स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ
नांदेड– ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY
NANDED-431606, MAHARASHTRA STATE, INDIA.
Established on 17th September 1994 - Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade

ACADEMIC (1-BOARD OF STUDIES) SECTION
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संलग्नित महाविद्यालयांतील औषधनिर्माणशास्त्रे विद्याशाखेतील बी.फार्म. तृतीय वर्ष (सत्र पाचवे व सहावे) आणि चतुर्थ वर्ष (सत्र सातवे व आठवे) हे अभ्यासक्रम शैक्षणिक वर्ष २०१६–१७ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक १२ मे २०१६ रोजी संपन्न झालेल्या ३६व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/३६–२०१६** च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील औषधनिर्माणशास्त्रे विद्याशाखेतील** खालील अभ्यासक्रम शैक्षणिक वर्ष २०१६–१७ पासून लागू करण्यात येत आहेत.

१) बी.फार्म. – तृतीय वर्ष (सत्र पाचवे व सहावे)
२) बी.फार्म. – चतुर्थ वर्ष (सत्र सातवे व आठवे)

सदरील अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक(१)/परिपत्रक/औषधनिर्माणशास्त्रे/
२०१६–१७/**२९६**
दिनांक : ०१.०७.२०१६.

स्वाक्षरित/–
संचालक
महाविद्यालय व विद्यापीठ विकास मंडळ

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. परीक्षा नियंत्रक यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) उपकुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) साहाय्यक कुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : **Pharmaceutical Technology-I (DFD-I)**

Subject Code/Paper No : **BPH51**

Credits : **03 (02T+01Pr.)**

OBJECTIVE:

1. To give training at advanced level in preformulation studies of drugs and other requisites aspects.
2. To impart knowledge regarding several other ingredients used in formulation of a dosage form.
3. To train students in formulation of various dosage forms their evaluation and quality control packing material used for packing these dosage forms.
4. Assuring design of quality pharmaceutical formulations offering improved patient compliance and therapeutic efficacy.
5. To understand techniques and technologies used to manufacture drugs/formulations,
6. To ensure the quality of product by exercising quality assurance tools, in particular analytics.

Course Content (Theory)

1. Preformulation **05 Hrs**

Consideration of Importance, physical properties, physical forms, particle size, crystal forms, bulk control, solubility, wetting, flow cohesiveness, compressibility, organoleptic properties and its effect on final product consideration of Chemical properties, hydrolysis, oxidation, recemization, polymerization, somerization, decarboxylation, enzymatic decomposition, formulation additives, stabilizers, suspending and dispersing agents, dyes, solid excipients etc. and its effect on quality of finished product

2. Design of Tablets: **08Hrs**

Tablets as a dosage form, advantages and disadvantages of compressed tablets, types of tablets Essential properties of tablets. Influence of tableting method on formulations – Powder fluidity,

powder compressibility, the need for granulations prior to compression, tableting methods, Tablet excipients ,Tablet coating – Tablet coating principles, development of film coating and sugar coating, materials used coating, tablet coating defect.

3. Design of Capsules: 07 Hrs

Gelatin capsules, Raw materials for gelatin capsules, types of capsule, capsule formulation. Hard gelatin capsules – Sizes of hard gelatin capsule shells determinations of capsule fill weight, filling, formulations of powders for filling, formulation of non-powder for filling – granules and pellets, tablets, semisolids. Bioavailability aspects of hard gelatin capsules- disintegrations and dissolutions, formulations factors affecting release form hard gelatin capsules. – Active ingredient, diluents, glidants and lubricants, Soft gelatin capsules – Description, advantages, compressions, mixing and powder flow, stability, bioavailability. Manufacturing of soft gelatin capsules.

4. Topical preparations: 04 Hrs

Rational approach to topical formulation, treatments used in topical, Basic principles of diffusion through membrane, the diffusion process, complex diffusional barrirs, influence of material properties on diffusion, penetration enhancers, Biological and physicochemical factors methods for studying percutaneous absorption – In-vitro, in-vitro methods.

Recommended Books:

1) Pharmaceutics – The Science of dosage form design, Edited by, M.E. Aulton, International Student edition 1998
2) Pharmaceutical Dosage forms – Parenteral medications. Edited by, Liberman and Lachman, Marcel Dekkar Vol. I,II & III.
3) Pharmaceutical Dosage forms – Disperse systems. Edited by Lieberman & Reiger and Banker, Marcel Dekker Vol. I,II & III
4) Pharmaceutical Dosage forms – Tablets, Edited by Liebermann, Lachman, Marcel Dekker Vol. I,II & III
5) Modern Pharmaceutics, Second Edition Banker, Rhodes, Marcel Dekker
6) Sterile dosage forms, Their preparation and clinical application, 3rd Eition, Tarco, King, Lea and Febiger.

7) Pharmaceutical Dosage forms and drug delivery systems, Ansel, 7th Edition, International student edition.
8) Introduction to Pharmaceutical Dosage forms, Ansel, 4th Edition, Lea and Fibiger.
9) The theory & practice of industrial pharmacy Lachman, Lieberman, Kanig, 3rd Edition, Varghese Publishing House.
10) Remington, The science and practice of Pharmacy 20th Edition, Edited by Gennaro, Lippincott Williams and, Wilkins, International student edition.

Course Content (Practical/Lab Work)

1. Pre-formulation study of given powder drug (02 Pr)
2. Formulation of a tablet using different diluents. (01 Pr)
3. Formulation of a tablet using different binders. (01 Pr)
4. Formulation of a tablet using different disintegrants. (01 Pr)
5. Formulation of a tablet using wet granulation technique. (01 Pr)
6. Formulation of a tablet using dry granulation technique. (01 Pr)
7. Formulation of an effervescent tablet. (01 Pr)
8. Formulation of tablet for separation of incompatible drugs. (Multilayered tablets) (01 Pr)
9. Formulation of a capsule fill and selection of capsule size. (01 Pr)
10. Formulation of a medicated ointment. (02 Pr)
11. Formulation of a Lotion for external use (Calamine lotion) (01 Pr)

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : **Pharmaceutical Technology-I (DFM-I)**

Subject Code/Paper No : **BPH52**

Credits : **03 (02T+01Pr.)**

Objective:

The course aims at the study of common manufacturing stresses observed while manufacturing of solid and semisolid dosage forms at industrial scale. These stresses have impact on stability of formulations. The course prepares a pharmacist to rectify all these stresses, to improve the production at economic and stable level.

Learning goals:

On the successful completion of the following theory topics and laboratory work, students shall be able…

1. To be acquainted with the importance of granulation technology, understanding the mechanism of compression & consolidation of powders, the impact of various manufacturing stresses on the stability of tablet dosage form and to obtain the sufficient knowledge of coating equipments and related technology.
2. Study of capsule technology which encompasses the manufacturing of Hard & Soft gelatin capsules with the help of advanced machineries, their IPQC tests, and the ultimate effect of various parameters on the stability of capsule dosage form.
3. To implementation of knowledge of the packaging materials and related technology to improve the overall life of the product at the economical level.

Course Content (Theory)

1. Tablet Technology **09 Hrs**

A. Granulation Technology

Introduction, rationales of granulation, and techniques of granulation, granulation mechanisms,

Granulation Equipments: Wet granulators (shear granulator, Collette-Gral, Fluidized-Bed granulator, extrusion/ Spheronizer, Roller-compactor granulator,)

B. Physics of tablet compression and effect of stresses.

Mass- Volume relationship, Effect of applied forces (deformation, compression, consolidation and decompression) effect of friction, force distribution, die wall lubrication and ejection forces.

Common defects and remedies: Capping and Lamination, picking and sticking, mottling, weight variation, punch variation, hardness variation.

C. Evaluation equipments and Procedures: weight variation (USP, IP, BP).

Hardness tester, friabilator, disintegration test apparatus, dissolution test apparatus and their determinations

D. Coating Technology

Tablet coating principles, tablet properties to be considered and coating parameters (Air capacity, Coating composition, Tablet surface area, Equipment efficiency)

Equipments: Standard Coating Pan Perforated coating pan, spray application systems, coating parameters, facility and ancillary equipment. Coating defects and their remedies

2. Capsule Technology: 07 Hrs

A. Gelatin and its Pharmacopoeial specifications, production of gelatin, Manufacture of Hard gelatin shells, hand filling, semi-automatic, automatic filling machine, capsule sorting machine, IPQC test for capsules special techniques.

B. Soft gelatin Capsules: Rationale for the selection of soft-gels as a drug delivery system, properties of soft gelatin shells, soft gelatin capsule manufacturing process, capsule physical stability and packaging.

3. Topical Preparations and Manufacturing: 04 Hrs

Mechanism of drug penetration across the Skin, industrial processing, Low energy emulsification, Rheology of semisolid topical preparations, IPQC tests, effect of stresses, storage of semisolid

4. **Packaging Technology:** **04 Hrs**

   Importance of packaging, packaging materials, glass, Types of glass, plastic containers, plastic materials, drug- plastic considerations, collapsible tubes, closures, closures liners, Rubber stoppers tamper resistant packaging.

Recommended Books:

1. The theory and Practice of Industrial Pharmacy by Leon Lachman, Herbert Lieberman and Joseph Kanig, 4th edition, CBS Publishing House.
2. Pharmaceutics, The Science of Dosage Form Design by M E Aulton, Second Edition, Churchill Livingstone Publication.
3. Pharmaceutical dosage forms drug delivery systems, Ansel, 7thedition.
4. Pharmaceutical dosage forms- Tablets edited by Lieberman, Lachman and Marcwl Dekker Vol I, II, III.
5. Industrial Pharmaceutical Technology, Dr Javed Ali, Dr. Alka Ahuja, Dr. Sajula Baboota, Birla Publications

Course Content (Practical/Lab Work)

Granulation Technology

1. To manufacture and evaluate the properties of granules.
   a. Mean particle size and particle size distribution.
   b. Flow property.
   c. Granular density and Porosity.
2. To manufacture and study the effect of moisture content and particle size on the flow properties of granules.

Tablet Technology

3. To perform the quality control test (IPQC) test on the marketed uncoated tablets.
4. To perform the quality control test (IPQC) test on the marketed film coated tablets.
5. To manufacture Paracetamol tablet and evaluate the same.

Capsule Technology

6. To study empty gelatin capsules for the following parameters.
    a. Surface
    b. Stickiness
    c. Peeling
    d. Texture
    e. Dimensional variation
    f. Disintegration time
    g. Weight variation
    h. Moisture content
7. To prepare antacid capsule of magnesium oxide and sodium bicarbonate (1:1) and evaluate capsules for weight variation test and disintegration time.
8. To perform IPQC test on marketed capsules of different brands having same API.

Packaging Technology

9. To evaluate aluminium foil for thickness, extractive matter, leakage and quality of printing.
10. To evaluate plastic vials for their moisture transmission property.

Topical Technology

11. To manufacture and evaluate cream.

Demonstration and Calibration of Instruments

12. To perform Calibration of Disintegration Apparatus and Prepare calibration record for the same.
13. To perform Calibration of Roche Friabilator and Prepare calibration record for the same

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : Medicinal Chemistry-I
Subject Code/Paper No : BPH53
Credits : 03 (02T+01Pr.)

SCOPE

The study of medicinal chemistry play a very important role in understanding the drug design, chemical classification, chemistry, synthesis, SAR, mechanism of drug action by considering site of action or receptor structural components and thus helps in designing the drug molecule for disease with fewer side effects.

Objective of Theory

- Orientation of teaching approach should be focused on discussion of chemistry of drugs rather than pharmacological part.
- Emphasis should be given to **chemical classification** of all topics mentioned
- Synthesis in theory should cover **prototype of the respective category**
- **Review/ study of drugs available in market of each category is highly expected.**

Course Content (Theory)

Classes of drugs discussed in relation to: Introduction to the

- Rational of drug development/ drug design,
- Important physicochemical parameters/aspects in relation to p'kinetics and dynamics
- **Chemical classification (prototype drug of each class should be discussed),**
- Structure (nucleus or skeleton) & Nomenclature,
- Stereochemistry of drugs (if any)
- Synthesis of specified/ prototype drugs (given with*)
- mode of action (must be discussed by considering receptor site/structure)
- Structure Activity Relationships (SAR)**,**
- important therapeutic uses
- drug combination (compatibility, synergism, antagonism etc)

1. **Introduction to Medicinal chemistry**: 4 **hrs**
   Brief concepts of steps in drug discovery & CADD, physicochemcial parameters, streochemical aspects and drug receptor interaction
2. **Study of the following classes of drugs acting on CNS 14 hrs**

a) **General Anaesthetics**: Inhalational anaesthetics, Intravenous anaesthetics (Thiopental and Ketamine*).
b) **Local Anaesthetics**: Esters (Benzocaine), Amides (Lignocaine*), Dibucaine, Procaine
c) **Hypnotics and Sedatives**: Barbiturates (Phenobarbitone);benzodiazepines (Nitrazepam), propafol, ethionamide, phenobarbitone, thiopental, diazepam
d) **Anticonvulsants**: Barbiturates; Hydantoin (Phenytoin*); Oxazolidinediones (Troxidone); Benzodiazepines and Carbamazepine*, Sodium valproate*
e) **Central Nervous System Stimulants**: Natural and Synthetic (Nikethamide); methylxanthines (Theophyllines) and Modified methylxanthines. (Amphetamine*, Caffiene)
f) **Antipsychotic agents (Neuroleptics)**: Phenothiazines (chlorpromazine); butyrophenones and miscellaneous;
g) **Antidepressants:** Tricyclic antidepressants (Amitryptyline), Atypical antidepressants; Monoamine oxidase inhibitors;
h) **Anxiolytics:** Meprobamate and related drugs; benzodiazepines (Diazepam) **Haloperidol*,** Chlordiazepoxide, Imipramine
i) **Hallucinogens, Stimulants and related drugs of abuse or analeptics**, xanthines, psychedelics: Non classical Hallucinogens- cannabinoids, classical hallucinogens- Indolealkylamines, phenylalkylamines, cocaine related agents.
j) **Drugs used to treat neuromuscular disorder:** Antiparkinsonian and spasmolytic agents
k) **Skeletal Muscle Relaxants**- Chlorphenesin
l) **Drugs affecting serotonergic neurotransmission-** drugs for migrane, Irritable Bowel Syndrome, Antiemetic agents.
m) **Antitussives:** Centrally acting Antitussives, Opium alkaloids and related agents and Synthetic Antitussives, Peripherally acting antitussives and Expectorants.
n) **Narcotic Analgesics**

2. Drugs acting on neurotransmitters and their receptors: 06 hrs

i) **Cholinergic and anticholinergic agents**: Introduction to neurotransmitters, cholinergic receptors and their structural features, Biosynthesis and metabolism of Ach, Atropine
ii) **Adrenergic and anti adrenergic agents**: Introduction to receptors and their structural features, Biosynthesis, release and metabolism of NA, Methyldopa, Propranolol

MC-I (PR)

Objective of practical

- **Preparation of ppt, presentation by students, review of on line videos related to all practical, will be highly encouraged**
- **Study of reaction mechanism of synthesis included in syllabus is expected**
- **Study of peer Reviewed articles related to all articles time to time is expected**

Expected practical should be conducted along with related/ aptly related videos as per the link provided below

1. Computer-aided techniques used in drug design and discovery. **(03)**

Emphasis should be given on different **Technique (terminology used, its definition) used and respective Roles in drug design and discovery***

2. **Drug discovery, Drug designing basics and current scenario**

3. Following parameters/ aspects can be studied with steps involved or examples studies its working etc* **(03)**

a) Commercial software packages for drug design (Name, Owned and distributed by, Modules).
b) The most used docking programs in structure-based drug design.
c) Commonly used pharmacophore modeling programs*#.
d) Homology modeling programs used in drug design
e) Databases of interest for drug discovery
f) Major molecular dynamics programs used in drug design.
g) Quantum mechanics programs with frequent use in drug design.
h) Available ADME/T prediction programs
i) Programs for molecular visualization.

4) Stereochemistry and drug action
5) Bio-isosterism
6) Practical's based on CADD/ drug design soft wares for the molecules studied in theory part (molecules designed by consideration of Histamine, Ach and other CNs and ANS receptors) (05)
7) Benzocaine from PABA PABA from p nitrobenzoic acid- p nitro toluene (2 step)
8) Flavones (2 phenylbenzo-4-pyrone) (03 step)
9) Phenytoin Condensation (02 step)
10) Methyl 2 napthyl ether (beta napthol, dimethyl sulphate, NAOH, ethanol)

11) Thiobarbituric acid from diethyl malonate and thiourea
12) Practicals based on microwave synthesis
13) Probable and relevant practicals based on theory portion can also be covered
14) Photochemical reactions using sunlight
15) Solvent free solid phase reactions
16) Solvent recovery
17) Minimization of chemical pollution

Reference Books, Journals and Weblinks:

1. Wilson & Gisvold's Text book of Organic, Medicinal & P'Ceutical Chemistry, Lippoincott
2. M E Wolff, Burgers Medicinal Chemistry Vol I to V, John Wiley ans Sons
3. Indian Pharmacopoeia
4. Finar I L, Organic Chemistry Vol –II, ELBS publication
5. Willam and Smith, Drug Design series
6. Thomas Nagrady, Medicinal Chemistry (A Biochemical Aproach)
7. Gautam Mulik, Fine Chemicals and Pharmaceuticals
8. Pattrick, Greham L., An Introduction to Medicinal Chemistry, Oxford University.
9. Ales Gringauz, Introduction to Medicinal Chemistry, How Drug Act and why, Wiley.VCH
10. Kadam, Mahidak, Bothra, Principles of Medicinal Chemistry, Vol II, Nirali Prakashan.
11. Profiles in drug synthesis, edited by Dr. Gogte, Vol. – I & II, Gokul Publishers.
12. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Eleventh Edition, edited by J. H. Block and J. M. Beale Jr., Lippincott Williams & Wilkins, Philadelphia.
13. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York.
14. Foye's, Principles of Medicinal Chemistry, Sixth Edition, Wolters Kluwer (India), Lea & Febiger, Philadelphia, USA.
15. Singh, H. and Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Second Edition Vallabh Prakashan, Delhi.
16. Vogel's A Text book of Practical Organic Chemistry, A. Vogel, 3rd, 1962, Longman group limited, London.
17. Advanced Practical Organic Chemistry, J. Leonard, trvor P. Toube, B. Lygo, G. Proctor, 2nd , 1990, Stanley Thornes.
18. Practical Organic Synthesis: A Student's Guide, Reinhart Keese, Martin P. Brandle
19. Molecular Modeling and Computer Aided Drug Design. Examples of their Applications in Medicinal Chemistry, Current Medicinal Chemistry, 2000, 7, 141-158, F. Ooms* (http://www3.uah.es/farmamol/Public/Curr_Med_Chem/MolMod_CMC2000.pdf)

20. Integrating research and development: the emergence of rational drug design in the pharmaceutical industry Matthias Adam Department of Philosophy, Bielefeld University (http://philsci-archive.pitt.edu/2397/1/Adam_rational_drug_design.pdf)
21. **The Pharmaceutical Industry and the Future of Drug Development, David Taylor-From the book: Pharmaceuticals in the Environment (**http://pubs.rsc.org/en/content/chapterhtml/2015/9781782622345-00001?isbn=978-1-78262-234-5**)**
22. **Software and resources for computational medicinal chemistry,** Chenzhong Liao, Markus Sitzmann, Angelo Pugliese, and Marc C Nicklaus Future Med Chem. 2011 Jun; 3(8): 1057–1085.
23. Wadood A, Ahmed N, Shah L, Ahmad A, Hassan H, Shams S. In-silico drug design: An approach which revolutionarised the drug discovery process. OA Drug Design & Delivery 2013 Sep 01;1(1):3.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : Neuropharmacology
Subject Code/Paper No : BPH54
Credits : 03 (02T+01Pr.)

The Course & Objective

The course content in **Neuropharmacology** provides understanding of how drugs affect cellular function in the nervous system, and the neural mechanisms through which they influences disordered state. It also focuses with the overall goal of developing drugs that have beneficial effects in neurological disorders. Studying this course, students will understand drugs to treat many different neurological disorders, including pain, neurodegenerative diseases, psychological disorders, and many others along with management of such conditions.

Course Content (Theory)

1. **Neurohumoral transmission in CNS** **(01 Hrs)**
2. **Alcohol and Disulfiram** **(02 Hrs)**
3. **General anaesthetics** **(02 Hrs)**
4. **Hypnotics, Sedatives and Centrally acting muscle relaxants.** **(02 Hrs)**
5. **Anti-Epileptic drugs** **(02 Hrs)**
6. **Narcotic analgesics and antagonist** **(02 Hrs)**
7. **Psychopharmacological agents** **(06 Hrs)**
    a. Antianxiety agents
    b. Antidepressants
    c. Antipsychotics
    d. Antimaniacs
    e. Hallucinogens
8. **Drugs used in neurodegenerative diseases** **(03 Hrs)**
    a. Parkinson's Disease
    b. Alzheimer's Disease
9. **CNS stimulants** **(01 Hrs)**
10. **NSAID's and Anti-gout drugs** **(03 Hrs)**

Recommended Books:

1. Barar F.S.K., A Text Book Of Pharmacology, Mehta Publications
2. Tripathi K.D., Essentials of medical Pharmacology, Jaypee Brothers Medical Publishers Pvt Ltd, New Delhi,

3. R.S. Satoskar, S.D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai
4. Katzumg B.G., Basic And Clinical Pharmacology, Lange Medical Publications
5. Vogel H.G., Drug Discovery And Evaluation, Springer House
6. Barar F.S.K., Essentials Of Pharmacotherapeutics, S. Chand &Co. Pvt. Ltd.,
7. Rang M.P., Dale M.M., Riter J. M./4thed, Pharmacology, Churchill, Livingstone

Course Content (Practical/Lab Work)

Note: It is suggested to use alternative teaching methods such as Books, Models, Films, Videos and Computer aided instructional packages like MSBTE, Mumbai's CAI Package for Experiments in Pharmacology; ExPharmPro; ExPharm; X-Cology; or any other such packages for practicals enlisted below-

1. **Study the principle and working of following instruments by means of any one example of experiment for each instrument. (06)**

   It is expected to evaluate students for understanding of application of instrument and mechanism of drug category tested.

   Prerequisite: It is expected students shall aware about small laboratory animals (rat/mice) behaviour and terminologies of neuropharmacological agents.

   a. Actophotometer
   b. Analgiometer
   c. Convulsometer
   d. Pole Climbing Apparatus
   e. Rota rod apparatus
   f. Tele-thermometer

2. **Experiments based on isolated animal preparations- (07)**

   a. Study the effect of Acetylcholine on isolated animal heart preparation
   b. Study the effect of Adrenaline on isolated animal heart preparation
   c. Study the effect of Atropine like parasympatholytics on isolated animal heart preparation
   d. Study the effect of Propranolol like *Beta* blockers on isolated animal heart preparation
   e. Study the effect of Temperature on isolated animal heart preparation
   f. Study the effect of electrolytes like Na, K, Ca using modified physiological salt solution on isolated animal heart preparation
   g. Study the effect of known antihypertensive in experimental animals.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : Physico-electro Analytical Technique
Subject Code/Paper No : BPH55
Credits : 03 (02T+01Pr.)

Scope:

Analysis of Pharmaceuticals play a very important role in industry as it relies upon both qualitative and quantitative chemical analysis to ensure that the raw material used meets Pharmacopoeial specifications and also ensures a quality of finished product in terms of proportion of components.

The subjects of Pharma Analysis are designed and distributed at third and fourth level of the programme. The objective of the course is to study the various techniques employed in analysis of Pharmaceuticals. The course encompasses the methods of production of analytical data, which is related to quality of the product assured by employing different instrumental techniques.

Course content (Theory)

1. Density measurement and its applications: (02 Hrs)
Density, Specific Gravity, Pycnometer, Archimedes Principle, Procedure, Applications

2. Refractometry: (03 Hrs)
Refractive index, Snell's law, factors affecting refractive index, specific refraction, molar refraction, instrumentation and applications.

3. Polarimetry: (03 Hrs)
3.1 Definitions: Optical active compound, Asymmetric carbon, Enantiomers, Diastereomers, Racemic Mixture, Circular birefringence, plane polarized light, plane of polarization Optical activity
3.2 Theory: Principle, Specific Rotation, Molar Rotation, factors affecting on angle of rotation Instrumentation of polarimeter, Applications

4. Phase solubility analysis: (02 Hrs)
Phase solubility diagram and their interpretation, Limitation, applications

5.Thermal Analytical Techniques: (04 Hrs)
5.1 Definition and principle of Thermogravimetry (TG), Derivative Thermogravimetry (DTG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC)
5.2 Instruments of DTA and DSC

5.3 Experimental and Instrumental Factors
5.4 Applications of DTA and DSC

6.Radio immune assay: (02 Hrs)
6.1 Definition: Antigen, Hapten, Epitope, Antibody, Antiserum, Antibody affinity, Cross reaction
6.2 Theory: Principle, General procedure, Assay design, Applications

7. Electro Analytical Techniques: (10 Hrs)
Oxidation and reduction reactions, Electrolyte, Electrolysis, Indicator Electrodes, Reference Electrode , Electrochemical cell, Electromotive force (EMF)
7.1 Conductometry:
7.1.1 Definitions: Resistance, Specific Resistance, Conductance, Specific Conductance, Equivalent Conductance, Molar Conductance
7.1.2 Theory: Ohms law, Principle, Effect of dilution on various conductances
7.1.3 Instrumentation: Conductivity meter, Conductivity cell and its types, Polarization, Platinization, Cell Constant, Conductivity Water
7.1.4 Conductometric Titration: Principle, Types, Titration Curves
7.1.5 Applications

7.2 Polarography:
7.2.1 Definition: Polarisable and Non-polarisable electrodes, Half Wave potential, Diffusion Current, Residual current, Migration Current, Maxima Suppressor, supporting electrolyte
7.2.2 Theory: Principle, Polarogram
7.2.3 Instrumentation: Polarography Apparatus, Dropping Mercury Electrode: Merits, Limitations and Care
7.2.4 Applications

1. **Amperometry:** Principle, Instrumentation, Titration Curves, Advantages, Disadvantages, Applications

7.4 Potentiometry: Principle, Instrumentation: Reference electrodes, Indicator electrodes, Ion selective electrodes, Potentiometry titrations**,** Applications

Course Content (Practical/Lab Work)

I. General Physical methods

1. Specific gravity and density determination of liquid.
2. Determination of percentage of components present in the mixture

II. Refractometry

1. Refractive index measurement in identification and quantitative analysis.
2. Critical micell concentration (CMC) determination by refractometry.

III. Polarimeter: Polarimetric measurements in identification and quantitative analysis.

1. Measurement of specific rotation
2. Quantitative analysis of Dextrose solution.

IV pH and potentiometry

1. Calibration, use and care of potentiometer
2. Potentiometric titration of 0.1 N HCl V/s 0.1 N NaOH
3. Determination of pKa value of acetic acid by using pH meter.
4. Determination of pKa value of phosphoric acid by using pH meter.
5. Determination of amount of phosphoric acid from mixture of HCl and Phosphoric acid.
6. Determination of pH of hair shampoos/other liquid sample.
7. Potentiometric determination of fluoride in drinking water using fluoride ion sensitive electrode.

V Conductometry-

1. Calibration of conductometer and estimation of conductivity of distill water.
2. Estimation of acids in given sample by conductometric titration.
3.

Recommended Books

Text Books:

1. K. A. Connors, A Text Book of Pharmaceutical Analysis, John Wiley & Sons.

Reference Books:

1. A.H. Beckett and J.B. Stenlake, Practical Pharmaceutical Chemistry, Vol. I & II.
2. Willard and Meritt, Instrumental methods of Analysis, CBS Publication.
3. J.W.Munson, Pharmaceutical Analysis, Modern methods, Part A & B
4. G.W. Ewing, Instrumental methods of chemical Analysis, McGraw Hill International Edition.
5. Skoog, Principles of Instrumental Analysis, Saunders college publishing.
6. D.C. Harris, Exploring chemical Analysis, W.H. Freeman and Company.
7. Gary D. Christian, Analytical Chemistry, John Wiley and Sons. Inc.
8. P. parimoo, Pharmaceutical Analysis, CBS Publishing.
9. Robert de Levie, Principles of quantitative chemical Analysis McGraw Hill International Series.
10. Chatwal and Anand, Instrumental methods of chemical analysis, Himalaya publishing house
11. Gary D. Christian, Analysitical Chemicatry, John Wiley and Sons. Inc.
12. B.G.Nagavi, Laboratory hand book of instrumental drug analysis, Vallabh Prakashan.
13. Indian Pharmacopoeia 1996.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : Phytochemical Approaches of Natural Products
Subject Code/Paper No : BPH56
Credits : 03 (02T+01Pr.)

Course content (Theory)

1. Pharmacognostic study of crude drugs: (16 Hrs)

Emphasis shall be on Biological Source, Chemical constituents, Substituents, Aadulterants, Uses, Diagnostic macroscopic & microscopic features and specific Chemical test.

1.1 Glycosides

i)	Saponins	: Liquorice, Ginseng, Dioscorea, Senega.
ii)	Cardioactive sterols	: Digitalis, Squill, Stophanthus, Thevetia
ii)	Anthraquinone Cathartics	: Aloe, Senna, Rhubarb, Cascara.
iv)	Others	: Psoralea, Amis majas, Ammivisnaga, Gentian, Saffron, Chirata, Quassia Picroriza, Kalmegh.

1.2 Volatile oils:

i)	Alcohol	: Cardamom, Coriander, Sandalwood
ii)	Aldehyde	: Cinnamon, Lemon grass, Dill, Bitter almond
iii)	Ester & Hydrocarbon	: Gultheria, Mustard, Black pepper
iv)	Ketone & Oxide	: Caraway, Musk, Spearmint, Chenopodium, Eucalyptus
v)	Phenol and Phenolic Ether	:Clove, Fennel, Nutmeg

2. Fundamentals of raw material from plant source for natural product (03 Hrs)

i) Procurement and supply channels of plant drug materials through cultivation, wild collections, commercial market sources, traders and brokers.
ii) Authentication of plant material through comparison with reference samples, gross morphology and diagnostic microscopic character.

3. Extraction & Distillation of Phytopharmaceuticals: (06 Hrs)

i) Definition & Categories of extraction
ii) Various extraction and distillation process.
Infusion, Decoction, Digestion, Maceration, Percolation, Successive Solvent Extraction, Supercritical Fluid Extraction, Steam Distillation, Headspace Technique.
iii) Selection of a suitable extraction process.

Recommended Books:

1. W.C. Evans Trease and Evens, Text book of Pharmacognosy
2. C.K.Atal and B.M.Kapur, "Cultivation and Collection of Medicinal Plants".
3. C.K.Atal and B.M. Kapur, "Cultivation and Collection of Aromatic Plants".
4. C.K.Kokate, A.P.Purohit, S.B.Gokhale, "Text book of Pharmacognosy".
5. T.E.Wallis, Text book of Pharmacognosy.
6. V.E.Taylor, L.R.Brady and J.E.Robbers, "Pharmacognosy"
7. S S Agrawal and M Paridhavi, Herbal drug Technology, University Press, Hydrabad.
8. The Practical Evaluation of Phyto pharmaceuticals Brain and Turner.
9. V.D. Rangari; Pharmacognosy & Phytochemistry; Part I&II; First edition; Career publication; Nashik.

Course Content (Practical/Lab Work)

1) To study Morphological and Microscopic characteristics of crude drugs and their powder from volatile oils and glycosides categories of drugs listed in theory syllabus. (**08 Practical)**

2) Authentication of plant drug material through gross morphology and diagnostic microscopic character. (**01Practical)**

3) Extraction of volatile oils from plant drug. (**04 Practical)**

Recommended Books:

1. Bain KR and Turner TD, Practical Evaluation of Phytopharmaceuticals. Wright Suintechnica, Bristol.
2. C.K.Kokate; Practical pharmacognosy; Vallabh prakashan;Delhi.
3. K.R. Khendelwal; practical pharmacognosy; Nirali prakashan, Pune.
4. V.D. Rangari; Pharmacognosy & Phytochemistry; Part II; First edition; Career publication; Nashik.
5. A N Kalia , Text book of Industrial Pharmacognosy, CBS Publishers & distributers, New Delhi.
6. S S Agrawal and M Paridhavi, Herbal drug Technology, University Press, Hydrabad.
7. T. N Vasudevan and K S Laddha, Herbal Drug Microscopy, Yucca Publishing House, Mumbai.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : **Immunology**

Subject Code/Paper No : **BPH57**

Credits : **02 (02T)**

Objective:

This course aims at general principles governing the structures and functions of various molecules of the Immune system at an elementary level. Development of immunological tolerance, hypersensitivity reactions, auto immunity, tissue transplantation and rejection are emphasized.

It also aims to have practical application of organisms or their cellular components to manufacturing and service industries like pharmaceuticals.

Learning Goals:

The study encompasses general principles of immune system and biotechnology to develop newer, safe and better therapeutic products.

Course Content (Theory)

1. Etiology of diseases **(04 Hrs)**

Concept of Normal flora of human body, Host microbe relationships, pathogens, pathogenicity and virulence, normal microflora, Koch's postulates, kinds of diseases, classification of diseases, communicable and non-communicable diseases, contamination, Infectious diseases, Stages of infectious diseases, Virulence factors: invasiveness and toxigenicity, Signs, symptoms and syndrome.

2. Epidemiology **(03 Hrs)**

What is epidemiology, diseases in populations, epidemiological studies, portals of entry and portals of exit of pathogens, reservoirs of infection, modes of disease transmission, herd immunity, control of disease transmission.

3. Non specific host defenses and host systems **(05 Hrs)**

Non specific and specific host defences, physical barriers, cellular defenses (defensive cells, phagocytes, process of phagocytosis, extra cellular killing, inflammation (characteristics of

inflammation, the acute inflammatory process, repair and refiner action, chronic inflammation) fever, molecular defences e.g. interferon's.

4. Immunology-I: Basic principles of specific immunity and immunization (05 Hrs)

Immunology and types of immunity (acquired, active and passive), general properties of immune responses, properties of antigen and antibodies, dual nature of the immune system, humoral immunity, cell mediated immunity, primary and secondary responses, kinds of antigen antibody reactions.

5. Immunology-II (07 Hrs)

Overview of immunological disorders and tests, hypersensitivity, immunodeficiency, Immediate (Type-I) hypersensitivity - allergen, mechanism of immediate hypersensitivity, localized anaphylaxis, generalized anaphylaxis, genetic factors in allergy, Catatonic (Type-II) hypersensitivity- mechanism of catatonic reaction, examples, Immune complex (Type-III) hypersensitivity - mechanism of immune complex disorders, Cell mediated (Type-IV) hypersensitivity- mechanism of cell mediated reactions, examples. Autoimmune disorders – autoimmunization, transplantation – histocompatibility antigens, transplant rejection, primary immunodeficiency diseases

Recommended Books:

1. Microbiology- Principles and Explorations, Jacquelyn Black
2. Hugo and Rusell'sPharmacutical Microbiology, Stephan P Denyer, N. A. Hodges S. P. Gormao, Balckwell Publication
3. Fundamentals of Microbiology , Frobisher
4. Foundations in Microbiology, UlhasPatil, J. S. Kulkarni, A. B. Chaudhari, S. B. ChincholkarPublisherNiraliPrakashan PUNE.
5. Molecular Biology and biotechnology, edited by J.M. Walkar and R. Rapley, Panima Publishing corporation, New Delhi, 4th edition, 2002.
6. Pharmaceutical Biotechnology, S.P.Vyas and U.K.Dixit, CBS Publishers and distributors, New Delhi. 2001.
7. Pharmaceutical Microbiology, Chandrakant Kokare.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, Vth Semester

Subject : Pharmacology of Hormones & CVS
Subject Code/Paper No : BPH58
Credits : 02 (02T)

The Course & Objective

The content in this course provides understanding with the actions of Hormones & endocrine diseases, and its treatment. Hormones show its effect on different organ systems in the body and are involved a number of feedback mechanisms, so that often one hormone will control the action or release of another secondary hormone and also maintaining homeostasis. Hormones therapeutically used both as replacement therapy and or for cure of disordered state at pharmacological doses.

The variety and scope of cardiovascular drugs have increased tremendously in the past few decades, and new drugs are being approved annually. This course focuses on drugs used to treat cardiovascular diseases and also consideration is given on diuretics & drugs acting on blood components. Studying this course, students will understand drugs to treat heart related disorders and management of such conditions.

Course Content (Theory)

I) Endocrine System (10 Hrs)

1. Hypothalamic and pituitary hormones
2. Thyroid hormones and Antithyroids drugs, PTH, Calcitonin and Vit D
3. Insulin, oral hypoglycaemic agents and glucagon
4. Corticosteroids
5. Androgens and drugs for erectile dysfunction
6. Estrogens, progestin and contraceptives

II) Cardiovascular System (09 Hrs)

1. Digitalis and cardiac glycosides.
2. Antihypertensive drugs.
3. Antianginals and Vasodilator drugs
4. Antiarrythmic drugs

III) Haemopoietic System (03 Hrs)

Haematinics, anticoagulants, fibrinolytics, anti-platelets, hypolipidemic drugs

IV) Diuretics and their role in cardiovascular disorders (02 Hrs)

Recommended Books:

1 Barar F.S.K., A Text Book Of Pharmacology, Mehta Publications
2 Tripathi K.D., Essentials of medical Pharmacology, Jaypee Brothers Medical Publishers Pvt Ltd, New Delhi.

3 R.S. Satoskar, S.D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai
4 Katzung B.G., Basic And Clinical Pharmacology, Lange Medical Publications
5 Vogel H.G., Drug Discovery And Evaluation, Springer House
6 Barar F.S.K., Essentials Of Pharmacotherapeutics, S. Chand &Co. Pvt. Ltd..
7 Rang M.P., Dale M.M., Riter J. M./4thed, Pharmacology, Churchill, Livingstone

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : **Pharmaceutical Technology-I (DFD-II)**

Subject Code/Paper No : **BPH61**

Credits : **03 (02T+01Pr.)**

Course content (Theory)

Dosage Form Necessities and Additives **02 hrs**

Antioxidants, preservatives, coloring agents, flavoring agents and diluting agents, emulsifying agents, suspending agents, ointment bases, solvents, and others

Design of Solutions: **04 hrs**

Advantages and disadvantages of solutions as an oral dosage form. - Formulation of oral solutions.- Aqueous solution, Non-aqueous solutions Formulation additives.

Design of Suspensions: **06 Hrs**

Advantages and disadvantages of suspension dosage form. ideal properties of a well formulated suspension. Formulation of suspension – Particle size control, wetting agents – surface active agents, hydrophilic colloids and solvents. Types of suspension – Flocculating agents, degree of flocculation. Rheology of suspension – viscosity modifiers – polysaccharides, acacia, tragacanth, alginates, starch. Water soluble celluloses,Hydrated silicates –Formulation additives, Stability testing of suspension – centrifugation, rheological assessment, temperature cycling.

Design of Emulsions: **06 hrs**

Advantages and disadvantages, identification test, Theory of emulsification ,Formulation of emulsions – Choice of emulsion type, choice of oil phase, emulsion consistency – volume concentrations of dispersed phase, particle size of dispersed phase, viscosity of continuous phase, viscosity of dispersed phase, nature and concentration of emulsifying system. Choice of emulsifying agents, classifications of emulsifying agents Formulations by the HLB method, Other formulation additives, Stability of emulsions –Stability testing of emulsions. Methods of assessing stability.

Design of parenteral products: **06 Hrs**

Routes of administration, Formulations of injections, Osmotic pressure – Intravascular injections, intrathical injections, intramuscullar, intracutaneous and subcutaneous injections. Hydrogen – ion concentration and its effect, Suspension for injection parameter, Particle size, emulsion for injection – Intravenous therapy and emulsion. Colloidal dispersions and solubilized products – quality assurance of injections – Microbiological preservation chemical stability of the medicament particulate contamination.

Recommended Books:

1. Pharmaceutics – The Science of dosage form design, Edited by, M.E. Aulton, International Student edition 1998
2. Pharmaceutical Dosage forms – Parenteral medications. Edited by, Liberman and Lachman, Marcel Dekkar Vol. I,II & III.
3. Pharmaceutical Dosage forms – Disperse systems. Edited by Lieberman & Reiger and Banker, Marcel Dekker Vol. I,II & III
4. Pharmaceutical Dosage forms – Tablets, Edited by Liebermann, Lachman, Marcel Dekker Vol. I,II & III
5. Modern Pharmaceutics, Second Edition Banker, Rhodes, Marcel Dekker
6. Sterile dosage forms, their preparation and clinical application, 3rd Edition, Tarco, King, Lea and Febiger.
7. Pharmaceutical Dosage forms and drug delivery systems, Ansel, 7th Edition, International student edition.
8. Introduction to Pharmaceutical Dosage forms, Ansel, 4th Edition, Lea and Febiger.
9. The theory & practice of industrial pharmacy Lachman, Lieberman, Kanig, 3rd Edition, Varghese Publishing House.
10. Remignton, The science and practice of Pharmacy 20th Edition, Edited by Gennaro, LIpincott Williams and ,Willkins, International student edition.

Course content (Practical/Lab Work)

1.	Formulation of a solution for Paediatric use.	(01 Pr)
2.	Formulation of syrup for reconstitution (Dry syrup).	(01 Pr)
3.	Formulation of a solution for external use (Antibacterial solution)	(01 Pr)
4.	Formulation of a suspension having low solid content.	(01 Pr)
5.	Formulation of a suspension having high solid content.	(01 Pr)
6.	Formulation of a suspension using structured vehicle.	(01 Pr)
7.	Formulation of an emulsion for internal use.	(01 Pr)
8.	Formulation of a fat emulsion for parenteral nutrition.	(01 Pr)
9.	Formulation of an emulsion with high internal phase (w/o)	(01 Pr)
10.	Formulation of an emulsion for external application	(01 Pr)
11.	Formulation of parenteral products.	(02 Pr)

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : **Pharmaceutical Technology-III (DFM-II)**

Subject Code/Paper No : **BPH62**

Credits : **03 (02T+01Pr.)**

Objective:

The course aims at the study of common manufacturing stresses observed while manufacturing of liquid dosage forms at industrial scale. These stresses have impact on stability of formulations. The course prepares a pharmacist to rectify all these stresses, to improve the production at economic and stable level.

Learning goals:

1. On the successful completion of the following theory topics and laboratory work, students shall be able…
2. To study the different liquid dosage forms to be formulated as state of art at large scale manufacturing and deal the manufacturing problems in pharmaceutical formulations.
3. To understanding the manufacturing principles of suspensions and emulsions, impact of manufacturing stresses on the stabilization of dispersed system etc…

Course content (Theory)

1. **Suspension Technology:** **(07 Hrs)**

   Introduction, Pharmaceutical applications of suspensions, preparation methods (Precipitation method, dispersion method) aggregated system, rheological consideration formulation adjuvants, evaluation of Suspension stability (Sedimentation volume, rheologic method, electro-kinetic Technique)

   Effect of stresses: particle size and particle size distribution, temperature fluctuations, crystal growth, concentration of suspending agents, Ostwald ripening, *zeta* potential and Its application in suspension stability.

2. **Emulsion Technology:** **(07 Hrs)**

   Introduction, pharmaceutical applications, equipments for emulsification (mechanical stirrers, homogenizers, colloidal mill, ultrasonifiers) Identification of emulsion, Evaluation of physical stability of emulsion (creaming, phase inversion, droplet size and its determination, accelerated stability studies and effect of centrifugation)

   Effect of stresses: Temperature change, timing, agitation, concentration of emulsifying agents with respect to HLB value and *zeta* potential.

3. **Solutions:** **(04 Hrs)**

   Manufacturing considerations, Raw materials, equipments, compounding procedure,

   Common stresses: pH, viscosity, temperature, weight/ml, dry syrup etc.

4. **Parenteral Technology:** **(06 Hrs)**

   Introduction, large scale preparation, manufacturing facilities, environmental control, personnel, packaging components, product preparation, control, labeling.

   In Process quality control- Physical, Chemical and Biological indicators.

Recommended Books:

1. The theory and Practice of Industrial Pharmacy by Leon Lachman, Herbert Lieberman and Joseph Kanig, 4th edition, CBS Publishing House.
2. Pharmaceutics, The Science of Dosage Form Design by M E Aulton, Second Edition, Churchill Livingstone Publication.
3. Textbook of Physical Pharmaceutics, by CVS Subrahmanyam, Vallabh Prakashan, Delhi
4. Pharmaceutical dosage forms an drug delivery systems, Ansel, 7thedition.
5. Pharmaceutical dosage forms- dispersed system, edited by Lieberman, Lachman, Marcwl Dekker Vol I, II & III.
6. Pharmaceutical dosage forms- Parenterals edited by Lieberman, Lachman, Marcwl Dekker Vol I, II & III.
7. Industrial Pharmaceutical Technology, Dr Javed Ali, Dr. Alka Ahuja, Dr. Sajula Baboota, Birla Publications.

Course content (Practical/Lab Work)

Solutions

1. Manufacture of Paracetamol syrup for Paediatric use.
2. Study the effect of concentration on the stability of syrup
3. To study the effect of temperature on the stability of syrup
4. To study the effect of agitation on the viscosity of syrup

Suspension Technology

5. To prepare and evaluate suspension for the various parameters.
6. To study the effect of particle size on the stability of suspension.
7. To study the effect of temperature cycling on the stability of suspensions.

Emulsion Technology

8. To manufacture and identify the type of an emulsion
9. To manufacture and evaluate the emulsion.
10. To study the effect of homogenization on the stability of emulsion.
11. To study the effect of temperature and agitation time on the stability of emulsion.

Parenteral Technology

12. To evaluate different types of glass containers

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : Medicinal Chemistry-II
Subject Code/Paper No : BPH63
Credits : 03 (02T+01Pr.)

SCOPE

The study of medicinal chemistry play a very important role in understanding the drug design, chemical classification, chemistry, synthesis, SAR, mechanism of drug action by considering site of action or receptor structural components and thus helps in designing the drug molecule for disease with fewer side effects.

Objective of Theory

- Orientation of teaching approach should be focused on discussion of chemistry of drugs rather than pharmacological part.
- Emphasis should be given to **chemical classification** of all topics mentioned
- Synthesis in theory should cover **prototype of the respective category**
- **Review/ study of drugs available in market of each category is highly expected.**

Course Content (Theory)

Classes of drugs discussed in relation to: Introduction to the

- Rational of drug development/ drug design,
- Important physicochemical parameters/aspects in relation to p'kinetics and dynamics
- **Chemical classification (prototype drug of each class should be discussed),**
- Structure (nucleus or skeleton) & Nomenclature,
- Stereochemistry of drugs (if any)
- Synthesis of specified/ prototype drugs (given with*)
- mode of action (must be discussed by considering receptor site/structure)
- Structure Activity Relationships (SAR)**,**
- important therapeutic uses
- drug combination (compatibility, synergism, antagonism etc)

1. **Drugs acting on Hormones and their receptors: (10 Hrs)**
   i) Insulin and synthetic hypoglycemic agents: Chlorpropamide, Phenformin, Tolbutamide
   ii) Steroids:
   Adrenocorticoids: Prednisolone, Triamcinolone, Betamethasone, Dexamethasone
   Sex Hormones: Testosterone, Progesterone, Methyl testosterone
   Oral contraceptives: Estradiol, Mestranol, Lynestrenol
   iii) Prostaglandins, Thromboxanes and non-steroidal anti-inflammatory agents: Aspirin, Paracetamol, Ibuprofen, Piroxicam, Diclofenac

2. **Drugs acting on cardiovascular system (12 Hrs)**

   i) Cardiotonic: cardiac glycosides
   ii) Antianginal and vasodilators : Organic nitrates, **ISDN*, Nifedipine***
   iii) Antiarrhythmic agents Quindine, **Mexilitene***, **Verapamil*.**
   iv) Antihypertensive agents Propranolol, Minoxidel, Hydralazine.
   v) Coagulants and anticoagulants: Heparin, **Dicoumarol***.

3. **Diuretics**: (**02 Hrs)**
   Acetazolamide, Furosemide, Hydrochlorthiazide

Course content (Practical/Lab Work)

Objective of practical

- **Preparation of ppt, presentation by students, review of on line videos related to all practical, will be highly encouraged**
- **Study of reaction mechanism of synthesis included in syllabus is expected**
- **Study of peer Reviewed articles related to all articles time to time is expected**

1. Practical's based on CADD/ drug design soft wares for the molecules studied in theory part (molecules designed by consideration of anti-inflammatory; both steroidal and non steroidal receptors; CVS receptors) (7)
2. Attending CADD based conference/ workshops etc/ visit the place where CADD related facilities are available (01)
3. Collection and Review of articles based on CADD for the drugs related to theory topics (01)
4. Synthesis of Benzhydrol (the Benzhydryl group is present in the structure of many histamine H1 antagonists) (01)

5. Synthesis of Benzilidine acetophenone (01)
6. Probable synthesis of drugs studied in theory (01)
7. Synthesis of Mefenamic acid. (01)
8. Synthesis of Benzyl benzoate. (01)
9. Practicals based on microwave synthesis (01)
10. Probable and relevant practicals based on theory portion can also be covered (01)
11. Photochemical reactions using sunlight (01)
12. Solvent free solid phase reactions (01)
13. Solvent recovery
14. Minimization of chemical pollution

Recommended Books:

1. Wilson & Gisvold's Text book of Organic, Medicinal & P'Ceutical Chemistry, Lippoincott
2. M E Wolff, Burgers Medicinal Chemistry Vol I to V, John Wiley ans Sons
3. Indian Pharmacopoeia
4. Finar I L, Organic Chemistry Vol –II, ELBS publication
5. Willam and Smith, Drug Design series
6. Thomas Nagrady, Medicinal Chemistry (A Biochemical Aproach)
7. Gautam Mulik, Fine Chemicals and Pharmaceuticals
8. Pattrick, Greham L., An Introduction to Medicinal Chemistry, Oxford University.
9. Ales Gringauz, Introduction to Medicinal Chemistry, How Drug Act and why, Wiley.VCH
10. Kadam, Mahidak, Bothra, Principles of Medicinal Chemistry, Vol II, Nirali Prakashan.
11. Profiles in drug synthesis, edited by Dr. Gogte, Vol. – I & II, Gokul Publishers
12. Molecular Modeling and Computer Aided Drug Design. Examples of their Applications in Medicinal Chemistry, Current Medicinal Chemistry, 2000, 7, 141-158, F. Ooms* (http://www3.uah.es/farmamol/Public/Curr_Med_Chem/MolMod_CMC2000.pdf)
13. Integrating research and development: the emergence of rational drug design in the pharmaceutical industry Matthias Adam Department of Philosophy, Bielefeld University (http://philsci-archive.pitt.edu/2397/1/Adam_rational_drug_design.pdf)
14. The Pharmaceutical Industry and the Future of Drug Development, David Taylor- From the book: Pharmaceuticals in the Environment (http://pubs.rsc.org/en/content/chapterhtml/2015/9781782622345-00001?isbn=978-1-78262-234-5)
15. Software and resources for computational medicinal chemistry, Chenzhong Liao, Markus Sitzmann, Angelo Pugliese, and Marc C Nicklaus Future Med Chem. 2011 Jun; 3(8): 1057–1085.
16. Wadood A, Ahmed N, Shah L, Ahmad A, Hassan H, Shams S. In-silico drug design: An approach which revolutionarised the drug discovery process. OA Drug Design & Delivery 2013 Sep 01;1(1):3.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : Chemotherapy of Anti-infective & Neoplastic Diseases
Subject Code/Paper No : BPH64
Credits : 03 (02T+01Pr.)

The Course & Objective

Antimicrobial or anti-infectives are agents that kill microorganisms or inhibit their growth and are used to treat different infectious conditions. Such medicines can be grouped according to the microorganisms they act primarily against. The use of antimicrobial medicines to treat infection is known as antimicrobial chemotherapy, while the use of antimicrobial medicines to prevent infection is known as antimicrobial prophylaxis. This course content focuses on understanding mechanism behind action, selectivity approach and management of infectious conditions including Neoplastic/cancer condition.

Course Content (Theory)

1. **General principles of chemotherapy.** **(01 Hrs)**
2. **Sulphonamides and co-trimoxazole.** **(02 Hrs)**
3. **Antibiotics-** Penicillins, cephalosporins, chloramphenicol, Macrolides, Quinolines and fluoroquinolins, Tetracyclines, Amino glycosides **(08 Hrs)**
4. **Chemotherapy** of tuberculosis, leprosy, Malaria, fungal diseases, Viral diseases, protozoal diseases, worm infections, urinary tract infections and sexually transmitted diseases. **(10 Hrs)**
5. **Chemotherapy of malignancy** **(03 Hrs)**

Recommended Books:

1. Barar F.S.K., A Text Book Of Pharmacology, Mehta Publications
2. Tripathi K.D., Essentials of medical Pharmacology, Jaypee Brothers Medical Publishers Pvt Ltd, New Delhi,
3. R.S. Satoskar, S.D. Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan, Mumbai
4. Katzung B.G., Basic And Clinical Pharmacology, Lange Medical Publications
5. Vogel H.G., Drug Discovery And Evaluation, Springer House
6. Barar F.S.K., Essentials Of Pharmacotherapeutics, S. Chand &Co. Pvt. Ltd.,
7. Rang M.P., Dale M.M., Riter J. M./4thed, Pharmacology, Churchill, Livingstone

Course Content (Practical/Lab Work)

Note: It is suggested to use alternative teaching methods such as Books, Models, Films, Videos and Computer aided instructional packages like MSBTE, Mumbai's CAI Package for Experiments in Pharmacology; ExPharmPro; ExPharm; X-Cology; or any other such packages for practicals enlisted below-

I) Bioassay

1. Introduction to Bioassay, Bioassay Principle and types
2. Equipments used for Bioassay methods including modern techniques like use of force transducers, data acquisition system etc.
3. Study the techniques of isolation of small laboratory animal's tissue preparations like duodenum, uterus, fundus, tracheal chain, ileum etc & assembly setup for bioassay techniques for bioassay method.
4. Study the Concentration response Curve (CRC) of Acetylcholine like agonists.
5. Study the effect of Physostigmine on Concentration response Curve (CRC) of Acetylcholine
6. Study the effect of d-tubocurarine on Concentration response Curve (CRC) of Acetylcholine
7. Study the Matching Bioassay method to find out the strength of unknown sample.
8. Study the Interpolation Bioassay method to find out the strength of unknown sample
9. Study the Three Point Bioassay method to find out the strength of unknown sample
10. Study the Four Point Bioassay method to find out the strength of unknown sample

It is expected to provide data to the individual student for practical number 4-10 as required and accordingly students shall be evaluated on the basis of understanding above techniques and their applications.

II) Biostatistics (Problem solving skill based practicals)

a. Standard Deviation and Standard error
b. Test of significance, student 't' test, paired 't' test
c. Analysis of variance test(ANOVA)
d. The Chi-square test

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : Separation Techniques
Subject Code/Paper No : BPH65
Credits : 03 (02T+01Pr.)

Course content (Theory)

1. Introduction of Separation Techniques: (01 Hr)

Definition, Types of separation method, Importance of separation techniques in Pharmaceutical Analysis

2. Solvent extraction: (05 Hrs)

Introduction, Distribution law and partition coefficient, Linear and Nonlinear partition isotherm, Steps involved in extraction, Single and Multiple extractions: theory and problem, Factors affecting extraction,
Extraction techniques: Batch extraction, Back extraction, Continuous extraction, Counter current extraction, Soxhlet extraction, Counter Current Distribution Technique (CCD), Applications.

3. Chromatographic techniques: (18 Hrs)

i. Introduction of Chromatography
ii. Detail Classification.
iii. Separation Techniques.
iv. Choice of method.
v. **Column Chromatography:** Principle, Operational Technique, Elution Procedure, Factors Affecting Column Efficiency and Applications.
vi. **Thin Layer Chromatography (TLC) :** Introduction, Principle, Operational Technique, Rf value , Factors affecting Rf value, Stahl Triangle, Advantages, Applications
vii. **High Performance Thin Layer Chromatography (HPTLC):** Introduction, Theory, Instrumentation, & Applications.
viii. **Paper Chromatography:** Introduction, Theory, Operational Technique, Types of paper Chromatography, Advantages, Applications
ix. **Ion-exchange Chromatography:**
Ion Exchange Resin: Definition, Classification, Requirements, Physical Properties, Ion Exchange Capacity, Regeneration of Ion Exchange Resin
Theory: Mechanism of ion exchange process, Operational Technique & Applications.
x. **Gel Chromatography:** Introduction, Mechanism of separation and Operational Technique.

xi. **High Performance/Pressure Liquid Chromatography (HPLC):** Introduction, Theory, Instrumentation & Applications.

xii. **Gas Chromatography (GC):** Introduction, Theory, Techniques of Gas Chromatography, Instrumentation & Applications.

xiii. **Programmed Temperature Gas Chromatography (PTGC):** Introduction, Instrumentation & Applications.

Course Content (Practical/Lab Work)

I. Solvent extraction

1. Extraction of Chloroquin phosphate from Chloroquin phosphate tablet.
2. Extraction of Caffeine from Tea
3. Extraction of Strychnine and Brucine from Nux-vomica seeds.

II. Column Chromatography

1. Separation of a mixture of Methylene blue and Flourescein on an alumina column.
2. Separation of mixture of ortho and para-nitro aniline on an alumina column.
3. Separation of chlorophyll pigments from leaves extract by column chromatography

III. Thin Layer Chromatography

1. Separation and identification of sugar by TLC
2. Separation and identification of Compound from mixture by TLC
3. Separation and identification of phytochemical from mixture by TLC

IV. Paper Chromatography

1. Separation and identification of Amino acid by ascending paper chromatography.
2. Separation and identification of Amino acid by Circular paper chromatography.

V. Ion Exchange Chromatography

1. To determine the conc. of salt solution by ion-exchange chromatography.
2. Preparation of free acid or base from the salt of an organic acid or base by ion-exchange chromatography.

VI. High Performance Liquid Chromatography

1. Separation and identification of Compound from mixture by HPLC
2. Separation , identification and quantification of Compound from mixture by HPLC

Recommended Books:

Text Book:

1. K. A. Connors, A Text Book of Pharmaceutical Analysis, John Wiley & Sons.

Reference Books:

1. A.H. Beckett and J.B. Stenlake, Practical Pharmaceutical Chemistry, Vol. I & II.
2. G.W. Ewing, Instrumental methods of chemical Analysis, McGraw Hill International Edition.
3. Skoog, Principles of Instrumental Analysis, Saunders college publishing.
4. D.C. Harris, Exploring chemical Analysis, W.H. Freeman and Company.
5. Robert de Levie, Principles of quantitative chemical Analysis McGraw Hill International Series.
6. Chatwal and Anand, Instrumental methods of chemical analysis, Himalaya publishing house
7. S. W. Rajbhoj., Dr. T. K. Chondhekar., Systematic Experimental Physical Chemistry, Anjali Publication.
8. Indian Pharmacopoeia 1996 Ministry of Health Government of India.
9. British Pharmacopoeia.
10. A.H. Beckett and J.B. Stenlake, Practical Pharmaceutical Chemistry, Vol. I & II.
11. Nagavi B.G., Laboratory hand book of Instrumental Drug Analysis.
12. Clarke's, Isolation and identification of drug.
13. Journals related to pharmaceutical analysis.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : Chemistry of Natural Products
Subject Code/Paper No : BPH66
Credits : 03 (02T+01Pr.)

Course Content (Theory)

1) Study of Crude Drugs Containing Alkaloids (08 Hrs)

Systematic study of source, cultivation, collection, processing, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic macroscopic and microscopic features and specific chemical tests for following categories alkaloids containing drugs.

i) Pyridine: - Piperidine – Tobacco, Areca and Lobelia.
ii) Tropane: - Belladonna, Hyoscyamus, Datura Duboisia, Coca and Withania.
iii) Quinoline and isoquinoline:- Cinchona, Ipecac, Opium.
iv) Indole: - Ergot, Rauwolfia, Catharanthus, Nux-vomica and Physostigma.
v) Imidazole: - Pilocarpus.
vi) Steroidal: - Veratrum and Kurchi.
vii) Alkaloidal amine:-Ephedra and colchicum.
viii) Glycoalkaloid :- Solanum
ix) Purines: - Coffee, tea and cola.

2) **Biogenesis of Phytopharmaceuticals: (08 Hrs)**

i) Introduction, general techniques of biosynthetic studies and basic metabolic pathways.
ii) Primary and secondary metabolites such as fatty acids, amino acids, alkaloids, glycosides & volatile oils viz; Morphine, Ephedrine, Quinine Papaverene, Atropine, Citral, Carvone, Sennosides, Digitoxin, Diosgenin.

1. **Chemistry and pharmacological activity of Phytoconstituents: (09 Hrs)**

i) Alkaloids: Atropine, Quinine, Morphine, Papaverene & Ephedrine.
ii) Terpenoids: Citral, Carvone. Zinziberane, Fernesol & Abietic acid
iii) Carotenoids: Alpha & Beta Carotenes, vitamin- A & Xanthophylls.

Recommended Books:

1. Trease and Evans: Pharmacognosy: ELBS, London.
2. Text book of Pharmacognosy by T.E. Wails
3. Pharmacognosy by V.E.Tylor, L.R.Brady and J.E.Robbers
4. Cultivation and Utilization of Medicinal Plants by Atal & Kapoor
5. Powdered Vegetable Drugs by B.P. Jeckson & D.W. Snewden
6. V.D. Rangari; Pharmacognosy & Phytochemistry; Part I&II; First edition; Career publication; Nashik.
7. C.K. Kokate; S.B.Gokhale; A.P. Purohit, pharmacognosy; Nirali Prakashan, 22nd edition, Pune.
8. Chatwal, Organic Chemistry of Natural Products, Vol- I & II.
9. O P Agrawal , Chemistry of organic Natural Products, Vol-I & Vol-II

Course Content (Practical/Lab Work)

1) Morphological and Microscopic characteristics of crude drugs mentioned under the category of alkaloids in theory syllabus.

(**06)**

2) Microscopic study of mixture of powdered crude drugs for identification mentioned under the category of alkaloids in theory syllabus

(**03)**

3) Phytochemical screening for alkaloids, polycyclic compounds (saponins, sterols, cardenolides and bufadienolides), flavonoids, tannins, anthraquinones, and carbohydrates (gums, mucilages)

(**04)**

Recommended Books:

1. C.K.Kokate; Practical pharmacognosy; Vallabh prakashan;Delhi.
2. K.R. Khendelwal; practical pharmacognosy; Nirali prakashan, Pune.
3. V.D. Rangari; Pharmacognosy & Phytochemistry; Part II; First edition; Career
4. publication; Nashik.
5. A N Kalia , Text book of Industrial Pharmacognosy, CBS Publishers & distributers, New Delhi.
6. S S Agrawal and M Paridhavi, Herbal drug Technology, University Press, Hydrabad.
7. T. N Vasudevan and K S Laddha, Herbal Drug Microscopy, Yucca Publishing House, Mumbai.
8. The Practical Evaluation of Phyto pharmaceuticals Brain and Turner.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : **Biotechnology of Pharmaceutical Products**

Subject Code/Paper No : **BPH67**

Credits : **02 (02T)**

Objective:

This course aims at a basic platform of advances in biotechnology of pharmaceutical products at an elementary level. Number of genetically modified technologies has been studied by different researchers which are emphasized in the syllabus.

It also aims to have practical application of technologies in manufacturing and service industries like pharmaceuticals.

Learning Goals:

The study encompasses general principles of biotechnology to develop newer, safe and better therapeutic products.

Course Content (Theory)

1. **Introduction to biotechnology-** Definition of biotechnology, scope and importance, commercial potential of biotechnology in India. **(03 Hrs)**

2. **Nucleic acids** – DNA, RNA Biological significance of DNA, Gene and gene function, Genetic control of proteins, information transfer and protein synthesis, nature of the genetic code, gene regulation. **(05 Hrs)**

3. **Recombinant DNA technology** **(07 Hrs)**

Restriction endonucleases – types, nomenclature, recognition sequence, cleavage patterns.

Gene coloring - steps involved.

Isolation of the desired gene – DNA library, preparation of DNA, isolation of m-RNA Genomic library – Construction of a genomic library identification of the desired clone. Vectors – Properties of a good vector, coloring and expression vectors, E coli plasmid, bacteria phage. Gene amplification through polymerase chain reaction applications of R-DNA technology

4. Fermentation Technology: **(07 Hrs)**

Fermentation processes –Definition, Types, Fermentation as a biochemical process, general description of equipments, design of a fermenter. Isolation methods for micro organisms, screening techniques, media composition, Media sterilization, inoculum preparation. Scale up of fermentation. Production of antibiotic - Penicillin, streptomycin, tetracycline. Production of vitamins (B_2 and B_{12})

5. Enzyme immobilization: **(02 Hrs)**

Definition, importance, applications and techniques of enzyme immobilization.

Recommended Books:

Text Books:

1. Biotechnology – B.D. Singh, Kalyani Publishers, 2001.

Reference Books:

1. Biotechnology – John E. Smith, Cambridge University Press, 3rd edition 1996.
2. Molecular Biotechnology – Principles and applications of recombinant DNA, Bernard R. Glick, Jack J. Pasternak, ASM Press, Washington DC, 2nd edition 1998.
3. Molecular Biology and biotechnology, edited by J.M. Walkar and R. Rapley, Panima Publishing corporation, New Delhi, 4th edition, 2002.
4. A text book on Biotechnology, H.D. Kumar, Affiliated EAST WEST Press, Pvt. Ltd., New Delhi. 2nd Edition, 2000.
5. Pharmaceutical Biotechnology, S.P.Vyas and U.K.Dixit, CBS Publishers and distributors, New Delhi. 2001.
6. Genetic Engineering and its applications, Dr. Preeti Joshi, Agorobios (India), 2001.
7. L.E.Casida, Jr., Industrial Microbiology (9th edition), New Age International (p) Ltd., Publishers, New Delhi.
8. Gerald Reed, Prescott and Dunn's Industrial Microbiology, (4th edition), CBS publishers and distributors, Delhi.

Swami Ramanand Teerth Marathwada University, Nanded

Third Year B. Pharmacy, VIth Semester

Subject : **Laws Governing Trade and Commerce of Pharmaceuticals**

Subject Code/Paper No : **BPH68**

Credits : **02 (02T)**

Objective:

Law governs attitude and behavior of persons in society. Pharmaceutical legislations are legal provisions that every person engaged in the business of pharmaceuticals must be aware of.

Learning Goals:

The business of pharmaceuticals is controlled. The students are expected to refer to legislative provisions controlling and regulating the trade, commerce, profession and administration whichever they want to enter into.

Course Content (Theory)

1 Pharmaceutical Legislation in India: A brief review **(01 Hr)**

2. Pharmacy Act – 1948 **(05 Hr)**

Pharmacy council of India: Constitution, composition and Incorporation of State Pharmacy Council and Joint State Pharmacy Council, functions and power, Education regulation, the central register of pharmacist, Registration in central register.

3 Drug and Cosmetics Act, 1940 and Rules in 1945 **(09 Hr)**

Definition, Drugs Technical Advisory board, Drug consultative committee central drug, Laboratory – composition and functions, Import of Drugs and cosmetics, Manufacturing, sales and distribution of drugs and cosmetics, Prohibition relating to Ayurvedic, Siddha and Unani drugs, Drug inspector –qualification, powers, duties, sampling procedures.

4 Drug and magic remedies act 1954 **(02 Hr)**

Definition, official duties and penalties

5 Narcotic and Psychotropic Substance Act 1985 (02Hr)

Historical background of opium act and dangerous drug act, Prohibition and Penalties under Narcotic and Psychotropic Substance Act 1985

6 Drugs (Prices Control) Order (03 Hr)

Drug as an essential commodity. Definitions, schedules to drugs (price control) orders. Discussion on following drug (price control order), Power to fix maximum sale prices of bulk drugs Information to be furnished by manufacturer in relation to schedule and Non- schedule bulk drugs. Power to direct manufacturing of bulk drugs to sale bulk drug to others manufacturing of formulation. Calculation of retail price of formulation. Power to fix retail price of scheduled formulations. Power to fix selling price of scheduled formulations. Revision of prices of bulk drugs and formulations. Drug price equalization count. Display of prices and price list. Sale of split quantity of formulation. Manufacturer, distributor or dealer not to refuse sale of drugs. Entry, search and seizures and penalties.

7 Introduction to Indian Patents Act (02Hr)

Recommended Books:

1. Drugs and Cosmetic Act and rules, 3rd Edition, by S.W. Deshpande and Nilesh Gandhi, Sumit Publishers, Mumabai, 2004
2. Drugs and Cosmetic Act, 1940 by Vijay malik, Eastern Book Company, Lucknow, 2002
3. Text Book of Forensic Pharmacy by C.K. Kokate and S.B. Gokhale, Pharma Book Syndicate,2006
4. Forensic Pharmacy, 4th Edition, by B. S. Kuchekar, A.M. Khadatare and S.C. Itkar, Nirali Prakashan, Pune, 2004
5. Hand Book of Drug Laws, 10th Edition by M.L. Mehra, Universal Law Publishing Company, Delhi