## I YEAR  I SEMESTER

<table>
<thead>
<tr>
<th>Subject</th>
<th>Hours/Week</th>
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<tbody>
<tr>
<td>Modern Pharmaceutical Analytical Techniques</td>
<td>4</td>
</tr>
<tr>
<td>Biostatistics, Intellectual property rights and regulatory affairs</td>
<td>4</td>
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<tr>
<td>Advanced Pharmacognosy and phytochemistry- I</td>
<td>4</td>
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<tr>
<td>Industrial Pharmacognosy - I</td>
<td>4</td>
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<tr>
<td>Modern Pharmaceutical Analysis-Practical</td>
<td>6</td>
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<tr>
<td>Advanced Pharmacognosy and phytochemistry- I</td>
<td>6</td>
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<tr>
<td>Practical</td>
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<tr>
<td>Mini-project- I</td>
<td>3</td>
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## I YEAR  II SEMESTER

<table>
<thead>
<tr>
<th>Subject</th>
<th>Hours/Week</th>
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<tbody>
<tr>
<td>Advanced Pharmacognosy and photochemistry- II</td>
<td>4</td>
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<tr>
<td>Industrial Pharmacognosy - II</td>
<td>4</td>
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<tr>
<td>Medicinal plant biotechnology</td>
<td>4</td>
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<tr>
<td>Herbal drug development and standardization</td>
<td>4</td>
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<tr>
<td>Industrial Pharmacognosy- Practical</td>
<td>6</td>
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<tr>
<td>Medicinal plant biotechnology- Practical</td>
<td>6</td>
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<tr>
<td>Mini-project- II</td>
<td>3</td>
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## II YEAR  (III & IV Semesters)

<table>
<thead>
<tr>
<th>SUBJECTS</th>
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<tbody>
<tr>
<td>Seminar</td>
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<tr>
<td>Project work</td>
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</tbody>
</table>
1. **UV-VIS SPECTROSCOPY**: Brief review of electromagnetic spectrum, UV-Visible range, energy, wavelength and color relationships. Interaction of electromagnetic radiation (UV-visible) with matter and its effects. Chromophores and their interactions with E.M.R. Absorption spectra of organic compounds and complexes illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs. Shifts and their interpretation (including solvent effects). Empirical correlation of structure with absorption phenomena (Woodward’s rules etc) Quantitative estimations, Modern instrumentation.


b) **OPTICAL ROTATORY DISPERSION**: Fundamental principles of ORD, cotton effect curves, their characteristics and interpretation. Octant rule and its application with examples. Circular dichroism and its relation to ORD.

3. **NMR SPECTROSCOPY**: Fundamental principles of NMR (Magnetic properties of nuclei, applied field and precession; absorption and transition; frequency). Chemical shifts concept: Isotopic nuclei, Reference standards: Proton magnetic spectra, their characteristics, presentation terms used in describing spectra and their interpretation (Signal No., Position, Intensity). Brief outline of instrumental arrangements and some practical details. Signal multiplicity phenomenon in high resolution PMR. Spin-spin coupling. Application of Signal split and coupling constant data to interpretation of spectra. De-coupling and shift reagent methods. Brief outline of principles of FT-NMR with reference to 13CNMR. Spin-spin and spin-lattice relaxation phenomenon. Free induction decay (FID) proton noise de-coupling signal, average time domain and frequency domain signals nuclear overhauser enhancement 13CNMR spectra, their presentation; characteristics, interpretation, examples and applications. Brief indication of application of magnetic resonance spectral data of other nuclei by modern NMR instruments. Introduction to 2-D NMR techniques.

4. **MASS SPECTROSCOPY**: Basic principles and brief outline of instrumentation. Ion formation and types; molecular ion, Meta stable ions, fragmentation processes. Fragmentation patterns and fragmentation characteristics in relation to parent structure and functional groups. Relative abundances of isotopes and their contribution to characteristic peaks. Mass spectrum, its characteristics, presentation and interpretation. Chemical ionization Mass Spectroscopy. GC-MS, other recent advances in MS. Fast atom bombardment mass spectrometry. LC-MS, LC MS-MS.
5. **CHROMATOGRAPHIC TECHNIQUES:** Classification of chromatographic methods based on mechanism of separation. Column chromatography, column materials, merits and demerits. Paper chromatography; techniques and applications. Thin Layer Chromatography, comparison to paper chromatography and HPLC, adsorbents for TLC. Preparation techniques, mobile phase selection, reversed phase TLC, High performance TLC detection methods, quantitative methods in TLC. Programmed multiple development techniques.

6. **GAS CHROMATOGRAPHY:** Instrumentation packed and open tubular column, Column efficiency parameters, the Vandeeemer equation, Resolution, liquid stationary phase, derivatization methods of GC including acylation, perfloro acylation, alkylation and esterification. Detectors: FID, ECD, TCD, NPDA. Critical comparison of sensitivity, selectivity and field of applications of these detectors. Examples of GC applications in pharmaceutical analysis.

7. **LIQUID CHROMATOGRAPHY:** Comparison of GC and HPLC, instrumentation in HPLC, analytical, preparative and microbore columns, normal and reversed phase packing materials, reverse phase HPLC, Column selection, Mobile phase selection, Efficiency parameters, resolution, detectors in HPLC refractive index, photometric and electrochemical. Comparison of sensitivity, selectivity and field of applications of these detectors. HPTLC-instrumentation and applications.

8. **ELECTROPHORESIS:** Moving boundary electrophoresis, Zone electrophoresis, Iontophoresis, PAGE, Isotacophoresis and applications in pharmacy.

**X-ray Diffraction methods:** introduction, generation of X-rays, elementary crystallography, Miller Indices, X-rays diffraction, Bragg’s law, X-ray powder diffraction, X-ray powder diffractometer, obtaining and interpretation of X-ray powder diffraction data. Principle, instrumentation and application of the following: Differential Scanning Colorimetry (DSC), DTA &TGA in analysis of pharmaceuticals.

**REFERENCES:**
3. Instrumental methods of analysis by Willard, Merit, Dean, Settle.
5. Spectrometric identification of organic compounds by silverstein, Webster.
6. Spectroscopy by B.K.Sharma
7. Fundamentals of analytical chemistry by Skoog
8. Instrumental methods of analysis by Skoog.
10. Organic spectroscopy by William kemp
I. BIO-STATISTICS

1. **An introduction** to statistics and biostatistics - collection and organization of data, graphical, pictorial presentation of data, measures of central tendency and dispersion, sampling techniques, sample size, Coefficient of variation, mean error, relative error, precision and accuracy.


3. **Design of Experiments**: Principles of randomization, replication and local control; CRD, RBD, LSD – their applications and analysis of data; Factorial Experiments – Principles and applications; Probit analysis: Dose – effect relationships, calculation of LD$_{50}$, ED$_{50}$.

4. **Statistical quality control**: Meaning and uses, Construction of $\bar{X}$, R, P, np and $\bar{C}$ charts.

II. INTELLECTUAL PROPERTY RIGHTS & REGULATORY AFFAIRS


   b). Documentation: Types related to pharmaceutical industry, protocols, harmonizing formulations, development for global filings, ANDA, NDA, CTD, dealing with post – approval changes – SUPAC, handling and maintenance including electronic documentation.

REFERENCES:

2. Irfan Alikhan ‘Fundamentals of Biostatistics’ Ukaaz Publications
5. Applied statistics by S.C.Gupta & V.K.Kapoor
8. Protection of Industrial Property rights, P. Das & Gokul Das
9. Law and Drugs, Law Publications. S.N. Katju
10. Original Laws Published By Govt. of India
11. Laws of drugs in India, Hussain
13. fda.org, wipo.int, patentlawlinks.com, hc-sc.gc.ca, ich.org, cder.org
ADVANCED PHARMOCOGNOSY AND PHYTOCHEMISTRY-I

1. Plant drug cultivation: General aspects involved in the cultivation of medicinal plants. Conservation of medicinal plants: *ex-situ* and *in-situ* cultivation; Biodiversity loss; WTO and TRIPS agreement.

2. Factors involved in production of crude drug:
   i. Exogenous
   ii. Edaphic factors
   iii. Mineral supplements
   iv. Nutrients and growth regulators and inhibitors

3. Pest and weed control: study of pesticides and weedicides with special importance to natural pesticides and weedicides. Disease management of medicinal and aromatic plants.

4. Detailed Phytochemical study of following classes of phyto constituents including important drugs -I.
   i. Plant lipids
   ii. Terpenes and terpenoids
   iii. Resins and related compounds
   iv. Plant phenols

5. Detailed Phytochemical study of following classes of phyto constituents including important drugs -II
   i. Alkaloids
   ii. Glycosides
   iii. Steroids
   iv. Flavanoids

6. Study of information retrieval methods of natural plants and herbal data bases. Screening and review of literature for the following activities:
   i. Hepatoprotectives
   ii. Anti-fertility agents
   iii. Anti-microbial and anti-viral
   iv. Anti-cancer agents
   v. Hypolipidemics
7. Study of information retrieval methods of natural plants and herbal data bases. Screening and review of literature for the following activities:
   i. Anti-obesity agents
   ii. Anti-diabetics
   iii. Anti-allergic
   iv. Adoptogenics
   v. Immuno-modulators
   vi. Cardiovascular agents

8. Chemotaxonomy:
   a. Definition, significance, types.
   b. Chemotaxonomic significance of flavanoids and alkaloids.

REFERENCES:

1. An introduction to pharmacognosy and phyto chemistry , Durai Swamy and Dr.K.N.Jayaveera, S.Chand
9. Pharmacognosy-Tyler, Brady, Robbers
10. Modern Methods of Plant Analysis- Peach & M.V. Tracey, Vol. I & II
13. Marine Natural Products-Vol. I to IV.

2. Phytochemical screening of natural compounds

3. Isolation and characterization of the following phytopharmaceuticals.
   a. Adhatoda vasica-Vasicine
   b. Andrographis paniculata-Andrographolides
   c. Bacopa monnieri-Bacosides
   d. Curcuma longa-Curcumin
   e. Gymnema sylvestre-Gymnemic acid
   f. Phyllanthus amarus-Phyllanthin
   g. Pipernigrum/longum-Peperine
   h. Tinospora cordifolia-Cordifolioside
   i. Tribulus terrestris-Total saponins
   j. Withania somnifera-Withanolides
   k. Zingiber officinale-gingerol
   l. Commiphora mukul-guggulosterone

4. Commerce and Quality control of drugs:
   a. Indian & international trades in medicinal and aromatic plants.
   b. Factors affecting herb quality

5. Quality control methods for medicinal plant materials:
   Development of standardization parameters according to WHO guidelines for assessment of crude drugs:
   a. Evaluation of identity, purity and quality of crude drugs.
   b. Determination of pesticide residue.
   c. Determination of Arsenic and heavy metals.
   d. Determination of microorganisms.
   e. Determination of aflotoxins


8. Pilot scale-up techniques: Production of standardized extracts by suitable techniques with special reference to some folklore medicinal plants.

REFERENCES:

1. Organic Chemistry by I.L. Finar vol.ii
2. Chemistry of Natural Products by K.W. Bentley
4. Pharmacognosy by Trease and Evans, ELBS.
5. Clark’s isolation and Identification of drugs by A.C. Mottal.
6. Introduction to chromatography theory and practical by Srivastava, K. Kishore.
10. CMPC Guidelines.
MODERN PHARMACEUTICAL ANALYSIS - PRACTICAL

2. UV-Visible spectrum scanning of certain organic compounds- absorption and co-relation of structures, comparisons. Ex: a. Chloramphenicol  
   b. Sulphadiazine  
   c. Analgin
3. Effect of pH and solvent on UV spectrum of certain drugs.
4. Two dimensional paper chromatography and TLC.
5. Gradient elution and other techniques in column chromatography.
6. Separation by electrophoresis.(PAGE and agarose Gel electrophoresis)
7. Experiments based on HPLC and GC.
8. IR, NMR and Mass spectroscopy of compound each.
9. DSC/XRD curves of a sample and mixture to understand polymorphism.
10. Determination of insulin / any other hormones by ELISA method.
1. Phytochemical screening of plant extracts and drugs.
2. Isolation, separation, purification and identification of important phytoconstituents belonging to different classes:
   a. Starch, Amylose and Amylopectin
   b. Meristicin and Trimeristicin from nut meg.
   c. Eugenol from clove.
   d. Stigmasterol from soyabean.
   e. Lycopene from tomato.
   f. Curcumin from turmeric.
   g. Sennoides from senna.
   h. Glycyrrhizin from Glycyrrhiza.
   i. Strychnine and Brucine or quinine or caffeine or nicotine or piperine or hesperidine.
3. Anti-microbial screening of plant extracts and drugs.
4. Screening of drugs for the presence of enteric organisms.
5. Screening of drugs for microbial count
6. Isolation, separation, purification of bioactive agents from marine source.
7. Extractive value determination
8. Ash value determination
9. Moisture content determination
10. Volatile oil content determination
11. Estimation of volatile oil content by UV, spectral analysis
1. Biosynthetic studies on the following:
   a. Shikimic acid pathway – Atropine and Morphine
   b. Acetate pathway – Cardiac glycosides and Anthraquinone glycosides, terpenoids

2. Structural elucidation of important phytoconstituents belonging to different groups.
   b. Glycosides – Amygdalin, Strophanthin.
   c. Steroids – cholesterol.
   d. Terpenes – Citral.

3. Marine Pharmacognosy:
   a. Definition, present status, classification of important bioactive agents.
   b. General methods of isolation and purification.
   c. Study of important bioactive agents including chemistry and uses

4. Plant toxins: An overview of poisonous plants and their mode toxicity with special emphasis to indigenous poisonous plants

5. Recent advances in phytochemical research. Natural substances as raw materials in Drug synthesis. Biomolecules of recent discovery.

6. Nutraceuticals: Food pharmacy, guidelines on food safety includes HACCP, WHO, FPO, FDA, USFDA etc.

7. Problems encountered in and prospects of discovering new drugs from plants.

8. Use of computers in Pharmacognosy
REFERENCES:

1. An introduction to pharmacognosy and phyto chemistry, Durai Swamy and Dr.K.N.Jayaveera, S.Chand
6. Pharmacognosy-Tyler, Brady, Robbers
7. Modern Methods of Plant Analysis- Peach & M.V. Tracey, Vol. I&II
11. Marine Pharmacognosy Ed. by Dean F. Martin & George Padilla.
12. Marine Natural Products-Vol.I to IV.
15. Text Book of Pharmacognosy by T.E. Wallis
1. Herbal based industries-types, forms, scope and applications.
   Study of infrastructure for different types of industries involved in making standardized extracts and various dosage forms including traditional ayurvedic dosage forms and modern dosage forms.

2. Research in Herbal based industries: Needs, area and current on going research.
   Application of pharmacy concepts, analytical methods and clinical evaluation techniques.


4. Patents:
   a. Indian and international patent loss, proposed amendments as applicable to herbal/natural products and process important points to be kept in mind while drafting and filing a patent.
   b. Plant breeder’s rights.

5. Study of herbal extracts: Estimation techniques and principle behind them for the following drugs with special emphasis on HPLC and HPTLC
   a. Adhatoda vasica-Vasicine
   b. Andrographis paniculata-Andrographolides
   c. Bacopa monnieri-Bacosides
   d. Curcuma longa-Curcumin
   e. Gymnema sylvestre-Gymnemic acid
   f. Phyllanthus amarus-Phyllanthin
   g. Pipernigrum/longum-Peperine
   h. Tinospora cordifolia-Cordifolioside
   i. Tribulus terrestris-Total saponins
   j. Withania somnifera-Withanolides
   k. Zingiber officinale-gingerol
   l. Commiphora mukul-guggulostereone

6. Profile for commercial cultivation technology and post harvest technology of following medicinal plants: Ashwagandha, Periwinkle, Medicinal yams, Guggul, Senna, Isapgol, Neem, Psyllium, Artemesia, Stevia, Gymnema, Coleus, Ammimajus, Spirolina and Hypericum species.
7. Technology for commercial scale cultivation and processing of following aromatic plants: Lemongrass, Geranium, Basil, Vitiver, Peppermint, Thyme, Celery, Rose, Clove, Jasmine, sandal, Cinnamon, Dill, Anise, Eucalyptus and Davana.

8. Bio-Assays: In-Vitro and In-Vivo methods with reference to Anti cancer, Anti diabetic, Anti obesity, Hepato protective, Anti inflammatory, Analgesics, Hypolipidemics, Immunomodulatory activities, etc.

REFERENCES:

1. Chemistry of Alkaloids by S.W. Pelletier
2. Organic chemistry by i.L. Finar Vol.II
3. Chemistry of Natural Products by k.W. Bentley
5. Pharmacognosy by Trease and Evans, ELBS.
6. Clark’s isolation and Identification of drugs by A.C. Mottal.
8. Indian Pharmacopoeia, United States Pharmacopoeia, Ayurvedic Pharmacopoeia
10. Research guideline for evaluating the safety and efficacy of herbal medicines WHO publications.
11. CMPC Guidelines.
1. Introduction to genetics & molecular biology:
   a. Structural and molecular organization of cell.
   b. Genetic material – DNA, RNA, Protein, replication, genetic code, regulation of gene expression, structure and complexity of genome.
   c. Cell cycle, cell signaling.
   d. Recombinant DNA Technology- principles, tools, process and applications.

2. Methods of improving quality of crops & their applications:
   a. Plant breeding
   b. Chemo demes
   c. Hybridization
   d. Mutation
   e. Polyploidy

3. Tissue Culture:
   a. Types, techniques & application of Callus, suspension, haploid, embryo, organ and immobilized Culture.
   b. Organogenesis, Embryogenesis, synthetic seed & Somaclonal variation.
   c. Micropropagation.
   d. Production of Secondary metabolities- Strategies involving use of precursor, growth regulators and elicitors: Production of Shikonin and other biomolecules.
   e. Hairy root culture & Multiple shoot culture & their applications.
   f. Protoplast culture and protoplast fusion.
   g. Biotransformation.

4. Germplasm conservation : 
   a. In-situ conservation
   b. Invitro methods of conservation.

5. Gene transfer in plant: Introduction, transgenic plants, methods used in gene identification. Gene transfer using
   a i. vectors of Agarobacterium
   ii. DNA mediated gene transfer electroporation, micro projectile, macro & micro injection, liposomes, Ultra-sonication & chemical mediated gene transfer.
   b Localization of transfer gene in genetically modified plants:
      i. Nucleic acid hybridization
ii. Use of radio isotopes & molecular markers
iii. Autoradiography
iv. Electrophoresis

6. Applications of transgenic plants:
   a. Resistant to herbicide
   b. Resistant to insect, fungus & Virus.
   c. Resistant to physiological stress
   d. Production of phytopharmaceutical
   e. Edible vaccine

7. Gene Mapping & Molecular Maps of Plant Genomes
   a. Plant chromosome analysis.
   b. Uses of PCR in gene mapping.
   c. Molecular maps – RFLP, RAPD.
   d. Physical maps used in-situ hybridization

8. Enzymes:
   a. Types & properties of enzymes.
   b. Isolation & Purification of enzymes.
   c. Immobilization of enzymes & its applications
   d. Enzyme reactors
   e. Detailed study of Plant enzymes – Papain & Bromelain.

REFERENCES:

1. Plant tissue culture – Bhagwani, Vol 5. (Elsevier)
6. An introduction to plant tissue culture by M. K. Razdan.
7. Breeding field crops by John. M. P and David A. S.
9. Experiments in plant tissue culture by John H. D and Lorin W. R.
11. Plant cell and tissue c culture by Jeffrey W. Pollard and John M Walker.
13. Plant tissue culture by Street.
15. Biotechnological applications to tissue culture by Shargool.
17. Secondary plant metabolism by Margaret L. Vikery and Brian Vikery.
18. Plant tissue culture by W. E. George.
HERBAL DRUG DEVELOPMENT AND STANDARDISATION

1. Study of Indian system of medicine / ethno medicines: Ayurveda, unani, yoga and naturopathy, homeopathy, sidha and Chinese medicines

2. Herbal Cosmetics:
   a. Raw materials of herbal origin used in cosmetics; Oils, waxes, gums, hydrophilic colloids, colors, perfumes, protective agents, bleaching agents, preservatives, anti-oxidants and other ancillary agents.
   b. Formulation aspects of incorporating herbal extracts in various preparations like skin care creams, deodorants, anti-perspirants, Hair care preparations.
   c. Detailed methods of preparation of few representative preparations and standardization of above categories.

3. Ayurveda: History, principle, formulations, types and their standardization of ayurvedic medicines with their applications.


7. Study of traditional formulation as per Ayurvedic Formulary of India and few dosage forms (Modern) in market.

8. Shelf life study, stability studies for herbal based products, different approaches for both physical, physico-chemical parameters for in-process and finished herbal products, interpretation of data and its limitation

REFERENCES:

1. Ayurvedic pharmacopoeia
2. Merck index
3. Text book of Pharmacognosy by Trease and Evans, ELBS
5. Text book of Pharmacognosy and Bio-technology by Mohammed Ali
7. Plant drug analysis by Wagner.
8. Ayurvedic formulary by IMPCOPS
9. Siddha formulary by IMPCOPS
10. Unani formulary by IMPCOPS.
11. Herbal drug industry by R.D.Choudhary 1/e Eastern publishers, New Delhi, 1996.
12. Pharmacopoeial standards for ayurvedic formulations, central council for research in Ayurveda And Siddha, New Delhi
13. Herbal cosmetics, formulation and standardization by P.P.Sharma.
14. Remington’s pharmaceutical sciences vol-I &II.
1. Thin layer chromatography
2. Paper chromatography
3. HPLC and HPTLC
4. Pharmacognostic evaluation of crude drugs.
5. Extractive value determination
6. Moisture content determination
7. Ash value determination
8. Volatile Oil content determination
9. Determination of heavy metals, mycotoxins, pesticidal residues.
10. Spectroscopic analysis of isolated compounds.
11. Flourimetric analysis of isolated compounds.
12. Monograph analysis of crude drugs.
15. Preparation of two herbal and medicinal cosmetic formulation and their evaluation.
16. Titrimetric analysis of isolated compounds.
17. Quantitative microscopy.
18. Isolation and estimation of the following phytopharmaceuticals
   a. Curcumin
   b. Berberine
   c. Piperine
   d. Gingerol
   e. Forskolin
M.Pharm Pharmacognosy
I year II semester

MEDICINAL PLANT BIOTECHNOLOGY
PRACTICAL

1. Media preparation and sterilization.
2. Initiation of Callus.
3. Growth determination- cell counts, cell staining, mitotic index, media analysis.
4. Organogenesis.
5. Chromosomal analysis by Onion root tip culture.
7. Isolation of DNA & RNA from plant source.
8. Estimation of DNA & RNA.
9. Isolation of Enzymes
10. Immobilization of Enzymes and study of their activity.
11. Isolation & fusion of protoplast.
13. Isolation of Plasmids.
14. Restriction enzyme digestion.
15. Transformation of bacteria
16. Ligation of DNA
17. Isolation of Chloroplast.

LIST OF EQUIPMENTS REQUIRED FOR PHARMACOGNOSY:

1. UV-Spectrophotometer
2. IR
3. HPLC and HPTLC
4. Rotary Flash Evaporator
5. Centrifuge and micro centrifuge
6. Gel Electrophoresis
7. Column Chromatography
Mini Projects:

The mini projects can be taken up as industrial visit/training and report submission. Or
A suitable project shall be carried out in the college.

The Project Work:

Separate guidelines will be issued