

## PY-401 :PHARMACEUTICAL CHEMISTRY-IV (ORGANIC CHEMISTRY-III)

### Course objectives:

- To provide fundamental knowledge of scientific nomenclature of heterocyclic compounds.
- To impart knowledge of structure, chemistry, synthesis, and reactions mechanism of some important heterocyclic compounds with one or two hetero atoms and fused heterocyclic compounds.
- To understand stereoisomerism in organic compounds.
- To understand the role of reagents in organic synthesis.

### Course outcomes:

Upon completion of this course the students are expected to be able to:

- Understand the structure, chemistry, synthesis and reactions of aryl halide,  $\alpha$ - $\beta$  unsaturated carbonyl compounds, some important heterocyclic compound with one or two hetero atoms and fused heterocyclic compounds.
- Perform synthesis, purification, and characterization of heterocyclic compounds.
- Recognize isomers, like R/S isomers, Cis-Trans and E/Z.
- Predict the role of reagents like NaBH<sub>4</sub> and LiAlH<sub>4</sub> etc. in drug synthesis.

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## THEORY

### **Stereo isomerism**

Optical isomerism – Optical activity, enantiomerism, diastereoisomerism, meso compounds  
Elements of symmetry, chiral and achiral molecules, DL system of nomenclature of optical isomers, sequence rules, RS system of nomenclature of optical isomers. Reactions of chiral molecules, Racemic modification and resolution of racemic mixture. Asymmetric synthesis: partial and absolute.

### **Geometrical isomerism**

Nomenclature of geometrical isomers (Cis Trans, EZ, Syn Anti systems), Methods of determination of configuration of geometrical isomers. Conformational isomerism in Ethane, n-Butane and Cyclohexane. Stereo isomerism in biphenyl compounds (Atropisomerism) and conditions for optical activity. Stereospecific and stereoselective reactions.

### **Heterocyclic compounds:**

Nomenclature and classification, Synthesis, reactions and medicinal uses of following compounds/derivatives Pyrrole, Furan, and Thiophene - Relative aromaticity, reactivity and Basicity of pyrrole,

Synthesis, reactions and medicinal uses of following compounds/derivatives Pyrazole, Imidazole, Oxazole and Thiazole, Pyridine, Quinoline, Isoquinoline, Acridine and Indole. Basicity of pyridine, synthesis and medicinal uses of Pyrimidine, Purine, azepines and their derivatives

### **Reactions of synthetic importance**

Metal hydride reduction (NaBH<sub>4</sub> and LiAlH<sub>4</sub>), Clemmensen reduction, Birch reduction, Wolff Kishner reduction. Oppenauer-oxidation and Dakin reaction. Beckmanns rearrangement and Schmidt rearrangement. Claisen-Schmidt condensation

**PRACTICALS: Minimum 15 experiments based on following:**

1. Laboratory Rules and Regulations
2. To Determine Melting Point, Molecular Weight & Thin layer chromatography of given sample.
3. Synthesis of Benzoyl Glycine (Hippuric Acid)
4. Synthesis of Dibenzylideneacetone
5. Synthesis of Chalcone (Benzylidene Acetophenone)
6. Preparation of Acetophenone Phenylhydrazone
7. Synthesis of Synthesis of 7-hydroxy-4-methyl Coumarin
8. Synthesis of Benzimidazole from O-Phenylenediamine.
9. Synthesis of 3-methyl-1-phenyl-5-pyrazolone
10. Synthesis of 4-arylidene-3-methyl-1-phenyl-5-pyrazolone
11. Synthesis of 2, 3-diphenyl quinoxaline
12. Synthesis of Isoxazole from Chalcone.
13. Synthesis of Pyrazole from Chalcone.
14. Synthesis of Pyrimidine derivative from Chalcone
15. Synthesis of 2-Phenyl Indole from Acetophenone Phenyl Hydrazone

**BOOKS & REFERENCES RECOMMENDED**

**Textbooks:**

1. Carey A. F., and Giuliano M. R., Organic Chemistry (2011): 8th Edition. McGraw-Hill Companies, Inc.
2. Finar I. L., Organic Chemistry (2011) vol. 1,: 6th Edition. Longman.
3. Finar I. L., Organic Chemistry (2011) vol.2, Organic Chemistry: 6th Edition. Longman.
4. Robert T. Morrison and Robert N. Boyd (2008) Organic Chemistry: 7th Edition. Printice Hall
5. Heterocyclic Chemistry, 2 nd Ed., T. L. Gilchrist
6. Heterocyclic Chemistry, 3 rd Ed., J. A. Joules, K. Mills and G. F. Smith (QD 400 J8)

**Reference recommended:**

1. Cleyden J., Greeves N., Warren S., and Wothers P., (2001) organic chemistry: 1st Edition. Oxford university press.
2. Mann, G. F., and Saunders, C. B., (1960) Practical Organic Chemistry: 4th Edition. Longman
3. Vogel, I. A., (1956) A Text Book of Practical Organic Chemistry Including Qualitative Organic Analysis: 3rd Edition. Longman

**Internet references:**

1. [http://www.internetchemistry.com/chemistry/organic\\_chemistry.htm](http://www.internetchemistry.com/chemistry/organic_chemistry.htm)

## PY-402 :MEDICINAL CHEMISTRY – I

### **Course objectives:**

- To impart fundamental knowledge on the structure, chemistry and therapeutic value of drugs belonging to cholinergic, anticholinergic, adrenergic, antiadrenergic, antihistaminics, analgesics, antipyretics, anti-inflammatory, calcium channel blockers, potassium channel openers, renin-angiotensin receptor inhibitors, vasodilators, anticoagulants, diuretics and vitamins.
- To develop the knowledge of students about effect on biological activity with respect to changes in structure and use of this practice for drug development.
- To acquaint them about importance of physicochemical properties and metabolism of drugs.
- To clarify about synthetic routes of drugs.

### **Course outcomes:**

After completion of the course the student will be able to define

- The chemistry of drugs with respect to their biological activity.
- The drug metabolism pathway and structure activity relationship of drugs.
- The chemical synthesis of drugs

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Study of the development of the following classes of drugs, Classification, mechanism of action, uses of drugs mentioned in the course, Structure activity relationship of selective class of drugs as specified in the course and synthesis of drugs superscripted (\*)

### **THEORY**

#### **Introduction to Medicinal Chemistry**

History and development of medicinal chemistry

#### **Physicochemical properties in relation to biological action**

Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism.

#### **Drug metabolism**

Drug metabolism principles- Phase I and Phase II.

Factors affecting drug metabolism including stereo chemical aspects.

#### **Drugs acting on Autonomic Nervous System**

##### **Adrenergic Neurotransmitters:**

Biosynthesis and catabolism of catecholamine.

Adrenergic receptors (Alpha & Beta) and their distribution.

##### **Sympathomimetic agents: SAR of Sympathomimetic agents**

Direct acting: Nor-epinephrine, Epinephrine, Phenylephrine\*, Dopamine, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol\*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline.

- Indirect acting agents: Hydroxyamphetamine, Pseudoephedrine, Propylhexedrine.
- Agents with mixed mechanism: Ephedrine, Metaraminol.

##### **Adrenergic Antagonists:**

**Alpha adrenergic blockers:** Tolazoline\*, Phentolamine, Phenoxybenzamine, Prazosin, Dihydroergotamine, Methysergide.

**Beta adrenergic blockers:** SAR of beta blockers, Propranolol\*, Metibranolol, Atenolol, Betazolol, Bisoprolol, Esmolol, Metoprolol, Labetolol, Carvedilol.

**Cholinergic neurotransmitters:**

Biosynthesis and catabolism of acetylcholine.

Cholinergic receptors (Muscarinic & Nicotinic) and their distribution.

**Parasympathomimetic agents: SAR of Parasympathomimetic agents**

**Direct acting agents:** Acetylcholine, Carbachol\*, Bethanechol, Methacholine, Pilocarpine.

**Indirect acting/ Cholinesterase inhibitors (Reversible & Irreversible):** Physostigmine, Neostigmine\*, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride, Isoflurophate, Echothiophate iodide, Parathione, Malathion.

**Cholinesterase reactivator:** Pralidoxime chloride.

**Cholinergic Blocking agents: SAR of cholinolytic agents**

**Solanaceous alkaloids and analogues:** Atropine sulphate, Hyoscyamine sulphate, Scopolamine hydrobromide, Homatropine hydrobromide, Ipratropium bromide\*.

**Synthetic cholinergic blocking agents:** Tropicamide, Cyclopentolate hydrochloride, Clidinium bromide, Dicyclomine hydrochloride\*, Glycopyrrolate, Methantheline bromide, Propantheline bromide, Benztropine mesylate, Orphenadrine citrate, Biperidine hydrochloride, Procyclidine hydrochloride\*, Tridihexethyl chloride, Isopropamide iodide, Ethopropazine hydrochloride.

**Drugs acting on Central Nervous System**

**A. Sedatives and Hypnotics:**

**Benzodiazepines:** SAR of Benzodiazepines, Chlordiazepoxide, Diazepam\*, Oxazepam, Chlorazepate, Lorazepam, Alprazolam, Zolpidem

**Barbiturates:** SAR of barbiturates, Barbitol\*, Phenobarbital, Mephobarbital, Amobarbital, Butobarbital, Pentobarbital, Secobarbital

**Miscellaneous:**

Amides & imides: Glutethimide.

Alcohol & their carbamate derivatives: Meproamate, Ethchlorvynol.

Aldehyde & their derivatives: Triclofos sodium, Paraldehyde.

**B. Antipsychotics**

**Phenothiazines:** SAR of Phenothiazines - Promazine hydrochloride, Chlorpromazine hydrochloride\*, Triflupromazine, Thioridazine hydrochloride, Piperacetazine hydrochloride, Prochlorperazine maleate, Trifluoperazine hydrochloride.

**Chlorprothixene, Thiothixene, Loxapine succinate, Clozapine.**

**Fluorobutyrophenones:** Haloperidol, Droperidol, Risperidone.

**Beta amino ketones:** Molindone hydrochloride.

**Benzamides:** Sulpieride.

**C. Anticonvulsants:** SAR of Anticonvulsants, mechanism of anticonvulsant action

**Barbiturates:** Phenobarbital, Methobarbital.

**Hydantoins:** Phenytoin\*, Mephénytoin, Ethotoin

**Oxazolidinones:** Trimethadione, Paramethadione

**Succinimides:** Phensuximide, Methsuximide, Ethosuximide\*

**Urea and monoacylureas:** Phenacemide, Carbamazepine\*

**Benzodiazepines:** Clonazepam

**Miscellaneous:** Primidone, Valproic acid, Gabapentin, Felbamate

**Drugs acting on Central Nervous System**

**General anesthetics:**

Inhalation anesthetics: Halothane\*, Methoxyflurane, Enflurane, Sevoflurane, Isoflurane, Desflurane.

Ultra short acting barbiturates: Methohexital sodium\*, Thiamylal sodium, Thiopental sodium.

Dissociative anesthetics: Ketamine hydrochloride.\*

Narcotic and non-narcotic analgesics

Morphine and related drugs: SAR of Morphine analogues, Morphine sulphate, Codeine, Meperidine hydrochloride, Anileridine hydrochloride, Diphenoxylate hydrochloride, Loperamide hydrochloride, Fentanyl citrate\*, Methadone hydrochloride\*, Propoxyphene hydrochloride, Pentazocine, Levorphanol tartarate.

Narcotic antagonists: Nalorphine hydrochloride, Levallorphan tartarate, Naloxone hydrochloride.

Anti-inflammatory agents: Sodium salicylate, Aspirin, Mefenamic acid\*, Meclofenamate, Indomethacin, Sulindac, Tolmetin, Zomepirac, Diclofenac, Ketorolac, Ibuprofen\*, Naproxen, Piroxicam, Phenacetin, Acetaminophen, Antipyrine, Phenylbutazone.

**PRACTICALS: Minimum 15 experiments based on following:**

**I Preparation of drugs/ intermediates**

- 1 1,3-pyrazole
- 2 1,3-oxazole
- 3 Benzimidazole
- 4 Benzotriazole
- 5 2,3- diphenyl quinoxaline
- 6 Benzocaine
- 7 Phenytoin
- 8 Phenothiazine
- 9 Barbiturate

**II Assay of drugs**

- 1 Chlorpromazine
- 2 Phenobarbitone
- 3 Atropine
- 4 Ibuprofen
- 5 Aspirin
- 6 Furosemide

**III Determination of Partition coefficient for any two drugs**

**BOOKS & REFERENCES RECOMMENDED:**

**Text Books:**

1. Block J. H., Beale J. M., "Wilson and Gisvold's Textbook of organic medicinal and pharmaceutical chemistry", 11<sup>th</sup> edition, 2004, Lippincott Williams and Wilkins-A Wolters Kluwer Company.
2. Lemke T. L., Williams D. A., "Foye's principles of medicinal chemistry", 6<sup>th</sup> edition, 2008, Lippincott Williams and Wilkins-A Wolters Kluwer Company.

**Reference Recommended:**

1. Wolff M. E., "Burger's medicinal chemistry and drug discovery" 5th edition, 1995, Wiley-

Interscience, New York.

### **PY -403 : PHARMACEUTICAL ANALYSIS -I**

#### **Course objectives:**

- To provide advanced technical skills and knowledge base required in the field of qualitative and quantitative chemical analysis.
- To provide basic knowledge of electroanalytical techniques used in drug quality control with reference to Pharmacopoeial standards.
- To impart hands-on experience in executing elementary analytical assays.

#### **Course outcomes:**

After completion of course, student should be able to:

- Understand the principles of volumetric and electro chemical analysis.
- Carryout various volumetric and electrochemical titrations and develop analytical skills.
- Use Pharmacopoeial standards for quality control of drug products.
- Perform elementary analytical assay procedures.

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## **THEORY**

**Pharmaceutical analysis-** Definition and scope

- i. Different techniques of analysis
- ii. Methods of expressing concentration
- iii. Primary and secondary standards.
- iv. Preparation and standardization of various molar and normal solutions- Oxalic acid, sodium hydroxide, hydrochloric acid, sodium thiosulphate, sulphuric acid, potassium permanganate and ceric ammonium sulphate

**Errors:** Sources of errors, types of errors, methods of minimizing errors, accuracy, precision and significant figures

**Acid base titration:** Theories of acid base indicators, classification of acid base titrations and theory involved in titrations of strong, weak, and very weak acids and bases, neutralization curves

**Non aqueous titration:** Solvents, acidimetry and alkalimetry titration and estimation of Sodium benzoate and Ephedrine HCl

**Gravimetry:** Principle and steps involved in gravimetric analysis. Purity of the precipitate: co-precipitation and post precipitation, Estimation of barium sulphate.

**Precipitation titrations:** Mohrs method, Volhard's, Modified Volhard's, Fajans method, estimation of sodium chloride.

**Complexometric titration:** Classification, metal ion indicators, masking and demasking reagents, estimation of Magnesium sulphate, and calcium gluconate.

**Redox titrations:** Concepts of oxidation and reduction, Types of redox titrations (Principles and applications), Cerimetry, Iodimetry, Iodometry, Bromatometry, Dichrometry, Titration with potassium iodate

#### **Electrochemical methods of analysis**

- a) **Conductometry-** Introduction, Conductivity cell, Conductometric titrations, applications.
- b) **Potentiometry** - Electrochemical cell, construction and working of reference (Standard hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine end point of potentiometric titration and applications.
- c) **Polarography** - Principle, Ilkovic equation, construction and working of dropping mercury

electrode and rotating platinum electrode, applications.

**PRACTICALS: Minimum 15 experiments based on the following:**

**Preparation and standardization of**

1. Sodium hydroxide
2. Sulphuric acid
3. Sodium thiosulfate
4. Potassium permanganate
5. Ceric ammonium sulphate

**Assay of the following compounds along with Standardization of Titrant**

1. Ammonium chloride by acid base titration
2. Ferrous sulphate by Cerimetry
3. Copper sulphate by Iodometry
4. Calcium gluconate by complexometry
5. Hydrogen peroxide by Permanganometry
6. Sodium benzoate by non-aqueous titration
7. Sodium Chloride by precipitation titration

**Determination of Normality by electro-analytical methods**

1. Conductometric titration of strong acid against strong base
2. Conductometric titration of strong acid and weak acid against strong base
3. Potentiometric titration of strong acid against strong base

**BOOKS & REFERENCES RECOMMENDED**

**Text books:**

1. Vogel's, Text book of Quantitative chemical Analysis, fifth edition, 1989, Longman Scientific & Technical UK.
2. David Harvey, Modern Analytical Chemistry, first edition, 2000, McGraw Hill Companies, New York.
3. Bentley and Driver's Textbook of Pharmaceutical Chemistry
4. John H. Kennedy, Analytical chemistry principles
5. Daniel C. Harris, Quantitative Chemical Analysis, Eighth edition, W. H. Freeman and Company, New York.

**Reference recommended:**

1. Pharmacopoeia of India, Govt. of India, Ministry of Health and Family Welfare, New Delhi.
2. Beckett, A.H. and Stenlake, J.B., Practical Pharmaceutical Chemistry, fourth edition, Vol. I and II, CBS Publishers and Distributors, New Delhi, India.

## PY-404- PHARMACOLOGY-I

### Course Objectives:

- To understand pharmacology of drugs with basics of drug action and effect (desirable and undesirable) consequences in the course of disease treatment.
- To experimentally understand basic principles of pharmacology at laboratory level with consideration of ethical and legal issues.

### Course outcomes:

After completion of course, student should be able to:

- Understand scientific principles of drug action and the various mechanisms by which drugs can mediate their pharmacological and other effects.
- Understand principles of pharmacokinetics that underlay the absorption, distribution, metabolism and elimination of drugs in the body and thereby affect drug effectiveness.
- Understand the biochemical reactions that result in the metabolism of drugs within the body.
- Understand the drug treatment of major diseases related to ANS, CNS.
- Understand legal requirements for animal house facility and ethical handling of animals.

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## THEORY

### General Pharmacology

- Introduction to Pharmacology-** Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists( competitive and non competitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy.
- Pharmacokinetics-** Membrane transport, absorption, distribution, metabolism and excretion of drugs .Enzyme induction, enzyme inhibition, kinetics of elimination

### General Pharmacology

- Pharmacodynamics-** Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors. drug receptors interactions signal transduction mechanisms, G-protein–coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK-STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.
- Adverse drug reactions.**
- Drug interactions** (pharmacokinetic and pharmacodynamic)
- Drug discovery and clinical evaluation of new drugs** -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance.

### Pharmacology of peripheral nervous system

- Organization and function of ANS.
- Neurohumoral transmission, co-transmission and classification of neurotransmitters.
- Parasympathomimetics, Parasympatholytics, Sympathomimetics, sympatholytics.
- Neuromuscular blocking agents and skeletal muscle relaxants (peripheral).
- Local anesthetic agents.
- Drugs used in myasthenia gravis and glaucoma



- g. **Pharmacology of central nervous system**
- a. Neurohumoral transmission in the C.N.S. special emphasis on importance of various neurotransmitters like with GABA, Glutamate, Glycine, serotonin, dopamine.
- b. General anesthetics and pre-anesthetics.
- c. Sedatives, hypnotics and centrally acting muscle relaxants.
- d. Anti-epileptics
- e. Alcohols and disulfiram

**Pharmacology of central nervous system**

- a. Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics and hallucinogens.
- b. Drugs used in Parkinsons disease and Alzheimer's disease.
- c. CNS stimulants and nootropics.
- d. Opioid analgesics and antagonists
- e. Drug addiction, drug abuse, tolerance and dependence.

**PRACTICALS: Minimum 15 experiments based on following:**

1. Study the commonly used instruments in experimental pharmacology.
2. Study the common laboratory animals.
3. Study the CPCSEA guidelines for ethical management of laboratory animal facility.
4. Study of common laboratory techniques: blood withdrawal, serum and plasma separation, anesthetics and euthanasia used for animal studies.
5. Study of different routes of drugs administration in mice/rats.
6. Study the effect of hepatic microsomal enzyme inducers on the phenobarbitone sleeping time in mice.
7. Study the effect of drugs on rabbit eye.
8. Study the effects of skeletal muscle relaxants using rota-rod apparatus.
9. Study the effect of drugs on locomotor activity using actophotometer.
10. Study the anticonvulsant activity of drugs by MES and PTZ method.
11. Study the stereotype and anti-catatonic activity of drugs on rats/mice.
12. Study of anxiolytic activity of drugs using rats/mice.
13. Study of local anesthetics by different methods

**BOOKS & REFERENCES RECOMMENDED:**

**Textbooks**

1. Tripathi, K. D. Essentials of Medicinal Pharmacology, 7th ed. 2013, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.
2. Satostkar, R.S., Rege, N.N., Bhandarkar, S.D. Pharmacology and Pharmacotherapeutics. Revised 23rd edition 2013, Popular Prakashan Pvt. LTD., Mumbai,
3. Rang, H.P., Dale, M.M., Ritter, J.M., Flower, R.J., Henderson, G. Rang and Dale's Pharmacology. 8th edition 2015, Elsevier India.
4. Ghosh, M. N. Fundamentals of Experimental Pharmacology. 2nd edition 1984, Scientific Book Agency, Calcutta.
5. Kulkarni, S.K., Hand Book of Experimental Pharmacology, 3rd Edition, 1999, Vallabh Prakashan.
6. Mycek M.J, Gelnet S.B and Perper M.M. Lippincott's Illustrated Reviews- Pharmacology

**Reference recommended:**

B.Pharm IV Semester

1. Brunton, L., Chabner, B.A., Knollman, B. Goodman and Gillman's the Pharmacological Basis of Therapeutics. 12th edition 2011, McGraw Hill Education.
2. Katzung B. G., Trevor A.J. Basic and Clinical Pharmacology. 13th edition 2015, McGraw-Hill Medical
3. Vogel, H. G. Drug Discovery and Evaluation. 2nd edition 2002, Springer Publication, Berlin.

**Website:**

1. <http://www.indphar.org>

**Software:**

- 1 Ex-Pharm, Raveendran R. Department of pharmacology, JIPMER, Pondicherry, India, 2009.

**Mobile application:**

- 1 Pharmacology by Apple Medical Group 2014.

## PY -405 : PHARMACEUTICAL ENGINEERING

### Course objectives:

Upon completion of the course student shall be able:

- To enable the students to understand the engineering principles involved in the processing of drugs and pharmaceutical products.
- To create understanding about the basic principles of process engineering.
- To impart knowledge on operations of various equipments and machineries.
- To develop concept of unit operations.

### Course Outcome:

On the completion of the course the student should be able to

- Develop strong background in basics of the pharmaceutical processing.
  - Develop understanding the concepts of unit operations in pharmaceutical process.
  - Create new process and can be able to modify the existing process.
  - Impart knowledge on basic operations involved in material movement.
  - Understand process of fluid flow and role of filtration for complex suspensions.
  - Changes of micromeritic properties of pharmaceutical substances by crystallization technique.
  - Understand the role of distillation in purification of multi component system.
  - Understand the applications of particle size in pharmaceuticals.
  - Effectively extract desired constituent from solid materials.
  - Understand the application of automation in pharmaceutical process.
  - Understand the material handling techniques.
  - To know significance of plant lay out design for optimum use of resources.
  - Understand the preventive methods used for corrosion control in pharmaceutical industries.
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### THEORY

- **Flow of fluids:** Types of manometers, Reynolds number and its significance, Bernoulli's theorem and its applications, Energy losses, Orifice meter, Venturimeter, Pitot tube and Rotometer.
- **Size Reduction:** Objectives, Mechanisms & Laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of Hammer mill, ball mill, fluid energy mill, Edge runner mill & end runner mill.
- **Size Separation:** Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.
- **Mixing:** Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, Construction, Working, uses, Merits and Demerits of Double cone blender, twin shell blender, ribbon blender, Sigma blade mixer, planetary mixers, Propellers, Turbines, Paddles & Silverson Emulsifier,

- **Crystallization:** Objectives, applications, & theory of crystallization. Solubility curves, principles, construction, working, uses, merits and demerits of Agitated batch crystallizer, Swenson Walker Crystallizer, Krystal crystallizer, Vacuum crystallizer. Caking of crystals, factors affecting caking & prevention of caking.
- **Evaporation:** Objectives, applications and factors influencing evaporation, differences between evaporation and other heat process. principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator, triple effect evaporator & Economy of multiple effect evaporator.
- **Heat Transfer:** Objectives, applications & Heat transfer mechanisms. Fourier's law, Heat transfer by conduction, convection & radiation. Heat interchangers & heat exchangers.
- **Drying:** Objectives, applications & mechanism of drying process, measurements & applications of Equilibrium Moisture content, rate of drying curve. principles, construction, working, uses, merits and demerits of Tray dryer, drum dryer spray dryer, fluidized bed dryer, vacuum dryer, freeze dryer.
- **Distillation:** Objectives, applications & types of distillation. principles, construction, working, uses, merits and demerits of (lab scale and industrial scale) Simple distillation, preparation of purified water and water for injection BP by distillation, flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation
- **Filtration:** Objectives, applications, Theories & Factors influencing filtration, filter aids, filter medias. Principle, Construction, Working, Uses, Merits and demerits of plate & frame filter, filter leaf, rotary drum filter, Meta filter & Cartridge filter
- **Centrifugation:** Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.
- **Plant location, industrial hazards and plant safety:** Plant Layout, utilities and services, Mechanical hazards, Chemical hazards, Fire hazards , explosive hazards and their safety.
- **Materials of pharmaceutical plant construction, Corrosion and its prevention:** Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and there prevention. Ferrous and nonferrous metals, inorganic and organic non metals.
- **Material handling systems:** Objectives & applications of Material handling systems, different types of conveyors such as belt, screw and pneumatic conveyors.

**PRACTICALS: Minimum 15 experiments based on following:**

1. Determination of radiation constant of brass, iron, unpainted and painted glass(4 experiments).
2. Steam distillation – To calculate the efficiency of steam distillation.
3. To determine the overall heat transfer coefficient.
4. Construction of drying curves (for calcium carbonate and starch).
5. Determination of moisture content and loss on drying.
6. Determination of humidity of air – i) From wet and dry bulb temperatures –use of humidity chart, II) Dew point method.

7. Description of Construction working and application of Pharmaceutical Machinery such as
8. rotary tablet machine, fluidized bed coater, fluid energy mill, de humidifier.
9. Size analysis by sieving – To evaluate size distribution of tablet granulations –
10. Construction of various particle size frequency curves including arithmetic and logarithmic probability plots.
11. Size reduction: To verify the laws of size reduction using ball mill.
12. Demonstration of colloid mill, planetary mixer, fluidized bed dryer, freeze dryer and such other major equipments.

### **BOOKS & REFERENCES RECOMMENDED:**

#### **Textbooks:**

1. Walter L. Badgre and T. Banchemo, Introduction to chemical Engineering, McGraw-Hill, 1955.
2. Kaning J. K. (Editor), S. J. Carter, Tutorial Pharmacy, CBS Publishers & distributors, 1986, Indian Edition. 6<sup>th</sup> Ed.
3. Hickey A. J., and Ganderton D., Pharmaceutical Process Engineering, Marcel Dekker, 2001.

#### **Reference recommended:**

1. Parry H. (Editor), Chemical Engineering Hand Book, McGraw-Hill, 1997, 7<sup>th</sup> Ed.
2. Leon Lachman and H. R. Libberman, The Theory and Practice of Industrial Pharmacy, CBS Publishers & Distributors, Special Indian Edition, 2009.
3. Max S. Peters, Elementary Chemical Engineering, Tata McGraw-Hill, 2009 2nd Ed.
4. Ganderton C., Unit Processes Pharmacy, William Heinemann medical book ltd, 1968.
5. Browns G., Unit Operations, Wiley and Sons, 1955.
6. Warren L. Maccabe, Juliano C. Smith. Unit Operations of Chemical Engineering. Biohazardous Waste Management., <http://biosafety.uk.edu/waste/>

## PY-406:PATHOPHYSIOLOGY

### Course objectives:

- To understand the pathological changes and their basic mechanisms that leads to disease.
- To understand mechanism of resistance and adaptation towards pathological changes.
- To understand pathological presentation of common diseases of CNS, CVS, Hormones, respiratory system, GIT, bones, cancer, liver and kidney.

### Course outcomes:

After completion of course, student should be able to:

- Develop understanding of modulation in normal anatomy and physiology during initiation and progression of diseases.
- Understand the mechanism of tissue repair process.
- Understand causes, symptoms and contributing factor in occurrence and progression of various diseases.
- Connect the mechanism of pathological modulations while studying pharmacology of drug molecule.
- Sort the pathways that require modulating in disease treatment.
- Understand pathological issues during designing and testing of drug molecules and dosage forms.

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## THEORY

**(a) Basic principles of Cell injury and Adaptation:** Introduction, definitions, Homeostasis, Components and Types of Feed back systems, Causes of cellular injury, Pathogenesis (Cell membrane damage, Mitochondrial damage, Ribosome damage, Nuclear damage), Morphology of cell injury – Adaptive changes (Atrophy, Hypertrophy, hyperplasia, Metaplasia, Dysplasia), Cell swelling, Intra cellular accumulation, Calcification, Enzyme leakage and Cell Death Acidosis & Alkalosis, Electrolyte imbalance

**(b) Basic mechanism involved in the process of inflammation and repair:** Introduction, Clinical signs of inflammation, Different types of Inflammation, Mechanism of Inflammation– Alteration in vascular permeability and blood flow, migration of WBC's, Mediators of inflammation, Basic principles of wound healing in the skin, Pathophysiology of Atherosclerosis

**(a) Cardiovascular System:** Hypertension, congestive heart failure, ischemic heart disease (angina, myocardial infarction, atherosclerosis and arteriosclerosis)

**(b) Respiratory system:** Asthma, Chronic obstructive airways diseases.

**(c) Renal system:** Acute and chronic renal failure.

**(a) Haematological Diseases:** Iron deficiency, megaloblastic anemia (Vit B12 and folic acid), sickle cell anemia, thalasemia, hereditary acquired anemia, hemophilia

**(b) Endocrine system:** diabetes, thyroid diseases, disorders of sex hormones

**(c) Nervous system:** Epilepsy, Parkinson's disease, stroke, psychiatric disorders: depression, schizophrenia and Alzheimer's disease.

**(d) Gastrointestinal system:** Peptic Ulcer

Inflammatory bowel diseases, jaundice, hepatitis ( A,B,C,D,E,F) alcoholic liver disease.

**(a) Disease of bones and joints:** Rheumatoid arthritis, osteoporosis and gout

**(b) Principles of cancer:** classification, etiology and pathogenesis of cancer

**(c) Diseases of bones and joints:** Rheumatoid Arthritis, Osteoporosis, Gout

**(d) Principles of Cancer:** Classification, etiology and pathogenesis of Cancer

**Infectious diseases:** Meningitis, Typhoid, Leprosy, Tuberculosis, Urinary tract infections

**Sexually transmitted diseases:** AIDS, Syphilis, Gonorrhea

**BOOKS & REFERENCES RECOMMENDED:**

**Text books:**

1. Mohan, H. Textbook of Pathology, 7th revised edition 2014, Jaypee Brothers Medical Publishers.
2. Mandal, A.K., Choudhary, S. Textbook of Pathology for MBBS - General Pathology and Haematology / Systemic Pathology (Volume 1 and 2) 1st Edition 2014 Avichal Publishing Company.
3. Sharma S.C., Pathophysiology of Common Disease 1st edition

**Reference recommended:**

1. Kumar, V., Abbas, A.K., Fausto, N., Aster, J.C., Robbins and Cotran Pathologic Basis of Disease, 8th Edition, Elsevier Publication.
2. DiPiro, J., Talbert, R.L., Yee, G., Wells, B., Posey, L.M. Pharmacotherapy A Pathophysiologic 9th edition 2014, McGraw-Hill Education.
3. Kirkhorn, L.E.C.C. & Banasik, J.L. Pathophysiology 2009, W B Saunders Co.
4. Huether, S. E. and McCance, Kathryn, L. Understanding Pathophysiology. 6th Edition, Mosby.
5. Hart, M.N., Loeffler, A.G. Introduction to Human Disease: Pathophysiology for Health Professionals 5th edition 2011, Jones & Bartlett Learning.

**Website:**

1. <http://library.med.utah.edu/WebPath/GENERAL.html>