NOTIFICATION

No. 195 /2022 Date : 01/12/2022

Subject : Introduction of new syllabi for the subject Herbal Science at M.Sc. Part-I (Sem.I& II) level, which is implemented from the academic session 2022-23 and onwards.

It is notified for general information of all concerned that the authorities of the University has introduced and approved the syllabi for the new subject Herbal Science at M.Sc. Part-I (Sem. I & II) level, under choice based credit system, which is to be implemented from the academic session 2022-23 & onwards, as given in in Appendix- A.

It is further notified that the eligibility criteria and other details along with schemes of Examination shall be as provided under Direction No.97 of 2022 & Direction No.78 of 2022 respectively.

Sd/-
(Dr.Tushar Deshmukh)
Registrar
Sant Gadge Baba Amravati University

Appendix-A

Syllabus prescribed for M.Sc. Part-I (Sem. I & II) Herbal Science to be implemented from the session 2022-2023

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

Syllabus Prescribed for year 2022-23		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC I	**Introduction to Herbal Science**	**03**
COs : 1. To understand the fundamentals of the herbal science. 2. To understand basics of various ancient systems of medicines. 3. To understand the role of plants in development of herbal science. 4. To understand role of major pharmacopoeias across the globe.		
Unit: I:	**Introduction to Herbal Sciences** o Historical Background, Present Status and Scope of herbal Science o Medicinal Botany and Folklore Medicine o Need to preserve the ancient knowledge	
Unit- II:	**Indigenous Knowledge systems** • Fundamental concepts and updates of- o Ayurveda o Siddha o Unani o Homeopathy and o Tibetian system of medicine.	
Unit- III:	**Rediscovery of Natural Herbal Medicine** o Reasons for the popularity of Natural herbal remedies o Overview with suitable examples- ▪ Pharmacognosy ▪ Aromatherapy ▪ Cosmetology	
Unit- IV:	**Introduction to Pharmacopoeia** • **Introduction to major pharmacopoeia across the globe** o Indian Pharmacopoeia o US Pharmacopoeia o European Pharmacopoea o British Pharmacopoeia o WHO's International Pharmacopoeia	
Laboratory Exercise : Introduction to Herbal Science		
1. Identification of the following medicinal plants and chemical tests for their active constituents: • Medicinal Plants: *Datura* (tropane alkaloids), *Andrographis* (diterpene lactose), *Curcuma* (curcuminoids), *Boerhaavia* (glycosides), *Ricinus* (fatty acids), *Terminalia belerica* (tannins), *Allium sativum* (sulphur compounds). 2. Identification of the following plants used in cosmetics and aromatherapy and chemical tests for their active constituents: • Cosmetics and Aromatherapy: *Vetiveriazizanoidis*, *Rosa sinensis*, *Jasminum* spp., *Pogostemonpatcholi*. 3. Identification of the following Food additives and chemical tests for their active constituents: • Food additives: *Bixaorelana*, *Beta vulgaris*, *Cinamomumtamala*, *Zingiberofficinalis*, *Allium sativum*, *Curcuma longa*.		

Suggested Reading:

Indian Pharmacopeia commission (2018) Indian Pharmacopeia (8thEdn), Published by Indian Pharmacopeia commission
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.
Joshi, M. C. (2019) Handbook of Indian Medicinal Plants, Scientific Publisher, India
Kochhar, S. L. (2016) Economic Botany: A comprehensive approach, Cambridge Publication.
Lewis Walter H. (2010) Medical Botany: Plants affecting human health, John Wiley & Sons Inc.
Maheshwari, J. K. (2003) Ethno- Botany and Medicinal plants of Indian subcontinent. Scientific Publisher, India
Murthy K. R. S. (2016) SushrutaSamhitaVol.I to IV, ChaukhambhaOrientalia.
Rastogi Ram and Mehrotra B. N. (1990) Indian Medicinal Plants Vol. 1 to 4
Seth Ashok (2007) The herbs of Ayurveda Vol. I to IV, Dattani Book Agency.
Sharma P. V. (2005) CharakaSamhita Vol. I to IV, ChaukhambhaOrientalia.
Shiva, M.P., Lehri, Alok., Shiva, Alka (2007) Aromatic and Medicinal Plants. International Book Distributor, Deharadun.
Staff, E. (2007) Handbook of mushroom cultivation, processing and packaging. Engineers India Research Institute.
TrivediPravin Chandra (2006) Ethnobotany, Published by Agrobios, Jodhpur
WHO (2020) The International Pharmacopeia
WHO (2013) Review of World Pharmacopeias, International Meeting of World Pharmacopoeias World Health Organization, Geneva, Executive Board Room 29 February–2 March 2012.
ZoharaYaniv and Uriel, B. (2005) Handbook of Medicinal Plants, CRC Press

Learning Outcomes:

1. The students will be able to understand the basic concept of herbal science.
2. They will have information regarding the ancient systems of medicine in India
3. They will learn about the major pharmacopoeia across the world.
4. They can critically think over the safety aspects of herbal products.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
ACE I	**Analytical Techniques**	**01**

COs :

5. To understand how to analyze the plant drugs using various analytical techniques.
6. To give exposure with different techniques of plant analysis.
7. To impartknowledge about techniques required for herbal formulations.

Unit: I:	• **Qualitative analysis of plant samples** (Chemical tests for various primary and secondary metabolites) • **Proximate analysis of plant samples** (Analysis of Protein and Carbohydrates in given sample) • **Principle, Working and Applications of,** o Visible and UV-Spectrophotometry o IR (Infra- red spectroscopy) o AAS (Atomic Absorption Spectroscopy) o MS (Mass Spectroscopy) o XRD (X-ray Diffractometer)

Suggested Readings:

Heinz- Helmut, P. (1992) UV- Visible spectroscopy and its applications. Springer Ltd.
James V. (2019) Analytical Spectroscopy, Pacific Books International.
Kafle, B. P. (2019) Chemical analysis and material characterization by spectrophotometry, Elsevier Inc.
Kaur, H. (2020) Spectroscopy, PragatiPrakashan,
Mark, F. Vitha (2018) Spectroscopy: Principles and Instrumentation. John Wiley & Sons Inc.
Scott, R. P. W. (1995) Techniques and Practice of Chromatography, CRC Press
Sharma, B. K. (2020) Spectroscopy, 27th Ed., Goel Publishing House.

Learning Outcomes:

1. The students will study and understand how to analyze the plant drugs using various analytical techniques.
2. The students will well verse with different techniques of plant analysis.
3. The students will be acquainted with modern analytical methodsrequiredfordevelopment of herbal formulations.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC II	**Basics of Plant Science**	**04**

COs :

1. The students will understand the general outline of plant classification.
2. The students will understand the characteristic features of angiosperms and will study the important medicinal plants of locally available plant families.
3. To deliver how to characterize the plants.

Unit: I:	**General Outline of Plant Classification:** • Major taxonomic groups of Plants o General Characteristics features and Medicinal importance - Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms • Binomial Nomenclature • Taxonomic hierarchy
Unit- II:	**Angiosperms-I:** • Bentham and Hooker's system of classification up to orders (family) level • General Characteristic features of Angiosperms • Describe locally available plants with respect to the following prescribed families with at least two plants of medicinal importance from each: Annonaceae, Malvaceae, Anacardiaceae and Myrtaceae.
Unit- III:	**Angiosperms- II** • Describe locally available plants with respect to the following prescribed families with at least two plants of medicinal importance from each: Leguminosae, Apiaceae, Rubiaceae, Apocyanaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Scitaminae.

Unit- IV:	**Taxonomic Characterization:**
	• Application of information from interrelated subjects.
	  o Exomorphic characters. Endomorphic characters: Anatomical, Cytological, Palynological and Embryological.
	  o Physico-chemical characters: Ash content, extractive values, qualitative chemical values, quantitative chemical analysis.

Laboratory Exercise: Basics of Plant Science

1. Identification of given algal material.
2. Identification of given fungal material.
3. Identification of given bryophytic material.
4. Identification of given pteridophytic material.
5. Identification of given gymnospermic material.
6. Exomorphic features of four medicinal plants each, from the families prescribed for theory.
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)

Suggested Readings:

Bhatnagar, S. P. and Moitra, A. (1996) Gymnosperms. New Age Publishers.
Ganguli, H. C., Das, K. S., Datta, C. (2011) College Botany Vol. I, New Central Book Agency.
Ganguli, H. C., Das, K. S., Datta, C. (2011) College Botany Vol. II, New Central Book Agency.
Jain, D. K. and Singh.V. (2009) Taxonomy of Angiosperms. Rastogi Publication
Joshi, S. G. (2018) Medicinal Plants. Oxford and IBH Publishing
Kaur, Inderdeep and Uniyal, PremLal (2019) Text Book of Gymnosperms. Daya Publication House
Kumar, Anil (2006) Medicinal Plants. Kalyani Publication
Naik, V. N. (1984) Taxonomy, Tata McGrow Hill Publication
Pandey, B. P. (2001) Text Book of Botany- Angiosperms. S. Chand and Company
Pandey, S. N. (2009) Taxonomy of Angiosperms.
Saxena, N. B. and Saxena, S. (2019) Plant Taxonomy. PragatiPrakashan
Shiva, M. P. and Shreenath, K. P. (2013) Taxonomy of some selected Medicinal Plants. LAP Lambort Publishing.
Singh, Gurucharan (2017) Plant systematics: an integrated approach. CRC Press
Sinha, R. K. (2013) Practical Taxonomy of Angiosperms. IK International Publishing House
Smith G. M. (2019) Cryptogamic Botany, Algae and Fungi, 2nd Edn. Surjeet Publication.
Smith G. M. (2019) Cryptogamic Botany, Bryophytes and Pteridophytes, 2nd Edn. Surjeet Publication.
Vashista, P. C., Sinha, A. K. and Kumar, A. (2010) Botany for Degree students: Gymnosperms. S. Chand and Company.

Learning Outcomes:

1. The students will be able to understand the classification of plant kingdom.
2. The students will learn about the characteristics of angiosperms and various angiospermic medicinal plants available in the region.
3. The students will be able to characterize medicinal plants on the basis of exomorphic, endomorphic and physic-chemical characters

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC III	**Cultivation Practices**	**04**

COs :

1. The students will understood various methods of vegetative and sexual reproduction in plants.
2. The students get acquainted with the fundamentals aspect of soil-less production i.e. hydroponics technology
3. The students will have better understanding about polyhouse technology.

Unit: I:	**Vegetative Reproduction Techniques** **A) Natural Methods by Specialized vegetative structures**: Tuberous roots, stem tubers, rhizome, bulb, corm, runner, offset, stolon, sucker, bulbils **B) Artificial methods:** Cutting (stem and leaf), Grafting, Budding, Layering.
Unit- II:	**Sexual Reproduction in Angiosperms** • Microsporogenesis and Microgametogenesis • Megasporogenesis and Megagametogenesis • Fertilization • Embryo and Endosperm development • Seed Germination, • Seed dormancy – types and Methods of overcoming seed dormancy

Unit- III:	**Hydroponics**
	• Origin and historical account of Hydroponics
	• Scope of hydroponics
	• Techniques in Hydroponics –
	  o Static solution culture,
	  o Continuous –flow solution culture,
	  o Aeroponics, Passive sub-irrigation,
	  o Bubbleponics.
	• Media used for Hydroponics:
	  o Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fibre.
	• Nutrient Solutions – Major and Minor nutrients, role of nutrients.
	• Commercial Utility of Hydroponics

Unit- IV:	**Polyhouse Technology** • Introduction to Polyhouse technology • Type of polyhouses, construction, additional facilities in polyhouses, • Maintenance of Polyhouse. • Applications of Polyhouse technology

Laboratory Exercise: Cultivation Practices:

1) Demonstration of natural vegetative reproduction
(As you studied in theory syllabus)
2) Perform any two types of artificial vegetative reproduction
(As you studied in theory syllabus)
3) Demonstrate megasporogenesis in angiosperms
4) Demonstrate microsporogenesis in angiosperms
5) Growing crop plants using hydroponic method
(any one plant as per regional suitability)

Suggested Readings:

Dumas, C. and Russell, S. (1992) Sexual Reproduction in flowering plants. Academic Press
Godfrey- Sam-Aggrey, W. and Norman, J. C. (1996) Handbook of common vegetative propagation methods for food crops and ornamental Plants. Vantage Publisher
Gosh, A. (2018) Greenhouse Technology, New India Publishing Agency
Johari, B. M. and Shrivastava, P. S. (2001) Reproductive Biology of Plants. Springer Publishing
Jones, J. B. Jr. (2004) Hydroponics: a practical guide for soilless growers, 2nd Edn. CRC Press
Madhuri, G. and Bharad, A. V. (2014) Carnation under Polyhouse. LAP Lambert Academic Press
Mogie, M. (1992) Evolution of Asexual Reproduction in Plants.Springer Publication.
Ramawat, K. G., Merillon, J-M, Shivanna, K. R. (2014) Reproductive Biology of Plants.CRC Press.
Raviv, M., Lieth, H. and Bar- Tal., A. (2019) Soilless cultures: Theory and Practice 2nd Edn, Academic Press.
Resh, H. M. (2012) Hydropic Food Production: A definitive guide book for the advanced home gardener and the commercial hydroponic grower, 7th Edn. CRC Press.
Resh, H. M. (2015) Hydroponics for home growers. CRC Press.
Shivanna, K. R., Tondon, R. and Kaul, M. (2020) Reproductive ecology of flowering plants: Pattern and Processes. Springer Publication
Singh, B. (2014) Advances in Protected cultivation. Nipa Books.
Tiwari, G. N. (2009) Greenhouse technology for controlled environment. Narosa Publication,
USAID (2007) Vegetative Propagation Techniques. Alternative Livelihood Program.

Learning Outcomes:

1. The students will be able to learn the vegetative reproduction techniques in Angiospermic plants and its performance skills.
2. The students will lean about the sexual reproduction in angiospermic plants and seed dormancy.
3. The students will get acquainted with the emerging hydroponics methods of growing soilless crops.
4. The students will well verse with the theoretic and practical aspects of polyhouse technology.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC IV	**Plant Authentication techniques**	**04**

COs :

1. To expose the students to various modern techniques used for plant authentication.
2. To impart the analytical skills to students.
3. To make the students to analyze and interpret the results with accuracy.

Unit: I:	• **Chromatography** Principles, Instrumentation, processes, applications of – o Adsorption Chromatography, o Partition Chromatography, o HPLC,
Unit- II:	• **Chromatography** Principles, Instrumentation, processes, applications of – o TLC, o HPTLC, o Gas- liquid chromatography, o GC , o Affinity Chromatography
Unit- III:	• **Electrophoresis:** o Principles of Electrophoresis, o Agarose Gel Electrophoresis, o Polyacrylamide Gel Electrophoresis o Basic protein chemistry, principles of separation, equipment and process, standardization of technique Electro-focusing, o Southern, Northern and Western Northern Blotting
Unit- IV:	• **Spectroscopy:** Introductory principles: Principles and Instrumentation of- o UV and Visible spectrophotometer, o Turbidometry, o IR, o AAS, o NMR, and o X-ray diffraction.

Laboratory Exercise :

1. Separation of Phytochemicals using different methods of Chromatography
   - Paper Chromatography
   - Thin Layer Chromatograph,
   - Liquid Chromatography
   - Column chromatography.
2. Extraction and separation of Proteins from the given raw material/products using PAGE.
3. Extraction and separation Nucleic acid by Gel electrophoresis.
4. Principles, working and applications of UV and Visible spectrophotometer.
5. Principles, working and applications of IR Spectroscopy.
6. Principal, working and applications of XRD.

Suggested Reading:

Mark, F. Vitha (2016) Chromatography: Principles and Instrumentation, Wiley Publication.
McNair, H. M. and Miller, J. M. (2009) Basic Gas Chromatography, Wiley- Blackwell Publisher.
Scott, R. P. W. (1995) Techniques and Practice of Chromatography, CRC Press
Nikalje, A. P. and Bhosale, D. (2017) A Handbook of Chromatography, Scholars Press, Germany.
Robards, K., Haddad, P. R. and Jackson, P. E. (1994) Principles and Practice of Modern Chromatographic Methods. Elsevier Ltd.
Sherma, J. and Fried, B. (2003) Edn. Handbook of Thin-Layer Chromatography Third Edition, Revised and Expanded. Marcel Decker, Inc.
Coskun, O. (2016) Separation techniques: Chromatography. North Clinic.Instamb. 3(2): 156- 160
Mitchell, G. H. (2017) Gel electrophoresis: Types, Applications and Research, Nova Science Publishers Inc.
Westernmier, R. (2004) Electrophoresis in practice: A guide to methods and applications of DNA and Protein separation, Wiley VCH Publisher
Magdeldin, Sameh (2012) Gel electrophoresis: Principles and Basics, Open access –Peer reviewed edited volume, IntechOpen
Bier, M. (2013) Electrophoresis: Theory, method and applications. Elsevier Publication
Kafle, B. P. (2019) Chemical analysis and material characterization by spectrophotometry, Elsevier Inc.
Heinz- Helmut, P. (1992) UV- Visible spectroscopy and its applications. Springer Ltd.
Mark, F. Vitha (2018) Spectroscopy: Principles and Instrumentation. John Wiley & Sons Inc.

Learning Outcomes:

1. The students will learn about the Principal, working and applications of various analytical techniques including chromatography, spectroscopy and electrophoresis.
2. The students will acquire the skill of handling various instruments at laboratory level.
3. The students will understood the applications of various equipments and how and when to use them.
4. The students will learn to analyze the samples and interpret the results with accuracy.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
Open Elective	**Medicinal Plants**	**04**

COs :

1. To introduce the students with fundamentals of Medicinal plants.
2. To impart the knowledge about the plant parts with medicinal potential.
3. To develop skills among students to identify medicinal plants and plant parts.

Unit: I:	• Medicinal Plants: Definition, history, present and future needs • Introduction of plant parts (fruit, leaves, roots, stem, seeds and their modification) • Medicinal plant processing and storage • Role of medicinal plant in human health
Unit- II:	• Important Indian Medicinal Plants Plant parts used as powder: Identification and utilization of Amla (Embelicaofficinalis), Behra (Terminalia bellerica), Harad (Terminalia chebula), Turmeric (Curcuma longa), Garlic (Allium sativum), Black plum (Syzygiumcumini), Fenugreek (Trigonellafoenumgraecum), Cinnamon (Cinnamomumverum), Sarpgandha (Raulfiaserpentina), Black pepper (Piper nigrum), Ashwagandha (Withaniasomnifera),

Unit- III:	• **Important Indian Medicinal Plants** **Plant parts used as juice/ decoction:** Identification and utilization of Amla (Embelicaofficinalis), Ginger (Gingiberofficinalis), Onion (Aliumcepa), Basil (Oscimumsantum), Arjun (Terminalia arjuna), Neem (Azadirectaindica), Brahmi (Bacopamonnieri), Giloy (Tinosporacordifolia), Shankhpushpi (Convolvulus prostrate), Bael (Aegle marmelos)
Unit- IV:	**Important Indian Medicinal Plant** 1. Plant Parts Used as Lotion and Ointments: Identification and utilization of Gwarpatha (Aloe vera), Fenugreek (Trigonellafoenumgraecum), Pot marigold (Calendula officinalis), Neem (Azadirectaindica) 2. Plant Parts Used as Oil: Clove (Syzygiumaromaticum), Neem (Azadirectaindica), Coconut (Coccus nucifera), Nilgiri (Eucalyptus sp.)

Suggested Reading:

Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi.

CSIR – Cultivation and Utilization of Medicinal Plants

Brahmvarchas, AyurvedkaPran: Vanoshadhivigyan, VedmataGayatri Trust, ShaktikunjHaridwar 2004

Chaudhry R. D., Herbal Drug Industry, Eastern Publication

Atal and Kapoor, Cultivation and Utilization of Medicinal Plants, RRL Jammu Tavi. 1982

RaphaelIkan, Natural Products: A Lab Guide, Academic Press, 1991, 2nd edition

DuttAshwin,An Introduction to Medicinal Plants, Adhyayan Publishers and distributers, 2009, 1st edition

Learning Outcomes:

After studying this course, the students will be able to understand :-

- The utility of plants as medicines
- The preparation of basic herbal medicinal products
- The idea of cultivation practices
- The storage, packaging and marketing of herbal medicines
- To work with individual plant and plant products.

M. Sc. I, Semester- I (Herbal Science)

Practical: I

(Introduction to Herbal Science and Basics of Plant Science)

Time: 6.00 Hrs] **[Total Marks: 100**

1. Identify the given plants/ plant parts of-	
A. Plants/ plant parts used as Medicine	10 M
B. Plant / plant parts used in cosmetics &Aromatherapy	10 M
C. Plant/ plant parts used as Food additives	10 M
2. Identify given algal material and mention its medicinal uses.	10 M
3. Identify given fungal/ Lichen material and mention its medicinal uses	10 M
4. Identify given bryophytic material and mention its medicinal uses	10 M
5. Identify given pteridophytic material and mention its medicinal uses	10 M
6. Identify of given gymnospermic material and mention its medicinal uses	10 M
6. *Viva- voce*	10 M
7. Practical record submission	10 M
Total	100 M

M. Sc. I, Semester- I (Herbal Science)

Practical: II (Cultivation Practices and Plant Authentication techniques)

Time :6.00 Hrs] **[Total Marks: 100**

1. Perform the illustrate the artificial vegetative reproduction in angiospermic plant (Any one from Cutting, budding, grafting and layering)	20 M
2. Prepare the slide for microsporogenesis/ megasporogenesis	10 M
3. Separation of Phytochemicals using Paper/ Thin layer/ Liquid Chromatography	20 M
4. Extraction and separation of Proteins using Gel electrophoresis	20 M
5. Principal, working and applications of Visible/ UV- visible/ IRspectrophotomerer	10 M
5. Viva- voce	10 M
6. Practical record submission	10 M
Total :	100M

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

Syllabus Prescribed for year 2022-23		
Programme	PG Programme	
M. Sc. Herbal Science	Semester-I	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC V	**Plant Metabolites**	**03**

COs :

1. To understood various primary metabolites, their types, roles and applications.
2. To analyze various aspects of secondary metabolites, synthesis, structure and applications.
3. To exercise the screening methods of primary and secondary metabolites.

Unit: I:	**Primary Metabolites** • Biosynthesis and Biodegradation of Carbohydrates – Sucrose, Starch, Cellulose. • Lipid Metabolism - Biosynthesis and Degradation of fatty acids and glycerol, • Respiratory metabolism in germinating seeds, β-oxidation & energetics of βoxidation, • Types of lipids.
Unit- II:	**Nitrogen Metabolism:** o Nitrogen Nutrition, o Asymbiotic and Symbiotic N fixation, o Synthesis of Amino acids and Amides, Proteins.
Unit- III:	**Secondary Metabolites** • History, Classification, Properties, Distribution in Nature, Extraction, Biosynthesis, Biological role and applications of- o Alkaloids and o Glycosides.
Unit- IV:	**Secondary Metabolites** • History, Classification, Properties, Distribution in Nature, Extraction, Biosynthesis, Biological role and applications of- o Tannins and other Phenolic Compounds. o Volatile oils and resins

Laboratory Exercise: Plant Metabolism

1) Screening of primary metabolite from given plant materials -
   - Amino acids
   - Vitamines
   - Carbohydrates
   - Lipids
2) Screening of secondary metabolites from given plant materials –
   - Alkaloids
   - Phenolics
   - Flavonoids
   - Steroids
   - Glycosides
   - Tannins

Suggested Readings:

Bhat, G. A., and Raise Ul- Haq, M. and Bhat, M. I. (2020) Secondary Metabolites from Plants.Books Enclave.

Buchanan, B. B., Gruissem, W. and Jones, R. (2015) Biochemistry and Molecular Biology of Plants.,2nd Edn. Wiley Publication.

Cooper, R., and Nicola, G. (2014) Natural Products Chemistry: Sources, separation and structure. CRC Press.

Cseke, L. J., Kirakosyan, A., Kaufman, P. B., Warber, S., Duke, J. A., and BrielmannH.L. (2006) Natural Products from Plants.CRC Press.

Daniel, M. (2006) Medicinal Plants: Chemistry and Properties. Science Publishers

Day, P. M. (1989) Methods in Plant Biochemistry.Academic Press.

Gleason, F., and Chollat, R. (2011) Plant Biochemistry.Jones and Bartlett Publishers, Inc

Goyal, M. R., Joy, P. P. and Suleriya, H. A. R. (2019) Plant Secondary Metabolites for human Health.Apple Academic Press.

Granger, T. (2018) Plant Biochemistry: Concept and Applications.Callisto Reference Publisher

Harborne, J. B. (1998) Phytochemical methods, a guide to modern techniques of plant analysis. Springer Netherland

Nagaraj, G. (2015) Plant Biochemistry: Techniques and Procedures. Nipa Books.

Nagaraj.G. (2015) Agricultural Plant Biochemistry. New India Publishing Agency.

Nelson, D. K. and Cox. M. M. (2021) Lehninger- Principle of Biochemistry, 8th Edn. Macmillan Publishing.

Pooja (2011) A Textbook of Plant Chemistry. Discovery Publishing House.

Shrivastava, H. S. (2005) Plant Physiology and Biochemistry. New India Publishing Agency.

Siddiqui, M. W., Bansal, V. and Prasad, K. (2016) Plant Secondary Metabolites, Vol.I& II, CRC 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 be learn about synthesis, structure, types and applications of primary metabolites
2. The students will understand the process of secondary metabolite synthesis, their structure and applications.
3. The students will be skilled in screening methods of various primary and secondary metabolites.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
AEC II	**Plant Biochemical Techniques**	**01**

COs : 1. The students will study and understand how to analyze the plant compounds using various analytical techniques. 2. The students will well verse with different techniques of plant biochemical analysis.	
Unit: I:	1 Plant vitamin analysis: Various methods of extraction and estimation. 2 Plant hormone analysis: Detection methods and estimation of major plant hormones. 3 Plant Pigment detection: Extraction and identification of various pigments. 4 Phytochemical tests: Various extraction methods of different phytochemicals, chemical detection and estimation
Suggested Readings:	
Harborne, J. B. (1980) Phytochemical methods: a guide to modern techniques of plant analysis, Springer, Netherlands. Harborne, J. B. (1996) Method of Plant Analysis, Spingerlink. Pp-1-36. Ermakove, A. et.al (1998) Methods for the biochemical analysis of Plants. Wiley Publication. Sadashivam, S. and Manikam, A. (1996) Biochemical Methods, New Age International. 8th Ed. 2015.	
Learning Outcomes: Students will able to- • Understand basic principle and mechanism of various plant analytical methods. • Understand and expertize in plant analysis techniques.	
Syllabus Prescribed for year 2022-23 Programme: PG Programme M. Sc. Herbal Science: Semester-II **Code of the Course Subject: DSC VI** **Title of the Course/ Subject: Plant Propagation for Commercial Utility** **No. of Periods/week: 04**	
COs : 1. To impart the knowledge and skill to student about the in vitro propagation. 2. To deliver the basics and applied aspect of transgenic plants 3. To understand the various alternative methods of secondary metabolite production.	
Unit: I:	***In vitro* Plant Propagation techniques-I** • Setting up of a plant tissue Culture Lab. • Aseptic conditions, • Micropropagation by Node culture, Organogenesis, Embryo culture, Anther and Pollen culture
Unit- II:	***In vitro* Plant Propagation techniques-II** • Micropropagation by Somatic Embryogenesis and synthetic seed production • Somatic Hybridization • Standardization of cultivation protocols of any two medicinal plants
Unit- III:	**Transgenic Plants:** • Production of Transgenic Plants: Artificial direct DNA uptake by protoplast, electroporation, liposome mediated, and particle gun transformation. • Natural method of gene transfer *Agrobacterium* and viruses. • Marker and Reporter genes. • Transgenic Plants for improving seed quality, insect and disease resistance, • Production of golden rice and edible vaccines •
Unit- IV:	**Alternative Methods of Secondary Metabolite Production:** • Organ culture and Cell culture. • Biotransformation (microbial and plant cells) Scale up: Enhancement of product formation by elicitation, permeabilization of plant cells for product release.

Laboratory Exercise :

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, BioscientificPublichers
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.
PratibhaChaturvedi, 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, 3rdEdn. Oxford and IBH Publishing
Santosh Kumar and MadhaviAdhav (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 AfrozAlam (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 skill in it.
2. The students will understood the pros and cons of transgenic plants/ crops
3. The students will be well verse with the methods of secondary metabolite production in vitro.

Syllabus Prescribed for year 2022-23

Programme	PG Programme	
M. Sc. Herbal Science	Semester-II	
Code of the Course Subject	**Title of the Course/ Subject**	**No. of Periods/week**
DSC VII	**Fundamental Pharmacognosy**	**04**

COs :

1. To provide knowledge about the basic pharmacognosy to students.
2. To impart knowledge about agrotechnology of medicinal plants
3. To give skills to identify various herbal drugs using pharmacognostic evaluation methods..

Unit: I:	• Preparation of Herbarium specimen • Use of flora and keys of plant identification • Microtomy and histological techniques applied to pharmacognosy • Chemotaxonomy of plants (with special reference to alkaloids, glycosides and terpenoids)
Unit- II:	• Agrotechnology of medicinal plants • Ecotypic, phenotypic and genotypic variability affecting phytopharmaceuticals • Standardization and quality proceedures for assay of plant products • Prospects and economics of medicinal plants in India

Unit- III:	• Recent advances in the field of pharmacognosy with respect to following types of drugs of plant origin- o Anticancer o Antidiabetic o Anti-inflammatory o Hepatoprotective o Immunomodulatory
Unit- IV:	Methods of phytochemical and biological screening of plant samples: • Extraction methods • Purification and isolation of plant constituents o Alkaloids o Phenolics o Glycosides o Volatile oils

Laboratory Exercise :

1) Identify and given plant material using Key and flora upto species level.
2) Histological screening of given plant material
3) Anatomical characterization of given plant material with reference to its pharmacognosy
4) Chemical evaluation of given powdered drug material for availability of phytoconstituents.
5) Crude drug identification- stomatal types and idex, trichomes, palisade ratio, ash content.
6) Evaluation of drug for antimicrobial activity.

Suggested Reading:

Arumugam, K. R. and Murugesh, N (2018) Text book of Pharmacognosy, 7thedn, Sathya Publication.
Deore, S. L. and Khadabali, S. S. (2018) Pharmacognosy and Phytochemistry : A comprehensive approach. 2ndEdn.,Pharmamade Press/ BSP Books.
Gokhale, S. B., Tatiya, A. U. and Kalaskar, M. G. (2017) PracticalPharmacognosy and Phytopharmaceuticals, NiraliPrakashan.
Gokhale, S. B. and Kokate, C. K. (2017) Practical Pharmacognosy, NiraliPrakashan.
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, NiraliPrakashan
Kokate, C. K., Purohit, A. P. and Gokhale S. B. (2017) Pharmacognosy-II, NiraliPrakashan
Kokate, C. K., Purohit, A. P. and Gokhale S. B. (2017) Pharmacognosy-III, NiraliPrakashan
Kulkarni, S. K. and Dandliya, P. C. (2018) Introduction to Pharmacology
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.
Murugesh, N. (2020) A Concise text book of Pharmacognosy, 7th edition, Sathya Publication.
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, 17thEdn. CBS Publisher.
Sambhath Kumar, S. and Murugesh, N. (2021) Essentials of Pharmacognosy, Sathya Publication.
SayeedAhamad (2020) A laboratory Manual of Pharmacognosy, Dreamtech Press under Wiley.
Shukla, P., Alok, S., Shukla P. (2019) Pharmacognosy and Phytochemistry- I, NiraliPrakashan.
Shukla, P., Alok, S., Shukla P. (2019) Pharmacognosy and Phytochemistry- I, NiraliPrakashan.

Learning Outcomes:

The students will learn to-

- Prepare herbarium, identify plant taxonomically and using chemotaxonomic approach.
- Agrotechnology of medicinal plants
- Work out the evaluation of various drug material
- Extract and isolate the biologically active compounds from given drug material.

Syllabus Prescribed for year 2022-23

Programme PG Programme
M. Sc. Herbal Science Semester-II

Code of the Course Subject	Title of the Course/ Subject	No. of Periods/week
DSC VIII	**Herbal Drug Technology**	**04**

Cos :

1. To understand 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.

Unit: I:	• Herbal drug- Definition • Importance of herbal drug and herbal therapies • Herbal verses conventional drugs • Safety of herbal drugs • Toxicity of herbal drugs
Unit- II:	• Isolation, identification tests and estimation methods for following phytoconstituents- o Aloin from Aloe vera and A. barbadensis o Vasicine from Adathodavasica o Andrographolides from Andrographispaniculata o Curcumin from Curcuma longa o Piperine from Piper longum
Unit- III:	• Preparation and use of herbal medicine for common ailments like cold, skin infections and diarrhea. • Analytical profile of selected herbs- o Aegle marmelos o Andrographispaniculata o Bacopamonnieri o Centellaasiatica o Gymnemasylvester
Unit- IV:	• Monoherbal and polyherbal formulations : Examples, Preparation, merits and demerits • WHO guidelines about quality control and quality assurance of herbal ingredients/ formulations • Determination of tannins, ash value, extractable matter and pesticide residues in formulation or ingredients.

Laboratory Exercise :

1) Identification of Sugar in given plant extract
2) Preparation of plant extracts and their standardization by analytical profiles (Any three)
3) Quality control tests for raw materials used in herbal preparation.
4) Antimicrobial (Antibacterial and antifungal) activity of given crude drug sample.
5) Antioxidant activity of given crude drug sample.
6) Determination of Ash values of given drug samples.
7) Estimation of pesticide residues in herbal preparations.

Suggested Reading:

Agrawal, S. S. and Paridhavi, M. (2012) Herbal Drug Technology, 2nd 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 WasimAkram (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, SantramLodhi, Tushar A. Deshmukh, Rageeb Md. Usman, Vaibhav M. Darvhekar (2022) Herbal Drug technology, NiraliPrakasan.

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.

NeeleshMalviya and SapnaMalviya (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, NiraliPrakashan.

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 verse 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: III (Plant Metabolites and Plant Propagation for Commercial Utility)

Time :6.00 Hrs] [Total Marks: 100

1. Screening of any two primary metabolites from given plant material/ sample.	15 M
2. Screening of any two Secondary metabolites from given plant material/ Sample.	15 M
3. Principle, working and applications equipments used in plant tissue culture laboratory	10 M
4. Induction of Callus/ Organ Culture	15 M
5. Preparation of synthetic seeds.	15 M
6. Demonstration of Protoplast culture.	10 M
7. Viva- Voce	10 M
8. Submission of Practical Records	10 M

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

Practical: IV (Fundamentals of Pharmacognosy and Herbal Drug Technology)

Time : 6.00 Hrs] [Total Marks: 100

1. Screening of given plant material.	15 M
2. Anatomical Characterization of given plant material/ herbal drug.	15 M
3. Chemical evaluation of Crude drug sample	10 M
4. Induction of Callus/ Organ Culture	15 M
5. Preparation of plant extracts and their standardization by analytical profiles	15 M
6. Identification of Sugar in given plant preparation.	10 M
7. Viva- Voce	10 M
8. Submission of Practical Records	10 M

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the ProgrammeHerbal Science
(Two year- Four Semester Degree Programme- C.B.C.S.)
(M.Sc. Part I) Semester I

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-I: Introduction to Herbal Science	HSC 101	3	-	-	3	3	-	3	3	80	20	-	-	100	40	P
2	AEC- I: Analytical Techniques	HSC 102	-	1	-	1	1	-	1	1	-	-	50	-	50	25	P
3	DSC-II : Basics of Plant Science	HSC 103	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
4	DSC -III : Cultivation Practices	HSC 104	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
5	DSC- IV: Modern Plant Authentication techniques	HSC 105	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
6	Lab- 1Practical Based on DSC I& II	HSCL 101	-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
7	Lab-2Practical Based on DSC III&IV	HSCL 102	-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
8	# Internship/ Field Work/ Work Experience																
9	Open elective/ GIC/ Open skill/ MOOC*/ Medicinal Plants	HSOEC	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
Total						28			26						650		

L: Lecture, T: Tutorial, P: Practical

Student may complete their Internship/ Field Work/ Work experience in First or Second or Third semester of Master of Science in the Programme, according to their convenience; @ denotes Non-Examination credits.
Note: Internship/ Apprenticeship/ Field Work Experience (during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 Credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.
-OEC (Optional) can be studied during semester I to IV

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the ProgrammeHerbal Science
(Two year- Four Semester DegreeProgramme- C.B.C.S.)
(M.Sc. Part I) Semester II

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-V : Plant Metabolites	HSC 201	3	-	-	3	3	-	3	3	80	20	-	-	100	40	P
2	AEC- II : Chromatography	HSC 202	-	1	-	1	1	-	1	1	-	-	50	-	50	25	P
3	DSC-VI : Plant Propagation for Commercial Utility	HSC 203	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
4	DSC -VII : Fundamental Pharmacognosy	HSC 204	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
5	DSC- VIII : Herbal Drug Technology	HSC 205	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
6	Lab- 3Practical Based on DSC V&VI	HSCL 201	-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
7	Lab-4Practical Based on DSC VII&VIII	HSCL 202	-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
8	# Internship/ Field Work/ Work Experience @																
9	Open elective/ GIC/ Open skill/ MOOC*	HSOEC	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
Total						28			26						650		

L: Lecture, T: Tutorial, P: Practical

Student may complete their Internship/ Field Work/ Work experience in First or Second or Third semester of Master of Science in the Programme, according to their convenience; @ denotes Non-Examination credits.

Note: Internship/ Apprenticeship/ Field Work Experience (during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 Credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

-OEC (Optional) can be studied during semester I to IV