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MODERN PHARMACEUTICAL ANALYSIS(PCG 101)

1. UV- Ultraviolet/Visible Spectroscopy and Fluorimetry

Energy level and selection rules, effect of substituents, effect of conjugation, conformation and geometry, the Woodward-Fisher rules, the Fisher-Kuhn rules, applications of UV with reference to different electronic systems. Derivative spectroscopy and its applications. Fluorescence and chemical structure, fluorescence intensity, factors affecting fluorescence, instrumentation, comparison of fluorometry with spectrophotometry, applications of fluorimetry in pharmaceutical analysis.

2. **Spectrofluorimetry:** Fluorescence, Phosphorescence, Chemiluminescence- Theory, instrumentation and applications.

3. Infra-Red spectroscopy:

The Hook's law and calculation of stretching frequencies for different types of bonds and their bond strengths, coupled interactions, hydrogen bonding, examination of infrared spectrum, survey of important functional groups with examples, radiation source, detectors used, sample handling, quantitative applications, qualitative applications with special reference to stereochemical aspects and hydrogen bonding, Near-IR spectroscopy, absorption and reflectance spectrophotometry, instrumentation, applications, Far Infrared spectroscopy. Introduction to FTIR and its applications. Raman spectroscopy Introduction, theory and polarization measurement, rules of selection and polarization, instrumentation, applications in pharmaceutical sciences. Comparison of Infrared and Raman spectra.

4. Optical Rotatory Dispersion:

a. Principle, plain curves, Cotton effect, Circular dichroism and. Measurement of rotation angle in ORD and applications.

b. Principles and application of light, Phase contrast, Scanning and Transmission electron microscopy, Cytometry and Flow cytometry.

5. Nuclear Magnetic Resonance spectroscopy:

Nuclear Magnetic Resonance Spectroscopy ^1H -NMR spectroscopy Magnetic equivalence, failure of the N+1 rule, chemical shifts, local diamagnetic shielding, hybridization effects, magnetic anisotropy, mechanism of spin-spin coupling, the origin of spin-spin splitting, Pascal's triangle, the coupling constant, protons on oxygen, nitrogen and sulphur, diastereomeric protons, chemical shift reagents, long range coupling, spin decoupling methods, nuclear over Hauser effect. Correlation NMR spectrometry: introduction to ^1H - ^1H cosy and ^1H - ^{13}C cosy and its



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applications. Introduction and applications of 2D NMR; solid state NMR. 13 C-NMR spectroscopy.

Introduction, peak assignments, off resonance decoupling, selective proton decoupling; chemical shift equivalence; chemical shifts; spin coupling. Spectrometry of other important nuclei
Introduction to 15N, 19F, 31P, basic concepts.

Electron Spin Resonance Spectroscopy

Introduction, derivative curves, g values, hyperfine splitting, ESR instrumentation, ESR spectra of free radicals, applications.

6. Mass spectroscopy:

Basic principle and theory involved; instrumentation, type of ions; various ion sources, electron impact source, chemical ionization sources, field ionization sources, desorption sources, mass analysers, double focusing, quadripole, time of flight, ion trap analyzer, ionization, fragmentation, rearrangements, mass spectra of representative compounds, recognition of molecular ion peak, metastable peak, isotopic peaks, applications.

7. X- ray Crystallography: Production of X rays, Different X ray methods, Braggs law, Rotating crystal technique, X ray powder technique, Types of crystals, Interpretation of diffraction patterns and applications of X-ray diffraction

8. Chromatographic methods, Introduction, classifications,

a) Liquid chromatography, instrumentation, materials, column selection, resolution optimization and efficiency parameters. HPLC detectors, modes of HPLC, Ion –pair, Ion exchange, Size exclusion, Supercritical, gel-permeation, flash chromatography, applications.

b) High Performance Liquid Chromatography: Partition, adsorption, ion exchange, size exclusion; pharmaceutical applications of HPLC and LC-MS. Super critical fluid chromatography; brief introduction to HPTLC.

c) Gas Chromatography: Gas liquid chromatography, gas solid chromatography, instrumentation and applications (GC-MS and GC-FTIR). Column parameters, Resolution, Liquid Phases Derivatization and detectors, Derivatization as a means of sampling of thermosensitive compounds.

d) Capillary electrophoresis.: Introduction, methods and applications.

9. Radio Immuno Assay and ELISA for some drugs.



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10. Thermal methods: Thermo Gravimetry (TG), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA).

Practical

1. Practical based on instrumental methods of analysis. A sufficient training will be given through exercises using different kinds of spectral analysis.
2. Microbial analysis of Vitamins and Anti-biotics
3. Pharmacological Bioassay of some drugs.

Reading Material Recommended

1. Willard, H.H., Merrit, L.L., Dean, J.A., Settle P.A., Instrumental Methods of Analysis, Van Nostrand.
2. Skoog, D.A., Heller, F.J., Nieman, T.A., Principles of Instrumental Analysis, WB Saunders.
3. Hunson, J.W., ed. Pharmaceutical Analysis, Modern Methods, part A & B, Marcel Dekker.
4. Schirmer, R.E., ed. Modern Methods of Pharmaceutical Analysis, Vols 1, 2. Boca Raton F.L., CRC Press.
5. Mann, C.K., et al., Instrumental Analysis Harper & Row.
6. Jaffe, H.H., Orchin M., Theory & Applications of Ultraviolet Spectroscopy, Willy.
7. Silverstein, Spectrometric identification of Organic Compounds, Willy.
8. Bovey, F., Jelinski, L., Miran, P., Nuclear Magnetic Resonance Spectroscopy, Sau: Diego Academic.
9. Stothers, J.B., Carbon-13 NMR.Spectroscopy, Academic.
10. Gordy, W., Theory & Applications of Electron Spin Resonance, Willy.
11. Haswell, S.J., ed. Atomic Absorption Spectroscopy, Elsevier.
12. Ardrey, R.E., Pharmaceutical Mass Spectra, Pharmaceutical Press, London.
13. Budzikiewicz, et al., Interpretation of Mass Spectra of Organic Compounds, Holden-Day San Francisco.
14. Beckett and Stenlake, Practical Pharmaceutical Chemistry, CBS.
15. Stahl, E., Thin Layer Chromatography- A laboratory Handbook, Springer-Verlag
16. Giddings, J.C., Principles and Theory- Dynamics of Chromatography, Marcel Dekker.
17. Sethi, P.D., Quantitative Analysis of Pharmaceutical formulations, CBS Publishers, New Delhi.
18. Kemp William, Organic spectroscopy, Pal grave, New York.
19. Kalsi, P.S., Spectroscopy of organic compounds, New age publishers, New Delhi.
20. Gross - Mass Spectrometry
21. WHO - Quality Assurance of Pharmaceuticals, Vol. I, II.
22. Sethi, P.D., HPLC, Quantitative Analysis of Pharmaceutical Formulations, CBS Publishers, Delhi.
23. Sethi, P.D., HPTLC, Quantitative Analysis of Pharmaceutical Formulations, CBS



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Publishers, Delhi.

24. Haffmann, Chromatography.

25. Sethi and Charcankar, Identification of Drugs in Pharmaceutical Formulations by TLC.

26. Robert D. Braun, Introduction to Instrumental Analysis.

27. Wilfried, M.A. Niessen- Liquid Chromatography-Mass Spectrometry.

28. Harry G. Brittain, Spectroscopy of Pharmaceutical Solids.

29. George, S., Steroid Analysis in Pharmaceutical Industry.

30. Higuchi, Pharmaceutical Analysis.

31. Bidingmeyer, Practical HPLC Methodology and Applications.

32. Hoffmann, Mass Spectrometry: Principle and Application.

33. Scott, Techniques and Practice of Chromatography.

34. Wilkins, Identification of Microorganism by Mass Spectrometry.

35. Wu, Handbook for Size Exclusion Chromatography and related Techniques.

36. Silverstein RM and Webster FX. Spectrometric Identification of Organic Compounds. John Wiley and Sons, New York. Latest Edition.

37. Chatten LG. Pharmaceutical Chemistry, Vol. I & II. Marcel Dekker, New York. Latest Edition.

38. James WD and Kenneth HT. Analytical Chemistry by Open Learning: Thermal Methods. John Wiley and Sons, New York. Latest Edition.

39. Abraham RJ, Fisher J and Bftus P. Introduction to NMR Spectroscopy. John Wiley and Sons, New York. Latest Edition.

40. Pavia DL, Lampman GM and Kriz GS. Introduction to Spectroscopy. Harcourt College Publishers, Orlando. Latest Edition.



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ADVANCED PHARMACOGNOSY(PCG 102)

1. :- Plant drug cultivation

- General introduction to the importance of Pharmacognosy in herbal drug industry,
 - General aspects involved in cultivation of medicinal plants.
 - Factors affecting the cultivation of curde drugs.(I) Exogenous (II) Endogenous factors (III) Mineral supplements (IV) Nutrients (V) Soil and Soil fertility (VI)Pest and Pest control (VII) Plant Growth Regulators (VIII) Genetic manipulators (IX) Diseases management of medicinal and aromatic plants
 - Systemic method of Cultivation and post harvest technology of medicinal plant, cultivated in India
- (i)Senna (ii) Opium (iii)Aswaghandha (iv)Lemon Grass (v) Ispaghula (vi)Turmeric (vii)Ginger.
- Conservation of medicinal plants - *Ex-situ* and *In-situ* conservation of medicinal plants

2. :- Chemotaxonomy

- Definition,significance and Types
- Chemotaxonomic significance of Flavonoids and Alkaloids

3. :- Marine natural products

- Definition, Present status, Classification of important bioactive agents from marine sources
- General methods of isolation and purification
- Study of Marine toxins, Marine biomedicals falling under the class of Cardiovascular, Anticancer, Antimicrobial, Antiinflammatory and Antibiotic drugs

4. :- Extraction Methods And Chromatography

- General methods, types and principles of extraction.
- Selection of solvents for extraction and purification of extracts using chromatographic methods including HPLC, HPTLC and GC

5. Neutraceuticals

- General introduction
- Classification



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- Inorganic mineral supplements
- Vitamin supplements
- Digestive enzymes
- Probiotics
- Prebiotics
- Dietary fibres
- Cereals and grains
- Health drinks
- Antioxidants
- Polyunsaturated fatty acids
- Herbs as functional foods

6. Methods of improving quality of crops and their application

- Plant Breeding
- Chemodemes
- Hybridization
- Mutation
- Polyploidy

7. Alternative system of medicine

- Principles of Ayurveda, Homeopathy and Unani system of medicines, their merits and demerits
- Formulation of ayurvedic dosage forms
 - a) Asava
 - b) Arista
 - c) Churna
 - d) Bhasma
- Ayurvedic cosmetic formulations
- Standardisation of Ayurvedic dosage forms using



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- a) Physical methods
- b) Chemical methods
- c) Biological methods

8. Role of Medicinal Plants in National Economy

- Economic Growth Potential in natural health and cosmetic products. Future economic growth. Development of Herbal medicine industry
- Demand For Medicinal Plants and Herbal plants. Trends in worldwide trade in medicinal plants.
- Export potential of Indian medicinal herbs. Indian Medicinal plants used in aromatherapy.
- Spices and there export

9. WHO Guidelines for the assessment of crude drugs.

- Evaluation of identity, quality and purity of crude drugs.
- Determination of Pesticidal Residue
- Determination of Arsenic and heavy metals.
- Determination of microorganism.

10. Patents

- Indian and International patent laws,proposed amendments as applicable to herbals / natural products and processes
- Important points while to be kept in mind while drafting and file a patents
- Plant breeders rights.



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References

1. Cultivation of medicinal and aromatic crops, Ist edn, by A.A.Farooqui and B.S.shreeramu, University press., 2001
 2. Medicinal plants of India, Ist edn, by S.N.Yoganarasimhan, Interline publication Pvt.Ltd., 2000
 3. Medicinal natural products (a biosynthetic approach), Ist edn, by Paul M.Dewick, John Wiley and sons Ltd., England 1998
 4. Natural Products from plants, Ist edn, by Peter B. Kaufman, CRC press, Newyork, 1998
 5. Glimpses of Indian Ethanopharmacology by P. Pushpangadam,UIF Nyman, V.George, Tropical botanic Gardon and research institute., 1995
 6. Natural Products:A lab guide by Raphael Ikan, IInd edn, academic press, 1991
 7. Organic chemistry of natural products, volume 1 and 2. by Gurdeep R.Chatawal
 8. Organic Chemistry by I.L.Finar –Vol. I and II
 9. Text book of Pharmacognosy, by G.E.Treese nad W.C.Evans, 15th edn, W.B. Saunders Edenburg, NewYork.,
 10. Text book of Pharmacognosy by Tyler, Brady and Robers
 11. Modern methods of Plant analysis by Peach and M.V.Tracey, Volume I and II
 12. Chemistry of marine natural products by Paul J.Schewer, 1973.
 13. Marine Pharmacognosy Ed by Dean F. Martin and George Pedilla
 14. Marine natural products Volume I to IV
 15. Cultivation of medicinal plants by C.K.Atal and B.M. Kapoor
 16. Cultivation and utilization of aromatic plants,by C.K.Atal and B.M. Kapoor
 17. Text book of Pharmacognosy by C.K.Kokate, Purohit, Ghokhale, 5th edn nirali prakassan., 1996
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1. Text book of Pharmacognosy, by G.E. Treese and W.C. Evans, 15th edition, W.B. Saunders
 2. Edenburg, New York.,
 3. Pharmacognosy and Phytochemistry by Vinod D. Rangari, Part I and II
 4. Ayurvedic Formulary of India, Government of India
 5. W.H.O Quality control methods for medicinal plant material
 6. Quality control of herbal drugs by pulok Mukherjee, Business horizon
 7. Text book of Industrial pharmacognosy by A.N. Kalia, CBS publishers and Distributors, New Delhi
 8. Herbal drug industry by Choudhary R.D. Eastern publication
 9. PDR for herbal medicines, IInd Edn, Medicinal economic company, New Jersey



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PHYTOCHEMISTRY(PCG 103)

1. Biogenesis

- General techniques involved in biosynthetic studies and brief introduction to the biogenesis of secondary metabolites

- Primary and secondary metabolites

- Factors affecting secondary metabolites in medicinal plants

2. Biosynthetic studies on the following

- Alkaloids:- Ephedrine, Hyoscyamine, Hyoscine, Morphine, Papaverine, Reserpine and Ergometrine

- Glycosides :- Digitoxin, Scillaren and Sennosides

3. Extraction, Isolation and Purification of Phytoconstituents.

- 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.

a) Asavone from *Acorus Calamus*

b) Aloin from *Aloes*

c) Vasicine from *Adhatoda vasica*

d) Andrographolides from *Andrographis paniculata*

e) Curcumin from *Curcumin Longa*

f) Piperine from *Piper Longum*

g) Berberine from *Berberis aristata*

h) Gingerol from *Zingiber Officinalis*

i) Hesperidine from Orange peel

4. General methods for determining the structure of the following class of compounds

a) Alkaloids

b) Glycosides

c) Flavanoids

d) Terpenoids

e) Carotenoides

5. Structural elucidation of following class of phytoconstituents

- Structural elucidation of important phytoconstituents belonging to different groups

a) Alkaloids- Nicotine, Atropine, Morphine, Caffeine.

b) Glycosides- Amygdalin, Strophanthidin

c) Steroids- Cholesterol,

d) Caratenoids- Vitamin A, Lycopine and Beta-carotene

e) Terpinods-Camphor, Eugenol, Taxol, Pyrithrine.

f) Flavonoids:-Rutin, Quercetin.



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List of Experiments

1. Phytochemical screening*
2. Thin layer chromatography and identification of phytoconstituents*
3. Paper chromatography and identification of phytoconstituents*
4. Isolation of Caffeine from tea dust
5. Isolation of Nicotine as Nicotine picrate from Tobacco leaves
6. Isolation of Piperine from Black pepper
7. Isolation of Curcumin from Turmeric
8. Isolation of Berberine from Berberis spp
9. Isolation of Hesperidine from Orange peel
10. Estimation of Eugenol in Clove oil- IP*
11. Estimation of Citral in Lemon grass oil- IP*
12. Estimation of Caffeine by HPLC*
13. Separation of active constituents using flash chromatography

References

1. Text book of Pharmacognosy, by G.E. Treese and W.C. Evans, 15th edition, W.B. Saunders
Edenburgh, New York.,
2. Phytochemistry – Volume I to IV, by Miller Jan, Nostrant Renhold
3. Recent advances in Phytochemistry - Volume I to IV, Scikel Runeckles Appleton century
Crofts
4. Pharmacognosy and Phytochemistry of Medicinal plants by Jean Bruneton, Rechnique and
documentation – Lavoiser, 1995
5. Pharmacognosy and Phytochemistry by Vinod D. Rangari Part I and II
6. Organic chemistry of natural products, Volume 1 and 2 by Gurdeep R. Chatawal
7. Organic chemistry by I.L. Finar – Vol. I and II
8. Natural product chemistry by Nakanishi Golo
9. Introduction to Molecular Phytochemistry by C.H. J. Wells (Chapman And Hall)
10. Comparative Phytochemistry, Ed. By T. swain
11. Natural products: A lab guide by Raphael Iran. IInd Edition Academic press, 1991
12. Text book of Pharmacognosy by C.K. Kokate, Purohit, Gokhlae



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HERBAL PRODUCT DEVELOPMENT & FORMULATION(PCG 104)

1. Introduction

- Herbal Based industry : Scope, study of infrastructure, staff requirements, project profiles, equipments, processing, research and development & Regulatory requirements.
- Role of natural products in herbal medicines.
- General status and importance of herbal medicines.
- Safety of herbals/herbalpharmacovigilance.
- W.H.O Policy on herbal medicines.

2. Herbs as raw materials 6 hr

- Definition of herb, herbal medicines, herbal medicinal product and herbal drug preparations.
- Source, selection, identification and authentication of herbal materials.
- Drying and processing of herbal raw materials.
- Packing and labelling of finished products.

3. Standardization of herbal extracts as per WHO/CGMP Guidelines 15 hr

- Physical, chemical, spectral and toxicological standardization, qualitative and quantitative estimations exemplified by the methods of preparation of at least two standardized extracts.
- Stability studies for extracts.
- Predictable chemical and galenic changes

4. Herbal Product Development 20 hr

- Preparation of liquid orals, tablets, capsules, ointments, creams and cosmetics
- Methods involved in monoherbal and polyherbal formulation with their merits and demerits.



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- Excipients used in herbal formulation
- Compatibility studies
- Stability studies
- Bioavailability & Pharmacokinetic aspects for herbal drugs with examples of well known documented, clinically used herbal drugs.
- Quality Control of finished herbal medicinal products.

5. Screening of natural products for the following biological activities 13 hr

- (a) Antidiabetic (b) Antifertility (c) Antihypertensive (d) Antiarrhythmics
- (e) Antipyretics (f) Antioxidants (g) Antibacterial (h) Antifungal
- (i) Antiepileptics, (j) Osteoporosis (k) Nephroprotective
- (l) Immunomodulators, (m) Alzheimers

References

1. Pharmacognosy by G.E. Trease, W.C. Evans, ELBS.
2. Pharmacognosy by Verno E. Taylor, Linn. R. Braddy, James E. Roberts, K.M. Varghese Co. Mumbai.
3. Text Book of Pharmacognosy by T.E. Wallis, CBS Publication, Delhi.
4. Clark's Isolation and Identification of drugs by A.C. Mottal.
5. Drug Analysis by Chromatography by P.K. Lalla
6. Phytochemical methods of chemical analysis by Harborne
7. Quantitative Thin layer chromatography and its industrial application by Trieber L.R.
8. HPTLC- Quantitative analysis of Pharmaceutical Formulation by P.D. Sethi
9. Plant drug analysis by H. Wagner
10. Indian Herbal Pharmacopoeia Vol. I and II
11. British Herbal Pharmacopoeia
12. Herbal drug industry by R.D. Chaudhari
13. The complete German Commission E. Monographs- Bluementol, Busse, Goldberg Greenwald. Hall, Klien, Riggins and Rister
14. Quality control methods of Herbal Drugs by Pulok. V. Mukherjee
15. HPLC methods of drug analysis by Mantuke Ghosh
16. Standardisation of botanicals testing and extraction methods of Medicinal Herbs by Dr. Rajpal. Vol. I and II
17. General Pharmacy by J.W. Cooper and Coline Gunn



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18. Tutorial Pharmacy by S.J.Carter
19. Cosmeceuticals- Drugs Vs Cosmetics by Peter Elsner and Howard D. Maibach
20. Herbal Medicinal Plants by Fraukle and Barbana Steinhoff
21. Research guideline for evaluating for the safety and efficacy of herbal medicines, WHO publications (ISBN)
22. Quality control methods for medicinal plant materials- WHO