

## **CBCS PATTERN SYLLABUS M. Sc. (MEDICINAL PLANTS)**

### **Semester- I**

|                  |  |
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| <b>Core 1.</b>   | <b>Indian System of Medicines (ISM)</b>      |
| <b>Core 2.</b>   | <b>Systematics of Plants (SOP)</b>           |
| <b>Core 3.</b>   | <b>Cell and Molecular Biology (CMB)</b>      |
| <b>Core 4.</b>   | <b>Modern Analytical Techniques (MAT)</b>    |
| <b>Practical</b> | <b>Practical I &amp; II (Question Paper)</b> |

### **Semester – II**

|                  |  |
|------------------|--|
| <b>Core 5.</b>   | <b>Fundamentals of Pharmacognosy (FOP)</b>     |
| <b>Core 6.</b>   | <b>Plant Biochemistry (PBC)</b>                |
| <b>Core 7.</b>   | <b>Plant Metabolism and Development (PMD)</b>  |
| <b>Core 8.</b>   | <b>Medicinal Plant Biotechnology (MPB)</b>     |
| <b>Practical</b> | <b>Practical III &amp; IV (Question Paper)</b> |

### **Semester – III**

|                             |   |
|-----------------------------|---|
| <b>Core 9.</b>              | <b>Immunology and Microbiology (IMM)</b>                        |
| <b>Core 10.</b>             | <b>Herbal Cosmetics (HCT)</b>                                   |
| <b>Core Elective 1.</b>     | <b>Natural Plant Products &amp; Phytochemistry – I (NPP -I)</b> |
| <b>Or</b>                   |   |
| <b>Core Elective 1.</b>     | <b>Forensic and Industrial Botany -I</b>                        |
| <b>Foundation Course 1.</b> | <b>Fermentation Technology (FMT)</b>                            |

**OR**

|                             |  |
|-----------------------------|--|
| <b>Core Subject Centric</b> | <b>Cultivation and Utilization of Medicinal Plants</b> |
| <b>Practical</b>            | <b>Practical V &amp; VI (Question Paper)</b>           |

### **Semester – IV**

|                         |   |
|-------------------------|---|
| <b>Core 11.</b>         | <b>Herbal Drug Technology &amp; Development (HDD)</b>             |
| <b>Core 12.</b>         | <b>Drug Standardization and Regulations (DSR)</b>                 |
| <b>Core Elective 2.</b> | <b>Natural Plant Products &amp; Phytochemistry - II (NPP –II)</b> |

**Or**

|                             |   |
|-----------------------------|---|
| <b>Core Elective 2.</b>     | <b>Forensic and Industrial Botany -II</b> |
| <b>Foundation Course 2.</b> | <b>Ethnobotany (ETH)</b>                  |

**OR**

|                             |   |
|-----------------------------|---|
| <b>Core Subject Centric</b> | <b>Cultivation and Utilization of Aromatic Plants</b> |
| <b>Practical</b>            | <b>Practical VII (Question Paper)&amp; Project</b>    |

### **Theory Question Paper Pattern**

**Note: Scheme of Examination, pattern of question paper and pattern of practical examination along with project is adopted as per CBCS pattern of other M. Sc. Courses run by RTM Nagpur University, Nagpur.**

**CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**  
**Semester-I**  
**Core –1**  
**INDIAN SYSTEMS OF MEDICINE.**

**Unit-I.**

**Ayurvedic System of Medicine:**

Principles with merits and demerits.

Methods of preparation of Ayurvedic medicines.

Standardization of Ayurvedic medicines.

**Unit-II**

**Siddha System of Medicines:**

Principles with merits and demerits.

Method of preparation of Siddha medicines.

Standardization of Siddha medicines.

**Unani System of Medicines:**

Principles with merits and demerits.

Method of preparation of Unani medicines.

Standardization of Unani medicines.

**Unit-III**

**Homeopathy System of Medicines:**

Principles with merits and demerits.

Method of preparation of Homeopathic medicines.

Standardization of Homeopathic medicines.

**Unit-IV**

**Tribal medicine:** Principles, Importance, Merits and Demerits of Tribal Medicines.

**Complimentary Medicines:**

Medicinal sources—Herbal sources, Mineral sources, Animal sources, their collection, purification and processing.

Rules and Regulations to Safeguard the Complimentary Medicines.

**Note: Practicals based on above theory syllabus.**

## **Suggested Readings:**

1. Ayurvedic Pharmacopoeia.
2. Ayurvedic Formulary of India, the Indian Medical Practitioners Co-operative Pharmacy and Stores Ltd, IMPCOPS.
3. Hand Book on Ayurvedic Medicines, H.Panda National Institute of Industrial Research, Delhi-7.
4. Ayurvedic system of medicine, 2nd edition, Kaviraj, Nagendranath Sengupta, vol. I & II.
5. Siddha Pharmacopoeia by Dr.S. Chidambarathanu pillai, 1st edition.
6. Unani Pharmacopoeia.
7. Homeopathic Pharmacopoeia.
8. Homeopathic Pharmacy An introduction & Hand book by Steven B. Kayne.
9. Alternative medicine, by Dr. K.B. Nangia.
10. Aromatherapy, Valerie Gennari Cooksley.
11. Indian Herbal Pharmacopoeia vol. I & II Indian Drug Manufacturer's association, Mumbai.
12. British Herbal Pharmacopoeia British Herbal Medicine Association, 1990 vol. I.
13. GMP for Botanicals - Regulatory and Quality issues on Phytomedicine, Business Horizons, New Delhi, First edition, 2003. Robert Verpoorte, Pulk K Mukharjee.
14. Screening methods of Pharmacology by Robert Turner.
15. Toxicology and Clinical Pharmacology of Herbal Products, Melanie Johns Cupp.

**SEMESTER –I**  
**Core –1 Practicals**  
**INDIAN SYSTEM OF MEDICINES**

**Suggested Laboratory Exercise:**

1. Demonstration of various dosage forms available in each system.
2. Simple preparations used in Ayurvedic System and their Standardization (with special emphasis on TLC/HPTLC).
3. Simple preparations used in Siddha system and their Standardization (with special emphasis on TLC/HPTLC).
4. Simple preparations used in Unani system and their Standardization (with special emphasis on TLC/HPTLC).
5. Simple preparations used in Homeopathy system and their Standardization (with special emphasis on TLC/HPTLC).
6. Ethnomedicinal Survey & documentations.

**Suggested Laboratory Readings.**

1. Ayurvedic Pharmacopoeia.
2. Ayurvedic Formulary of India, the Indian Medical Practitioners Co-operative Pharmacy and Stores Ltd, IMPCOPS.
3. Hand Book on Ayurvedic Medicines, H.Panda National Institute of Industria Research, Delhi-7.
4. Ayurvedic system of medicine, 2nd edition, Kaviraj, Nagendranath Sengupata, vol. I &II.
5. Siddha Pharmacopoeia by Dr.S. Chidambarathanu pillai, Ist edition.
6. Unani Pharmacopoeia.
7. Homeopathic Pharmacopoeia.
8. Homeopathic Pharmacy An introduction & Hand book by Steven B. Kayne.
9. Alternative medicine, by Dr. K.B. Nangia.
10. Aromatherapy, Valerie Gennari Cooksley.
11. Indian Herbal Pharmacopoeia vol. I &II Indian Drug Manufacturer's association Mumbai.
12. British Herbal Pharmacopoeia British Herbal Medicine Association, 1990 vol.I.
13. GMP for Botanicals - Regulatory and Quality issues on Phytomedicine, Busines horizons, New Delhi, First edition, 2003. Robert Verpoorte, Pulok K Mukharjee.
14. Screening methods of Pharmacology by Robert turner.
15. Toxicology and Clinical Pharmacology of Herbal Products, Melanie Johns Cupp.

# CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)

## Semester-I

### Core – 2

## SYSTEMATICS OF PLANTS

### Unit I

*Angiosperm Morphology*, structural units and floral symmetry, dicot and monocot flower; structure, diversity origin and evolution of stamen, carpels; placentation types and evolution.

Floral adaptation to different pollinators.

*Angiosperm Taxonomy*: Scope, aims, principles of taxonomy, historical development of plant taxonomy, Taxonomic structure: taxonomic hierarchy, concept of taxa, concept of species, concept of genus and family.

### Unit II

Classification of angiosperms: Natural, Artificial, Phylogenetic system of classification

Systems of classification: Linnaeus, Bentham & Hooker and Hutchinson (merits and demerits)

Taxonomic tools: herbarium, floras, monographs, botanical gardens, biochemical and molecular techniques, computers and GIS.

### Unit III

Plant nomenclature: Salient features of ICBN

Probable ancestors of angiosperms, primitive living angiosperms, speciation and extinction, IUCN categories of threat, distribution and global pattern of biodiversity.

### Unit IV

Study of Families (Dicot): Ranunculaceae, Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae) Cucurbitaceae, Lamiaceae, Asteraceae, Apocynaceae, Euphorbiaceae, Amaranthaceae.

Study of Families (Monocot): Liliaceae, Poaceae, Orchidaceae.

**Note: Practicals based on above theory syllabus.**

## Suggested Readings

1. Devis, P.H. and Heywood, V. H. 1973. Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.
2. Grant, V. 1971. Plant Speciation, Columbia University press, London.
3. Grant W. F. 1984. Plant Biosystematics. Academic press, London.
4. Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
5. Hislop-Harisson, J. 1967. Plant Taxonomy. English Language Book Sco. And Edward Arnold Pub. Ltd, UK.
6. Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
7. Jones, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.
8. Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw- Hill Book Co., New York.
9. Nordentam, B., El Gazaly, G. and kassas, M. 2000. Plant systematic for 2ft century. Portlant press. Ltd, London.
10. Radford, A. E. 1986. Fundamentals of plant systematic. Harper and Raw publication, USA.
11. Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co. Publication Co. Inc., USA.
12. Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.
13. Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
14. Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd, London.

**SEMESTER-I**  
**Core – 2 Practicals**  
**SYSTEMATICS OF PLANTS**

**Suggested Laboratory Exercise:**

1. To study the floral symmetry in various taxa.
2. To study and work out the differences in dicot and monocot flower.
3. To study the variation in stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To study anatomical features of various taxa.
7. To study embryological features of various taxa.
8. To study palynological features of various taxa.
9. To study cytological features of various taxa.
10. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.
11. Description of a specimen from representative, locally available families.
12. Location of key characters and use of keys at genera & family level.
13. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of medicinal plants.
14. Training in using floras herbaria for identification of specimens described in the class.
15. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.

Note: Frequent field visits are expected for the observation of plants in local and nearby areas.

**Suggested Laboratory Readings.**

1. Devis, P.H. and Heywood, V. H. 1973. Principles of angiosperms taxonomy. Robert E. Kreiger Pub. Co. Newyork.
2. Grant, V. 1971. Plant Speciation, Columbia University press, London.
3. Grant W. F. 1984. Plant Biosystematics. Academic press, London.
4. Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
5. Hislop-Harisson, J. 1967. Plant Taxonomy. English Language Book Sco. And Edward Arnold Pub. Ltd, UK.
6. Heywood, V. H. and Moore, D. M. 1984. Current concepts in Plant Taxonomy. Academic Press, London.
7. Jones, A. D. and Wibins, A. D. 1971. Variation and adaptation in Plant species Hickman and Co. New York.
8. Jones, S. B., Jr. and Luchsinger, A. E. 1986. Plant Systematics (gd edition). McGraw- Hill Book Co., New York.
9. Nordentam, B., El Gazaly, G. and kassas, M. 2000. Plant systematic for 2ft century. Portlantpress. Ltd, London.
10. Radford, A. E. 1986. Fundamentals of plant systematic. Harper and Raw publication, USA.
11. Solbrig, O.T. 1970. Principles and methods of plant Sytematics. The Macmillan Co Publication Co. Inc., USA.
12. Woodland, D. W. 1991. Contemporary Plant Syatematics, Pentice Hall, New Jersery.
13. Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York.
14. Stebbins, G. L. 1974. Flowering Plants-evolution Above species Level. Edvard Arnold Ltd,

# CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)

## Semester-I

### Core –3

## CELL AND MOLECULAR BIOLOGY

### UNIT-I

**Cell wall:** Structure; function; biogenesis and growth; cell differentiation

**Plasma membrane:** Membrane architecture (fluid mosaic model); sites for ATPases; membrane transport - ion carriers, channels, pumps and aquaporins; receptors.

**Plasmodesmata:** Structure, role in movement of molecules and macromolecules; comparison with gap junction.

**Cellular organelles:** Ultra-structure and function of golgi complex, lysosomes, peroxisomes, Endoplasmic reticulum, mitochondria, chloroplast and plant vacuoles.

### UNIT-II

**Cell shape and motility:** The cytoskeleton; organization and role of microtubules and microfilaments; motor movements, implications in flagellar & other movements, cell division.

**Protein sorting:** Machinery involved, vesicles, coat proteins; protein targeting to plastids, mitochondria, peroxisomes, nucleus, vacuoles; modification during transport.

### UNIT-III

**Nucleus-** Ultra structure and functions, Chromosome structure and types,

**DNA-** Denaturation and Renaturation, C-value paradox, DNA replication - polymerases, primers and mechanism - molecular methods of DNA replication.

**RNA -** Types, molecular organization, genetic code, transcription mechanism in prokaryotes and post transcription processing, enzyme system in transcription, transcription process in eukaryotes.

Ribosomes and Translation in Prokaryotes and Eukaryotes

### UNIT-IV

**Cell cycle and apoptosis:** Control mechanisms, role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; programmed cell death in plants; regulation in plant growth and development.

**Signal transduction:** Overview, receptors and G- proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascades, diversity in protein kinases and phosphatases, specific signaling mechanisms e.g. two-component sensor-regulator system in bacteria and plants, sucrose sensing mechanism

**Techniques:** Electrophoresis, immunotechniques, FISH, GISH, confocal microscopy, Gene amplification - PCR, DNA finger printing.

**Note: Practicals based on above theory syllabus.**



### **Suggested Readings:**

1. Atherly, A.G., Griton, J.R. and Mc Donald, J. F. 1999. The Science of Genetics. Saunders College Pub. Fort Worth, USA
2. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology of Plants. American Soc. Of Plant Physiologists, Maryland, USA.
3. Bush, H. Rothblum, L. 1982. Vol. X. The Cell Nucleus RDNA part A. Academic Press.
4. De, D. N. 2000 Plant cell vacuoles: An introduction. CSIRO Publication, Collingwood, Australia.
5. Karp, G. 1999 Cells and Molecular Biology; Concepts and Experiments. John Wiley & Sons, Inc., USA.
6. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2<sup>nd</sup>Edi.) Harper Collins Coll. Publisher, New York, USA.
7. Krishnamurthy, K.V. 2000 Methods in Cell wall Cyto-chemistry. CRC Press, Boca Raton, Florida
8. Lodish, H., Berk, A. Zipursky, S. L. Matsudaira, P., Baltimore, D. and Darnell, J. 2000 Molecular Cell Biology Edi. W.H. Freeman and Co., New York, USA
9. Russel, P. J. 1998 Genetics (5<sup>th</sup> Edi.) The Benjamin/ Cummings Publishing Com. Inc., USA
10. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA
11. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999.
12. Molecular Biology of Cell, Garland Publishing, Inc., New York.
13. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology 8<sup>th</sup> Ed. B. IWaverly Pvt. Ltd., New Delhi.
14. Khush, G.s. 1973 Cytogenetics of Aneuploids, Academic Press, New York, London
15. Kleinsmith, L.J. and Kish, V.M. 1995 Principles of Cell and Molecular Biology (2<sup>nd</sup>Edi.) Harper Collins Coll. Publisher, New York, USA.
16. Lewin, B. 2000 Gene VII Oxford Univ. press, New York.
17. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3<sup>rd</sup> Edi.)Jones and Bartiet Pub. Inc., London.
18. Russel, P. J. 1998 Genetics (5<sup>th</sup> Edi.) The Benjamin/ Cummings Publishing Com. Inc.,USA
19. Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2<sup>nd</sup> Edi.) John Wiley& Sons Inc., USA.
20. Tamarin, R. H. 2001 Principles of Genetics 7<sup>th</sup> Edi. The McGraw–Hill Companies.
21. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co.,California, USA.

**SEMESTER-I**  
**Core – 3 Practicals**  
**CELL & MOLECULAR BIOLOGY**

**Suggested Laboratory Exercise:**

1. Observation of salivary gland chromosomes of Chironomus or Drosophila.
2. Cell fractionation & isolation of Chloroplast and mitochondria.
3. Isolation of plant DNA and its quantification by spectrophotometric method.
4. Isolation of DNA and preparation of Cot-curve.
5. Demonstration of vital structure and functions of cell
6. Isolation of chloroplast and demonstration of two subunits of RUBISCO by SDS PAGE
7. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis, visualization by ethidium bromide staining.
8. To study in vitro transcription.
9. To study in vitro translation.
10. Isolation of RNA and quantification by spectrophotometric method.
11. Observation of prokaryotic and eukaryotic cells and cell types - Living Cells/Temporary/Permanent Preparations.
12. Isolation, determination, purification and separation of protein.
13. PCR amplification of desired gene

**Suggested Laboratory Readings.**

1. Cell and molecular biology-Concept and experiment. 2nd edn., Harris,D(Ed.), Karp, G.1999. John wiley & sons, sons, New York.
2. Principles of cell and molecular biology. 2nd edn., Mclaughlin,S., Trost,K., Mac Elree,E.(eds), Kleinsmith,L.J.& Kish, V.M., 1995. Harper Collins Publisher, New York.
3. Molecular biology of the cell.3rd edn., Alberts,B., Bray,D., Lawis,J., Raff,M., Roberta, K., Watson, J.d(eds.), 1994. Garland Publication, Inc., New York.
4. Cell and Molecular Biology. 8th edn., De Robertis, E.D.P. and De Roberts, E, M.F.1995. B.I.Waverly Pvt. Ltd., New Delhi.
5. Glick, B. R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida USA.
6. Goswami, H. K. 1986. Practical cytology – Applied Genetics and Biostatistics Himalaya Pub. House, Bombay.
7. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function Jones and Barlett Publishers, Boston, Massachusetts.
8. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells Academic Press, London, U.K.
9. Harris,N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
10. Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Har Academic Publishers, Australia.
11. Shaw, C.H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach. IRL Press,

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-I**

#### **Core –4**

### **MODERN ANALYTICAL TECHNIQUES**

#### **Unit - I**

UV-Visible Spectroscopy: Principle of UV-Visible Spectroscopy, Chromophores and their interaction with UV-visible radiation and their utilization in structural, qualitative and quantitative analysis of drug molecules. Fundamentals of Optical Rotatory Dispersion. Cotton effect curves, octant rule, circular dichroism.

#### **Unit - II**

Infrared Spectroscopy: Infrared radiation and its interaction with organic molecules, vibrational mode of bonds, instrumentation and applications, interpretation of IR spectra. FTIR and ATR, X-ray diffraction methods.

#### **Unit - III**

Nuclear magnetic resonance spectroscopy: Magnetic properties of nuclei, field and precession, chemical shift concept, isotopic nuclei, reference standards and solvents. <sup>1</sup>H NMR spectra, chemical shifts, multiplicity, coupling constants, integration of signals, interpretation of spectra, decoupling-double resonance and shift reagent methods; APT and DEPT techniques.

#### **Unit - IV**

Chromatographic techniques: Principles of separation and application of Column, Paper, Thin layer and Gas chromatography, HPLC, HPTLC, Size exclusion chromatography, Affinity chromatography, Electrophoresis. Instrumentation of HPLC, Preparative and micropore columns, Reverse phase columns, Mobile phase selection and detectors in HPLC.

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. Spectrometric identification of Organic Compounds, Robert. M. Silverstein, Basseler, Morrill (John Wiley and Sons. N.Y).
2. Spectroscopy of Organic Compounds by P. S. Kalsi.
3. Principles of Instrumental Analysis by Douglas A. Skoog, James, J. Leary, 4th Edition.
4. Pharmaceutical Analysis – Modern Methods – Part A, Part B, James W. Munson 2001.
5. Organic Spectroscopy – William Kemp, 3rd Edition.
6. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
7. Practical Pharmaceutical Chemistry, Part two, A. H. Beckett & J. B. Stenlake – 4<sup>th</sup> Edition.
8. Instrumental Methods of Chemical Analysis – B. K. Sharma - 9th Edition.
9. Instrumental Methods of Analysis – Willard, Merritt, Dean, CBS, Delhi.
10. Techniques and Practice of Chromatography – Raymond P. W. Scott, Vol. 70.
11. Liquid Chromatography – Mass Spectrometry, W. M. A. Niessen, J. Van Der Greef, Vol. 58.
12. Modern Methods of Pharmaceutical Analysis, Vol 1,2, RE Schirmer, Franklin Book
13. Colorimetric Methods of analysis- F. D. Snell and C. T. Snell (Van Nostrand Reinhold Company, N.Y.).
14. Indian Pharmacopoeia
15. British Pharmacopoeia
16. U.S. Pharmacopoeia
17. Clarke's Analysis of Drugs and Poisons, A.C.Moffat, M. David Osselton, Brain Widdop, L. Y. Galichet. 3<sup>rd</sup> edition, Pharmaceutical Press
18. Text book of Pharmaceutical Analysis, K. A. connors, 3rd Ed. Johnwiley & sons, New York
19. Spectrometric identification of Organic Compounds, Robert. M. Silverstein et al, 7th Edition, 1981.
20. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor.
21. Principles of Instrumental Analysis by Douglas A. Skoog, James, J. Leary, 4th Edition.
22. Pharmaceutical Analysis – Modern Methods – Part A, Part B, James W. Munson – 2001.
23. Vogel's Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
24. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
25. Practical Pharmaceutical Chemistry, Part two, A. H. Beckett & J. B. Stenlake – 4th Edition.
26. Instrumental Methods of Chemical Analysis – B. K. Sharma - 9th Edition.
27. Organic Spectroscopy – William Kemp, 3rd Edition.
28. Techniques and Practice of Chromatography – Raymond P. W. Scott, Vol. 70.
29. Identification of Drugs and Pharmaceutical Formulations by Thin Layer Chromatography – P. D. Sethi, Dilip Charegaonkar, 2nd Edition.
30. HPTLC – Quantitative Analysis of Pharmaceutical Formulations – P. D. Sethi.
31. Liquid Chromatography – Mass Spectrometry, W. M. A. Niessen, J. Van Der Greef, Vol. 58.
32. Stereo Chemistry – Conformation and Mechanism by P. S. Kalsi, 2nd Edition.

**SEMESTER –I**  
**Core – 4 Practicals**  
**MODERN ANALYTICAL TECHNIQUES**

**Suggested Laboratory Exercise:**

1. UV/Visible spectrum scanning of a few organic compounds for UV- absorption and correlations of structures and isobestic point in case of mixtures.
2. Estimation of single drug (raw material/ formulations) by UV spectrophotometry.
3. Estimation of multicomponent formulation by UV- Spectrophotometer in formulations.
4. Effect of pH and solvent on UV Spectrum of certain drugs.
5. Calibration of IR Spectrophotometer using polystyrene film and checking the performance of the instrument.
6. Interpretation of structure of drugs by Infra red spectra.
7. Experiments based on the application of derivative spectroscopy.
8. Standardization and dissolution studies of solid dosage form.
9. Experiments using HPLC: Determination of chromatographic parameters- capacity factor, selectivity, resolution, efficiency of column HETP, asymmetric factor.
10. Estimation of drugs in biological fluids by HPLC.
11. Experiments based on application of HPTLC for quantification of Berberin from *Berberis aristata* and Andrographolide from *Andrographis paniculata*.

**Suggested Laboratory Readings.**

1. Skoog, DA, Holler, FJ, Crouch, SR. Principles of instrumental analysis. 6th ed., Baba Barkha Nath Printers, Haryana, 2007.
2. Silverstein, RM, Webster, FX. Spectrometric identification of organic compounds. 6th ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2005.
3. William Kemp. Organic Spectroscopy, 3rd ed., Palgrave, New York, 2006
4. Connors KA. Text book of Pharmaceutical analysis, 3rd ed., John Wiley and Sons, Singapore, 2004
5. Willard HH, Merritt LL, Settle FA. Instrumental methods of analysis, 7th ed., CBS Publishers and Distributors, New Delhi, 1986
6. Sharma BK. Instrumental methods of chemical analysis, 25th ed., Goel Publishing House, Meerut, 2006.
7. Beckett, AH, Stenlake, JB. Practical Pharmaceutical Chemistry, Part I and Part II, 4th ed., CBS Publishers and Distributors, New Delhi, 2004.
8. Ewing, GW. Instrumental methods of chemical analysis, 5th ed., McGraw Hill Book Company, New York, 1985.
9. Houghton P, Mukherjee PK. Evaluation of Herbal Medicinal Product, Pharmaceutical Press, London, 2009.
10. Kalsi, P S. Spectroscopy of Organic Compounds, 2nd ed., Wiley Eastern Ltd., Delhi
11. Instrumental methods of chemical analysis by Chatwal. K, Anand, 5th edition.
12. Organic spectroscopy by Y.R.Sharma.
13. Text book of pharmaceutical analysis by S.Ravishankar.
14. Spectrometric identification of Organic Compounds, Robert. M. Silverstein et al, 7<sup>th</sup> Edition, 1981.
15. Principles of Instrumental Analysis by Douglas A. Skoog, James, J. Leary, 4th Edition.
16. Pharmaceutical Analysis – Modern Methods – Part A, Part B, James W. Munson –2001.
17. Practical Pharmaceutical Chemistry, Part two, A. H. Beckett & J. B. Stenlake – 4<sup>th</sup> Edition.
18. Instrumental Methods of Chemical Analysis – B. K. Sharma - 9th Edition.
19. Chromatography – P. D. Sethi, Dilip Charegaonkar, 2nd Edition.

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER- I**

**Practical –I**

**Time: 6 hours.**

**Full Marks: 100**

|  |    |
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| <b>Q. 1</b> Onequestion from Sr. No 1-3 of Core-1  | 15 |
| <b>Q. 2</b> Onequestion from Sr. No 4-6 of Core-1  | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 1-7 of Core-2  | 15 |
| <b>Q. 4</b> Onequestion from Sr. No 8-15 of Core-2 | 15 |
| <b>Q. 5</b> Spotting (2 spots from each core)      | 20 |
| <b>Q. 6</b> Viva-voce                              | 10 |
| <b>Q. 7</b> Practical Record                       | 10 |

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER- I**

**Practical –II**

**Time: 6 hours.**

**Full Marks: 100**

|  |    |
|--|----|
| <b>Q. 1</b> Onequestion from Sr. No 1-7 of Core-3  | 15 |
| <b>Q. 2</b> Onequestion from Sr. No 8-13 of Core-3 | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 1-5 of Core-4  | 15 |
| <b>Q. 4</b> Onequestion from Sr. No 6-11 of Core-4 | 15 |
| <b>Q. 5</b> Spotting (2 spots from each core)      | 20 |
| <b>Q. 6</b> Viva-voce                              | 10 |
| <b>Q. 7</b> Practical Record                       | 10 |

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-II**

#### **Core –5**

### **FUNDAMENTALS OF PHARMACOGNOSY**

#### **Unit I**

Definition, history and scope of pharmacognosy including indigenous system of medicine.

Various system of classification of drugs of natural origin.

Adulteration and drug evaluation; significance of pharmacopoeial standards.

#### **Unit-II**

Occurrence, distribution, organoleptic evaluation, microscopical evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of following categories of drugs.

a) Laxatives: Aloes, Castor oil, Isapgol, Senna

b) Cardiotonics – Digitalis, Arjuna

c) Carminatives & G.I. regulators – Umbelliferous fruits, Coriander, Fennel, Ajwaen, Cardamom, Ginger, Black pepper, Asafoetida, Nutmeg, Cinnamon, Clove.

d) Astringents – Catechu

#### **Unit-III**

Occurrence, distribution, Organoleptic evaluation, Microscopical evaluation, chemical constituents including tests wherever applicable and Therapeutic efficacy of following categories of drugs.

a) Drugs acting on nervous system – Hyoscyamus, Ashwagandha, Opium, Cannabis,

b) Antihypertensives – Rauwolfia

c) Antitussives – Vasaka, tolu balsam, Tulsi

d) Antirheumatics – Guggul, Colchicum

e) Antitumour – Vinca

f) Antileprotics – Chaulmoogra Oil

g) Antidysenterics – Holarhaena

h) Antiseptics and Disinfectants - Benzoin, Murraya, Neem, Curcuma.

i) Antimalarials – Cinchona, Andrographis

j) Oxytocics – Ergot

k) Vitamins – Shark liver oil and Amla

l) Enzymes – Papaya, diastase yeast

#### **Unit-IV**

Gross anatomical studies of: Senna, Cinchona, Fennel, Clove, Ginger, Nuxvomica & Ipecacuanha. Brief outline of occurrence, distribution outline of isolation, identification tests, therapeutic effects and pharmaceutical applications of alkaloids, terpenoids' glycosides, volatile oils tannins and resins.

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. W.C.Evans & Trease, Pharmacognosy, 15th edn.2008, W.B. Saunders & Co.Ltd., London.
2. Guidelines for the Assessment of herbal medicines, 1991,WHO Report, Geneva.
3. Quality Control Methods for Medicinal Plant material, 1992, WHO Guidelines.
4. Indian Pharmacopoeia, 1996, Govt. of India, Ministry of Health and family welfare, Delhi.
5. A.N. Kalia, Textbook of Industrial Pharmacognosy, 2005, CBS Publishers, New Delhi.
6. Dr.C.K. Kokate, Practical Pharmacognosy, 1988, Vallabh Prakashan, Delhi.
7. Dr.P.Mukherjee, Quality control herbal drugs, 2005, Business Horizons, New Delhi
8. Trease and Evans Pharmacognosy, W.C. Evans.
9. Pharmacognosy, Varro E.Tyler, Lynn. R.Brady, James E.Robbers
10. Text Book of Pharmacognosy, T.E. Wallis, CBS Pub. Delhi.
11. Ramstad - Modern Pharmacognosy.
12. John - Dodds - Lorin - Experiments in Plant Tissue Culture.
13. CSIR- Cultivation and Utilization of Medicinal Plants.
14. Handa S.S. & Kaul. K.L. Supplement to cultivation & utilization of
15. CSIR - Wealth of India, Raw Materials.
16. Bartz - Reinhard - Zenk - Plant Tissue Culture and its Biotechnical Applications.
17. Pharmacognosy, C.K. Kokate, A.P. Purohit, and S.B. Gokhale.
18. Quality Standards of Indian Medicinal Plants Vol-I, ICMR, New Delhi.
19. WHO guide lines for the quality control of Herbal plant materials.
20. The Practical evaluation of phytopharmaceutical by brain & turner.
21. Harborne - Comparative Biochemistry of Flavonoids.
22. Biological standardization by J.N.Barn, D.J.Finley and L.G. Good win.
16. Indian pharmacopoea, Indian Herbal Pharmacopoea and other pharmacopoeia.
17. Ayurvedic Formulary of India.
18. British Herbal Pharmacopoeia.
19. Screening methods of Pharmacology By Robert turner.



**SEMESTER-II**  
**Core – 5 Practicals**  
**FUNDAMENTALS OF PHARMACOGNOSY**

**Suggested Laboratory Exercise:**

1. Identification of crude drugs containing *Carbohydrate* by morphological characters.
2. Identification of crude drugs containing *Lipids* by morphological characters.
3. Identification of crude drugs containing *Glycosides* by morphological characters.
4. Identification of crude drugs containing *Volatile Oils* by morphological characters.
5. Identification of crude drugs containing *Alkaloids* by morphological characters.
6. Physical and chemical tests for evaluation of crude drugs wherever applicable
7. Microscopic studies of Senna leaf, Rauwolfia root, Cinamon bark, Datura flower and stem.
8. Measurement of length and width of different constituents (starch grains, oxalate crystals, phloem fibres) in powdered crude drugs.
9. Determination of ash value of different powdered crude drugs.
10. Determination of Antibacterial activities of different powdered crude drugs.
11. Determination of Antifungal activities of different powdered crude drugs.

**Note:** One Pharmaceutical industry visits is compulsory for the observation of various processes in industry.

**Suggested Laboratory Readings:**

1. Mukherjee Pulok, Quality Control of Herbal Drugs, Business Horizons Limited, New Delhi.
2. Advances in Natural Product Chemistry, extraction and isolation of biologically active compounds. S. Natori et al., Wiley, New York.
3. Phytochemical methods by J.B. Harborne, Chapman and Hall, International Ed., London.
4. Modern methods of plant analysis by Peach and Tracey, Vol. II, IV, Springer Verlag.
5. G.E. Trease and W.C. Evans., Pharmacognosy, W.B. Saunders Co. Ltd., Harcourt Publishers Ltd. UK.
6. Chaudhari R.D., Herbal Drug Industry, Eastern Publication.
7. Quality Control Methods for medicinal plant material, WHO Geneva.
8. Wagner H, Bladt S, 1996. Plant Drug Analysis- A Thin Layer Chromatography Atlas, 2nd Ed., Springer-Verlag, Berlin.
9. Stahl Egon, Thin layer chromatography, 2nd Edition, Springer Publication.
10. Herbal Drug technology by SS Agrawal and M Paridhavi, Orient Longman
11. Indian Herbal Pharmacopoeia, Vol. I- II, SS Handa, RRL Jammu Tawi, and IDMA Mumbai.
12. The Aurvedic Pharmacopoeia of India, 1999. Government of India, Ministry of Health and Family Welfare, Department of Indian Systems of Medicine and Homeopathy, New Delhi.
13. Standardization of Botanicals by V. Rajpal, Vol. I and Vol II, Eastern Publishers, New Delhi.
14. Practical Evaluation of Phytopharmaceuticals by K.R. Brain and T.D. Turner, Wright-Scientifica, Bristol.
15. Houghton P, Mukherjee PK. Evaluation of Herbal Medicinal Product, Pharmaceutical Press, London, 2009.
16. British pharmacopoeia, 2008. The department of Health, Vol I- IV, British Pharmacopoeia Commission, London.
17. Neutraceuticals by Lisa Rapport and Brain Lockwood.

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-II**

#### **Core –6**

### **PLANT BIOCHEMISTRY**

#### **Unit I**

Biochemical organisation of the cell and transport processes across cell membrane.

The concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics, production of ATP and its biological significance.

Introduction to 3D structure of protein, stability and denaturation of protein, allosteric proteins.

#### **Unit-II**

Enzymes : Nomenclature, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis.

Co-enzymes : Vitamins as co-enzymes and their significance, Metals as coenzymes and their significance.

#### **Unit-III**

Lipids Metabolism : Oxidation of fatty acids,  $\alpha$ -oxidation & energetic,  $\beta$ -oxidation,  $\mu$ -oxidation, Biosynthesis of ketone bodies and their utilization,

Biosynthesis of saturated and unsaturated fatty acids, Control of lipid metabolism, Essential fatty acids & eicosanoids (prostaglandins, thromboxanes and leukotrienes) phospholipids, and sphingolipids.

#### **Unit-IV**

Biological Oxidation : Redox-Potential, enzymes and co-enzymes involved in oxidation reduction & its control, The respiratory chain, its role in energy capture and its control, Energetic of oxidative phosphorylation, Inhibitors of respiratory chain and oxidative phosphorylation, Mechanism of oxidative phosphorylation.

**Note: Practicals based on above theory syllabus.**

## **Suggested Readings:**

1. Buchanan, B. B., Gruissem, W. and Jones, R.L. 1989. Biochemistry and Molecular Biology of plants. American Society of Plant Physiologists, Maryland, USA. 24
2. Dennis, D.T., Turpin, D. H., Lefebvre, D.D. and Layzell, D.B. (eds).1997. Plant Metabolism (2nd Ed.) Longman, Essex, England.
3. Gaiston, A.W.1989. Life Processes in Plants. Scientific American Library, Springer- Verlag, New York, USA.
4. Hooykass P.J.J., Hall, M. A. and Libbenga, K.R.(eds).1999. Biochemistry and Molecular Biology of plant Horm. Elsevier, Amsterdam, The Netherlands.
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
6. Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000. Molecular Cell Biology (4thed). W. H. Freeman and Company. New York ,USA.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2nded). Springer Verlag, New York, USA.
8. Nobel, P.S.1999. Physicochemical and Environmental Plant Physiology (2nd ed). Academic Press, Diego, USA.
9. Salisbury, F.B. and Ross, C.W.1992: Plant Physiology (4thed). Wadsworth Publishing Co., California, USA.

**SEMESTER-II**  
**Core – 6 Practicals**  
**PLANT BIOCHEMISTRY**

**Suggested Laboratory Exercise:**

1. pH measurements and preparation of buffers.
2. Determination of saponification number of lipids.
3. Estimation of amino acids.
4. Separation and identification of sugars and amino acids by chromatography.
5. Determination of amylase, peroxidase, catalase activity using spectrophotometer.
6. To study the effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. phosphatase, nitrate reductase).
7. To study the effect of substrate concentration on activity of enzyme and determination of its  $K_m$  value.
8. Determination of succinate dehydrogenase activity, its kinetics and sensitivity inhibitors.
9. To determine the total carbohydrate content in the given sample.
10. Estimation of Pectic Substances-gravimetric method.
11. To prove Beer-Lambert's law using a suitable solution.
12. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophyll and carotenoids.
13. Preparation of standard curve of protein (BSA) and estimation of protein content in extracts of plant material by Lowry's or Bradford's method.
14. Preparation of Leaf Protein Concentrates from green vegetables.
15. Determination of reducing sugars by Nelson – Somogyi Method.

**Suggested Laboratory Readings:**

1. Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
3. Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis. VCH Publishers, New York.
4. Dennison C. 1999. A guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur.
6. Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
7. Hames, B.D. (Ed.). 1998. Gel Electrophoresis of Proteins: A Practical Approach, 8<sup>th</sup> edition. PAS, Oxford University Press, Oxford, UK.
8. Harborne, T.C. 1981. Phytochemical Methods: A Guide to Modern Techniques of Plants Analysis. Chapman & Hall, London.
9. Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
10. Ninfa, A. J. and Ballou, D. P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
11. Plummer, D.F. 1988. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
12. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
13. Wilson, K. and Goulding, K.H. (Eds), 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.
14. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> edition. Cambridge University Press, Cambridge, UK.
15. Sadasivam and Manikum: Biochemical Methods, New Age International (p) Limited Publishers 4835/24, Ansari Road, Daryaganj, New Delhi- 110002
16. Physiology Chemistry, Oser. B.L. Hawks, 1965. TATA McGraw Hill.
17. Laboratory manual in biochemistry, Strolve, B.L.A., Mzka vora, V.C., 1989. MIR Publisher, Moscow.

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-II**

#### **Core –7**

### **PLANT METABOLISM AND DEVELOPMENT**

#### **Unit I**

Plant-water relations: Properties of water, diffusion, diffusion pressure deficit and its significance; Osmosis: Concept, types, osmotic potential and its significance; Imbibition: concept and significance  
Water conduction through xylem: Root pressure theory, cohesion-adhesion theory; transpiration; stomatal opening mechanism with reference to  $K^+$ -malate hypothesis  
Phloem transport: Munch hypothesis

#### **Unit II**

Mineral nutrition: Role and deficiency symptoms of macro- and micro- nutrients (N, P, Fe, Mn, B, Ca); Solute transport: passive (Donnan's equilibrium), active (carrier concept)  
Respiration: Structure of ATP, types (aerobic and anaerobic respiration), respiratory substrates and Respiration quotient, glycolysis, Kreb's cycle, oxidative phosphorylation (ETS), chemiosmotic potential theory; fermentation (alcohol and lactic acid), photorespiration

#### **Unit III**

Photosynthesis: concept, definition, significance, photosynthetic pigments and their role, action spectra, Emerson's enhancement effect, red drop mechanism; photolysis of water (Hill's reaction), cyclic and non-cyclic photophosphorylation, Light independent reactions: C<sub>3</sub>, C<sub>4</sub> and CAM pathways and their significance; factors affecting photosynthesis  
Nitrogen metabolism: Mechanism of biological nitrogen fixation, importance of nitrate reductase

#### **Unit IV**

Phytochromes: Pr and Pfr forms, their role, Circadian rhythms and biological clock  
Plant growth regulators: Role of auxin, cytokinins, gibberilins, ABA and ethylene  
Plant movements: Tropic and nastic movements  
Photoperiodism: physiology of flowering, photoperiodism and vernalization, role of florigen  
Senescence and abscission  
Seed dormancy: Causes and role, methods to break seed dormancy  
Plant defence: Definition: Hypersensitive response and Systemic acquired resistance; Role of secondary metabolites (Terpenes and phenolic compounds)

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. Buchanan, B. B., Gruissem, W. and Jones, R.L. 1989. *Biochemistry and Molecular Biology of plants*. American Society of Plant Physiologists, Maryland, USA. 24
2. Dennis, D.T., Turpin, D. H., Lefebvre, D.D. and Layzell, D.B. (eds).1997. *Plant Metabolism (2nd Ed.)* Longman, Essex, England.
3. Gaiston, A.W.1989. *Life Processes in Plants*. Scientific American Library, Springer- Verlag, New York, USA.
4. Hooykass P.J.J., Hall, M. A. and Libbenga, K.R.(eds).1999. *Biochemistry and Molecular Biology of plant Horm.* Elsevier, Amsterdam, The Netherlands.
5. Hopkins, W.G. 1995. *Introduction to Plant Physiology*. John Wiley & Sons, Inc., New York, USA.
6. Lodish, H., Berk, A., Zipursky S.L., Matsudaira, P., Baltimore, D and Darnell, J. 2000. *Molecular Cell Biology (4thed)*. W. H. Freeman and Company. New York ,USA.
7. Moore, T.C. 1989. *Biochemistry and Physiology of Plant Hormones (2nded)*. Springer Verlag, New York, USA.
8. Nobel, P.S.1999. *Physicochemical and Environmental Plant Physiology (2nd ed)*. Academic Press, Diego, USA.
9. Salisbury, F.B. and Ross, C.W.1992: *Plant Physiology (4thed)*. Wadsworth Publishing Co., California, USA.
10. Singhal G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee.1999: *Cocepts in Photobiol Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi.
11. Taiz, L. and Zeiger, E. 1998: *Plant Physiology*. Sinaucr Associates, Inc., Publishers, Massachus, USA.
12. Thomas,B. and Vince-Prue,D.1997: *Photoperiodism in Plants (2nd ed)*. Academic Press,San Diego, USA.
13. Westhoff, P.1998: *Molecular Plant Development: From gene to plant*. Oxford University Press, Oxford, UK.
14. Dey, P. M. And Harborne, J. B. 2000: *Plant Biochemistry* ,Harcourt Asia PTE Ltd. A
15. Harcourt Publishers International Company, 583 Orchard Road 09-01 Forum Singapore 238884
16. Ranjan, purohit, Prasad 2003: *Plant Hormones Action and Application*,
17. Agrobios(India), agro house, behind Nasrani cinema Chopasani Road, Jodhpur -34
18. Fosket, D.E. 1994. *Plant Growth and Development.A molecular Approach*. Academic Press, San Diego.
19. Howell, S.H. 1998, *Molecular Genetics of Plant Development*. Cambridge University Press, Cambridge.
20. Lyndon, R.F., 1990. *Plant Development.The Cellular Basis*. Unnin Hyman, London.
21. Murphy, T.M. and Thompson, W.F. 1988. *Molecular Plant Development*. Prentice Hall, New Jersey.

**SEMESTER-II**  
**Core – 7 Practicals**  
**PLANT METABOLISM AND DEVELOPMENT**

**Suggested Laboratory Exercise:**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determine water potential of given tissue by weight method and falling drop method.
3. Study of the effect of various environmental factors on transpiration in an excised twig/leaf.
4. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through stomata in a mesophyte and a xerophyte.
5. Study of the mechanism of stomatal opening and closing
6. Bolting experiment / *Avena* coleoptiles bioassay.
7. Study of seed dormancy and methods to break seed dormancy.
8. Detection of the presence of plant enzymes amylase, catalase, nitrate reductase urease (in vivo) in various sources.
9. To study properties (thermolability, proteinaceous nature and specificity) of any one of the enzymes (catalase/urease).
10. To study the effect of various factors (concentration, temperature, pH, inhibitor) on the activity of catalase enzyme.
11. Demonstration of dye reduction by isolated chloroplasts.
12. Study the effect of different factors on O<sub>2</sub> evolution during photosynthesis and demonstrate the law of limiting factors.
13. Chemical separation of chloroplast pigments and determination of their absorption spectra.
14. To extract anthocyanin pigments and study the effect of pH on their absorption spectra.
15. Study of the rate of aerobic respiration and respiratory quotient in different plant parts/materials.
16. Identification tests for carbohydrates (Fehling's test, Benedict test) and proteins (Ninhydrin test, Xanthoproteic test).

**Suggested Laboratory Readings:**

1. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
2. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th
3. Conn, E.E., Stumpf, P.K. and Bruening, G. (2006) Outlines of Biochemistry, 4th
4. Elliot (2009) Biochemistry and Molecular Biology. Oxford Publishers.
5. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th
6. Taiz, L. and Zeiger, E. (2006) Plant Physiology, 4 Edition, WH Freeman and Company, New York, USA.
7. Dennis, D.T., Layzell, D.B., Lefebvre, D.D. and Turpin, D.H. (1997) Plant Metabolism. Addison Wesley Longman. Edition Sinauer Associates Inc. Publishers, Massachusetts, USA
8. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
9. Kaul RP (2009) Plant Metabolism. Swastik Publishers and Distributors.
10. Fosket, D.E. 1994. Plant Growth and Development. A molecular Approach. Academic Press, San Diego.
11. Howell, S.H. 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
12. Leins, P., Tucker, S.C. and Endress, P.K. 1988. Aspects of Floral Development. J. Cramer, Germany.

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-II**

#### **Core- 8**

### **MEDICINAL PLANT BIOTECHNOLOGY**

#### **UNIT-I**

Scope and Definitions, Plant genome organization, structural features of a representative plant gene. Organization of chloroplast genome and mitochondrial genome - Plant genetic diversity - variation allozyme, RFLP and RAPD techniques - A general account of IBPGR and NBPGR.

#### **UNIT-II**

Cell and tissue culture - plant tissue culture media, plant hormones and growth regulators in tissue culture, preparation of suitable explants - Immunodiagnosics and molecular diagnostics in selection of elite plant species - Callus culture, suspension cultures, embryo culture; anther, pollen and ovary cultures. Micropropagation of plants - somatic embryogenesis, protoplast culture, somatic hybridization and synthetic seeds.

#### **UNIT-III**

Symbiotic nitrogen fixation in legumes by rhizobia - biochemistry and molecular biology; Agrobacterium and crown gall tumours - mechanism of T-DNA transfer to plants - Ti plasmid vectors for plant transformation - Agroinfection - molecular biology of plant stress response (stress genes).

#### **UNIT-IV**

Genetic engineering in plants, selectable markers, reporter genes and promoters used in plant vectors - direct transformation of plants by physical methods.

Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance - stress tolerance (heat & salt) - cytoplasmic male sterility - resistance to fungi and bacteria - delay of fruit ripening - secondary metabolite production.

**Note: Practicals based on above theory syllabus.**



## Suggested Readings:

1. Baxevanis, A. D., Davison, D. B.; Page, R. D. M.; Petsko, G. A.; Stein, L. D. and Stormo, G. D. 2008 Current Protocols in Bioinformatics, John-Wiley and Sons Publications, New York.
2. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
3. Brown, T. A. 1999. Genomes, John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
4. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.
5. Chrispeels, M. J. and Sadava, D. E. 1994, Plants, Genes and Agriculture. Jones & Barlett Publishers, Boston, USA.
6. Glazer, A. N. and Nikaido, H. 1995. Microbial Biotechnology. W. H. Freeman & Company, New York, USA.
7. Gustafson, R. J. 2000. Genomes. Kluwer Academic Plenum Publishers, New York, USA.
8. Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
9. Jain, S. M., Sopory, S. K. and Veilleux, R.E. 1996. *In vitro* Haploid Production in Higher Plants, Vols. 1-5, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, The Netherlands.
10. Jolles, O. and Jornvall, H. (eds) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
11. Kartha, K. K. 1985. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida USA.
12. Kingsman, S. M. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford, 1998
13. Mount W. 2004 Bioinformatics and sequence genome analysis 2<sup>nd</sup> Edi. CBS Pub. New Delhi
14. Old, R. W. and Primrose, S. B. 1989. Principles of Genome Analysis. Blackwell Scientific Publications. Oxford, UK.
15. Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Scientific Ltd., Oxford, UK.
16. Raghavan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.
17. Watson, J. , Tooze and Kurtz Recombinant DNA: A short course
18. Biotechnology and Plant Improvement Dr. Arun K. Zingare 978-81-921419-5-4, Satyam, 2013
19. Plant Genetics, Biotechnology and Microbiology Vol. I & II Dr. Arun K. Zingare 978-93-82664-04-8, Satyam , 2014

**SEMESTER-II**  
**Core – 8 Practicals**  
**MEDICINAL PLANT BIOTECHNOLOGY**

**Suggested Laboratory Exercise:**

1. Tissue culture methods-
  - a) Preparation of Media,
  - b) Sterilization Techniques,
  - c) Inoculation of Explants,
  - d) Callus Culture,
  - e) Suspension Cultures,
  - f) Anther Cultures.
  - g) Surface sterilization of the given seeds/explants.
2. Isolation of protoplasts, viability test for protoplasts & protoplast culture.
3. Protoplast fusion for somatic hybrid production.
4. Working gel documentation system and analysis of electrophoretic gels.
5. Growth characteristics of *E.coli* using plating and turbidimetric methods.
6. Isolation of plasmid from *E.coli* and its quantification.
7. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
8. Cloning of a DNA fragment in a plasmid vector
9. Bacterial transformation and selection of transformed cells.
10. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.

**Suggested Laboratory Readings:**

1. Plant molecular biology, Grierson and S.N. Convey, 1988. Blackie
2. Genetic engineering of crop plants, G.W. Lycett and D. Grierson (Eds.), 1990.
3. Plants, Genes and Agriculture, M. J. Chrispeeds and D.F. Sadava, 1994. Jones and Barlett.
4. Molecular Biotechnology - Principles and Applications in Recombinant DNA, Glick and Pastermark, 2002. Panima Publishing Co-operation.
5. Molecular cloning- a lab manual, Manites Vol I-III.
6. Biotechnology - V, Rajeshwari S. Setty and G. R. Veena, 2003. New age International Publishers (p) Ltd., New Delhi.
7. Genetic engineering of plants, Kosuage, T. and Meredith, C.P., 1989. Hollaender Plenum Press.
8. Conservation and genetic resources, Virchow, D., 1998. Springer Verlag, Berlin.
9. Molecular plant development from gene to plant, Pester Westhoff.
10. Molecular genetics of plant development, Howell, S. H.
11. Methods in Plant molecular biology. A laboratory course manual by (Ed.) Oak Nakuga, 1995. Cold spring Harbour Laboratory Press.
12. Plant Genetic Transformation and Gene expression, (Eds.) J. Draper et al., 1988. Blackwell scientific publications, Oxford.
13. Plant molecular biology. Manual, S.B. Gelvin, R.A. Sehil Peroort and D.P.S. Verma (Eds.), 1991. Kluwer Academic Publishers, Doredirect.

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER – II**

**Practical –III**

**Time: 6 hours.**

**Full Marks: 100**

|  |    |    |
|--|----|----|
| <b>Q. 1</b> Onequestion from Sr. No 1-6 of Core-5  | 15 |    |
| <b>Q. 2</b> Onequestion from Sr. No 7-11 of Core-5 |    | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 1-8 of Core-6  | 15 |    |
| <b>Q. 4</b> Onequestion from Sr. No 9-15 of Core-6 |    | 15 |
| <b>Q. 5</b> Spotting (2 spots from each core)      |    | 20 |
| <b>Q. 6</b> Viva-voce                              |    | 10 |
| <b>Q. 7</b> Practical Record                       |    | 10 |

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER- II**

**Practical –IV**

**Time: 6 hours.**

**Full Marks: 100**

|  |    |    |
|--|----|----|
| <b>Q. 1</b> Onequestion from Sr. No 1-8 of Core-7  | 15 |    |
| <b>Q. 2</b> Onequestion from Sr. No 9-16 of Core-7 |    | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 1-5 of Core-8  | 15 |    |
| <b>Q. 4</b> Onequestion from Sr. No 6-10 of Core-8 |    | 15 |
| <b>Q. 5</b> Spotting (2 spots from each core)      |    | 20 |
| <b>Q. 6</b> Viva-voce                              |    | 10 |
| <b>Q. 7</b> Practical Record                       |    | 10 |

## **CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-III**

#### **Core –9**

### **IMMUNOLOGY & MICROBIOLOGY**

#### **UNIT-I: - Overview of the Immune system and CMI**

**Cells involved in Immune system:** Hematopoiesis, Lymphocytes, mononuclear phagocytes, Antigenpresenting cells, Granulocytes.

**Lymphoid organ:** Lymphatic system, Primary and Secondary lymphoid organs.

**Complement System:** Pathways of complement activation, regulation of complement system, Biological functions of complement system.

**Inflammation:** Intracellular cell adhesion molecules, Mechanism of cell migration, Inflammation. Pathways of antigen processing and presentation.

#### **UNIT-II: -**

**Cell Mediated Immunity:** General properties of effector T cells, Cytotoxic T Cells, Natural Killer cells, Antibody-Dependent cell mediated cytotoxicity. T-Cell dependent and T-cell independent defense mechanisms.

**Cancer and the Immune system:** Origin and Terminology, Malignant Transformation of cells, oncogenes and cancer induction, Tumor Antigens, Immune surveillance theory, Tumor evasion of the Immune system, Cancer Immunotherapy.

#### **Unit-III**

Introduction to the scope of microbiology, Structure of bacterial cell, Classification of microbes and their taxonomy. Actinomycetes bacteria, rickettsiae, spirochetes and viruses. Identification of Microbes : Stains and types of staining techniques, electron microscope. Nutrition, cultivation, isolation of bacteria, actinomycetes, fungi, viruses, etc. Microbial genetics and variation.

#### **Unit-IV**

Control of microbes by physical and chemical methods.

a) Disinfection, factors influencing disinfectants, dynamics of disinfection, disinfectants and antiseptics and their evaluation.

b) Sterilization, different methods, validation of sterilization methods & experiments.

Sterility testing of all Pharmaceutical products. Immunity, primary and secondary, defensive mechanisms of body, microbial resistance, interferon.

Microbial assays of antibiotics, Vitamins (Vitamin B12 & Niacin), amino acids. Diseases and disease-producing microorganisms, like Staphylococcus aureus, Streptococcus pyogenes, E. coli, Salmonella typhi, Vibrio cholerae and Yersinia pestis; virulence factors.

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. Pelczar, T.B. of Microbiology.
2. R.Y. Steiner, General microbiology.
3. Zudykandal, Essential and application of microbiology.
4. Waxman S.A., Actionomycocytes.
5. Bhojwani SS, plant tissue culture: applications and limitations(edition 1990).
6. Bhojwani SS and Rajdan MK (1983), plant tissue culture theory and practice.
7. Lewin R.(1988), Automated plant tissue culture for mass propagation, Biotechnology.
8. Street HE, (1977), plant cell and tissue culture, Balckwell, London.
9. Vasil IK (1986), cell culture and somatic cell genetics of plants, vol 1,2,3.
10. Ananthanarayan and Paniker, (2009), "Textbook of Microbiology", 8th Edition. Universal Press
11. Cedric Mims et al, " Medical Microbiology", 3rd Edition Mosby
12. Prescott, Harley, Klein, "Microbiology", . 6th Edition McGraw Hill
- 13 Konemann, "Diagnostic Microbiology", 5th and 6th Edition. Lippincott
- 14 Teri Shors Jones "Understanding Viruses" Bartlett Publishers
15. Richard A. Goldsby, Janis Kuby, "Immunology", , 6th and 7th Edition. W. H. Freeman and company.
16. Fahim Halim Khan, "The elements of Immunology",.Pearson Education.
17. Pathak, S., Palan U, "Immunology Essential and Fundamental" ,2nd Edition. Capital Publishing company
18. Ian R. Tizard, "Immunology, An Introduction", 4th - Edition, Saunders college publishing
19. Microbiology and Plant Pathology Dr. Arun K. Zingare 978-81-921419-4-7, Satyam , 2013

**SEMESTER-III**  
**Core – 9 Practicals**  
**IMMUNOLOGY & MICROBIOLOGY**

**Suggested Laboratory Exercise:**

**A. Immunology Experiments**

***Precipitation reactions of antigen-antibody:***

1. Immunoelectrophoresis
2. Rocket immunoelectrophoresis
3. Single and Double diffusion techniques

***Agglutination techniques:***

4. Preparation of O and H antigen of *Salmonella* and its testing using known antisera,
5. Titre determination of isoantibodies to human blood group antigens;

***ELISA***

**6. *Blood grouping***

**7. *Pregnancy test.***

**B. Microbiology Experiments**

1. Isolation, identification and characterization of actinomycetes, halophiles, cyanobacteria, molds and yeast.
2. Gram staining of bacteria.
3. Bioassay and Chemical estimation of penicillin
4. Aseptic techniques
5. Media preparation
6. Culture techniques
7. Microbial Assay of Antibiotics
8. Estimation of antimicrobial activity using standard guidelines (NCCLS/CLSA)
9. Study of plant virus diseases: Collecting data and samples,

**Suggested Laboratory Readings:**

1. Christian Barnett, Alan Smith, Bernard Scanlon and Cleanthes J. Israilide, (1998), *Pullulan production by Aureobasidium pullulans growing on hydrolysed potato starch waste*, Elsevier Science Ltd.
2. Stanbury P.F., Whittaker A., Hall S.J., Principles of Fermentation Technology 2<sup>nd</sup> Edition.
3. Wilson & Walker, (1995) Practical Biochemistry, Principles & Techniques
4. Plummer David T., (1988), An introduction to practical biochemistry, 3rd Ed., Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 109-121
5. Talwar G. P. (1983) *Handbook of Immunology*, Vikas Publishing Pvt. Ltd. New Delhi
6. Sambrook J, Fritsch E F, Maniatis T (1989) Molecular cloning – a laboratory Manual 2nd ed. Cold spring harbour NY: cold spring harbour laboratory press.
7. Ausbel F. M. and Brent R., (1994), Current protocols in Molecular biology, John Wiley & sons Inc, NY

## CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)

### Semester-III

#### Core –10

### HERBAL COSMETICS

#### Unit I

Cosmetics preparations: Incorporating the herbal extracts in various cosmetic formulations like Skin care preparations (Creams and Lotions), Sunscreens and Sunburn applications, Hair care preparations (Hair oils and Hair shampoos) and Beautifying preparations (Lipsticks, Face powders and Nail polish).

Skin care herbs :

- a. Lipids** :Apricot, Ranolin, Beesay, Olive oil, Sesame oil (Cleansing & emollient)
- b. Glycosides** :Almond Aloe, Ambiholds, Rhubers, (Emollient & Skin Pigmentation)
- c. Alkaloids** :Black peper, Vinca, Cinchona, Withania, (Antipimples, Antiallulite)
- d. Volatile oils** :Chandan Khus, Saffron, Cinnamon, (Fresshers, Pigmentations & perfumes)
- e. Tannins** :Amla , Netmeg, Tannic acid, Ashoka , Hirda, (Astringents, Antibacterial)
- f. Carbohydrades** :Accacia, Agar, Tragacanth, Pectin Sland (Bindes, Golmorner, Emulgents)

#### Unit II

**Standardization of herbs** :Importance of standardization (asper WHO guidelines), assessment of Herbal extracts & informulations, methods employed for standardization of herbs with special reformes to industrial methods HPLC, HPTLC ; Flash chromatography, GLC etc.

**Aromatherapy** :Various Oils used in Aromatherapy with their Significance & skin texture.

#### Unit III

**Nomenclature, characteristics** & classification, chemical constitution, method of isolation & estimation of herbs used for haircare.

**Hair grooming** :-Apricot, Aloe

**Hair growth promoter** : Brahmi, Manjistha, Jatamansi,

**Hair Tonics** : Bawachi, Hibuscus, Amla , Almond oil, Coconut oil Olive oil

**Antidandruff** : Tulsi, Neem, Wheat Gram Oil, Beturla Pedula.

**Hair Colorants** :Amala, Heena, Bhringaraja (*Eclipta alba*), Comomite, Safflower (*Carthamus Officinatis*)

**Hair cleansing** :Ritha, Shikakai, Amla

#### Unit IV

**Fruits & vegetables as hair & skin care** : Apple, Apricot, Banona, Barli, Melon, Carrot, Cucumber, honey, lemon, peach, pudina, tomato, Yogurt, tea. Extraction & isolation of active principles of herbs & their incorporation in various cosmetics formulations like creams, lotions, powders & other cosmetics, formulations. Production trade & market for culinary herbs.

**Analysis of herbs** : General method of analysis of herbs – Determination of standard values, qualitative & quantitative estimation of resin & sugars. Chromatographic techniques used in analysis of herbs & their constituents.

**Note: Practicals based on above theory syllabus.**

## **Suggested Readings:**

1. Novel Cosmetic Drug Delivery Systems, by Magdassi and Touitou.  
Cosmetics by Sagerin.
2. Perfumes, Cosmetics and Soaps by Poucher.
3. Drug and Cosmetic Act 1940 and rules.
4. Dr. A. Patani: The Drugs and Cosmetics Act 1940, Eastern Book Company, Lucknow.
5. Cosmetic Science and Technology Vol I, II, III by Sagarin.
6. Harry's Cosmetology
7. Theory and Practice of Industrial Pharmacy by Leon Lachman.
8. New Cosmetic Science
9. Indian Herbs by Chopra
10. Wealth of India by CSIR
11. Pharmacognosy Vol I & Vol II by Mohammed Ali
12. Materia medica
13. Herbs useful in dermatological Therapy, Behl P.N.
14. Dian Dinein Buchmans Herbal medicure , Gramercy, publication,company illustrated by Leaven Jarrett
15. Cosmetics Analysis selective methods with techniques by P. Bare.



**SEMESTER-III**  
**Core – 10 Practicals**  
**HERBAL COSMETICS**

**Suggested Laboratory Exercise:**

1. Study of Morphological & Microscopic characters of Herbs used in Skincare
2. Study of Morphological and Microscopic characters of various herbs used in hair care.
3. Phytochemical constituents identification & quality control and standardization.
4. Application of various methods for extraction, solvent systems & isolation of active constituents.
5. Study of Various oils used in Aromatherapy with special reference to its applications.
6. Study of various Extraction methods for active constituents from fruits and vegetable.

**Suggested Laboratory Readings:**

- 1) Pharmacognosy Vol I & Vol II by Mohammed Ali
- 2) Materia medica
- 3) Herbs useful in dermatological Therapy, Behl P.N.
- 4) Dian Dinein Buchmans Herbal medicure , Gramercy, publication, company illustrated by Leaven Jarrett
- 5) Wealth of India – C.S.P. Publications
- 6) The Ayurvedic Encyclopedia.
- 7) Herbs, Spices, and Medicinal plants Vol I, II, III & IV by Kyle , E. Craker & James E. Simon.
- 8) T.B. of Pharmacognosy by Trease & Evans
- 9) Hand Book of herbal products Vol I & II by NIIR Board of Technologist.
- 10) Pharmacopoeial standards of herbs by Dr. C.R. Karnik.
- 11) Cosmetics Analysis selective methods with techniques by P. Bare.
- 12) Pharmacognosy Vol I & II by Mohammed Ali CBS Publications, New Delhi.

**CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**  
**Semester-III**  
**Core –Elective 1**  
**NATURAL PLANT PRODUCTS & PHYTOCHEMISTRY – I**

**UNIT-I:**

**Extraction:** Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Extraction of Plant drugs by Microwave assisted techniques (wherever applicable) and their merits and demerits. Selection and Purification of Solvents For Extraction. Methods of isolation, (including industrial methods) purification and characterization of some natural products: Starch, Citric acid, Pectin, Sennosides, Phyllanthin, Curcumin, Lemon grass oil, Sandal wood oil, Emetine and Caffeine.

**UNIT-II :**

**Carbohydrates:** Introduction, Definition, Classification, Nomenclature, Sources (*Acacia arabica*, *Anogeissus latifolia*, *Plantago ovate*, *Zea mays* importance, Structure, chemistry, structural elucidation of Glucose & Sucrose.

**Glycosides:** Introduction, Definition, Classification, Nomenclature, Sources (*Cassia angustifolia*, *Aloe vera*, *Digitalis purpurea*, *Panax ginseng*, *Andrographis paniculata*), importance, Structure, chemistry, structural elucidation of cardiac glycosides - digoxin, Anthracene glycosides - Sennosides.

**Vitamins:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Ascorbic acid.

**UNIT-III:**

**Steroids:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of cholesterol.

**Plant Hormones:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Auxins.

**UNIT-IV:**

**Terpenoids:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Citral, Menthol and Zingiberene. Isoprene and Special Isoprene rule.

**Anti-biotics:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Penicillin's.

## Suggested Readings:

1. Nakanishi -Natural Products Chemistry, Vol. 1 & Vol. 2
2. Bonner - Plant Biochemistry.
3. Harborne - Comparative Biochemistry of Flavonoids.
4. Wagner - Wolf- New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutic Activity
5. Sim - Medicinal Plant Glycosides.
6. Sim - Medicinal Plant Alkaloids.
7. Manske- The Alkaloid- Chemistry and Physiology
8. IUPAC - Chemistry of Natural Products - International symposium.
9. Zechmeister - Progress in the Chemistry of Organic Natural Products.
10. Chatwal G. Organic Chemistry of Natural Products, Vol-I and II, 7th Reprint 1998, Himalaya Publishing House, Mumbai
11. Indian Herbal Pharmacopoeia, Volume I and II-1999, a Joint publication of IDMA and RRL Jammu Tawi.
12. Trease and Evans-Pharmacognosy, 14th Edition, 1997, W. B. Saunders Company, Singapore
13. Wallis, T. E. Textbook of Pharmacognosy, 5th Edition-1997, CBS Publisher
14. Tyler, Brady, Roberts-Pharmacognosy, 8th Edition-1981, K. M. Varghese Company, Mumbai
15. Sim. S. K. Medicinal Plant Alkaoids and Glycosides, 2nd Edition-1966 University of Toronto Press, Toronto.
16. Cultivation and Utilization of Medicinal Plants, Edited by Atal and Kapur, 1982, RRL Jammu Tawi
17. Cultivation and Utilization of Aromatic Plants, Edited by Atal and Kaur, 1982, RRL Jammu Tawi.
18. Harbone J. B. Phytochemical Methods, 3rd Edition-1998 Champan and Hall London
19. Natural products chemistry – Nakanishi Golo
20. Natural products – A Laboratory guide by Raphael Ikhan.
21. Organic Chemistry by I.L. Finar vol.ii
22. Chemistry of Natural Products by K.W. Bentley
23. Pharmacognosy by Trease and Evans, ELBS.
24. Practical Evaluation of Phytopharmaceuticals by K.r. Brain, T.D. Turner.
25. The Chemistry of Natural Products, Edited by R.H. Thomson, Springer International Edn. 1994.
26. Natural Products from Plants, 1st edition, by Peter B. Kaufman, CRC Press, New York, 1998.
27. Natural products: A lab guide by Raphael Ikan , 2nd Edition, Academic Press1991.
28. The review of Natural products – Ara Dermarderosia.
29. Modern methods of plant analysis –High performance Liquid chromatography in plant science –H.F.Linskens and J.F.Jacksons.
30. Encyclopedia of Medicinal Flora, Dr. Arun K. Zingare 978-81-921419-1-6, Satyam , 2012
31. Medicinal and Poisonous Plants Dr. Arun K. Zingare978-93-82664-09-3, Satyam , 2014
32. Handbook of Medicinal Plants Dr. Arun K. Zingare 978-93-82664-03-1, Satyam , 2014

**SEMESTER-III**  
**Core –Elective 1Practicals**  
**NATURAL PLANT PRODUCTS& PHYTOCHEMISTRY – I**

**Suggested Laboratory Exercise:**

1. Chemical tests for Carbohydrates.
2. Chemical tests for Glycosides.
3. Chemical tests for Terpenoids.
4. Chemical tests for Steroids.
5. Study of Medicinal Plants mentioned in theory syllabus, at least TWO from Carbohydrates, Glycosides, Terpenoids.Steroids.
6. Methods of Cultivation, with respect to the Medicinal Plants mentioned in theory syllabus - Sexual method (Seed propagation) &Asexual method (Vegetative Propagation)
7. Study of Soil- Physical & Chemical characteristics, with respect to the Medicinal Plants mentioned in theory syllabus
8. Study of Pests & Pests control, with respect to the Medicinal Plants mentioned in theory syllabus
9. Isolation and characterization of Natural plant products.
10. Phytochemical screening of Natural plant products.

**Suggested Laboratory Readings:**

1. Cutler, Stephen J.; Cutler, Horace G. (2000). *Biologically active natural products: pharmaceuticals*. CRC Press.
2. Newman DJ, Cragg GM (2007) Natural products as sources of new drugs over the last 25 years. *Journal of Natural Products* 70, 461-477.
3. Dossey, Aaron (2010). "Insects and their chemical weaponry: New potential for drug discovery". *Natural Product Reports* 27: 1737–1757.
4. Dan Bensky, Steven Clavey, Erich Stoger, and Andrew Gamble ( 2004) *Chinese Herbal Medicine: Materia Medica, Third Edition*
5. Hernan Garcia, Antonio Sierra, Hilberto Balam, and Jeff Connant (1999) *Wind in the Blood: Mayan Healing & Chinese Medicine*.
6. "The American Society of Pharmacognosy – Story of Taxol".
7. El-Shemy HA, Aboul-Enein AM, Aboul-Enein KM, Fujita K (2007) *Willow Leaves' Extracts Contain Anti-Tumor Agents Effective against Three Cell Types.*: PLoS ONE.;2:e178
8. G Brahmachari et Al. (2010), *Natural Products in Drug Discovery: Impacts and Opportunities—An Assessment.*,
9. AJ Giannini, AE Slaby. (1989) *Drugs of Abuse*. Oradell, NJ, Medical Economics Books.,
10. Dewick, P. M. (2009). *Medicinal Natural Products: A Biosynthetic Approach*. United Kingdom: John Wiley & Sons. 335-336.
11. Barbier P, Schneider F (1987). "Syntheses of tetrahydrolipstatin and absolute configuration of tetrahydrolipstatin and lipstatin". *Helvetica Chimica Acta* 70 (1): 196–202.
12. Goodman, Jordan; Walsh, Vivien (2001). *The Story of Taxol: Nature and Politics in the Pursuit of an Anti-Cancer Drug*. Cambridge University Press. p. 51.
13. Kinghorn, A. D., Chin, Y.-W., & Swanson, S. M. (2009). " *Discovery of Natural Product Anticancer Agents from Biodiverse*". *Curr Opin Drug Discov Devel.* 189–196.
14. Siddiqui A. A. And Seemi siddiqui (2012) *Natural Products Chemistry for Sci and Pharmacy Course*. Eds. CBS Publisher.
15. Praveen Kumar ( 2009) *Natural Products: Practical Manual* eds. Pharma Books Syndicate.
16. Miechel Verral (2011) *Downstream processing of Natural Products. A Practical Handbook*.

## SEMESTER-III

### Core –Elective 1

## Forensic and Industrial Botany-I (Elective-I)

**CREDIT: I** – DEVELOPMENTAL GROWTH OF FORENSIC SCIENCE : Introduction to Forensic science – nature, need and function Laws and Principles, basics of Forensic Science Historical development and scope of Forensic Science in India

**Forensic Botany:** Introduction, types, location, collection evaluation and forensic significance of fungi and plants in forensic science, wood and pollen grains,

**CREDIT: II:** Fiber Examination: Sampling, Fibre examination-microscopic, temporary mount, Maceration of plant fibres, cross-sectioning, physical methods (twist on drying, floatation method, burning test). Cotton, coir, wool, silk, jute, sisal, abaca rayon silk, wool, asbestos, nylon. Fabrics & cordage- sample handling, analysis, fabric examination, cordage examination

**Methods of identification and comparison** of various types of planktons and diatoms and their forensic importance; Limnology, Diatoms types and morphology, methods of isolation from different tissues. Study and identification of pollen grains, Identification of starch grains, powder and stains of spices etc.; Paper and Paper Pulp identification, Microscopic and biochemical examination of pulp material.

Study of Various types of Poisonous Plants. Identification of wood-physical properties, colour, fluorescence, hardness, weight, odour, lustre, texture, anatomical features, pore/vessel distribution, size and arrangement, pore numbers, pore arrangements, inclusions, colored deposits, etc.

**CREDIT : III:Other Biological Evidences:** Identification of Food stuffs & their stains: Plants used as food, animals used as food. Examination of plant foods (starch, herbs, spices & flavorings, fruits, vegetables).

**Narcotic Drug and Psychotropic Substances :-** Analysis of Narcotic Drugs and Psychotropic Substances, Drug effects, drug Hazards, Tolerance and dependence of drugs, Problems of drug addiction, Identification of drug addict, Drug addicts and crimes, Classification of Narcotics and other drugs, Analytical techniques for identification of drugs. Types of Pharma drugs, Steroids, Forensic Pharmacological studies, Ingestion of drugs ,absorption, distribution, metabolism, pathways of drug metabolism, drug metabolism and drug toxicity, excretion of drugs.

**CREDIT : IV:** Study of Analysis of Beverages :- Introduction, Definition of alcohol and illicit liquor, Alcoholic and nonalcoholic beverages and their composition, Proof spirit, absorption, de-toxication and excretions of alcohol, problems in alcohol cases and difficulties in diagnosis, Alcohol and prohibition, Consequences of drunken driving, Analytical techniques in the analysis of alcohol and other articles. Case study.

## References

1. A vision for the twenty first century Select Publisher, New Delhi.
2. Compute Crime and Computer Forensic by Dr. R.K. Tiwari
3. Crime Scene Management with Special Emphasis on National level Crime Cases by Dr. Rukmani Krishnamurthy under publishing
4. Crime Scene Processing and Laboratory Work Book by Patric Jones
5. Criminal Profiling: An Introduction to a Behavioral Evidence Analysis, 3rd ed. By Brent E. Turvey
6. Criminalistics: An Introduction to Forensic Science, 9th ed. By Richard Saferstein
7. Ethics in Forensic Science. Barnett (2001)
8. Forensic Biology by Shrikant H. Lade
9. Forensic Medicine, 2nd Ed., Guharaj, P. V., Chandran M. R. (2006) Universities Press (India) Pvt. Ltd., Hyderabad.
10. Forensic Science in Criminal Investigation and Trial, 4th ed. By B.R. Sharma
11. Forensic Science: An Introduction to Scientific and Investigative Techniques 3rd ed. by Stuart H. James
12. Forensic Science: An introduction to scientific and investigative techniques by James, S. H. and Nordby, J. J. (2003) CRC Press, USA.
13. Handbook of Forensic Pathology, Di Maio J. M. Vincent, Dana S. E. (2006) VIVA Books Pvt. Ltd., India.
14. Handbook of Forensic Psychology by Dr. Veerraghavan
15. Henry Lee's Crime Scene Handbook by Henry C Lee
16. Introduction to Criminalistics, 1949, O'Hara & Osterburg: The MacMillan Co., 1964
17. Introduction to Forensic Science in Crime Investigation By Dr. (Mrs.) Rukmani Krishnamurthy
18. Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology. Parikh C. K. (1999) Sixth Ed., CBS Publishers & Distributors Pvt. Ltd., India.
19. Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C.K.
20. The Identification of Firearms and Forensic ballistics by Barrard and Gerald

# CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)

## Semester-III

### Foundation Course 1

## FERMENTATION TECHNOLOGY

### UNIT-I:- General Principles of Fermentation

**Bioreactors:** Bioreactor types, immobilized bioreactors, types of fermentation.

**Fermentation kinetics and Monod's Model:** Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response, Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation.

**Process optimization:** factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

### UNIT-II:- Downstream Processing and scale up.

**Downstream processes:** types of processing units and systems, Storage and packaging methods.

**Scale up;** scale down, criteria involved in scale up Productivity, power requirements Basic control theory.

### UNIT-III: - Industrial Fermentation Products

**Biofuels:** Ethanol, Hydrogen, Methane

**Antibiotics:**  $\beta$ -lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.

**Biopreservative:** Lactobacillus sakei. Biopolymers: Xanthan, Polyhydroxyalkanoates.

**Thermostable enzymes:** Proteases. Biosurfactants: a comparative account.

### UNIT-IV:- Food and Healthcare products

SCP, various types and processes. Carotenoids

**Amino acids:** Lysine, Glutamic acid.

**Vitamins:** riboflavin, Vit. B12. Fatty acids (Palmitate, oleate).

**Note: Practicals based on above theory syllabus.**

### Suggested Readings:

1. Stanbury P.F., Whittaker A., Hall S.J., Principles of Fermentation Technology 2<sup>nd</sup> Edition.
2. *Operational Modes of Bioreactors*, (1992) BIOTOL series, Butterworths Heinemann.
3. Pepler H. J. and D. Perlman (1970) *Microbial Technology* Volume 1 and 2, Academic Press New York
4. Wiseman A. (1985) *Topics in Enzyme and Fermentation - Biotechnology*, Vol. 1 and 2, John Wiley and Sons, New York.
5. Industrial Microbiology By: A.H. Patel
6. Industrial Microbiology By: L.E. Casida.
7. Prescott and Dunns Industrial microbiology. By: Gerald Reed.
8. Advances in Applied microbiology. By: D. Pearlman academic press.

**Semester-III**  
**Foundation Course 1- Core Subject Centric**  
**Cultivation and Utilization of Medicinal Plants**

**Credit I. Introduction to medicinal plants:** Introduction to Medicinally important Plant parts: Fruits, Leaves, Stem and its modifications (underground and aerial), Roots, Study of some medicinally important families with reference to systematic position. Diagnostic features and medicinal uses only: Meliaceae, Myrtaceae, Apiaceae, Asclepiadaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Zingiberaceae, Musaceae and Poaceae.

Importance of medicinal plants – role in human health care – health and balanced diet (Role of proteins, carbohydrates, lipids and vitamins).

**Credit II. Medicinal plant cultivation**

Origin , Evolution and Cultivation methods of medicinal plants (Aloe vera, Ashwagandha, Daruhaldi,. Isapgol, Brahmi, Kalmegh. . Shankhpushpi Tulsi. and turmeric).storage and Protection ,Marketing and utilization - Export of medicinally important plants (General aspects),

**Credit III. Medicinal plants and Resource Management:**

- a) Concept, Medicinal resources, biological resources, plants as natural resources
- b) Management practices - need and methods
- c) Utilization –uses of medicinal plants (Aloe vera,Ashwagandha, Daruhaldi,. Isapgol, Brahmi, Kalmegh. . Shankhpushpi Tulsi. and turmeric)

**Credit IV. Quality control for medicinal plants:** QUALITY ASSUARANCE-: Concept of quality control, quality assurance & total quality controls. Sources of variation, Quality control of raw materials & pharmaceutical process & finished products.Documentation concepts of statistical quality control.Validation of pharmaceutical process (at least one case study of a process & analytical method.)

Contribution of national research laboratories (CDRI, CIMAP,RRC,AND NBRI) in medicinal plants research



## Reference:

1. A Manual of Ethnobotany – S.K.Jain, 1995, 2nd edition.
2. Contribution to Indian ethnobotany – S.K. Jain 1995, 3rd edition, Scientific publishers, P.B.No. 91, Jodhpur, India.
3. Contribution to Indian ethnobotany – S.K. Jain 1995, 3rd edition, Scientific publishers, P.B.No. 91, Jodhpur, India.
4. Ethnobiology – R.K.Sinha & Shweta Sinha – 2001. Surabhe Publications – Jaipur.
5. Farooqi, A.A., and B.S. Sreeramu (2004). Cultivation of Medicinal and Aromatic Crops. University Press (India) Pvt. Ltd., Hyderabad.
6. Gokhale, S.S., C.K.Kokate and A.P. Purohit (1994) Pharmacognosy. Nirali Prakashan. Pune.
7. Kocchar, S.L. 1998: Economic Botany in Tropics, 2nd edition, MacMillan India Ltd., New Delhi.
8. Kumar, N.C. (1993). An Introduction to Medical botany and Pharmacognosy. Emkay Publications, New Delhi.
9. Rao, A.P. (1999). Herbs that heal. Diamond Pocket Books (P) Ltd., New Delhi.
10. Sambammurthy, A.V.S.S. And Subramanyam, N.S. 1989: A Textbook of Economic Botany, Wiley Eastern Ltd., New Delhi.
11. Sharma, O.P. 1996: Hills Economic Botany (Late Dr. A.F. Hill adapted by O.P. Sharma), Tata McGraw Hill Co. Ltd., New Delhi.
12. Simpson, B.B. and Conner-Ogorzaly, M. 1986: Economic Botany- Plants in our World, McGraw Hill, New York.
13. Singh & Jain (1985) Taxonomy of Angiosperms. Rastogi Publications
14. Tribal medicine – D.C. Pal & S.K. Jain 1998, Naya Prakash, 206, Bidhan Sarani, Calcutta – 700 006.
15. Tribal medicine – D.C. Pal & S.K. Jain 1998, Naya Prakash, 206, Bidhan Sarani, Calcutta – 700 006.
16. Tyagi, Dinesh Kumar (2005) Pharma Forestry. Field Guide to Medicinal Plants. Atlantic Publishers and Distributors, New Delhi.

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER – III**

**Practical –V**

**Time: 6 hours.**

**Full Marks: 100**

|   |    |
|---|----|
| <b>Q. 1</b> Onequestion from Sr. No A-1-7 of Core-9 | 15 |
| <b>Q. 2</b> Onequestion from Sr. No B-1-9 of Core-9 | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 1-3 of Core-10  | 15 |
| <b>Q. 4</b> Onequestion from Sr. No 4-6 of Core-10  | 15 |
| <b>Q. 5</b> Spotting (2 spots from each core)       | 20 |
| <b>Q. 6</b> Viva-voce                               | 10 |
| <b>Q. 7</b> Practical Record                        | 10 |

**CBCS PATTERN SYLLABUS  
M. Sc. (MEDICINAL PLANTS)**

**SEMESTER- III**

**Practical –VI (Core Elective-1)**

**Time: 6 hours.**

**Full Marks: 100**

|   |    |
|---|----|
| <b>Q. 1</b> Onequestion from Sr. No 1-4 of Core elective-1  | 15 |
| <b>Q. 2</b> Onequestion from Sr. No 5-6 of Core elective-1  | 15 |
| <b>Q. 3</b> Onequestion from Sr. No 7-8 of Core elective-1  | 15 |
| <b>Q. 4</b> Onequestion from Sr. No 9-10 of Core elective-1 | 15 |
| <b>Q. 5</b> Spotting (4 spots from core elective -1)        | 20 |
| <b>Q. 6</b> Viva-voce                                       | 10 |
| <b>Q. 7</b> Practical Record                                | 10 |

**CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**  
**Semester-IV**  
**Core –11**  
**HERBAL DRUG TECHNOLOGY & DEVELOPMENT**

**Unit-I**

General methods of extraction, isolation and purification of phytoconstituents

Isolation, identification tests and estimation methods for the following phytoconstituents with special emphasis on HPLC, HPTLC and other advanced techniques

Aloin from Aloes; Vasicine from *Adhatoda vasica*; Andrographolides from *Andrographis paniculata*

**Unit-II**

Phytochemical study

Definition, occurrence, chemistry, isolation, estimation and biogenesis of alkaloids, glycosides, plant phenols, resins, terpenes and terpenoids, phospholipids and steroids

Screening procedures for herbal drugs with current innovations in following therapeutic classes-

Antihypertensive; Antioxidant; Antipyretic & anti-inflammatory; Antidiabetic; Anticancer; Antihepatotoxic; Immunomodulatory

**Unit-III**

**General Methods of Processing of Herbs:**

Definition, sources, identification and authentication of herbs; Different methods of processing of herbs like collection, harvesting, garbling, packing and storage conditions; Methods of drying – Natural and artificial drying methods with their merits and demerits.

**Methods of Preparation of Extracts:**

Principles of extraction and selection of suitable extraction method; Different methods of extraction including maceration, percolation, hot continuous extraction, pilot scale extraction and supercritical fluid extraction with their merits and demerits; Purification and Recovery of Solvents.

**Unit-IV**

**Isolation and Estimation of Phytoconstituents:**

Different methods (including industrial) for isolation and estimation of phytoconstituents from the following drugs (with special emphasis on HPLC and HPTLC).

1. Forskoline from *Coleus forskoli*; 2. Catechins from Green tea; 3. L-Dopa from *Mucuna pruriens*; 4. Alicin from Garlic; 5. Piperine from *Piper nigrum* / *Piper longum*.

**Herbal Formulation Development:**

Selection of herbal ingredients.

Different dosage forms of herbal drugs.

Evaluation of different dosage forms.

Stability studies of herbal formulations

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. Manske-The Alkaloid- Chemistry and Physiology.
2. Sim - Medicinal Plant Glycosides.
3. Sim - Medicinal Plant Alkaloids.
4. IUPAC - Chemistry of Natural Products - International symposium.
5. Zechmeister - Progress in the Chemistry of Organic Natural Products.
6. Reinhold - Liwschitz - Progress in Phytochemistry.
7. Wagner - Wolf- New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutic Activity
8. Finar- Organic Chemistry.
9. Peach - Tracey - Modern Methods of Plant Analysis.
10. Geissman - Modern Methods of Plant Analysis.
11. Garatt -The Quantitative Analysis of Drugs.
12. Backett - Stenlake - Practical Pharmaceutical Chemistry,
13. Arthur-Symposium on Phytochemistry.
14. Pridham - Swain - Biosynthetic Pathways in Higher Plants.
15. Greenbury - Metabolic Pathways.
16. Margaret - Brain - Secondary Plant Metabolism.
17. Wagner - Horhammer - Pharmacognosy and Phytochemistry
18. Harborne - Comparative Biochemistry of Flavonoids.
19. Lehninger - Principles of Biochemistry,
20. Bonner - Plant Biochemistry.
21. Harborne - Phytochemical Methods.
22. Rosenthaler -The Chemical Investigation of Plants.
23. Cheronis - Organic Functional Group Analysis.
24. Nakanishi -Natural Products Chemistry, Vol. 1 & Vol. 2
25. Screening methods in pharmacology (vol I & II)–R.A. Turner
26. Drug Discovery and Evaluation in Pharmacology assay: Vogel
27. Design and analysis of animal studies in pharmaceutical development, Chow, Shein, Ching.
28. Evaluation of Drug Activity: Pharmacometrics D.R. Laurence
29. Animal and Clinical pharmacologic Techniques in Drug Evaluation-Nodine and Siegler
30. Pharmacology and Toxicology- Kale S.R.
31. Fundamentals of experimental Pharmacology- Ghosh M.N.
32. Handbook of Experimental Pharmacology- Goyal R.K.
33. Handbook of Experimental Pharmacology- Kulkarni S.K.

**SEMESTER-IV**  
**Core – 11 Practicals**  
**HERBAL DRUG TECHNOLOGY AND DEVELOPMENT**

**Suggested Laboratory Exercise:**

1. Preparation of Ayurvedic formulation like Asava, Arista, Bhasma, Ghrita and Gutika.
2. General methods of screening of natural products for the following Biological activities.
  - a. Anti-inflammatory Activity.
  - b. Hypoglycemic.
  - c. Diuretic.
  - d. Cardiac Activity.
  - e. Antibacterial Activity.
3. Acute toxicity Study. Determination of LD50 and ED50. General methods of screening of natural products for the following Biological activities.
  - a. Antifertility Activity.
  - b. Screening of In-vitro Antioxidant Activity.
  - c. Antiulcer Activity.
  - d. Hepatoprotective Activity.
4. Determination of ascorbic acid (vitamin C) by UV spectroscopic method in various herbal formulations.
5. Determination of natural herbal products by UV Spectroscopic method.
6. Preparation of some important extracts by using preliminary Scale Extraction Plant.
7. Isolation and estimation of phytoconstituents by HPTLC.
8. Volatile oil Analysis by Gas chromatography.

**Note:** One Pharmaceutical industry visits is compulsory for the observation of various processes in industry.

**Suggested Laboratory Readings:**

1. W.C. Evans, Trease and Evans Pharmacognosy, 15th edition, 2002, W.B. Saunders & Co., London.
2. V.K. Srivastava, K.Kishore, Introduction to chromatography theory & practicals, 1991, S.Chand & Co. Ltd., Delhi.
3. A.C.Mottal , Clerk's Isolation & Identification of drugs , 1967, Pharmaceutical Press, London.
4. J.B. Harbone , Phytochemical methods of chemical analysis, 1973, Chapman & Hall, London.
5. B.N.Dhavan& R.C.Srimal, The use of Pharmacological techniques for the evaluation of natural products. CDRI, Lucknow.
6. C.K. Kokate ,Practical Pharmacognosy ,1988 ,Vallabh Prakashan, Delhi.
7. M.Williamson, David T.Okpako, J.Evans, Selection, Preparation and pharmacological evaluation of plantmaterial.
8. R.D.Chaudhury, Herbal Drug Industry, Eastern Publishers, New Delhi.
9. H. Gerhard Vogel, Drug Discovery & Evaluation, 2nd Edn.2002, Springer-Verlag Berlin Heidelberg New York.
10. Robert A.Turner, Screening Methods in Pharmacology, Elseveir's, London.
- 11 Herbal Drug Technology by S.S. Agrawal & M. Paridhavi
- 12 Modern Methods of Plant Analysis by Peach & Tracey
- 14 Quality control of herbal drugs: an approach to evaluation of botanicals by P. K. Mukherjee.

**CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**  
**Semester-IV**  
**Core –12**  
**DRUG STANDARDIZATION AND REGULATIONS**

**Unit I**

**General Introduction:**

Definition, source of herbal raw materials, identification, authentication, standardization of medicinal plants as per WHO guidelines & different herbal pharmacopoeias.

**Standardizations:**

Determination of physical and chemical constants such as extractive values, moisture content, volatile oil content, ash values, bitterness value and foreign matters applicable to the various herbal drugs.

**Unit II**

**Herbal Formulations:**

Principle, methods, single herb formulation, poly-herbal formulation & their merits and demerits. Standardization of various herbal formulations Drug Research (Laboratory-based)- Basic knowledge of the following: Drug sources: plant, animal and mineral. Methods of drug identification.

**Unit III**

Quality control and standardization aspects: Basic knowledge of Pharmacopoeial standards and parameters as set by Ayurvedic Pharmacopoeia of India.

Safety aspects: Protocols for assessing acute, sub-acute and chronic toxicity studies. Familiarization with AYUSH guidelines (Rule 170), CDCSO and OECD guidelines.

**Unit IV**

Introduction to latest Trends in Drug Discovery and Drug Development

-Brief information on the traditional drug discovery process

-Brief information on the latest trends in the Drug Discovery process through employment of rational approach techniques; anti-sense approach, use of micro and macro-arrays, cell culture based assays, use of concepts of systems biology and network physiology

-Brief introduction to the process of Drug development

**Note: Practicals based on above theory syllabus.**

## Suggested Readings:

1. W.C. Evans, Trease and Evans Pharmacognosy, 15th edition, 2002, W.B. Saunders & Co., London.
2. V.K. Srivastava, K.Kishore, Introduction to chromatography theory & practicals, 1991, S.Chand & Co. Ltd., Delhi.
3. A.C.Mottal , Clerk's Isolation & Identification of drugs , 1967, Pharmaceutical Press, London.
4. J.B. Harbone , Phytochemical methods of chemical analysis, 1973, Chapman & Hall, London.
5. B.N.Dhavan& R.C.Srimal, The use of Pharmacological techniques for the evaluation of natural products. CDRI, Lucknow.
6. C.K. Kokate ,Practical Pharmacognosy ,1988 ,Vallabh Prakashan, Delhi.
7. M.Williamson, David T.Okpako, J.Evans, Selection, Preparation and pharmacological evaluation of plant material.
8. R.D.Chaudhury, Herbal Drug Industry, Eastern Publishers, New Delhi.
9. H. Gerhard Vogel, Drug Discovery & Evaluation, 2nd Edn. 2002, Springer-Verlag Berlin Heidelberg New York.
10. Robert A.Turner, Screening Methods in Pharmacology, Elseveir's, London.
11. Dr.P.Mukherjee, Quality control herbal drugs, 2005,Business Horizons, New Delhi.
12. Forensic Pharmacy by B.S. Kuchekar, A. M. Khadatore and S. C. Jitkar, 6th Ed., Nirali Prakashan
13. Drugs and Cosmetics Laws by Krishnan Arora, Professional Book Publishers, New Delhi
14. Mittal B.M., A Textbook of Forensic Pharmacy, 9th Ed., Vallabh Prakashan
15. James Swarbrick, James C Boylon, Encyclopedia of Pharmaceutical Technology, 2nd Ed. Marcel Dekker Inc.
16. Deshpande S.W., Drugs and Cosmetic Act.1940
17. Bubuarm N.R, Whatever one should know about patent, 2nd Ed., Pharma Book Syndicate
18. Gnarino Richard A, New Drug Approval Process, 3rd Edition, Marcel Dekker Inc
19. Deshpande S.W, Drug and Magic Remedies Act 1954.
20. P. Warayan, Intellectual Property Laws, Eastern Law House.
21. Drug and Cosmetic Act 1940, Eastern Book company by Vijay Malic, 11th Ed. Patents for Medicine, by N. B. Zareri, Indian Drug Manufacturers Association (IDMA)
22. Pharmacy Law and Ethics by Dale and Appelbes, The Pharmaceutical Press, Joy Winfield.
23. Guidelines of various countries like MCA, TGA, ICH.
24. GLP regulation by Alen Hirsch Vol 38 Marcel Decker series.
25. GMP for pharmaceuticals forth edition by S. Willing, J. Stocker Marcel Decker series 1997.

**SEMESTER-IV**  
**Core – 12 Practicals**  
**DRUG STANDARDIZATION AND REGULATION**

**Suggested Laboratory Exercise:**

1. Qualitative and Quantitative Microscopic Examination: Microscopic evaluation of powder drugs and their mixtures with adulterants.
2. Exercises based on standardization and quality control of plant drugs.
3. Qualitative and Quantitative Estimation of Phytoconstituents:
4. Determination of phytoconstituents in crude drugs and commercial herbal formulations.
5. Pharmacopoeial evaluation of natural products.
6. Determination of ash values, extractive values, swelling index and foaming index of crude drugs as per WHO Guidelines.
7. Preparation of detailed monograph of at least one plant drug covering Pharmacognosy and Phytochemical investigation with its use in traditional system of medicine.
8. Experiment on raw material standardization, purification of extracts with chromatographic techniques.
9. Isolation of piperine from pepper.
10. Isolation of Hesperidine from orange peel.
11. Isolation & TLC of reserpine from Rauwolfia root.
12. Isolation & TLC of Menthol from mentha oil.
13. Preparation and Evaluation of Herbal formulations.

**Suggested Laboratory Readings:**

1. W.C. Evans, Trease and Evans Pharmacognosy, 15th edition, 2002, W.B. Saunders & Co., London.
2. V.K. Srivastava, K.Kishore, Introduction to chromatography theory & practicals, 1991, S.Chand & Co. Ltd., Delhi.
3. A.C.Mottal , Clerk's Isolation & Identification of drugs , 1967, Pharmaceutical Press, London.
4. J.B. Harbone , Phytochemical methods of chemical analysis, 1973, Chapman & Hall, London.
5. B.N.Dhavan& R.C.Srimal, The use of Pharmacological techniques for the evaluation of natural products. CDRI, Lucknow.
6. C.K. Kokate ,Practical Pharmacognosy ,1988 ,Vallabh Prakashan, Delhi.
7. M.Williamson, David T.Okpako, J.Evans, Selection, Preparation and pharmacological evaluation of plant material.
8. R.D.Chaudhury, Herbal Drug Industry, Eastern Publishers, New Delhi.
9. H. Gerhard Vogel, Drug Discovery & Evaluation, 2nd Edn. 2002, Springer-Verlag Berlin Heidelberg New York.
10. Robert A.Turner, Screening Methods in Pharmacology, Elseveir's, London.
11. Dr.P.Mukherjee, Quality control herbal drugs, 2005,Business Horizons, New Delhi.



**CBCS Pattern Syllabus for M. Sc. (Medicinal Plants)**  
**Semester-IV**  
**Core Elective 2**  
**NATURAL PLANT PRODUCTS & PHYTOCHEMISTRY - II**

**UNIT-I:**

**Natural Pigments:** Introduction, Definition, Classification, Nomenclature, Sources (*Lycopersicum esculentum*, *Bixa orlenata*, *Indigofera tinctoria*, *Quercus*), importance, Structure, chemistry, structural elucidation of Carotene, Lycopene, Bixin, Chlorophyll, Quercetin and Indigotine.

**Purines:** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Caffeine.

**UNIT-II:**

**Amino acids:** Introduction, Definition, Classification, Nomenclature, Source, importance, Preparation and Properties of amino acids.

**Peptides:** Introduction, Definition, Classification, Synthesis, determination of structure of Peptides.

**Proteins:** Introduction, Definition, Classification, properties, Sources (*Ananas comosus*, *Carica papaya*, *Hordeum disticho*) structure of Protein, Chemistry of Oxytocin, Thyroxin, Insulin.

**UNIT-III:**

**Alkaloids:** Introduction, Definition, Classification, Nomenclature, Sources (*Claviceps purpurea*, *Rauwolfia serpentina*, *Vinca rosea*, *Papaver somniferum*, *Datura metle*, *Adhatoda vasica*, *Withania somniferum*, *Atropa beladonna*), importance, Structure, chemistry, structural elucidation of quinine, morphine and atropine.

**Lipids (Fixed oils, Fats & Waxes)** Introduction, Definition, Classification, Nomenclature, Sources (*Arachis hypogea*, *Ricinus communis*, *Linum usitatissimum*, *Sesamum indicum*, *Carthamus tinctorius*, *Helianthus annus*, *Oryza sativa*, *Brassica campestris*, *Pongamia pinnata*, *Madhuca indica*)

**Volatile Oils** - Introduction, Definition, Classification, Nomenclature, Sources (*Cinnamomum camphora*, *Eucalyptus globules*, *Cymbopogon citratus*, *Mentha piperata*, *Elettaria cardamom*, *Citrus limon*, *Ocimum sanctum*, *Lavendula officinalis*, *Santalum album*, *Vetiveria zizanoides*)

**UNIT- IV**

**Drugs containing Tannins**-Introduction, Definition, Classification, Nomenclature, Sources (*Terminalia chebula*, *Terminalia bellerica*, *Terminalia arjuna*, *Acacia catechu*)

**Drugs containing Resins** Introduction, Definition, Classification, Nomenclature, Sources (*Zingiber officinale*, *Capsicum annum*, *Curcuma longa*, *Canabis sativa*, *Commifera mukul*)

**Natural products as markers for new drug discovery:**

The Role of natural products as potential new drug discovery. The Role of natural products chemistry in drug discovery. Selection and optimization of lead compounds for further development with suitable examples.

## Suggested Readings:

1. Nakanishi -Natural Products Chemistry, Vol. 1 & Vol. 2
2. Bonner - Plant Biochemistry.
3. Harborne - Comparative Biochemistry of Flavonoids.
4. Wagner - Wolf- New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutic Activity
5. Sim - Medicinal Plant Glycosides.
6. Sim - Medicinal Plant Alkaloids.
7. Manske- The Alkaloid- Chemistry and Physiology
8. IUPAC - Chemistry of Natural Products - International symposium.
9. Zechmeister - Progress in the Chemistry of Organic Natural Products.
10. Chatwal G. Organic Chemistry of Natural Products, Vol-I and II, 7th Reprint 1998, Himalaya Publishing House, Mumbai
11. Indian Herbal Pharmacopoeia, Volume I and II-1999, a Joint publication of IDMA and RRL Jammu Tawi.
12. Trease and Evans-Pharmacognosy, 14th Edition, 1997, W. B. Saunders Company, Singapore
13. Wallis, T. E. Textbook of Pharmacognosy, 5th Edition-1997, CBS Publisher
14. Tyler, Brady, Roberts-Pharmacognosy, 8th Edition-1981, K. M. Varghese Company, Mumbai
15. Sim. S. K. Medicinal Plant Alkaoids and Glycosides, 2nd Edition-1966 University of Toronto Press, Toronto.
16. Cultivation and Utilization of Medicinal Plants, Edited by Atal and Kapur, 1982, RRL Jammu Tawi
17. Cultivation and Utilization of Aromatic Plants, Edited by Atal and Kaur, 1982, RRL Jammu Tawi.
18. Harbone J. B. Phytochemical Methods, 3rd Edition-1998 Champan and Hall London
19. Natural products chemistry – Nakanishi Golo
20. Natural products – A Laboratory guide by Raphel Ikhan.
21. Organic Chemistry by I.L. Finar vol.ii
22. Chemistry of Natural Products by K.W. Bentley
23. Pharmacognosy by Trease and Evans, ELBS.
24. Practical Evaluation of Phytopharmaceuticals by K.r. Brain, T.D. Turner.
25. The Chemistry of Natural Products, Edited by R.H. Thomson, Springer International Edn. 1994.
26. Natural Products from Plants, 1st edition, by Peter B. Kaufman, CRC Press, New York, 1998.
27. Natural products: A lab guide by Raphael Ikan , 2nd Edition, Academic Press1991.
28. The review of Natural products – Ara Dermarderosia.
29. Modern methods of plant analysis –High performance Liquid chromatography in plant science –H.F.Linskens and J.F.Jacksons
30. Encyclopedia of Medicinal Flora, Dr. Arun K. Zingare 978-81-921419-1-6, Satyam , 2012
31. Medicinal and Poisonous Plants Dr. Arun K. Zingare978-93-82664-09-3, Satyam , 2014
32. Handbook of Medicinal Plants Dr. Arun K. Zingare 978-93-82664-03-1, Satyam , 2014

**SEMESTER-IV**  
**Core Elective 2 - Practicals**  
**NATURAL PLANT PRODUCTS & PHYTOCHEMISTRY – II**

**Suggested Laboratory Exercise**

1. Chemical tests for
  - a) Volatile Oils.
  - b) Enzymes and proteins.
  - c) Alkaloids.
  - d) Resins
  - e) Tannins
- f) Lipids (Oils) Fats & Waxes.
2. Study of Medicinal Plants mentioned in theory syllabus, at least TWO from Lipids, Fats, Waxes, Volatile Oils, Enzymes, Proteins, Alkaloids, Resins and Tannins.
3. Methods of Cultivation, with respect to the Medicinal Plants mentioned in theory syllabus - Sexual method (Seed propagation) & Asexual method (Vegetative Propagation)
4. Study of Soil- Physical & Chemical characteristics, with respect to the Medicinal Plants mentioned in theory syllabus
5. Study of Pests & Pests control, with respect to the Medicinal Plants mentioned in theory syllabus.
6. Isolation and characterization of Natural plant products.
7. Phytochemical screening of Natural plant products.

**Suggested Laboratory Readings:**

1. Mieschel Verral (2011) Downstream processing of Natural Products. A Practical Handbook
2. Cutler, Stephen J.; Cutler, Horace G. (2000). *Biologically active natural products: pharmaceuticals*. CRC Press.
3. Praveen Kumar (2009) Natural Products: Practical Manual eds. Pharma Books Syndicate.
4. Newman DJ, Cragg GM (2007) Natural products as sources of new drugs over the last 25 years. *Journal of Natural Products* 70, 461-477.
5. Siddiqui A. A. And Seemi Siddiqui (2012) Natural Products Chemistry for Sci and Pharmacy Course. Eds. CBS Publisher.
6. Dossey, Aaron (2010). "Insects and their chemical weaponry: New potential for drug discovery". *Natural Product Reports* 27: 1737-1757.
7. Dan Bensky, Steven Clavey, Erich Stoger, and Andrew Gamble (2004) *Chinese Herbal Medicine: Materia Medica, Third Edition*
8. Hernan Garcia, Antonio Sierra, Hilberto Balam, and Jeff Connant (1999) *Wind in the Blood: Mayan Healing & Chinese Medicine*.
9. "The American Society of Pharmacognosy – Story of Taxol".
10. El-Shemy HA, Aboul-Enein AM, Aboul-Enein KM, Fujita K (2007) *Willow Leaves' Extracts Contain Anti-Tumor Agents Effective against Three Cell Types*.: PLoS ONE.;2:e178
11. G Brahmachari et Al. (2010), Natural Products in Drug Discovery: Impacts and Opportunities—An Assessment.,
12. AJ Giannini, AE Slaby. (1989) *Drugs of Abuse*. Oradell, NJ, Medical Economics Books.,
13. Dewick, P. M. (2009). *Medicinal Natural Products: A Biosynthetic Approach*. United Kingdom: John Wiley & Sons. 335-336.
14. Barbier P, Schneider F (1987). "Syntheses of tetrahydrolipstatin and absolute configuration of tetrahydrolipstatin and lipstatin". *Helvetica Chimica Acta* 70 (1): 196-202.
15. Goodman, Jordan; Walsh, Vivien (2001). *The Story of Taxol: Nature and Politics in the Pursuit of an Anti-Cancer Drug*. Cambridge University Press. p. 51.
16. Kinghorn, A. D., Chin, Y.-W., & Swanson, S. M. (2009). "Discovery of Natural Product Anticancer Agents from Biodiverse". *Curr Opin Drug Discov Devel*: 189-196.

**SEMESTER-IV**  
**Core Elective 2 -**  
**Forensic and Industrial Botany-II**

**Credit 1- Entrepreneurship and Management**

**A. Entrepreneurship**

1. Entrepreneur: Concept, characteristics of entrepreneur, types and functions of entrepreneur, difference between entrepreneur and a manager.
2. Entrepreneurship Development Programmes (EDPs) - Need, objectives, course contents and curriculum, phases and evaluation of EDPs, Project Identification and Selection (PIS) -Meaning of project and report, project identification, project selection, contents of project reports, preparation of project report.
3. Institutional Finance to Entrepreneurs- Commercial banks, other financial institutions- IDBI, IFSI, SIDBI, and EXIM Bank Institutional Support to Entrepreneurs -Need of institutional support, institutional support to small entrepreneurs- NSIC, SIDCO, SSIDC, Industrial Estates, NABARD

**B. Management**

1. The Business – Its Nature and Scope Meaning, characteristics, objectives and scope of business, difference between business and profession, interrelationship between industry, commerce and trade
2. Fundamentals of Management : Meaning, characteristics, difference between management and administration, management process, working capital management, inventory management, human resource management, production and operation management, marketing management. Accounting-need, meaning, objectives, journal, ledger, trial balance, final accounts- profits and loss accounts,

**Credit:II- Herbal Technology**

1. Introduction, concepts and prospects. 2. Phyto-technology- value addition to biodiversity through chemo prospection. 3. Medicinal mushrooms for healthy life. 4. Natural dyes for cotton and silk industry –Tecomella leaves, Katha and Ravenchi wood, Seeds of Bixa, Babul flowers. 5. Medicinal herbs for dying hair and in cosmetics.

**Credit III - Plant Tissue culture**

1. Laboratory design, maintenance of plant tissue culture laboratory, sterilization practices in plant tissue culture laboratory.
2. Case studies of micro propagation of banana, sugarcane, b. Preparation of explants. c. Surface sterilization. d. Initiation of cultures.e. Subculture.f. In-vitro rooting/ In-vivo rooting. g. Acclimatization of tissue cultured raised plants. h. Market potential (National, International)
3. Transporting of ex-agar plantlet, rooting of ex-agar plantlet
4. Economics of micropropagation of banana, sugarcane, Lilium, orchids and Gerbera

## **Credit IV - Post-Harvest Technology of Fruits**

1. General account of tropical and subtropical fruits . a) Introduction. b) World fruit production and contribution to gross domestic product (GDP). c) Global consumption of tropical and subtropical fruits d) International trade in tropical and subtropical fruit
2. Postharvest biology of tropical and subtropical fruits. a) Introduction. b) Diversity in fruit characteristics. c) Maturation and ripening. d) Quality attributes. e) Environmental factors affecting deterioration. f) Biological factors affecting deterioration. g) Pathological disorders and insect infestation. h) Biotechnological approaches for improving quality and postharvest life
3. Preservation and processing of fruits a) Principles of conventional methods of preservation b) Fruit preparation for preservation purposes c) Refrigeration and freezing d) Drying e) Manufacturing and canning of fruit beverages and purees f) Manufacturing of jams and jellies

### **Reference Books**

1. Advances in Fruit Processing Technologies, Sueli Rodrigues, Fabiano Andre Narciso Fernandes, CRC Press.
2. Floriculture in India, Randhawa and Mukhopaddhay
3. Forest and Forestry, K P. Sagreiya, National Book Trust
4. Forest Management in India, Vasant Desai, Himalaya Publications
5. Gardening in India, Bose and Mukherjee, Oxford
6. Hand book of horticulture, ICAR, New Delhi
7. Handbook of Fruits and Fruit Processing, Y.H. Hui, John Wiley & Sons.
8. Introductory ornamental horticulture, Arora, Kalyani publishers
9. Postharvest biology and technology of tropical and subtropical fruits: Volume 1: Fundamental issues, Edited by E Yahia, Universidad Autónoma de Querétaro, Mexico, Woodhead Publishing Series in Food Science, Technology and Nutrition No. 206
10. Post-harvest handling of tropical fruit, B R Champ, E Highley & G I Johnson (eds), Australian Centre for International Agricultural Research Page | 62
11. Post-harvest technology of fruits and vegetables: Handling, processing, fermentation and waste management, L R Verma and V K Joshi, Indus Publishing Company.
12. Processing of Fruits and Vegetables for Value Addition, Vijay Sethi, B.C. Dekka, Vijay Sethi, Shruti Sethi, Shruti Sethi, Indus Publishing.
13. Quality Control in Fruit and Vegetable Processing, Issue 39, Food & Agriculture Org.
14. Small Scale Food Processing: A Guide to Appropriate Equipment, Peter Fellows, Ann Hampton, Intermediate Technology Publications.

## **CBCS Syllabus for M. Sc. (Medicinal Plants)**

### **Semester-IV**

#### **Foundation Course - 2**

#### **Ethnobotany**

##### **UNIT I**

Ethnobotany, its scope, interdisciplinary approaches.

Ethnic groups of India : major and minor tribes, life styles of ethnic tribes, conservation practices of biodiversity, taboos and totems.

World centers of Ethnobotany with special reference to India.

##### **UNIT II**

Role of Ethnobotany in national priorities, health care and development of cottage industries in India.

History and principles of ayurveda, Homeopathy, Allopathy, Unani and Siddha system of medicines.

A general idea of active principles of plants and plant parts their extraction and preparation of medicines in different systems.

##### **UNIT III**

Scope and uses of essential oil from plants as perfumes, cosmetics and as flavoring agents.

Preparation of perfumes from aromatic plants with special reference to the following Lemon grass, Palm-rosa, Mint, Lavender, Rose, Eucalyptus and Vetiver.

##### **UNIT IV**

Plants used in medicine with special reference to following.

*Adhatoda vasica, Asparagus racemosus, Argemone mexicana, Boerhaavia diffusa, Hollarhina antidysenterica, Tinospora cordifolia Terminalia arjuna, Terminalia bellerica, Terminalia chebula, Pterocarpus marsupium, Eclipta prostrata, Withania sominifera, Rauwolfia serpentina,*

Plants used in scarcity, emergency and as supplementary foods by tribals of India.

## Suggested Readings:

1. A-Z in Ethnobotany : Dictionary of Words and Whos Who in Indian Ethnobotany : S.K. Jain and Ashok K. Jain, Deep Publications, 2013, 178 p, col. photographs, ISBN : 9789380702049,
2. Advances in Horticulture : Volume 11: Medicinal & Aromatic Plants : Edited by K.L. Chadha, Malhotra Publishing House, 2006, Reprint, xl, 935 p, ISBN : 8185048290,
3. An Introduction to Ethnobotany : Definitions Methods New Concepts and Approaches : edited by S.K. Jain and Ashok K. Jain, Deep Publications, 2013, viii, 250 p, ISBN : 9789380702056,
4. An Introduction to Herbal Medicine in Ethnobotany : Rahat Ali, Vista International Pub House, 2012, 293 p, tables., ISBN : 9789380239828,
5. Ethnic Plants of India : Used in Cancer Cure -- A Compendium : S.K. Sood, Shipra Parmar and T.N. Lakhanpal, Bishen Singh Mahendra Pal Singh, 2005, vii, 314 p, ISBN : 8121104726,
6. Ethnic Tribes and Medicinal Plants : Edited by Pravin Chandra Trivedi, Pointer Pub, 2010, xii, 264 p, ISBN : 9788171326235,
7. Ethno Medicinal Plants of Manipur North-East India : Thoubal District : Mohd. Habibullah Khan and P.S. Yadava, Bishen Singh Mahendra Pal Singh, 2014, iii, 295 p, ISBN : 9788121108577,
8. Ethno Medico Botany of Arunachal Pradesh Nishi and Apatani Tribes : M.S. Rawat and S. Chowdhury, BSMPS, 1998, 206 p, col. photographs, maps, ISBN : 8121101530,
9. Ethno-Medicinal Plants of Mizoram : H. Lalramnghinglova, Bishen Singh Mahendra Pal Singh, 2003, xix, 333 p, tables, figs, photographs, boxes, ISBN : 8121102111,
10. Ethno-Medicine in India Vol. II: A Selective Bibliography : Kamal Kant Misra, Mohammad Rehan and Ravindra K. Gupta, Gyan Publishing House, 2013, 359 p, ISBN : 9788121211895,
11. Ethnobotanical Studies in India : Sanjeev Kumar, Deep Publications, 2014, vi, 353 p, figs, tables, col. & b/w plates, ISBN : 9789380702063,
12. Ethnobotanical Studies on Trees, Shrubs and Climbers of Himalaya : S.K. Sood, Sanjay K. Sharma, Neelam Kumar and Harish Kumar, Satish Serial Pub, 2009, xii, 546 p, figs, ISBN : 8189304674,
13. Ethnobotanical Study of a Kumauni Festival "Harella" : Jagdish Chandra, Sudhir Chandra, Kiran Bargali and Y.P.S. Pangtey, Bishen Singh Mahendra Pal Singh, 2005, iv, 68 p, tables, ISBN : 8121104769,
14. Ethnobotanical Wisdom and Microbial Studies on Medicinal Plants : Edited by D.R. Khanna, Ashutosh Gautam, R. Bhutiani and Gagan Matta, Daya Publishing, 2011, xii, 390 p, ISBN : 9788170357100,
15. Ethnobotanical Wisdom of Khasis (Hynniew Treps) of Meghalaya : Ayesha Ashraf Ahmed and S.K. Borthakur, Bishen Singh Mahendra Pal Singh, 2005, l, 306 p, photos, ISBN : 8121104343,
16. Ethnobotanical Wisdom of the Tribals in the Palni Hills : S M John Kennedy S J, Daya, 2008, xviii, 254 p, plates, figs, tables, ISBN : 8170355540,
17. Ethnobotany : Himalayan Region : S.K. Sood, Anjna Kharwal, T.N. Lakhanpal and A.K. Bhatnagar , I.K. International, 2014 , 640 p, ISBN : 9789382332374,
18. Ethnobotany and Conservation of Plant Diversity in Nepal : Status, Bibliography and Agenda for Sustainable Management : Ananda Raj Joshi and Kunjani Joshi, Rub Rick, 2005, pbk, viii, 159 p, figs, ISBN : 999463478X,
19. Ethnobotany and Medicinal Plants of India and Nepal (2 Vols-Set) : V. Singh and A.P. Jain, Scientific, 2003, Reprint, 1006 p, 2 Vols, colour and BW figs, tables, ISBN : 8172333471,
20. Ethnobotany and Medicinal Plants of India and Nepal, Vol. III : Edited by V. Singh, Scientific Pub, 2009, viii, 338 p, figs, tables, 12 plates, maps, ISBN : 8172336035, Ethnobotany of Dadra, Nagar Haveli and Daman (Union Territories) : P P Sharma & N P Singh, Botanical Survey of India, 2001, vi, 322 p, tables, figs., maps, colour plates,
21. Ethnobotany of Jalgaon District, Maharashtra : Shubhangi Pawar and D A Patil, Daya, 2008, xii, 568 p, ISBN : 8170355151,
22. Ethnobotany of Mysore and Coorg, Karnataka State : Rajendra D Kshirsagar and N P Singh, Bishen Singh Mahendra Pal Singh Pub, 2007, xxxii, 300 p, tables, photos, ISBN : 8121105781,
23. Ethnobotany of Nasik District, Maharashtra : M V Patil and D A Patil, Daya, 2006, x, 420 p, plates, ISBN : 8170354382,
24. Ethnobotany of Nepal : Keshab R. Rajbhandari, EthnoBotanical Sciences/anical Soc of Nepal, 2001, xiv, 189 p, ISBN : 9993334804,
25. Ethnobotany of Religious Practices in Kumaun (Havan) : Balwant Kumar; Sudhir Chandra; Kiran Bargali and Y P S Pangtey, Bishen Singh Mahendra Pal Singh, 2007, vi, 138 p, figs, ISBN : 8121105811,
26. Ethnobotany of Rewalsar Himalaya : S.K. Sood and Smriti Thakur, Deep and Deep, 2004, vi, 388 p, ills, ISBN : 8185622108,
27. Ethnobotany of Rice Weeds in South Asia : Edited by R.A. Raju, Today Tomorrow's, 1999, Aspect of Plant Science Vol. 16, 235 p, figs, ISBN : 8170194326,

**Semester-IV**  
**Foundation Course - 2Core subjects centric**  
**CULTIVATION AND UTILIZATION OF AROMATIC PLANTS**

Credit I: a. Aromatic plants: Introduction to aromatic plants with biological source,

- b. Aromatic plants as important sources of essence
- c. Utilization Status of Aromatic Plants: National and international level
- d. Patenting and IPR

.Credit II: Cultivation of Aromatic Plants: Cultivation aromatic plants under Agroforestry systems, Soil and Climate, Field preparation, Propagation : (a) Raising of Nursery (b) Planting , Irrigation, Fertilizer Application, Intercultural, Harvesting and Yield

Studies on botanical features and Cultivation methods of important species of

Mentha, Coriander, Ocimum, Geranium oil, Lemon grass, Citronella, Cumin

Credit III: Chemical constituents of Mentha, Coriander, Clove, Ocimum, Geranium oil, Lemon Grass, Citronella, Cumin, Eucalyptus, Cardamom.

Credit IV: Uses of aromatic plants in

1. Perfume industries
2. Cosmetic industries
3. Folk medicine
4. Ayurvedic Properties
5. Food



## References

1. Chadha, K.L. 2001. Hand Book of Horticulture. ICAR Publication, Krishi AnusandhanBhavan, Pusa, New Delhi.
2. Farooqi, A.A. and B.S. Sreeramu. 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd.3-5-819, Hyderguda, Hyderabad - 29.
3. H. Panda.Aromatic Plants Cultivation, Processing and Uses, Asia Pacific Business Press Inc.
4. Handa, S.S. and M.K. Kaul. 1987. Cultivation and Utilization of Medicinal Plants. RRL, Jammu.
5. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to spices, plantation crops, medicinal and aromatic plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. 1982. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Planters Chronicle. Monthly Publication. UPASI, Coonoor.
8. Shanmugavelu, K.G., N. Kumar and K.V. Peter. 2002. Production Technology of Spices and Plantation Crops. Agrobios Publications, Bikenar, Rajasthan.

### **CBCS PATTERN SYLLABUS M. Sc. (MEDICINAL PLANTS)**

#### **SEMESTER – IV**

#### **Practical –VII**

**Time: 6 hours.**

**Full Marks: 100**

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| <b>Q. 1</b> Onequestion from Sr. No 1-3 of Core-11           | 10 |
| <b>Q. 2</b> Onequestion from Sr. No 4-8 of Core-11           | 10 |
| <b>Q. 3</b> Onequestion from Sr. No 1-6 of Core-12           | 10 |
| <b>Q. 4</b> Onequestion from Sr. No 7-13 of Core-12          | 10 |
| <b>Q. 5</b> One question from Sr. No 1-3 of Corel elective-2 | 10 |
| <b>Q. 6</b> One question from Sr. No 4-7 of Corel elective-2 | 10 |
| <b>Q. 7</b> Spotting (1 spots from each core)                | 15 |
| <b>Q. 8</b> Viva-voce  | 15 |
| <b>Q. 9</b> Practical Record                                 | 10 |

**CBCS PATTERN SYLLABUS :M. Sc. (MEDICINAL PLANTS)**

**SEMESTER- IV**

**PROJECT**

**Full Marks: 100**

