant Secondary Metabolites for Human Health. Apple Academic Press.</p> <p>Granger, T. (2018) Plant Biochemistry: Concept and Applications. Callisto Reference Publisher</p> <p>Harborne, J. B. (1998) Phytochemical methods, a guide to modern techniques of plant analysis. Springer Netherland</p> <p>Nagaraj, G. (2015) Plant Biochemistry: Techniques and Procedures. Nipa Books.</p> <p>Nagaraj, G. (2015) Agricultural Plant Biochemistry. New India Publishing Agency.</p> <p>Nelson, D. K. and Cox. M. M. (2021) Lehninger- Principle of Biochemistry, 8<sup>th</sup>Edn. Macmillan Publishing.</p> <p>Pooja (2011) A Textbook of Plant Chemistry. Discovery Publishing House.</p> <p>Shrivastava, H. S. (2005) Plant Physiology and Biochemistry. New India Publishing Agency.</p> <p>Siddiqui, M. W., Bansal, V. and Prasad, K. (2016) Plant Secondary Metabolites, Vol.I &amp; II, CRC</p>	



Press.

Sukumaran, S., Suganthan, S. and Abdulhameed, S. (2020) Plant Metabolites: Methods, Applications and Prospects. Springer Singapore.

Verma, S. K. and Verma, M. (1995) A textbook of Plant Physiology, Biochemistry and Biotechnology. S. Chand Publication.

**Learning Outcome:**

1. The students will learn about the synthesis, structure, types, and applications of primary metabolites
2. The students will understand the process of secondary metabolite synthesis, their structure and its applications.
3. The students will be skilled in screening methods for various primary and secondary metabolites.

<b>Syllabus Prescribed for the year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSC II.2</b>	<b>Biotechnology in Secondary Metabolite Production</b>	<b>04 Credits = 04</b>
<b>COs :</b>		
1. To impart knowledge and skill to students about in vitro propagation and conservation. 2. To deliver the basics and applied aspects of transgenic plants 3. To understand the various alternative methods of secondary metabolite production.		
<b>Unit- I:</b>	<b><i>In vitro</i> Plant Propagation techniques-I</b>	
	1.1 Setting up of a plant tissue Culture Lab. 1.2 Aseptic conditions, 1.3 Micropropagation by Node culture, 1.4 Organogenesis, 1.5 Embryo culture, 1.6 Anther and Pollen culture	
<b>Unit- II:</b>	<b><i>In vitro</i> Plant Propagation techniques-II</b>	
	2.1 Micropropagation by Somatic Embryogenesis 2.2 Synthetic seed production 2.3 Somatic Hybridization 2.4 Standardization of cultivation protocols of any two medicinal plants	
<b>Unit- III:</b>	<b>Transgenic Plants:</b>	
	3.1 Production of Transgenic Plants: Artificial direct DNA uptake by protoplast, electroporation, liposome-mediated, and particle gun transformation. 3.2 The natural method of gene transfer Agrobacterium and viruses. 3.3 Marker and Reporter genes.	
<b>Unit- IV:</b>	<b>Transgenic Plants:</b>	
	4.1 Transgenic Plants for improving seed quality, insect and disease resistance, 4.2 Production of Golden rice and edible vaccines 4.3 Production of Flavor-Savr Tomato	
<b>Unit- V:</b>	<b>Alternative Methods of Secondary Metabolite Production:</b>	
	5.1 Organ culture and Cell culture. 5.2 Biotransformation (microbial and plant cells) Scale up: Enhancement of product formation by elicitation, and permeabilization of plant cells for product release.	
<b>Unit- VI:</b>	<b>Alternative Methods of Secondary Metabolite Production:</b>	
	6.1 Hairy root culture 6.2 Use of Elicitors 6.3 Role of endophytes in secondary metabolites production	
<b>Laboratory Exercise :</b>		

- 1) Sterilization of glassware and explants
- 2) Understanding Plant tissue culture media and media preparation.
- 3) Induction of callus culture and its maintenance
- 4) Induction of organ culture
- 5) Demonstration of suspension culture
- 6) Demonstration of protoplast culture
- 7) Demonstration of somatic embryogenesis
- 8) Preparation synthetic seeds.
- 9) Enhancement of phytochemicals in culture system using physical and chemical agents.

**Suggested Reading:**

Abid Ali, M. M. (2020) Secondary Metabolites of Medicinal Herbs, Biochemistry and Therapeutics. Discovery Publishing House Pvt. Ltd.

A. G. Rajlaxmi, (2018) Manual on Plant Tissue Culture, Notion Press, India

Archana, C. P. (2015) Tissue Culture for Plant Propagation, Free Lance

Bharat Singh and Ram Avtar Sharma (2020) Secondary Metabolites of Medicinal Plants: Ethnopharmacological properties, biological activities and Production strategies. Wiley VCH Publisher.

Jamwal, B. S. (2020) Plant Tissue Culture, Bioscientific Publishers

Jwala Agrawal and Shekhar K. Arora (2014) Plant Tissue Culture: Modern Techniques and Practices, Cumpus Books International.

Kalyan Kumar De (2020) Plant Tissue Culture, NCBA Publication.

Plant Biotechnology and Transgenic plants : 92, edited by Kirsi and Wolfgang (2002), CRC Press

Plant Biotechnology : Curent and Future applications of Genetically Modified Crops, Editor, Nigel Halford, (2015) John Wiley.

Plant Secondary Metabolites: Occurance, Structure and role in human diet, edited by A. Crozier et al., (2013). Wiley India Pvt. Ltd.

Ponmurugan, P (2012) Applications of Plant tissue culture, New Age International Pvt. Ltd. Publishers.

Pratibha Chaturvedi, Pushpa Khanna and Abhay Chaudhary (2012) In vitro production of secondary metabolites of Medicinal Plants.

Purohit, S. D. (2015) Introduction to Plant Cell, Tissue and Organ Culture, PHI learning publication.

Razdan, M. K. (2019) Introduction to Plant tissue culture, 3<sup>rd</sup> Edn. Oxford and IBH Publishing

Santosh Kumar and Madhavi Adhav (2019) Practical Book of Biotechnology and Plant tissue culture, S. Chand Publication.

Transgenic plants: Methods and Protocols, : 1864, Ed- Sandip Kumar et al., (2018) Humana Press, Springer Protocols.

Trivedi, P. C. (2015) Plant Tissue Culture and Biotechnology, Pointer Publisher

Vinay Sharma and Afroz Alam (2019) Plant Tissue Culture, Dremtech Press, under Wiley Publication.

**Learning Outcomes:**

1. After completion of this course, the students will be able to explain various methods of in vitro propagation and their skills in it.
2. The students will understand the pros and cons of transgenic plants/ crops
3. The students will be well-versed in the methods of secondary metabolite production in vitro.

<b>Syllabus Prescribed for year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSC III.2</b>	<b>Adulteration, Drug Evaluation, and Pharmacopoeial Standards</b>	<b>03</b> <b>Credits = 03</b>
<b>COs :</b>		
1. To provide knowledge about drug adulteration to students. 2. To impart knowledge about Guidelines of WHO for drug assessments 3. To skill the students in different methods of drug evaluation.		
<b>Unit: I:</b>	<b>Drug Adulteration</b> 1.1 Adulteration and Adulterants 1.2 Causes of adulteration 1.3 Types of Adulterants 1.4 Types of adulteration (Intentional and unintentional)	
<b>Unit- II:</b>	<b>Drug Adulteration</b> Adulteration and substitution in some common drug powders- Kumkum (Crocus sativus), Haridra (Curcuma longa), Hingu (Ferula asafoetida), Guggulu (Comiphora mukul), Sarja (Vateria indica), Kunduru (Boswellia serata)	
<b>Unit- III:</b>	<b>Drug Evaluation</b> 3.1 Morphological/ Organoleptic/ Macroscopic Evaluation 3.2 Microscopic evaluation 3.3 Chemical evaluation	
<b>Unit- IV:</b>	<b>Drug Evaluation</b> 4.1 Physical evaluation of drugs 4.2 Biological evaluation 4.3 Evaluation using chromatography / Spectroscopy	
<b>Unit- V:</b>	<b>Pharmacopoeial standards:</b> 5.1 Structural standards 5.2 Physical standards 5.3 Chemical standards	
<b>Unit- VI:</b>	<b>WHO guidelines for the assessment of Crude drugs</b> 6.1 Evaluation of Identity, quality, and purity of crude drugs 6.2 Determination of Pesticidal residue 6.3 Determination of Arsenic and heavy metals 6.4 Determination of microorganisms	
<b>Laboratory Exercises :</b>		
1) Morphological characterization of crude drug sample (2 samples) 2) Microscopic characterization of crude drug sample (2 samples) 3) Biological characterization of crude drug sample (2 samples) 4) Chemical characterization of crude drug sample (2 samples) 5) Identification adulterants in given drug samples ( 3 samples)		
<b>Suggested Reading:</b>		
Arumugam, K. R. and Muruges, N (2018) Text book of Pharmacognosy, 7 <sup>th</sup> edn, Sathya Publication. Gokhale, S. B., Tatiya, A. U. and Kalaskar, M. G. (2017) Practical Pharmacognosy and Phytopharmaceuticals, Nirali Prakashan. Gokhale, S. B. and Kokate, C. K. (2017) Practical Pharmacognosy, Nirali Prakashan. Kar, A. (2018) Pharmacognosy and Pharmacobiotechnology, New Age International Pvt. Ltd.		

Publisher.

Kokate, C. K., Purohit, A. P. and Gokhale S. B. (2017) Pharmacognosy-I, II & III Nirali Prakashan

Kumaresan, V. (2018) Herbal Biotechnology and Pharmacognosy, Saras Publication.

Mohammad Ali (2020) Pharmacognosy (Pharmacognosy and Phytochemistry) Vol- 1, CBS Publisher.

Mohammad Ali (2020) Pharmacognosy (Pharmacognosy and Phytochemistry) Vol- 2, CBS Publisher.

Pawar, C. R., Patil K. S., and Wadekar R. R. (2022) Fundamentals of Pharmacognosy, Everest Publishing house.

Quadry, J. S. (2019) A Text Book of Pharmacognosy, Theory and Practicals, 17<sup>th</sup> Edn. CBS Publisher.

Sambhath Kumar, S. and Muruges, N. (2021) Essentials of Pharmacognosy, Sathya Publication.

Sayeed Ahamad (2020) A laboratory Manual of Pharmacognosy, Dreamtech Press under Wiley.

Shukla, P., Alok, S., Shukla P. (2019) Pharmacognosy and Phytochemistry- I, Nirali Prakashan.

**Learning Outcomes:**

The students will learn to-

- Identify the adulteration in the drug sample.
- Evaluate the given drug samples using various methods.
- Interpret the quality and purity of given drug samples.

Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSE II</b>	<b>Phytochemistry and Pharmacognosy- II</b>	<b>03</b> <b>Credits= 03</b>
<b>Cos :</b>		
<ol style="list-style-type: none"> <li>1. To understand various major phytochemicals present in medicinal plants.</li> <li>2. To understand and analyze various phytoconstituents in plant samples.</li> <li>3. To understand and analyze the lead compounds from various medicinal plants.</li> </ol>		
<b>Unit- I:</b>	<b>Phytochemical study:</b> Definition, Distribution, Occurrence, Properties, Classification, Isolation, and tests of – Alkaloids, Glycosides, Phenolics, Flavonoids	
<b>Unit- II:</b>	<b>Phytochemical study:</b> Definition, Distribution, Occurrence, Properties, Classification, Isolation, and tests of – Terpenoids, Carotenoids, Tannins, Steroids, Resins	
<b>Unit- III:</b>	<b>Source, Chemistry, and uses of the following drugs-</b> Tropane alkaloids, Indole alkaloids, Steroidal alkaloids, Cardiac glycosides, Anthracene glycosides, Resins (Cannabis and Podophyllum) and Tannins	
<b>Unit- IV:</b>	<b>Characterization of the following drugs:</b> Vasicine, Andrographoloids, Phyllanthin, Gingerol, Curcumin and Lupeol	
<b>Unit-V:</b>	<b>Natural products and lead compounds:</b> Approaches to discovery and development of natural products as potential new drugs, selection and optimization of new lead compounds for further development with suitable example from CNS, Cardiovascular, Anticancer and antidiabetic drugs.	
<b>Unit- VI:</b>	<b>Bitter Principles:</b> Definition, classification of bitter principles; their isolation, characterizations, features, identification tests and uses.	
<b>Laboratory Exercise :</b>		
<ol style="list-style-type: none"> <li>1) Identification of various phytochemicals (studied in theory: 9) from a given plant sample using chemical methods.</li> <li>2) Characterization of various drug material (3 samples)</li> <li>3) Identification test for bitter principle (2 samples)</li> </ol>		
<b>Suggested Reading:</b>		

- Agrawal, S. S. and Paridhavi, M. (2012) Herbal Drug Technology, 2<sup>nd</sup> Edition, Orient Blackswan Publication.
- Bhutani, K. K., Singh, I. P., and Jachak, S. M. (2017) Analytical profiles of selected medicinal plants. Studium Press, New Delhi.
- Egbuna C et al. (2018) Phytochemistry: Fundamentals, modern techniques and applications, CRC Press.
- Garud, N., Joshi, R., Bhandkariya, S. and Wasim Akram (2019) Herbal Drug Technology, R. Narain Publisher and Distributor.
- Kunle, O. F. et. al., (2012) Standardization of herbal medicine. International Journal of Biodiversity and Conservation, 4(3): 101-112
- Muyumba, N.W., Mutombo, S.C., Sheridan, H., Nachtergael, A., Duez, P. (2021) Quality control of herbal drugs and preparations: The methods of analysis, their relevance and applications. Talanta Open (VOL. 4) <https://doi.org/10.1016/j.talo.2021.100070>.
- Neelesh Malviya and Sapna Malviya (2019) Herbal Drug Technology, CBS Publisher and Distributor.
- Rangari, V. D. (2015) Phytochemistry and Pharmacognosy, Career Publication.
- Songlin, Li et al., (2008) Chemical markers for quality control of herbal medicine: an overview. Chinese Medicine, 3:7
- Upton R. et al., (2019) Botanical Ingredient identification and quality assessment: Strengths and limitations of analytical techniques. Phytochemistry Review, 19: 1157-1177.
- World Health Organization (1998) Quality control methods for medicinal plant materials World Health Organization Geneva.
- World Health Organization (2011) Quality control methods for herbal materials, an updated version.

**Learning Outcomes:**

The students will be -

- Well versed with various phytochemicals found in medicinal plants
- Acquainted with the techniques of identifying various phytochemicals
- Skilled in characterizing various biological activities of crude drug samples.

<b>Syllabus Prescribed for the year 2023-24</b>		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
<b>Code of the Course Subject</b>	<b>Title of the Course/ Subject</b>	<b>No. of Periods/week</b>
<b>DSE II</b>	<b>Herbal Drug Technology- II</b>	<b>03</b>
<b>Credits= 03</b>		
<b>Cos :</b>		
1. To understand the basics of herbal drug preparation. 2. To understand and analyze various phytoconstituents in plant samples. 3. To understand and prepare mono-herbal and polyherbal formulations with their merits and demerits.		
<b>Unit- I:</b>	1.1 Herbs as raw materials: Definition of herbs, herbal medicine, herbal drug preparation 1.2 Source, selection, identification, and authentication of herbal material 1.3 Drying and processing of herbal raw material	
<b>Unit- II:</b>	1.1 Isolation, identification tests and estimation methods for following phytoconstituents- 1.1.1 Aloin from Aloe vera and A. barbadensis 1.1.2 Vasicine from Adathoda vasica 1.1.3 Andrographolides from Andrographis paniculata	
<b>Unit- III:</b>	2.1 Isolation, identification tests and estimation methods for following phytoconstituents- 2.1.1 Curcumin from Curcuma longa 2.1.2 Piperine from Piper longum	
<b>Unit- IV:</b>	3.1 Preparation and use of herbal medicine for common ailments like colds, skin infections, and diarrhea. 3.2 Analytical profile of selected herbs- 3.2.1 <i>Aegle marmelos</i> 3.2.2 <i>Andrographis paniculata</i> 3.2.3 <i>Bacopa monnieri</i> 3.2.4 <i>Centella asiatica</i> 3.2.5 <i>Gymnema sylvester</i>	
<b>Unit-V:</b>	4.1 Mono-herbal and polyherbal formulations: Examples, Preparation, Merits, and Demerits 4.2 WHO guidelines about quality control and quality assurance of herbal ingredients/ formulations 4.3 Determination of tannins, ash value, extractable matter and pesticide residues in formulation or ingredients.	
<b>Unit- VI:</b>	5.1 Standardization and quality evaluation of herbal drugs 5.2 Patenting and regulatory requirements of herbal drugs 5.3 Herbal drug regulations in India 5.4 Case studies	
<b>Laboratory Exercise :</b>		
1) Identification of given medicinal plants using flora (any 3). 2) Identification of phytoconstituents (Any three)		



## 3) Analytical profile of given medicinal herbs (any five)

**Suggested Reading:**

- Agrawal, S. S. and Paridhavi, M. (2012) Herbal Drug Technology, 2<sup>nd</sup> Edition, Orient Blackswan Publication.
- Balekundari, A. and Mannur, V. (2020) Quality control of traditional herbs: A review. Future Journal of Pharmaceutical Sciences. Vol. 6, Article No. 67.
- Bhutani, K. K., Singh, I. P., and Jachak, S. M. (2017) Analytical profiles of selected medicinal plants. Studium Press, New Delhi.
- Garud, N., Joshi, R., Bhandkariya, S. and Wasim Akram (2019) Herbal Drug Technology, R. Narain Publisher and Distributor.
- Kunle, O. F. et. al., (2012) Standardization of herbal medicine. International Journal of Biodiversity and Conservation, 4(3): 101-112
- Mohan Lal Kori, Santram Lodhi, Tushar A. Deshmukh, Rageeb Md. Usman, Vaibhav M. Darvhekar (2022) Herbal Drug technology, Nirali Prakasan.
- Muyumba, N.W., Mutombo, S.C., Sheridan, H., Nachtergael, A., Duez, P. (2021) Quality control of herbal drugs and preparations: The methods of analysis, their relevance and applications. Talanta Open (VOL. 4) <https://doi.org/10.1016/j.talo.2021.100070>.
- Neelesh Malviya and Sapna Malviya (2019) Herbal Drug Technology, CBS Publisher and Distributor.
- Pawar, H. A. and Achhra C. V. (2022) A Textbook of Herbal Drug Technology, Everest Publishing House.
- Songlin, Li et al., (2008) Chemical markers for quality control of herbal medicine: an overview. Chinese Medicine, 3:7
- Upton R. et al., (2019) Botanical Ingredient identification and quality assessment: Strengths and limitations of analytical techniques. Phytochemistry Review, 19: 1157-1177.
- Varsha Tiwari (2018) Herbal Drug Technology, Nirali Prakashan.
- World Health Organization (1998) Quality control methods for medicinal plant materials World Health Organization Geneva.
- World Health Organization (2011) Quality control methods for herbal materials, an updated version.

**Learning Outcomes:**

The students will be -

- Well versed with the methods of preparation of herbal formulations.
- Acquainted with the techniques of standardization of crude drug samples.
- Skilled in evaluating various biological activities of crude drug samples.
- Expert in analytical profiling of medicinal plants and herbal formulations.

**M. Sc. I, Sem- II (Herbal Science)**  
**Practical: V/ Lab- V**  
**(Bioactive Principles from Plants; DSC-I.2)**  
**(2Practicals/ week; 01 Credits)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25M and External: 25 M)**

**Internal Practical Examination:**

1. Visit to industry/ laboratory	10 M
2. Presentation on any one topic of interest	05 M
3. Any other formative assessment	10 M
	<b>Total: 25 M</b>

**External Practical Examination:**

1. Screening of any two primary metabolites from a given plant material/ sample.	05 M
2. Screening of any two Secondary metabolites from a given plant material/ Sample.	05 M
4. Viva- Voce	10 M
5. Submission of Practical Records	05 M
	<b>Total: 25 M</b>

**M. Sc. I, Sem- II (Herbal Science)**  
**Practical: VI/ Lab- VI**  
**(Biotechnology in Secondary Metabolite Production; DSC- II.2)**  
**(2Practicals/ week; 01 Credits)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25M and External: 25 M)**

**Internal Practical Examination:**

1. Visit to industry/ laboratory	10 M
2. Presentation on any one topic of interest	05 M
3. Any other formative assessment	10 M
	<b>Total: 25 M</b>

**External Practical Examination:**

1. Induction of Callus culture.	05 M
2. Preparation of synthetic seeds.	05 M
4. Viva- Voce	10 M
5. Submission of Practical Records	05 M
	<b>Total: 25 M</b>

**M. Sc. I, Sem- II (Herbal Science)**  
**Practical: VII/ Lab- VII**  
**(Adulteration, Drug Evaluation, and Pharmacopoeial Standards; DSC-III.2)**  
**(2Practicals/ week; 01 Credits)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25M and External: 25 M)**

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**Internal Practical Examination:**

1. Visit to industry/ laboratory	10 M
2. Presentation on any one topic of interest	05 M
3. Any other formative assessment	10 M
	<b>Total: 25 M</b>

**External Practical Examination:**

1. Microscopic/ macroscopic evaluation of the given drug sample.	05 M
2. Identification of adulterants in given drug sample	05 M
4. Viva- Voce	10 M
5. Submission of Practical Records	05 M
	<b>Total: 25 M</b>

**M. Sc. I, Sem- II (Herbal Science)**  
**Practical: VIII/ Lab- VIII**  
**(Phytochemistry and Pharmacognosy- II; DSE- II) Elective**  
**(2Practicals/ week; 01 Credits)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25M and External: 25 M)**

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**Internal Practical Examination:**

1. Visit to industry/ laboratory	10 M
2. Presentation on any one topic of interest	05 M
3. Any other formative assessment	10 M
	<b>Total: 25 M</b>

**External Practical Examination:**

1. Chemical test for identification of phytochemicals.	05 M
2. Characterization of crude drug material	05 M
4. Viva- Voce	10 M
5. Submission of Practical Records	05 M
	<b>Total: 25 M</b>

**M. Sc. I, Sem- II (Herbal Science)**  
**Practical: VIII/ Lab- VIII**  
**(Herbal Drug Technology- II; DSE- II) Elective**  
**(2Practicals/ week; 01 Credits)**

**Time: 3.00 Hrs]**

**[Total Marks: 50**  
**(Internal: 25M and External: 25 M)**

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**Internal Practical Examination:**

1. Visit to industry/ laboratory	10 M
2. Presentation on any one topic of interest	05 M
3. Any other formative assessment	10 M
	<b>Total: 25 M</b>

**External Practical Examination:**

1. Identification tests for given phytochemicals.	05 M
2. Analytical profile of given herb	05 M
4. Viva- Voce	10 M
5. Submission of Practical Records	05 M
	<b>Total: 25 M</b>