Bachelor of Pharmacy (B. Pharm.) (Hons)
Four Years Program

Total Credit for B. Pharm. (Hons): 168

Draft Syllabus and Curriculum for B. Pharm. (Hons) Four Years Program

The courses of study for the degree of B. Pharm. (Hons) program shall extend over four academic years. The examination shall be taken in four parts under the following heads:

B. Pharm. (Hons) Year I Examination
Total Credit hours 31.
Examination to be held at the end of the first year of study

B. Pharm. (Hons) Year II Examination
Total Credit hours 43.
Examination to be held at the end of the second year of study

B. Pharm. (Hons) Year III Examination
Total Credit hours 48.
Examination to be held at the end of the third year of study

B. Pharm. (Hons) Year IV Examination
Total Credit hours 46.
Examination to be held at the end of the fourth year of study

Total Credits for B. Pharm. (Hons) Program: 168

Theory Class	**Practical Class**
For 4 credit courses- 60 hours For 2 credit courses- 30 hours	30 hours for 1 credit laboratory courses
Duration of Theory Examination	**Duration of Practical Examination**
For 4 credit courses - 4 hours For 2 credit courses - 2 hours	6 hours for 1 credit courses.

Assignment of Marks

4 Credit theory course 100	1 Credit practical course 25
2 Credit theory course 50	1 & 2 Credit viva voce 25 & 50

Research Project: Students are required to complete at least one year 2 credits research project at third year of B. Pharm. (Hons) Program

Industrial Training: Students are required to complete at least 4 weeks of mandatory non-credit in-plant training in reputed pharmaceutical industries at the end of B. Pharm. (Hons) Year IV examination.

Listing of Pharmacy Courses and Credit Hours

B. Pharm. (Hons) Year-I

PHR 101	Inorganic Pharmaceutical Chemistry-I	Credit Hr: 4
PHR 101L	Inorganic Pharmaceutical Chemistry-I Lab	Credit Hr: 1
PHR 102	Organic Pharmaceutical Chemistry-I	Credit Hr: 2
PHR 103	Physical Pharmaceutical Chemistry-I	Credit Hr: 2
PHR 103L	Physical Pharmaceutical Chemistry-I Lab	Credit Hr: 1
PHR 104	Natural Product Chemistry-I	Credit Hr: 2
PHR 105	Physiology and Anatomy-I	Credit Hr: 4
PHR 105L	Physiology and Anatomy-I Lab	Credit Hr: 1
PHR 106	Biochemistry	Credit Hr: 4
PHR 106L	Biochemistry Lab	Credit Hr: 1
PHR 107	Pharmaceutical Technology-I	Credit Hr: 2
PHR 107L	Pharmaceutical Technology-I Lab	Credit Hr: 1
PHR 108	Pharmaceutical Microbiology-I	Credit Hr: 4
PHR 108L	Pharmaceutical Microbiology-I Lab	Credit Hr: 1
PHR 109	Viva Voce	Credit Hr. 1
	Total Credit Hours	**31**

B. Pharm. (Hons) Year-II

PHR 201	Inorganic Pharmaceutical Chemistry-II	Credit Hr: 2
PHR 202	Organic Pharmaceutical Chemistry-II	Credit Hr: 4
PHR 202L	Organic Pharmaceutical Chemistry-II Lab	Credit Hr: 1
PHR 203	Physical Pharmaceutical Chemistry -II	Credit Hr: 4
PHR 203L	Physical Pharmaceutical Chemistry -II Lab	Credit Hr: 1
PHR 204	Natural Product Chemistry-II	Credit Hr: 2
PHR 204L	Natural Product Chemistry-II Lab	Credit Hr: 1
PHR 205	Physiology and Anatomy-II	Credit Hr: 4
PHR 205L	Physiology and Anatomy-II Lab	Credit Hr: 1
PHR 206	Cellular and Molecular Biology	Credit Hr: 4
PHR 207	Pharmacology-I	Credit Hr: 4
PHR 207L	Pharmacology-ILab	Credit Hr: 1
PHR 208	Pharmaceutical Technology-II	Credit Hr: 4
PHR 208L	Pharmaceutical Technology-II Lab	Credit Hr: 1
PHR 209	Pharmaceutical Microbiology-II	Credit Hr: 2
PHR 209L	Pharmaceutical Microbiology-II Lab	Credit Hr: 1
PHR 210	Cosmetic Sciences and Technology	Credit Hr: 4
PHR 210L	Cosmetic Sciences and Technology Lab	Credit Hr: 1
PHR 211	Viva Voce	Credit Hr. 1
	Total Credit Hours	**43**

B. Pharm. (Hons) Year-III

PHR 301	Pharmaceutical Analysis-I	Credit Hr: 2
PHR 301L	Pharmaceutical Analysis-I Lab	Credit Hr: 1
PHR 302	Medicinal Chemistry and Drug Synthesis-I	Credit Hr: 4
PHR 302L	Medicinal Chemistry and Drug Synthesis -I Lab	Credit Hr: 1
PHR 303	Pharmaceutical Biotechnology	Credit Hr: 4
PHR 303L	Pharmaceutical Biotechnology Lab	Credit Hr: 1
PHR 304	Functional Foods and Herbal Medicines	Credit Hr. 2
PHR 305	Pharmacology-II	Credit Hr: 4
PHR 305L	Pharmacology-II Lab	Credit Hr: 1
PHR 306	Clinical Pathology and Toxicology	Credit Hr: 4
PHR 307	Hospital and Pharmacy Practice	Credit Hr: 2
PHR 308	Pharmaceutical Technology-III	Credit Hr: 4
PHR 308L	Pharmaceutical Technology-III Lab	Credit Hr: 1
PHR 309	Biopharmaceutics and Pharmacokinetics-I	Credit Hr: 4
PHR 309L	Biopharmaceutics and Pharmacokinetics-I Lab	Credit Hr: 1
PHR 310	Pharmaceutical Marketing and Management	Credit Hr: 4
PHR 310L	Pharmaceutical Marketing and Management Field Work/Report	Credit Hr: 1
PHR 311	Computer Applications and Artificial Intelligence in Pharmacy	Credit Hr. 4
PHR 312	Project	Credit Hr. 2
PHR 313	Viva Voce	Credit Hr. 1
	Total Credit Hours	**48**

B. Pharm. (Hons) Year-IV

PHR 401	Pharmaceutical Analysis-II	Credit Hr: 4
PHR 401L	Pharmaceutical Analysis-II Lab	Credit Hr: 1
PHR 402	Medicinal Chemistry and Drug Synthesis-II	Credit Hr: 4
PHR 402L	Medicinal Chemistry and Drug Synthesis-II Lab	Credit Hr: 1
PHR 403	Quality Control and Quality Assurance	Credit Hr: 4
PHR 403L	Quality Control and Quality Assurance Lab	Credit Hr: 1
PHR 404	Clinical Pharmacy	Credit Hr: 4
PHR 405	Pharmacovigilance	Credit Hr: 2
PHR 406	Pharmacology-III	Credit Hr: 4
PHR 406L	Pharmacology-III Lab	Credit Hr: 1
PHR 407	Pharmaceutical Technology-IV	Credit Hr: 4
PHR 407L	Pharmaceutical Technology-IV Lab	Credit Hr: 1

PHR 408	Pharmaceutical Process Engineering	Credit Hr: 4
PHR 408L	Pharmaceutical Process Engineering Lab	Credit Hr: 1
PHR 409	Biopharmaceutics and Pharmacokinetics-II	Credit Hr: 4
PHR 409L	Biopharmaceutics and Pharmacokinetics-II Lab	Credit Hr: 1
PHR 410	Pharmaceutical Regulatory Affairs	Credit Hr: 4
PHR 411	**Industrial Training**	**Non-Credit**
PHR 412	Viva Voce	Credit Hr. 1
	Total Credit Hours	**46**

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PHR 107	Pharmaceutical Technology-I	Credit Hr: 2
PHR 107L	Pharmaceutical Technology-I Lab	Credit Hr: 1
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PHR 108L	Pharmaceutical Microbiology-I Lab	Credit Hr: 1
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PHR 202	Organic Pharmaceutical Chemistry-II	Credit Hr: 4
PHR 202L	Organic Pharmaceutical Chemistry-II Lab	Credit Hr: 1
PHR 203	Physical Pharmaceutical Chemistry -II	Credit Hr: 4
PHR 203L	Physical Pharmaceutical Chemistry -II Lab	Credit Hr: 1
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PHR 205L	Physiology and Anatomy-II Lab	Credit Hr: 1
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PHR 209	Pharmaceutical Microbiology-II	Credit Hr: 2
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PHR 210	Cosmetic Sciences and Technology	Credit Hr: 4
PHR 210L	Cosmetic Sciences and Technology Lab	Credit Hr: 1
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PHR 301L	Pharmaceutical Analysis-I Lab	Credit Hr: 1
PHR 302	Medicinal Chemistry and Drug Synthesis-I	Credit Hr: 4
PHR 302L	Medicinal Chemistry and Drug Synthesis -I Lab	Credit Hr: 1
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PHR 303L	Pharmaceutical Biotechnology Lab	Credit Hr: 1
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PHR 309L	Biopharmaceutics and Pharmacokinetics-I Lab	Credit Hr: 1
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PHR 310L	Pharmaceutical Marketing and Management Field Work/Report	Credit Hr: 1
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PHR 312	Project	Credit Hr. 2
PHR 313	Viva Voce	Credit Hr. 1
	Total Credit Hours	**48**

B. Pharm. (Hons) Year-IV

PHR 401	Pharmaceutical Analysis-II	Credit Hr: 4
PHR 401L	Pharmaceutical Analysis-II Lab	Credit Hr: 1
PHR 402	Medicinal Chemistry and Drug Synthesis-II	Credit Hr: 4
PHR 402L	Medicinal Chemistry and Drug Synthesis-II Lab	Credit Hr: 1
PHR 403	Quality Control and Quality Assurance	Credit Hr: 4
PHR 403L	Quality Control and Quality Assurance Lab	Credit Hr: 1
PHR 404	Clinical Pharmacy	Credit Hr: 4
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Detailed description and course contents of B. Pharm. (Hons) (Four years) Program

B. Pharm. (Hons) Year-I

PHR 101 Inorganic Pharmaceutical Chemistry-I Credit Hr: 4

Course Number : PHR 101
Course Title : Inorganic Pharmaceutical Chemistry-I
Credit hours : 4

Introduction:
This is a core course and provides an introduction to some of the fundamental aspects of chemistry and is primarily aimed at students entering the B. Pharm. Program. This course will provide clear knowledge on atomic structure and bond theory: Atomic orbital importance for chemical bonding, covalent bonding, ionic, metallic and hydrogen bonding, Molecular orbital Theory: concept of hybridization, Introduction to coordination compounds, Review of the element's chemical properties with emphasis on periodic properties. Mechanism, preparation, and applications of inorganic gastrointestinal agents. Uses of medicinal gases: (oxygen, nitrogen, carbon dioxide, helium, nitrous oxide, mixtures Heliox). This course will be helpful for further education in organic and medicinal chemistry.

Specific Objectives:
The objectives of this course are to:

1. Have knowledge on different types of chemical bonding and MO theory to describe structure and shape of small molecule.
2. Illustrate different states of hybridization and calculation of bond order.
3. Review the classification of elements on the basis of periodic properties.
4. Offer a clear understanding on the nature of ligands, isomerism and coordination geometries in transition metal complexes.
5. Highlight the mechanism, preparation, application and side effects of some gastrointestinal agents.

Course Contents:

1. **Fundamentals of Chemical Bonding:** Electronic structure & valency, electronegativity, bonding types, salt formation, molecular geometry & hybridization, concepts of bonding/antibonding orbitals, HOMO/LUMO.
2. **Classification of Elements:** Modern periodic table & periodic law: s, p, d and f block elements, systematic variations in atomic/ionic size, ionization energy, electron affinity, electronegativity, metallic properties across periods and down groups, predicting properties of novel materials, critical discussion on limitations of modern periodic table.
3. **Chemistry of Alkali & Alkaline Earth Metals:** General characteristics of alkali and alkaline earth metals, chemistry of group IA & IIA elements and their compounds, comparison of

alkaline earth metals with alkali metals, physiological importance, pharmaceutical applications and commercial production of alkali and alkaline earth metals.

4. **Coordination Chemistry & Metallodrugs:** Ligands or co-ordinating groups, monodentate or unidentate ligands, polydentate ligands, co-ordination number, co-ordination sphere, chelation, factors affecting the stability of metal complexes, application of chelate formation, isomerism of co-ordination compounds, Warner's co-ordination theory, Sidgwick's electronic concept of co-ordinate bond in co-ordination compounds, valence bond theory, pharmaceutical importance of chelation. Chelation therapy (EDTA, DMSA, deferoxamine for Fe/Cu/Pb/As poisoning), Contrast agents (Gd^{3+}, Fe^{3+} complexes for MRI), Metalloenzyme mimics/catalysts, platinum anticancer drugs.
5. **Essential Ions & Trace Elements in Health**: Intra and extra cellular electrolytes (Na, K, Ca and Cl ions.); Electrolytes in acid base therapy; electrolytes in replacement therapy, electrolyte combination therapy. IV fluids, oral rehydration salts (ORS), antacids, phosphate binders. Essential trace elements and their preparations (Cu, Zn, Mn, S, I, Cr, Se, Co, Ni, etc.), applications of essential trace elements in pharmaceutical sciences. Biological roles of Fe, Zn, Cu, Mn, Se, Cr (III), Mo, Co (in B12), I & F. Role of Zn in immunity, Se in antioxidant enzymes, Cu/Zn SOD.
6. **Pharmaceutical Materials Science:** Antioxidants e.g., Se in GPx, Catalase (Fe, Mn), SOD (Cu/Zn, Mn), Synergists. Pharmaceutical Glass: Types (Type I Borosilicate, Type II/III Soda-Lime), properties (chemical resistance - hydrolytic class, thermal shock).
7. **Gastrointestinal Agents:** Classification of inorganic gastrointestinal agents. **Systemic and non-systemic antacids**: Mechanism, preparation, application and side effect of antacids, modern combination of antacids. **Adsorbents**: Mechanism, preparation and application of adsorbents. **Laxatives**: Saline laxatives or cathartics: Mechanism, preparation and applications.
8. **Medicinal Gases:** Medicinal gases (Oxygen therapy, hypoxia), Nitrous Oxide (analgesia/anesthesia), Heliox (airway obstruction), Carbon Dioxide (insufflation, pH control), Nitrogen (packaging, cryo), components, containers and closures, production and process control, packaging and labelling, delivery methods, monitoring parameters (e.g., pulse oximetry for O_2).

Learning Outcomes: Upon completion of the course, the students will be able to:

1. Understand and apply core chemical bonding concepts to predict chemical behavior and molecular interactions in pharmaceutical compounds.
2. Interpret and analyze periodic trends while critically evaluating the limitations of periodic classification.
3. Describe the chemistry, physiological roles, and pharmaceutical applications of alkali and alkaline earth metals including their use in electrolyte therapy, antacids, rehydration salts and their importance in biological systems and enzyme function.
4. Explain the principles and pharmaceutical significance of coordination chemistry, including types of ligands, chelation, coordination theories, and their applications in chelation therapy.

Assessment: As per the rules

Text books:

1. Introduction to Modern Inorganic Chemistry- S. Z. Haider, 1994, Friends International.
2. Modern Inorganic Chemistry- Madan, 1st (reprint 1997), S. Chard & Company Ltd.
3. Introduction to Modern Inorganic Chemistry-J. D. Lee, 5th edition, Blackwells.
4. Bentley and Driver's Textbook of Pharmaceutical Chemistry-Bentley, Arthur Owen, 8th edition, Oxford University Press.
5. Inorganic Medicinal & Pharmaceutical Chemistry- Block, John H., Roche, Edward B., Soine, Taito O., Wilson, Charles O., 1974, Lea and Febiger, Philadelphia.

References:

1. Modern Inorganic Pharmaceutical Chemistry-Clarence A. Discher, Leonard C. Bailet, Thomas medwick,2nd edition, Waveland Pr Inc.
2. Rogers Inorganic Pharmaceutical Chemistry-Rogers, Charles Herbert, Taito O. Soine and Charles O. Wilson, 7th edition, Philadelphia, Lea & Febiger, Philadelphia.

PHR 101L Inorganic Pharmaceutical Chemistry-I Lab Credit Hr: 1

Course Number : PHR 101L
Course Title : Inorganic Pharmaceutical Chemistry-I Lab
Credit hours : 1

Introduction:
This course is based on the theoretical course Inorganic Pharmaceutical Chemistry-I (PHR-102). It will provide a practical idea about the inorganic ions present in different pharmaceutical preparations. Students will learn to analyze qualitatively different cations and anions or free radicals. It also highlights the importance of ions in market preparations.

Specific Objectives:
The objectives of this course are to:

1. Learn the experimental procedures for tests of ions
2. Know the detection of these ions
3. Learn to compare the different outcomes
4. Prepare the students for doing industrial quality control of formulations and food products
5. Highlight the uses of free radicals in market preparations.

Course Contents:

1. Identification of inorganic ions from pharmaceutical formulations:
Ca^{2+}, Fe^{2+}, Al^{3+}, Mg^{2+}, K^{+} and Na^{+} ions from supplied preparations.

2. **Conversion of different water insoluble or sparingly soluble drugs into water soluble form:**
   a. Na/K-salicylate from salicylic acid.
   b. Na/K-benzoate from benzoic acid.
   c. Na/K-citrate from citric acid.

3. **Preparation of inorganic drugs:**
   a. Preparation of aluminium hydroxide gel.
   b. Preparation of magnesium hydroxide.
   c. Preparation of haematinics- ferrous chloride, ferrous gluconate and ferrous fumarate

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Learn the experimental procedures for tests of ions
2. Know the detection of these ions
3. Learn to compare the different outcomes
4. Prepare the students for doing industrial quality control of formulation and food products
5. Highlight the uses of free radicals in market preparations.

Assessment: As per the rules

Text books:

1. Inorganic Chemistry by Catherine E. Housecroft, Alan G. Sharpe, Paperback: 832 pages, Publisher: Prentice Hall.
2. Descriptive Inorganic Chemistry by Kathleen A. House, James E. House, Hardcover: 515 pages, Publisher: Brooks Cole.
3. Descriptive Inorganic, Coordination, and Solid State Chemistry by Glen E. Rodgers, Hardcover: 560 pages, Publisher: Brooks Cole.

References:

1. Inorganic Chemistry: Principles of Structure and Reactivity (4th Edition) by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Hardcover: 964 pages, Publisher: Benjamin Cummings.
2. Principles of Descriptive Inorganic Chemistry by Gary Wulfsberg, Hardcover: 461 pages, Publisher: University Science Books.

PHR 102 Organic Pharmaceutical Chemistry-I Credit Hr: 2

Course Number : PHR 102
Course Title : Organic Pharmaceutical Chemistry-I
Credit hours : 2

Introduction:

This course will provide students in pharmacy a solid foundation in organic chemistry where relevant pharmaceutical topics will be applied to illustrate organic chemistry. The course will also give the students the necessary knowledge to participate and understand the pharmacy curriculum in later courses, such as biochemistry, medicinal chemistry, pharmacognosy, drug analysis and pharmaceutics. In this course examples from medicinal chemistry and pharmacognosy will be used to acquire knowledge in organic chemistry.

Specific Objectives:

The objectives of this course are to:

1. Give pharmacy students a basic understanding of organic chemistry, especially in the context of daily life.
2. Achieve through the introduction of the chemistry of organic functional groups that form the basis of organic molecules.
3. Have solid knowledge on aromatic compounds and aliphatic compounds, but also knowledge about the most central reactions and the mechanisms of the compound classes.

Course Contents:

1. **Chemistry of aliphatic compounds**
   (a) Alkanes, alkenes and alkynes: Bonding in Alkenes and Alkynes; Acidity of Alkynes Nomenclature of Alkenes and Alkynes, Physical Properties of Alkenes and Alkynes, Spectra of Alkenes and Alkynes, Preparation of Alkenes and Alkynes, Preview of Addition Reactions,

Addition of Hydrogen Halides to Alkenes and Alkynes Addition of H_2SO_4, and H_2O to Alkenes and Alkynes, Hydration Using Mercuric Acetate, Addition of Borane to Alkenes.

(b) Carbonyl compounds (Aldehydes and ketones): Nomenclature, Physical Properties, Preparation of Aldehydes and Ketones, The Carbonyl Group, Addition of Reagents to the Carbonyl Group, Reaction with Water, Reaction with Alcohols, Reaction with Hydrogen Cyanide, Reaction with Ammonia and Amines, Reaction with Hydrazine and Related Compounds. The Wittig Reaction, Reaction with Grignard Reagents, Reduction of Aldehydes and Ketones, Oxidation of Aldehydes and Ketones, Reactivity of the Alpha Hydrogens, Tautomerism, Alpha Halogenation, 1.4-Addition to a,b-Unsaturated Carbonyl Compounds, Use of Aldehydes and Ketones in Synthesis.

(c) Alcohols, ethers and epoxides: Alcohols, Ethers, and Related Compounds: Bonding in Alcohols and Ethers, Physical Properties of Alcohols and Ethers, Nomenclature of Alcohols and Ethers, Preparation of Alcohols, Reactivity of Alcohols, Substitution Reactions of Alcohols, Other Reagents Used to Convert Alcohols to Alkyl Halides Elimination Reactions of Alcohols, Alcohols as Acids, Alkoxides and Phenoxides, Esterification Reactions, Inorganic Esters of Alcohols, Oxidation of Alcohols, Preparation of Ethers, Substitution Reactions of Ethers, Substitution Reactions of Epoxides, Thiols and Sulfides, Use of Alcohols and Ethers in Synthesis

(d) Carboxylic Acids & Carboxylic Acid Derivatives: Nomenclature, Physical Properties, Preparation of Carboxylic Acids, Acidity of Carboxylic Acids, Salts of Carboxylic Acids, How Structure Affects Acid Strength, Acid Strengths of Substituted Benzoic Acids, Esterification of Carboxylic Acids, Reduction of Carboxylic Acids, Polyfunctional Carboxylic Acids, Use of Carboxylic Acids in Synthesis. Derivatives of Carboxylic Acids, Reactivity of Carboxylic Acid Derivatives, Acid Halides, Anhydrides of Carboxylic Acids, Esters of Carboxylic Acids, Lactones, Polyesters, Thioesters, Amides, Polyamides, Compounds Related to Amides, Nitriles, Use of Carboxylic Acid Derivatives in Synthesis.

e) Enolates and Carbanions: Building Blocks for Organic Synthesis, Acidity of the Alpha Hydrogen, Alkylation of Malonic Ester, Alkylation of Acetoacetic Ester, Syntheses Using Alkylation Reactions, Alkylation and Acylation of Enamines Aldol Condensations, Reactions Related to the Aldol Condensation, Cannizzaro Reaction, Ester Condensations, Nucleophilic Addition to x,ß-Unsaturated Carbonyl Compounds.

(e) Amines: Classification and Nomenclature of Amines, Bonding in Amines, Physical Properties, Preparation, Basicity of Amines, Amine Salts, Substitution Reactions with Amines, Reactions of Amines with Nitrous Acid, Hofmann Elimination, Use of Amines in Synthesis.

2. **Aromaticity, Benzene and substituted benzenes:** Nomenclature of Substituted Benzenes, Physical Properties of Aromatic Hydrocarbons, Spectra of Substituted Benzenes, Stability of the Benzene Ring, The Bonding in Benzene, What Is an Aromatic Compound? Requirements for Aromaticity, Electrophilic Aromatic Substitution, The First Substitution, The Second Substitution, The Third Substitution, Phenols, Alkylbenzenes, Benzenediazonium Salts, Halobenzenes and Nucleophilic Aromatic Substitution, Syntheses Using Benzene Compounds.

Learning Outcomes: Upon completion of the course, the students will be able to:

1. Understand and Apply Core Principles of Aliphatic Chemistry
2. Analyze and Predict Organic Reactions
3. Integrate Functional Group Interconversions in Organic Synthesis
4. Explain Aromaticity and Reactivity of Aromatic Compounds
5. Understand Substitution Mechanisms in Aromatic Compounds

6. Demonstrate Knowledge of Synthesis and Application of Aromatic Compounds
7. Interpret Spectral Data for Structure Elucidation.

Assessment: As per the rules

Text books:

1. Robert T. Morrison & Robert N. Boyd. *Organic Chemistry*, 6th (Ed.), 1992. Prentice-Hall Inc., Upper Saddle River, NJ, USA.
2. Ralph J. Fessenden & Joan S. Fessenden. *Organic Chemistry,* 5th Edition, 1993, Brooks Cole Publisher, 511 Forest Lodge Rd, Pacific Grove, California, 93950, United States.

References:

1. Jonathan Clayden, Nick Greeves & Stuart Warren. *Organic Chemistry*, 2nd (Ed.), 2012. Oxford University Press Inc., New York, USA.
2. Peter Vollhardt & Neil Schore, *Organic Chemistry: Structure and Function*, 2018. W. H. Freeman and Company, One New York Plaza, Suite 4500, New York, NY.

PHR 103	Physical Pharmaceutical Chemistry-I	Credit Hr: 2

Course Number **:** PHR 103
Course Title **:** Physical Pharmaceutical Chemistry-I
Credit hours **:** 2

Introduction:

Physical pharmaceutical chemistry is a fundamental course in the field of Pharmaceutical Sciences that helps in proper understanding of successive courses such as pharmaceutics and pharmaceutical technology. It assimilates knowledge of mathematics, physics and chemistry and applies them to the pharmaceutical dosage form development. It concentrates on the theories needed for dosage form design. It enables the pharmacists to make rational decisions on scientific basis concerning the art and technology of solutions, suspensions, emulsions, etc.

Specific Objectives:

The objectives of this course are to:

1. Review the fundamental information about the solution, its types, different units of concentration, mathematical problems related to solution, extraction and different theories and properties of solution.
2. Offer a clear understanding on law of mass action, determination of equilibrium constant and related different principles.
3. Discuss thermodynamic consideration of solutions, theories of thermodynamics and application in pharmacy.

4. Highlight the phase rules and its thermodynamic deviation, phase diagram of different system, freeze drying.
5. Explain buffer, its importance in pharmacy, preparation, adjusting tonicity and pH of a solution.

Course Contents:

1. **Solution**: Definition and types of solution, units of concentration, solubility & dissolution, Henry's law, distribution law, partition coefficient and solvent extraction, colligative properties of dilute solution, real solution and ideal solution.
2. **Ionic Equilibria, Buffer and Isotonic Solution:** Modern theories of acids, bases and salts, acid-base equilibria, Sorensen's pH scale, species concentration as a function of pH, calculation of pH, acidity constant, buffer solution and its pharmaceutical and biological importance, buffer capacity, methods of preparation of buffer solution having various pH, buffered isotonic solution, methods of adjusting tonicity.
3. **Chemical equilibrium:** Law of mass action, determination of equilibrium constant, heterogeneous equilibrium and homogeneous equilibrium, Le Chatelier principle, Van't Hoff equation.
4. **Phase equilibria:** Phase, components and degree of freedom, phase rule and its thermodynamic derivation, the phase diagrams of water and sulphur systems, partially miscible liquid pairs: phenol and water, nicotine water system; completely miscible liquid pairs and their separation by fractional distillation, freeze drying (lyophilization).
5. **Thermodynamics:** Theories and laws of thermodynamics and their applications, energy related changes in reactions, concept on isothermal and adiabatic processes, free energy, calculation of free energy and its pharmaceutical application, activity coefficient, Van't Hoff equation, entropy & disorder, enthalpy.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Prepare solutions having different concentration or strength, solve mathematical problems related to solution preparation, know distribution law and solvent extraction, understand different laws and colligative properties of solution, explain solubility and dissolution concept of solution.
2. Explain law of mass action; understand equilibrium constant and its determination for different types of chemicals reactions.
3. Explain different law of thermodynamics and its applications in pharmacy
4. Understand phase rules and its thermodynamic deviation, phase diagram of different system, freeze drying.

5. Explain buffer and its importance in pharmacy, prepare different types of buffer solutions and adjust tonicity of a solution.

Assessment: As per the rules

Text books:

1. Patrick J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Sciences, 2010, 6th addition, Lippincott Williams & Wilkins, 145 London Road Kingston Upon Thames, KT2 6SR United Kingdom.
2. Mansoor M. Amiji and Beverly J. Sandmann, Applied Physical Pharmacy,2002, 1st Edition, (McGRAYV-Hill Medical Publishing Division, 1325 Avenue of the Americas, New York.

References:

1. Howard C. Ansel, *Pharmaceutical Calculations*, 2012, 13th Edition, Wolters Kluwer Health z Lippincott Williams & Wilkins.
2. Arun Bahl, Essentials of Physical Chemistry. 2021, S. Chand Publishing, 7361, Qutab Road, Ram Nagar, Paharganj, New Delhi, 110055, India.

PHR 103L Physical Pharmaceutical Chemistry-I Lab Credit Hr: 1

Course Number : PHR 103L
Course Title : Physical Pharmaceutical Chemistry-I Lab
Credit hours : 1

Introduction:
Physical Pharmaceutical Chemistry is a fundamental course in the field of Pharmaceutical Sciences that helps in proper understanding of successive courses such as pharmaceutics and pharmaceutical technology. It assimilates knowledge of mathematics, physics and chemistry and applies them to the pharmaceutical dosage form development. It concentrates on the theories needed for dosage form design. It enables the pharmacists to make rational decisions on scientific basis concerning the art and technology of solutions, suspensions, emulsions, etc.

Specific Objectives:
The objectives of this course are to:

1. Calculate and to prepare standard solution of different primary standard substances.
2. Determine the strength of unknown acid/base solution by titration.
3. Understand the concept of distribution co-efficient and to determine distribution co-efficient of benzoic acid in ether/water system.
4. Prepare buffer solution having a specific pH value.
5. Analyze phase diagram of binary system.
6. Determine molecular weight of a drug by Victor Meyer's method.
7. Determine pKa and pKb values of acids and bases.

Course Contents:

1. Standardization of acids and bases
2. Determination of pKa and pKb values.
3. Preparation of buffer solution of different pH and buffer capacity.
4. Determination of phase diagram of binary systems.
5. Determination of distribution co-efficient.
6. Determination of molecular weight of a drug by Victor Meyer's method.
7. Determination of heat of solution by measuring solubility as a function of temperature.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Prepare solutions having different concentration or strength, and determine the strength unknown solution.
2. Determine pKa and pKb value of acid and bases.

3. Understand the concept of distribution co-efficient and to determine distribution co-efficient of benzoic acid in ether/water system.
4. Prepare buffer solution having a specific pH value.
5. Analyze phase diagram of binary system.
6. Determine molecular weight of a drug by Victor Meyer's method.
7. To determine pKa and pKb values of acids and bases.

Assessment: As per the rules

Text books:

1. Martin's Physical Pharmacy and Pharmaceutical Sciences
2. Applied Physical Pharmacy by Mansoor M. Amiji and Beverly

References:

1. J. Sandmann (McGRAYV-Hill Medical Publishing Division)

PHR 104 Natural Product Chemistry-I Credit Hr: 2

Course Number : PHR 104
Course Title : Natural Product Chemistry-I
Credit hours : 2

Introduction:

This course is a prerequisite for the course PHR 204 of B. Pharm. Year 2. The content of this course is based on the history of pharmacognosy, knowledge of natural product chemistry, crude drugs, phytochemical methods, traditional medicines, vitamins, animal drugs, surgical dressings, etc. Thus, the course will familiarize the students with the contribution of natural products in pharmaceutical sciences.

Specific Objectives:
The objectives of this course are to know:

1. the history of pharmacy in terms of pharmacognosy.
2. the classification of drugs
3. the different aspects of crude drugs
4. the phytochemical methods of plant analysis
5. the natural product chemistry and biological roles of lipids, carbohydrates and alkaloids
6. the natural sources and impacts of vitamins
7. the contribution of traditional medicines
8. surgical dressings, fibres, etc.

Course Contents:

1. **Natural products as drugs:** Definition, scope, historical development, Pharmacognosy, official, nonofficial and unofficial drugs, etc.
2. **Crude drugs**: A general view of their origin, distribution, cultivation, collection, drying and storage, commerce and quality control, classification of drugs, preparation of drugs for commercial market, drug adulteration, evaluation of crude drugs.
3. **Plant analysis**: Primary and secondary metabolites, types of plant constituents, extraction, separation, chromatography, comparative phytochemistry, biosynthesis, chemotaxonomy.
4. **Phytochemistry and pharmaceutical uses of the following plant constituents:**

   (a) Lipids: Castor oil, Linseed oil, Coconut oil, Olive oil, Peanut oil, Chaulmoogra oil and Bees wax.

   (b) Carbohydrate and related compounds: Sugars and sugar containing drugs- dextrose, fructose, sucrose, lactose etc. Microbiota accessible carbohydrates, starches. Gums and mucilages- tragacanth, acacia.
5. **Contribution of traditional drugs to modern medicines:** Details of some common indigenous traditional drugs such as Vashaka, Arjuna, Chirata, Bahera, Haritaki, Tulsi, Neem, Garlic, Black Cumin, etc.
6. **Vitamins and vitamin containing few selected animal drugs**: Definition of vitamins, general uses, classification, structures of vitamins.
7. **Others:** As suggested by course teachers, if necessary.

Learning Outcomes:

Upon completion of the course, the students will be able to understand the:

1. history of pharmacognosy in drug discovery.
2. different classes of drugs.
3. background of crude drugs and its importance.
4. classification of lipids, some important sources of lipids along with chemistry and uses.
5. chemistry of carbohydrates along with classification, botanical origin, and medicinal uses
6. classification of alkaloids, collection and its biological roles.
7. sources of vitamins, their chemistry and biological roles.
8. importance of traditional medicines of Bangladesh.
9. importance of surgical dressings and fibers, etc.

Assessment: As per the rules

Text books:

1. William Charles Evans. *Trease and Evans' Pharmacognosy*, Sixteenth Edition, Saunders, 2009.

2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. *Pharmacognosy*, Ninth Edition, Philadelphia: Lea & Febiger, 1998.

3. Text Book of Pharmacognosy by T.E. Wallis

References:

1. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. *Fundamentals of Pharmacognosy and Phytotherapy*, Second Edition, Churchill Livingstone, Elsevier, 2012.
2. Mohammad Ali. *Pharmacognosy and Phytochemistry*, CBS Publishers & Distribution, New Delhi.
3. *Text book of Pharmacognosy* by C.K. Kokate, Purohit, Gokhlae (2007), 37th Edition, Nirali Prakashan, New Delhi.
4. *Practical Pharmacognosy*: C.K. Kokate, Purohit, Gokhlae

PHR 105 Physiology and Anatomy-I Credit Hr: 4

Course Number **:** PHR 105

Course Title **:** Physiology and Anatomy-I

Credit hours **:** 4

Introduction:

The study of physiology is, in a sense, the study of life. It asks questions about the internal workings of organisms and how they interact with the world around them. Physiology tests how organs and systems within the body work, how they communicate, and how they combine their efforts to make conditions favorable for survival. Human physiology, specifically, is often separated into subcategories; these topics cover a vast amount of information. Researchers in the field can focus on anything from microscopic organelles in cell physiology up to more wide-ranging topics, such as ecophysiology, which looks at whole organisms and how they adapt to environments. The most relevant arm of physiological research is applied human physiology; this field investigates biological systems at the level of the cell, organ, system, anatomy, organism, and everywhere in between. In this course, we will visit some of the subsections of physiology, developing a brief overview of this huge subject.

Specific Objectives:

The course will provide basic knowledge about fundamental physiological processes and mechanisms and with a view to meet the following objectives –

1. To explain the general terminologies and scopes of physiology and anatomy.
2. To illuminate the basic structural composition as well as arrangements of cells and organizations and functions of various organelles.
3. To enlighten the functions of various physiological tissues.

4. To elucidate the composition and function of blood and to describe the various types of blood cells.
5. To give a comprehensive idea about how the cardiovascular, digestive, respiratory and reticulo-endothelial system work.

Course Contents:

1. **General physiology:** Physiology and its scope in pharmacy, structure of cell, its various organelles and functions, cell division, body fluid compartments and its composition, transport across cell membrane and membrane potentials, homeostasis.

2. **Tissue:** Definition, classification, characteristics, distribution, minute structures and functions of different tissue, bone and cartilage.

3. **Blood system:** Composition and functions of blood, plasma and its components, plasma proteins and their functions, plasma pheresis, blood coagulation, blood transfusion and blood groups, haemolysis, ESR, Erythropoiesis, blood forming cells (RBS, WBC, Platelets), characteristics, functions, their formation and destruction; haemoglobin- its structure, properties, function and haemoglobin derivatives; immunity and its process, anaemia- definition and classification, causes and clinical features of various anaemia.

4. **Cardiovascular system:** Heart- structure and blood circulation, cardiac muscles, their properties, origin of heart beat and action potential, cardiac cycle, heart sounds, cardiac output, ECG, regulation of cardiac function, blood pressure- types, significance, measurement and regulation, hypertension-types and causes.

5. **Digestive system:** Structure of different parts of alimentary system, gastrointestinal motility and its control, swallowing and defaecation; secretion of digestive juices from saliva, stomach, pancreas; functions of digestive juices and their mechanism and regulation of secretions; digestion and absorption of various food stuffs; liver- its function, formation of bile and its circulation.

6. **Respiratory system:** Organs of respiratory system and its structure, inspiration and expiration, mechanism of respiration, lung compliance, pulmonary ventilation, pulmonary volumes and capacities, gaseous exchange through lungs, carriage of O_2 and CO_2, chemical and nervous regulation of respiration, hypoxia- causes and classification, asthma, COPD.

7. **Reticulo-endothelial system:** Spleen, thymus, tonsil, lymph node, bone marrow.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain the fundamental aspects of physiology and anatomy.
2. Understand the basic composition of cells.

3. Describe the composition and functions of various types of tissues.
4. Summarize the anatomy and physiology of cardiovascular, digestive, respiratory, and reticulo-endothelial system.

Assessment: As per the rules

Text books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.

References:

1. Review of Medical Physiology- W.F. Ganong.
2. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
3. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 105L	**Physiology and Anatomy-I Lab**	**Credit Hr: 1**

Course Number **:** PHR 105L
Course Title **:** Physiology and Anatomy-I Lab
Credit hours **:** 1

Specific Objectives:

To familiarize the students with basic laboratory experiments related to Physiology and Anatomy.

Course Contents:

1. Study of compound microscope and observation of blood cells (R.B.C., W.B.C. and platelets)
2. Estimation of hemoglobin and Erythrocyte sedimentation rate (ESR).
3. Total count of R.B.C. and W.B.C.
4. Differential count of W.B.C.
5. Examination of clot under the microscope and determination of clotting and bleeding time.
6. Fragility test of R.B.C. and effect of chemical agents on R.B.C.
7. Determination of blood group.

Learning Outcomes:

To enable the students to carry out the above experiments independently.

Assessment: As per the rules

Text books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.

References:

1. Review of Medical Physiology- W.F. Ganong.
2. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
3. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 106 Biochemistry Credit Hr: 4

Course Number **:** PHR 106

Course Title **:** Biochemistry

Credit hours **:** 4

Introduction:

Biochemistry course has been designed to study the science concerned with the chemical basis of life. The cell is the structural unit of living systems. Thus, biochemistry can also be described as the science concerned with the chemical constituents of living cells and with the reactions and processes, they undergo. The course encompasses the introductory foundations on large areas of cell biology, molecular biology and molecular genetics. The aim of biochemistry course is to describe & explain, in molecular terms, all chemical processes of living cells.

Specific Objectives:

1. The course is designed to cover the foundation knowledge on biological molecules at the molecular levels and the chemical processes such as nucleic acids, proteins, enzymes, lipids etc.
2. The course will provide the basics of how to determine their structures, and analyze how they function.
3. Student will learn the reciprocal relationships between biochemistry and medical science as well as drug functions.

Course Contents:

1. **Introduction to cell and nuclear structure:** Molecular design of life, cells and their types, composition and function of biological membrane and cell wall, cell cycle, animal cell division, transmembrane transport, structure and function of chromosomes, chromosomal aberrations.

2. **DNA, RNA and flow of genetic information:** Historical background of the discovery of nucleic acid, Bases of DNA/RNA, nucleosides, nucleotides, structure of DNA, DNA replication, synthesis of mRNA, post-transcriptional processing, genetic code and translation, DNA mutation, DNA repair, DNA cloning, DNA sequencing, heredity.

3. **Proteins:** Different amino acids structures and functions, common structural features, importance of amino acid study, peptides structure, ionization behavior, Biological activity of peptides, conjugated proteins, protein separation and purification, gel electrophoresis, unseparated protein quantifications, 2D gel electrophoresis, chemical synthesis of protein, protein sequencing, recombinant DNA technology for protein sequencing.

4. **Three dimensional structure of Proteins:** Overview on protein structure, rigid and planar peptide bond, proteins secondary structure; α-helix, β-sheet, β-turn, common bond angles and amino acid content, Protein tertiary and quaternary structures; α-keratin, globular proteins, myoglobulin, tertiary structures of globular proteins, super secondary structures-motifs or folds, protein structural classification on the basis of protein motifs, assisted folding, molecular chaperons, size limits of proteins, denaturation and renaturation of protein, hydrogen bonding potentiality.

5. **Enzymes:** An introduction to enzymes, enzyme classifications (according to IUPAC), activation energy, how enzymes work, specificity of enzymes, regulation of enzyme activity, enzymes and reaction equilibria, enzyme kinetics, substrate concentration affects the rate of Enzyme-Catalyzed reactions, Michaelis-Menten equation, enzyme inhibition, common features of enzymes, regulatory enzymes, enzyme cofactor/coenzyme, Vitamin B complex as coenzymes, FAD, FMN, TPP, NADP mediated reactions etc.

6. **Biosynthesis of Lipids, carbohydrates and proteins:** Biosynthesis of fatty acids, eicosanoids, regulation of fatty acid synthesis, biosynthesis of triglycerides, biosynthesis of membrane phospholipids, biosynthesis of cholesterol, steroids and isoprenoids, biosynthesis of amino acids, nitrogen cycle, biosynthesis of starch and sucrose, synthesis of cell wall polysaccharides etc.

Learning outcomes: After finishing the course, students will be able to:

1. Learn about the fundamental aspects, scopes and applications of Biochemistry in Pharmacy.
2. Understand the basic cellular and nuclear structures and their functions.
3. Explain how the genetic information is transferred and processed and how DNA and RNA are biosynthesized within the cells and how they can be manipulated.
4. Explore the basic structural organizations, classifications, functions separations and purification processes of proteins.
5. Comprehend the IUPAC classification and theory of enzyme action, enzyme kinetics and enzyme inhibition and their significance in drug designing and in understanding the actions of drugs.
6. Explore the biosynthetic pathways and biochemical roles of lipids, carbohydrates and proteins and elucidate how this knowledge can be exploited for various purposes including identification of druggable targets, association with diseases, etc.

Assessment: As per the rules

Text books:

1. Lehninger's Principle of Biochemistry. Albert L. Lehninger, 5th Edition, 2008.
2. Biochemistry. J. M. Berg, John L. Tymoczko, Lubert Stryer, 5th Edition, 2002.

References:

1. Harper's Illustrated Biochemistry. Murray, Bender, Botham, Kennelly, Rodwell and Weil, 28th Edition, 2009.
2. Lippincotts's Illustrated Reviews: Biochemistry. Richard A. Harvey, PhD and Denise R. Ferrier, PhD, 5th Edition, 2011.

PHR 106L Biochemistry Lab **Credit Hr: 1**

Course Number **:** PHR 106L
Course Title **:** Biochemistry Lab
Credit hours **:** 1

Specific Objectives:

To familiarize the students with basic laboratory experiments related to Biochemistry.

Course Contents:

1. Determination of protein content by spectrophotometric method.
2. Determination of plasma protein by Biuret method (method of Reinhold).
3. Identification and molecular weight determination of protein by SDS-PAGE.
4. Synthesis of DNA by PCR method and identification of DNA by agarose gel electrophoresis.
5. Estimation of blood cholesterol by chemical and enzymatic method.
6. Determination of serum creatinine, bold urea and BUN.
7. Determination of SGPT and SGOT levels in blood.

Learning Outcomes:

To enable the students to carry out the above experiments independently.

Assessment: As per the rules

Text books:

1. Lehninger's Principle of Biochemistry. Albert L. Lehninger, 5th Edition, 2008.
2. Biochemistry. J. M. Berg, John L. Tymoczko, Lubert Stryer, 5th Edition, 2002.

References:

1. Harper's Illustrated Biochemistry. Murray, Bender, Botham, Kennelly, Rodwell and Weil, 28th Edition, 2009.
2. Lippincotts's Illustrated Reviews: Biochemistry. Richard A. Harvey, PhD and Denise R. Ferrier, PhD, 5th Edition, 2011.

PHR 107 Pharmaceutical Technology-I Credit Hr: 2

Course Number : PHR 107
Course Title : Pharmaceutical Technology-I
Credit hours : 2

Introduction:

This subject will enrich the students with the basic knowledge about the history of pharmacy and pharmacy education, basic pharmaceutics, different dosage forms, and basic compounding and dispensing.

Specific Objectives:

The course will provide basic knowledge about fundamental pharmaceutics with a view to meet the following objectives –

1. Introduces the students to the profession of pharmacy and the role of the pharmacist within health care delivery in Bangladesh including the roles and responsibilities of a pharmacist.
2. The course also teaches dispensing, pharmaceutical calculations and counselling required in the practice of pharmacy.
3. This course also introduces basic concepts in Pharmaceutics including discussion on dosage form design and routes of administration.

Course Contents:

1. **Foundations of pharmaceutical technology:** History of technological advancements in the field of Pharmacy, development of Pharmacy in Bangladesh – education and industry, pharmacy education in various countries; fundamental knowledge of the followings terms: drug, dosage forms and drug delivery systems, drug products, medicines; route of drug administration; drug regulatory authorities; pharmacopoeia; pharmacists' code of ethics; career opportunities of pharmacists at home and abroad.

2. **Pharmaceutical excipients:** Definition, functions and role of excipients in drug formulations, general properties and characteristics of pharmaceutical excipients, safety and regulatory status of excipients, classification of excipients with relevant examples.

3. **Basic compounding and dispensing:** Weight, measures and units used in calculation for compounding and dispensing of pharmaceuticals; fundamental operation in compounding; good

pharmaceutical practices in compounding and dispensing; containers and closures for dispensed products; prescription and handling of prescription, responding to the prescription; labelling of dispensed medications.

4. **Pharmaceutical calculation:** Fundamentals of pharmaceutical calculations; pharmaceutical measurement; density, gravity, percentage and other expression of concentration; dose calculation; reducing and enlarging formula.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain the role of pharmacists in public health and primary health care in Bangladesh and globally.
2. Perform pharmaceutical calculations correctly and develop skills in the preparation of pharmaceutical products and dispensing.
3. Can understand the basic pharmaceutics including different dosage forms and their applications with route of administration.
4. Evaluate the properties and significance of different pharmaceutical excipients.

Assessment: As per the rules

Recommended books:

1. Introduction to Pharmacy, Dr. Md. Shah Amran, 1st edition, 2010, Krishnachura Prokashoni, Dhanmondhi, Dhaka, Bangladesh.
2. Pharmacy, Pharmaceutical sector and Healthcare, Dr. Md. Shah Amran, 1st edition, 2009, Shova Prokashoni, Bangla Bazar, Dhaka, Bangladesh.
3. Pharmaceutical Compounding and Dispensing: Chris Langley and Dawn Belcher.
4. Cooper and Gunn's: Dispensing for Pharmaceutical Students.
5. The theory and practice of Industrial Pharmacy (4th edition) - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
6. Remingtons' Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.
7. Pharmaceutics: the science of dosage form design – Aulton
8. Pharmaceutical Calculations – Howard C. Ansel

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 107L Pharmaceutical Technology-I Lab Credit Hr: 1

Course Number **:** PHR 107L
Course Title **:** Pharmaceutical Technology-I Lab
Credit hours **:** 1

Specific Objectives:
To familiarize the students with basic laboratory experiments related to basic pharmaceutics.

Course Contents:
1. Understanding and applying Good Laboratory Practice (GLP) in pharmacy labs.
2. Measurement of weight, volume, concentration, density, specific gravity and pH of pharmaceutical preparations.
3. Preparation of different percentage solution.
4. Dose calculation of pharmaceutical preparations.
5. Identification of different dosage forms.

Learning Outcomes:
To enable the students to carry out the above experiments independently.

Assessment: As per the rules

Recommended books:

1. Pharmaceutical Compounding and Dispensing: Chris Langley and Dawn Belcher.
2. Cooper and Gunn's: Dispensing for Pharmaceutical Students
3. Pharmaceutical Calculations – Howard C. Ansel

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 108 Pharmaceutical Microbiology-I Credit Hr: 4

Course Number : PHR 108
Course Title : Pharmaceutical Microbiology-I
Credit hours : 4
Introduction:
Microbiology forms an integral part of pharmacy as disease causing pathogens including bacteria, viruses and fungi are the principal targets of various pharmaceutical products e.g. antibiotics and vaccines. To better understand the clinical course of an infection and efficiently eradicate the disease with quality pharmaceuticals, it is crucial to have in-depth knowledge about the morphology, life-cycle, reproduction and sensitivity of micro-organisms. In addition, the study of constitutive human immune system is equally important to understand their vital role in the battle against pathogens. In this course, besides learning about the above mentioned topics some research methodologies and theories of diseases have also been discussed which will have implications in diagnosis and developing therapeutics.

Specific Objectives:
1. To know about the history and background of microbiology

2. To gain in-depth knowledge on the pathogenic microorganisms and basic concept on research methodologies
3. Safeguarding pharmaceutical products from microbial contamination/decomposition and ensuring biological safety of the workplace by applying the knowledge of microbiology.

Course Contents:

1. **Introduction to Pharmaceutical Microbiology:** History; theory of spontaneous generation; germs theory of diseases; Koch's postulates; scopes and applications of microbiology; basic concepts of microscopy.
2. **Bacteria:** Structure and morphology; growth curve; types of bacteria; staining of bacteria; culture media; bacterial culture; basic concepts of antibiotics; antibiotic resistance; clinical application of bacteria.
3. **Viruses:** Structure and morphology; replication; types of viruses; viral culture; clinical application of viruses; vaccines; antiviral drugs.
4. Fungi: Yeast and mold; reproduction; structure and morphology; antifungal drugs; application of fungi in bakery, fermentation, agriculture, and pharmaceutical aspects.
5. **Protozoa:** Morphology; clinical importance of protozoa; blood and tissue parasites; intestinal parasites; protozoal diseases; control of protozoan parasites.
6. **Algae:** Structure and morphology; biological and clinical significances of algae; algal toxins; reproduction of algae; methods of large-scale cultivation of algae.
7. **A) Food and Medicine's Spoilage by microorganisms:** Types of spoilage: Factors affecting microbial spoilage; adverse role of microorganisms in different types of dosage forms; evaluation of microbial contamination and spoilage.
   B) Preservation of Food and Medicine: Preservation of pharmaceutical products; evaluation of microbial stability of formulations.
8. **Role of microbiology in pharmaceutical industries:** The role of recombinant DNA technology in the pharmaceutical industry; pharmaceutical products made by genetic engineering, miscellaneous pharmaceutical products of microbial origin (vitamins, amino acids, streptokinase, dextran, etc.).

Learning outcomes:

Upon completion of the course, the students will be able to:

1. Have a comprehensive knowledge over the history and background of microbiology.
2. Comprehend the knowledge of microbiology in pharmaceutical sciences and ensuring microbiological safety in pharmaceutical products and workplace.
3. Utilize the basic research methodologies of microbiology, e.g. basic microscopy.
4. Learn about bacterial structure, major identifying characteristics and to differentiate between various bacterial strains including gram positive and gram negative bacteria.
5. Prepare bacterial media and grow different bacterial culture. The students will also learn about the growth cycle and pathogenesis of bacteria.
6. Acquire knowledge about the morphological features, life cycle, reproduction and virulence of other microbes including viruses, fungi and protozoas.

7. Develop basic concept on immunology including cells involved in natural and acquired immune system, their mode of action against infection, regulation of the immune system, hypersensitivity, and immunological products, e.g. vaccines and sera.

Assessment: As per the rules

Reference/recommended books:

1. Pelczar, M.J., Chan E.C.S & Krieg N.R. 1997. Microbiology. 15th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2. Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. & and Painter, P.R. 1993. General Microbiology. 5th Edition. The Macmillan Press Ltd., London.
3. Choudhury, M.R. 1999. Modern Medical Microbiology. 5th Edition. Ganim Printing & Packages, Dhaka.
4. Levinson, W. &Jawetz, E. 1989. Medical Microbiology & Immunology. 6th Edition. McGraw Hill.
5 Hugo, W.B and Russell, A.D. 1983. Pharmaceutical Microbiology. 3rd Edition. Blackwell Scientific Publications, Oxford.

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 108L Pharmaceutical Microbiology-I Lab Credit Hr: 1

Course Number **:** PHR 108L
Course Title **:** Pharmaceutical Microbiology-I Lab
Credit hours **:** 1

Specific Objectives:
To familiarize the students with basic knowledge of microbiological practice and adapt it for microbiological methods and ensuring biological safety in laboratory/pharmaceuticals.

Course Contents:
1. Operation of microscope.
2. Preparation of gram staining reagents.
3. Identification and characterization of bacteria.
4. Staining of bacterial cells and spores.
5. Preparation of pure bacterial cultures.
6. Preparation of pure culture and its identification.
7. Bacterial counts

Learning Outcomes:
At the end of the course the students will be able to culture, grow, identify, analyze & preserve bacteria.

Assessment: As per the rules

Reference/recommended books:

1. Pelczar, M.J., Chan E.C.S & Krieg N.R. 1997. Microbiology. 15th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2. Hugo, W.B and Russell, A.D. 1983. Pharmaceutical Microbiology. 3rd Edition. Blackwell Scientific Publications, Oxford.

PHR 109	**Viva Voce**	**Credit Hr: 1**

Course Number **:** PHR 109
Course Title **:** Viva Voce
Credit hours **:** 1

Course Description:
The viva voce in the B. Pharm. (Hons) program evaluates students' knowledge and communication skills. It ensures readiness to apply pharmaceutical knowledge in real practice.

Specific Objectives:

1. Assess understanding of core pharmaceutical sciences and practice.
2. Evaluate application of knowledge in patient-centered scenarios.
3. Test problem-solving, decision-making and communication skills.
4. Build confidence, professionalism and ethical reasoning.

Course Contents: Total Syllabus of B. Pharm. (Hons) year-I

Learning Outcomes:
After the viva, students will be able to:

- Demonstrate subject knowledge and competence.
- Apply reasoning to solve therapeutic problems.
- Integrate multidisciplinary concepts effectively.
- Communicate clearly and confidently.
- Show professionalism and ethical awareness.

Assessment: As per the rules

B. Pharm. (Hons) Year -II

PHR 201 Inorganic Pharmaceutical Chemistry-II Credit Hr: 2

Course Number : PHR 201
Course Title : Inorganic Pharmaceutical Chemistry-II
Credit hours : 2

Introduction:
Inorganic Pharmaceutical Chemistry II has been designed to present those principles of inorganic chemistry that apply to medicinal and/ or pharmaceutical chemistry. This is a core course that will present detailed discussions of those inorganic agents used as pharmaceutical aids and necessities or as therapeutic and diagnostic agents.

Specific Objectives: The objectives of this course are to:

1. Discuss inorganic compounds used therapeutically such as hematinic products.
2. Highlight the inorganic products such as topical agents, dental products, antidotes, etc.
3. Explain the causes of environmental pollutions including global warming, ozone layer depletion and toxicity problems associated with heavy metals.

Course Contents:
1. Hematinic preparations: Various types of iron and iron compounds, nano-iron formulations (ferumoxytol, iron sucrose complexes), liposomal iron, enteric-coated polymers, drug interactions (PPIs, calcium supplements).
2. Topical agents: Classification of topical agents, preparation, mechanism of action and applications of different protectives, antimicrobials and astringents.
3. **Dental preparations:** Dental plaque and antiplaque agents (preparation, mechanism of action, applications and side effects), enzymatic antiplaque systems (glucanohydrolases), dental caries, fluorides and other anticaries agents (preparation, mechanism of action and application), fluoride therapy: systemic and topical fluoridation, dental fluorosis, dentifrices, mouthwash.
4. **Radioactivity and radiopharmaceuticals:** Introduction, types of radiation and their properties, radioactive decay, half-life, average life, modes of radioactive decay, interaction of radiation with matter, measurement of radioactivity, radiation hazard and radiological safety, biological effects of radiation, control of radiation exposure, storage of radioactive materials, medical applications of radionuclides, official radioactive compounds and their importance, toxicity of radioactive isotopes.
5. **Environmental chemistry and environmental sciences:**
A. Definition, causes of environmental pollution, types of pollutions (gases like SO_2, SO_3, CO_2, CO, NO, HCl, NO_2 etc., hydrocarbons, global warming, suspended particulate, pesticides, gasoline and industrial waste, pharmaceutical food additives), deleterious effects of pollutants on life cycle, applications and importance of environmental sciences.

B. Heavy metal toxicity: Poisoning caused by mercury, arsenic, lead, iron and copper, their adverse effects on human life cycle and study of antidotes used in these poisoning cases.

Learning Outcomes:
Upon completion of the course, the students will be able to:

1. Define pharmacokinetic and pharmacodynamic properties of different inorganic drugs.
2. Describe the source, chemistry, mode of action, of different inorganic drugs.
3. Synthesize different inorganic drugs.
4. Explain the causes of environmental pollution, deleterious effects of pollutants on life cycle, applications and importance of environmental sciences
5. Explain toxicity problems associated with different heavy metals.

Assessment: As per the rules

Text books:

1. 1. Introduction to Modern Inorganic Chemistry- S. Z. Haider, 1994, Friends International.
2. Modern Inorganic Chemistry- Madan, 1st (reprint 1997), S. Chand & Company Ltd.

References:

1. Introduction to Modern Inorganic Chemistry- J. D Lee, 5th edition, Blackwells.
2. Bentley and Driver's Textbook of Pharmaceutical Chemistry- Bently, Arthur Owen, 8th edition, Oxford University Press.
3. Modern Inorganic Pharmaceutical Chemistry- Clarence A. Discher, Leonard C. Bailey, Thomas Medwick, 2nd edition, Waveland Pr Inc.
4. Rogers Inorganic Pharmaceutical Chemistry- Rogers, Charles Herbert, Taito O. Soine and Charles O. Wilson, 7th edition, Philadelphia, Lea & Febiger.
5. Inorganic Medicinal & Pharmaceutical Chemistry- Block, John H., Roche, Edward B., Soine, Taito O., Wilson, Charles O., 1974, Lea and Febiger, Philadelphia.

PHR 202 Organic Pharmaceutical Chemistry-II Credit Hr: 4

Course Number : PHR 202
Course Title : Organic Pharmaceutical Chemistry-II
Credit hours : 4

Introduction:
This is a core course and this course is a continuation of PHR 102. This course focuses on organic reactions and their mechanisms, chemistry of biological molecules and pharmaceuticals as well as basic principles of organic stereochemistry.

Specific Objectives:
The objectives of this course are to explore:

1. Mechanisms of the major chemical reactions
2. Chemistry of biological molecules such as carbohydrates, amino acids, lipids and vitamins
3. Basic principles of organic stereochemistry

Course Contents:

1. **Reaction mechanisms**:
   (a) Addition reaction: Electrophilic; nucleophilic and free-radical; 1,2- and 1,4- addition.
   (b) Substitution reaction: Unimolecular (S_N1) and bimolecular (S_N2), stereochemistry of S_N1 and S_N2 reaction, free-radical and intermolecular nucleophilic substitution.
   (c) Elimination reaction: Unimolecular (E1) and bimolecular (E2), stereochemistry of elimination reaction.
   (d) Rearrangement reaction: Hofmann, Claisen, Beckmann, Curtius, Sigmatropic and Fries rearrangement.
2. **Name reactions**: Arndt-Eistertd, Baklelite, Baeyer-Villiger, Birch reduction, Clemmensen reduction, Darzens condensation, Diels Alder, Eschweiler-Clarke, Friedel-Crafts, Gabriel synthesis, Gettermann- Koch and Sandmeyer, Grignard, Hofmann, Mannich, Michael, Meerwin-Pondorf-Verley, Oppenauer oxidation, Perkin, Reformatsky, Reimer-Tiemann, Vilsmeier- Haack, Wittig reaction, Wolf-Kishner reduction, Aldol & crossed Aldol Condensation, Cannizzaro Reaction, Mitsunobu reaction, Swern Oxidation, Jones Oxidation, Claisen & crossed Claisen Condensation.
3. **Stereochemistry**:
   a. General treatment of different types of isomerisms.
   b. Geometric isomerism of alkenes and cyclic compounds, cis, trans and (E), (Z) systems of nomenclature.
   c. Conformational isomers- conformation of open chain and cyclic compounds.
   d. Chirality of molecules- enantiomer, diastereomer, racemic modification, meso compound, (R) and (S) configuration, sequence rule, optical rotation.
   e. Asymmetric synthesis- preparation of enantiomer by asymmetric synthesis and optical resolution method.
   f. Stereoselective and stereospecific reaction.
   g. Pharmaceutical importance of stereochemistry.
4. **Chemistry of Carbohydrates**: Stereochemistry, classification, aldoses, ketoses, oxidation, effect of alkali, Kiliani- Fisher synthesis of aldoses, Ruff degradation, optical family, D-L, R-S cyclic structures of D (+) glucose, mutarotation, hemiacetal, acetal form of glucose, ring size determination, disaccharide, structure determination of polysaccharides, starch cellulose, glycogen, chemical and pharmaceutical importance of carbohydrate.
5. **Chemistry of Amino acids & proteins**: Structure of amino acids, acidity and basicity of amino acids, isoelectric point, preparations and reactions of amino acids, essential amino acids, metabolism of amino acids-deamination, transamination, racemization etc.
6. **Lipids**: a. Fatty acids – reactions; b. Hydrolysis, Hydrogenation, Saponification and Rancidity of oils, Drying oils; c. Analytical constants – Acid value, Saponification value, Ester value, Iodine value, Acetyl value, Reichert Meissl (RM) value – significance and principle involved in their determination. β- oxidation, catabolism of unsaturated fatty acids, ketone bodies, ketosis, ketourea, ketoacidosis, diabetic coma and its treatment, lactic acid and acidosis, phosphoglycerides, steroids, bile salts etc.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand and analyze reaction mechanisms
2. Recognize and apply named organic reactions
3. Apply concepts of stereochemistry
4. Explain the chemistry and pharmaceutical relevance of carbohydrates
5. Comprehend the chemistry of amino acids and proteins
6. Demonstrate knowledge of lipid chemistry

Assessment: As per the rules

Text books:

1. Robert T. Morrison & Robert N. Boyd. *Organic Chemistry*, 6th (Ed.), 1992. Prentice-Hall Inc., Upper Saddle River, NJ, USA.
2. *Heterocyclic Chemistry* by T.L. Gilchrist
3. Arun Bahl &B.S. Bahl. *Advanced Organic Chemistry.* S. Chand & Company Ltd, New Delhi, India.

References:

1. Jonathan Clayden, Nick Greeves & Stuart Warren. *Organic Chemistry*, 2nd (Ed.), 2012. Oxford University Press Inc., New York, USA.
2. John M. Beale & John H. Block, *Wilson & Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry*, 12th (Ed.), 2010. Lippincott Williams & Wilkins, Philadelphia, Pennsylvania, USA.

PHR 202L Organic Pharmaceutical Chemistry-II Lab Credit Hr: 1

Course Number **:** PHR 202L
Course Title **:** Organic Pharmaceutical Chemistry-II Lab
Credit hours **:** 1

Introduction:
This laboratory course provides an essential foundation in practical organic chemistry, focusing on core techniques for analysis, characterization, and synthesis of organic compounds. Designed to bridge theoretical knowledge with hands-on experimentation, the course equips students with the fundamental skills required to identify unknown substances and create targeted molecules through controlled chemical reactions. Through rigorous laboratory work, meticulous observation, and critical data interpretation, this course cultivates proficiency in essential organic chemistry laboratory techniques, safety protocols, and analytical reasoning, preparing students for advanced study and research.

Specific Objectives:
To equip students with practical skills in qualitative organic analysis (element detection and functional group identification), quantitative analysis of oils and fats, and fundamental synthetic organic chemistry techniques through hands-on laboratory experimentation.

Course Contents:

1. Detection of elements like Nitrogen, Sulphur and Halogen by Lassaigne's test
2. Functional group test like Phenols, Amides/ Urea, Carbohydrates, Amines, Carboxylic acids, Aldehydes and Ketones, Alcohols, Esters, Aromatic and Halogenated Hydrocarbons, Nitro compounds and Anilides.
3. Determination of following oil values (including standardization of reagents)
   Acid value,
   Saponification value,
   Iodine value
4. Preparation of compounds
   Benzanilide/Phenyl benzoate/Acetanilide from Aniline/ Phenol /Aniline by acylation reaction.
   2,4,6-Tribromo aniline/Para bromo acetanilide from Aniline/
   Nitro benzene by nitration reaction.
   Benzoic acid from Benzyl chloride by oxidation reaction.
   Benzoic acid/ Salicylic acid from alkyl benzoate/ alkyl salicylate by hydrolysis reaction.

Learning Outcomes: Upon completion of the course, the students will be able to:

1. Perform Qualitative Elemental Analysis
2. Identify Organic Functional Groups
3. Quantify Oil/Fat Characteristics
4. Synthesize Organic Compounds
5. Apply Laboratory Fundamentals

Assessment: As per the rules

Text books:

1. Organic Chemistry by Morrison and Boyd
2. Organic Chemistry by I.L. Finar , Volume-I

References:

1. Textbook of Organic Chemistry by B.S. Bahl & Arun Bahl.
2. Organic Chemistry by P.L.Soni
3. Practical Organic Chemistry by Mann and Saunders.
4. Vogel's text book of Practical Organic Chemistry
5. Advanced Practical organic chemistry by N.K.Vishnoi.

PHR 203 Physical Pharmaceutical Chemistry-II Credit Hr: 4

Course Number **:** PHR 203
Course Title **:** Physical Pharmaceutical Chemistry-II
Credit hours **:** 4

Introduction:

This course is a continuum of Physical Pharmaceutical Chemistry–I and a pre-requisite to Pharmaceutical Analysis-I for the degree of Bachelor of Pharmacy. This course provides a basic understanding of the core area of physical chemistry based around the theme of kinetics, drug stability, viscosity and rheology, surface phenomenon, micromeritics and electrochemistry. It helps the students to understand the significance and application of chemistry and chemical phenomena on pharmaceutical analysis.

Specific Objectives:

The objectives of this course are to discuss and make the students understand:

1. kinetics of chemical reactions
2. flow properties and behavior of surface
3. viscosity and colloidal behavior of pharmaceuticals
4. electrical conductivity of electrolytes and electrochemical cell
5. particle size and shape and their influence in production of pharmaceuticals

Course Contents:

1. **Chemical Kinetics and Stability of Pharmaceuticals:**
   (a) Rates, order, and molecularity of reactions; rate constants, half-life, shelf life, and apparent or pseudo-order specific rate constant; determination of order; Michaelis–Menten equation and its application.
   (b) Stability of pharmaceuticals; Decomposition and stabilization of medicinal agents; The chemical breakdown of drugs; Kinetics of chemical decomposition in solution; Factors influencing drug stability of solid and liquid dosage forms; Stability testing and calculation of shelf-life.
2. **Interfacial Phenomenon**: Surface tension and interfacial tension and their application in pharmaceutical sciences; Different methods of surface and interface tension measurements; Calculate surface and interface tensions; Surface free energy, its changes; Work of cohesion and adhesion; Activated charcoal and application; Electric properties of interfaces and Electric Double Layer; Nernst and Zeta potentials; Effect of electrolytes
3. **Rheology**: Definition; Pharmaceutical products exhibiting various rheologic behaviors, and the application of rheology in the pharmaceutical sciences; Concept on shear rate, shear stress, viscosity, kinematic viscosity, fluidity, plasticity, yield point, pseudoplasticity, shear thinning, shear thickening, thixotropy, hysteresis, anti-thixotropy, rheopexy, and viscoelasticity; Newton's law of flow and its application; Different flow properties and corresponding rheograms between Newtonian and non-Newtonian materials; Effects of temperature on viscosity; Types of viscometers and their utility and limitations.
4. **Colloids and Pharmaceutical Polymers**:

(a) **Colloidal systems and their main characteristics;** Micelles and the Critical Micelle concentration; Optical properties (The Faraday–Tyndall Effect),Kinetic properties and Electrical properties of colloids and their applications for the analysis of colloids; Donnanmembrane equilibrium; Pharmaceutical applications of colloids.

(b) **Basic concepts of polymers**; Principles of polymer synthesis; Homogeneous and dispersion polymerizations; Thermal, physical, and mechanical properties of polymers; Glass transition temperature and factors affecting the T_g; Effect of molecular weight on polymeric properties;Types of polymers and their usage in drug delivery applications

5. **Micromeritics:** Importance of particle size determination, different means of expressing particle size, methods of particle size determination, optical and electron microscope studies, coulter counter methods, laser beam technique, sieve analysis, sedimentation methods, particle shape and surface area, measurement of particle surface area.
6. **Complexation and Protein Binding**: Complexes (coordination compounds); Classification of complexes; Organic molecular complexes and their pharmaceutical application; Molecular sieve and methods of analysis; Drug-Protein binding and determination binding equilibrium; Equilibrium dialysis and Ultra-filtration; Dynamic dialysis; Factors affecting complexation and protein binding.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Know theories of chemical reactions, rate of the reaction and the factors affecting the rate of reaction
2. Understand the factors influencing the stability of pharmaceutical preparations and physical and chemical degradation processes and how to prevent them
3. Explain rheology, Newtonian and non-Newtonian flow, mixing, and effects of particle size on pharmaceuticals.
4. Demonstrate the application and uses of colloidal preparation
5. Understand the application of electrochemistry and electrochemical cell in pharmaceutical analysis

Assessment: As per the rules

Text books:

1. Principles of Physical Chemistry by Dr. Muhammad Mahbubul Huque, Dr. Muhammad Yousuf Ali Mollah.
2. Essentials of Physical Chemistry by Arun Bahl & J.D Tuli.

References:

1. Physical Pharmacy: Physical Chemical Principles in the Pharmaceutical Sciences by Alfred N. Martin.

PHR 203L Physical Pharmaceutical Chemistry-II Lab Credit Hr: 1

Course Number : PHR 203L
Course Title : Physical Pharmaceutical Chemistry-II Lab
Credit hours : 1
Introduction:

A practical course in physical pharmacy focusing on observing physicochemical phenomena at work in pharmaceutical dosage forms and systems. The aim of this course is to provide basis for future studies in chemistry and allied subjects, key mathematical concepts and skills required to succeed in physical chemistry, and an introduction to basic practical skills including safe working practices

Specific Objectives: The objectives of this course are to -

1. provide students with the practical laboratory skills of physical pharmacy.
2. demonstrate the effect of the physico-chemical properties phenomena on pharmaceutical systems.
3. clarify theoretical concepts learned in theory course Physical Pharmacy -II (PHR 203)
4. evaluate the risks associated with an experiment and understand how to mitigate against those risks.
5. provide students with the skills that will be needed in their future practical work

Course Contents:

1. Viscosity determinations:
   (a) Determination of viscosity of pure liquids such as glycerin, alcohol etc.
   (b) Determination of viscosity of liquid pharmaceutical preparation- syrup, emulsion, suspension etc.
   (c) Study of variation of viscosity of liquid with temperature using Ostwald of Engleris viscometer.
2. Determination of velocity constant of the hydrolysis of methyl/ ethyl acetate catalyzed by HCl/ NaOH.
3. Determination of adsorption isotherm of oxalic (or acetic) acid form aqueous solution by charcoal and calculation of the constant in Freundlich's equation.
4. Determination of the equilibrium constant of the reaction $KI + I = KI_3$.
5. Determination of solubility of a sparingly soluble salt in water by conductance measurement.
6. Determination of velocity constant for the hydrolysis of an ester in the basic medium by conductance measurements.
7. Determination of the molecular weight of an organic solid.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. develop the ability to suggest suitable techniques to evaluate some physicochemical properties of drug molecules and dosage forms
2. learn the use of basic instruments analysis and measurement instruments (analytical balance, viscometer etc.).
3. interpret scientific data and make sound scientific conclusions
4. know the measurement units and understand their conversions
5. know the general laboratory safety and basic techniques

Assessment: As per the rules

References:

1. Text books: Principles of Physical Chemistry by Dr. Muhammad Mahbubul Huque, Dr. Muhammad Yousuf Ali Mollah.
2. Essentials of Physical Chemistry by Arun Bahl & J.D Tuli.
3. Physical Pharmacy: Physical Chemical Principles in the Pharmaceutical Sciences by Alfred N. Martin.

PHR 204 Natural Product Chemistry-II Credit Hr: 2

Course Number **:** PHR 204
Course Title **:** Natural Product Chemistry-II
Credit hours **:** 2

Introduction:
This course is based on the knowledge of natural product chemistry which will provide a link between nature and drug discovery. Students will get a clear picture on the bioactive lead compounds obtained from nature as well as the role of plant parts, extracts, etc. as drugs.

Specific Objectives:

The objectives of this course are to:

1. Know the chemical skeleton and tests of natural products
2. Extraction and other collection procedures of drugs from plants
3. Biological roles of secondary metabolites and parts of the plant
4. Structure activity relationships of bioactive lead compounds obtained from nature
5. Semi-synthetic approach to obtain and modify drugs.
6. Understanding biosynthesis of secondary metabolites

7. Knowing importance of herbs as food

8. Poisonous aspects of plants

Course Contents:

1. **General introduction of natural product chemistry and drug discovery**

2. **Phytochemistry and pharmaceutical uses of the following plant constituents along with consideration of some important local and foreign drugs of each groups:**

a) Glycosides: Chemistry, classification, biosynthesis of glycosides.

The details of the followings:

i) Cyanogenic: Wild cherry
ii) Isothiocyanate: Mustard (Black mustard and white mustard)
iii) Cardiac: Digitalis, Strophanthus, Squill
iv) Saponins: Sarsaparilla, Glycyrrhiza, Dioscorea.
v) Anthraquinone glycosides: Cascara sagrada, Aloe, Senna, Rhubarb
vi) Other glycosides (alcohol, aldehyde, lactone, phenol, flavonoid) and neutral principles: Willow bark, Vanilla, Cantharide, Uva ursi, Gentian, Quassia, Saffron, etc.

b) Alkaloids: Chemistry, classification, biosynthesis

The details of the followings:

i) Tropane: Belladona, Stramonium, Hyoscyamus and Coca
ii) Quinoline: Cinchona
iii) Isoquinoline: Ipecac, Opium, Curare
iv) Indole: Rauwolfia, Nux vomica, Ergot
v) Imidazole: Pilocarpine
vi) Steroidal: Veratrum viride, Aconite
vii) Purine base: Coffee, Tea, Cocoa
viii) Pyridine-piperidine: Areca

c) Volatile oils and related terpenoids: Chemistry, methods of obtaining volatile oils, medicinal and commercial uses, biosynthesis of some important volatile oil used as drugs.

The details of the followings:

i) Terpenes or sesquiterpenes: Turpentine, Juniper

ii) Alcohols: Coriander, Sandalwood

iii) Ester: Peppermint, Lavender, Rosemarry

iv) Aldehydes: Cinnamon, Lemon

v) Ketones: Spearmint, Caraway, Camphor

vi) Phenols: Clove, Thyme, Cinnamon leaf

vii) Ethers: Fennel, Nutmeg, Eucalyptus, Anise

viii) Peroxides: Chenopodium

ix) Others: Mustard, Wintergreen, Bitter almond

d) Phenolic compounds and tannins: Chemical nature and test for tannins, medicinal and commercial uses, some tannin containing drugs such as Nutgall and Catechu.

e) Resin and resin combinations (e.g. resin, oleoresin, oleo gum resin, balsam): Definition, chemistry, importance, brief study of Podophyllum, Jalap, Cannabis, Capsicum, Ginger, Myrrh, Tolu Balsam and Benzoin.

3. **Herbs as health foods:** Definition, chemistry, uses in pharmacy; brief study of Alfa alfa, Apricot pits, Arnica, Garlic, Onion, Ginseng, Ginko biloba, Spiriluna Fenugreek, Sassafras, Honey, etc.
4. **Poisonous plants and natural pesticides:** Datura, Poison hemlock, Water Hemlock, Foxglove (Digitalis), Ipomoea, Tobbaco, Poppy, Pyrethrum flower, Derris and Lanchocarpus, Red squill, etc.
5. **Others:** As suggested by course teachers, if necessary.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand the link between natural product chemistry and drug discovery
2. Perceive the diversification in glycoside structures, natural sources and medicinal roles
3. Learn the variation in the chemistry of alkaloids, botanical sources, semi-synthetic approach, tests and biological functions

4. Understand the different aspects of volatile oil chemistry, extraction and medicinal uses
5. Learn the chemistry of tannins along with classification, botanical origin, tests and medicinal uses
6. Perceive the contribution of resins as drugs as well as their chemistry
7. Understand the importance of herbs as medicinal food
8. Understand the toxic nature of phytoconstituents and features of natural pesticides

Assessment: As per the rules

Text books:

1. William Charles Evans. *Trease and Evans' Pharmacognosy*, Sixteenth Edition, Saunders, 2009.
2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. *Pharmacognosy*, Ninth Edition, Philadelphia: Lea & Febiger, 1998.

References:

1. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. *Fundamentals of Pharmacognosy and Phytotherapy*, Second Edition, Churchill Livingstone, Elsevier, 2012.

PHR 204L Natural Product Chemistry-II Lab Credit Hr: 1

Course Number **:** PHR 204L
Course Title **:** Natural Product Chemistry-II Lab
Credit hours **:** 1

Introduction:
This course is based on the theoretical course Natural Product Chemistry-II (PHR-204). It will provide a practical look of bioactive agents available in plants and animals and show the gateway of drug discovery. Students will learn to investigate plant- and animal- based drugs through various experimental methods. It also highlights the importance medicinal plants used for traditional purposes.

Specific Objectives:

The objectives of this course are to:

1. Learn the extraction procedures of drugs from plants
2. Know the detection of secondary metabolites in plants
3. Learn to compare the outcomes various test methods
4. Prepare the students for doing industrial quality control of herbal drugs

5. Highlight the uses of medicinal plants for traditional uses

Course Contents:

1. Extraction of Indole Alkaloids from *Rauwolfia serpentina*
2. Extraction of Purine alkaloids from Tea or Coffee
3. Total Phenolic content analysis of plant extract by Folin-Ciocalteu method
4. Extraction and Identification of Cardioactive (Steroidal) Glycosides from *Nerium oleander*
5. Extraction and identification of Anthracene glycosides from Senna leaves
6 Study of some important medicinal and poisonous plants of Bangladesh.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Obtain the concept of indole alkaloids, their extraction from plants and detection.
2. Collect the caffeine from tea leaves and perform chemical test for indentificaiton.
3. Extract the anthracene glycosides from plants and confirm their presence through chemical tests.
4. Identify the cardioactive glycosides in plants having steroidal nucleus after extraction.
5. Quantify tannins in plant samples.
6. Know the value of medicinal plants.

Assessment: As per the rules

Text books:

1. William Charles Evans. *Trease and Evans' Pharmacognosy*, Sixteenth Edition, Saunders, 2009.
2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. *Pharmacognosy*, Ninth Edition, Philadelphia: Lea & Febiger, 1998.

References:

1. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. *Fundamentals of Pharmacognosy and Phytotherapy*, Second Edition, Churchill Livingstone, Elsevier, 2012.

PHR 205 Physiology and Anatomy-II Credit Hr: 4

Course Number **:** PHR 205

Course Title **:** Physiology and Anatomy-II

Credit hours **:** 4

Introduction:

This course will be the continuation of Physiology and Anatomy-I (PHR 105) and will be focusing on important physiological systems including nervous, endocrine, excretory and reproductive systems. This course will also provide basic understanding on metabolic systems and physiological system regulating body temperature.

Specific Objectives:

1. To learn and understand the fundamental scientific concepts relating to a broad range of topics in human physiology especially nervous system, endocrine system, cellular metabolism, excretory system, reproductive system and regulation of body temperature.
2. To become familiar with the basic factual information concerning the mechanisms and functioning of human that biology students will require in the rest of their scientific careers, to develop investigative skills and to become familiar with standard techniques of measurement.
3. To gain practice and confidence in applying this knowledge, in a quantitative manner where appropriate, to actual experiments.

Course Contents:

1. **Nervous system:** Neuron- properties, classification and functions; neuroglial cells and their functions; nerve fibres-definition, types, properties of nerve fibres, origin and propagation of nerve impulses across nerve fibres, action potential; synapse-classification, structure, properties and functions; neurotransmitters- classifications and functions, never endings.

   Different types of sensations- mechanism and properties of sensations; receptors-definition, classifications, properties and functions.

   Reflex and reflex arc, their classifications, properties and components of reflex arc. Principal division of nervous system - CNS and PNS, functions of different parts of CNS, ascending and descending tracts of spinal cord, differences between - somatic & autonomic, and sympathetic & parasympathetic nervous system; cranial and spinal nerves & their functions, regulation of autonomic nervous system; muscle tone-definition & regulation; CSF- definition, composition and function.

2. **Endocrine system:** Different endocrine glands & their structure; functions of pituitary, thyroid, parathyroid, adrenal & pancreatic glands; functions, regulation and secretion of hormones, disorders of abnormal hormone secretions.

3. **Metabolism:** Fat, carbohydrate, protein and nucleoprotein metabolism; metabolic pathways of fats, carbohydrates and proteins; enzymes, vitamins and hormones regulating various metabolic steps; vitamins and minerals: their physiological properties and functions.

4. **Excretory system:** Structure of kidney, nephron & its different parts; renal circulation-its regulation & measurements, renal clearance & its importance; urine- its composition

& properties, counter current mechanism, role of kidney in acid-base balance of blood & in maintenance of plasma volume.

5. **Reproductive system:** Testis & accessory reproductive systems & their functions, male hormones and their functions, spermatogenesis and its hormonal regulation.

   Organs of female reproductive system and their functions, menstruation cycle, different phases & its regulation; oogenesis' & ovulation and its control; female sex hormones & their functions; pregnancy and lactation & their hormonal control.

6. **Regulation of body temperature:** Heat production & heat dissipation, role of hypothalamus & other nerve factors in body temperature regulation, abnormalities in body temperature regulation.

Learning Outcomes:

1. The student will learn the physiology and mechanism of functions of the central nervous system, and the role of CNS to co-ordinate the functions of different other organ system.
2. The student will learn the histological features of different endocrine glands, how their secretion is regulated, the chemical nature of the hormones and their functions.
3. The student will learn the physiology of different metabolic organs, and the metabolism of carbohydrate, protein, fat, nucleic acids, vitamins and minerals. Besides students will learn about different enzyme systems involve in the metabolic process.
4. The student will be able to understand the basic physiological structure of renal system and its function as an excretory organ. Besides students will be able to learn different factors that regulate renal functions.
5. The student will learn both anatomical and histological organization of both male and female reproductive system. Besides student will learn the role of the sexual hormones in the reproductive process, spermatogenesis, oogenesis and the regulation of sexual act.
6. The student will learn different types of body temperature, temperature regulation, role of CNS and different chemicals in temperature regulation.
7. Most importantly, students will be able to apply those physiology knowledges to the disease process. They will be able to correlate the use and the mode of action of different pharmacological agents under the abnormal physiological situation.

Assessment: As per the rules

Text books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.

References:

1. Review of Medical Physiology- W.F. Ganong.

2. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
3. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 205L Physiology and Anatomy-II Lab Credit Hr: 1

Course Number **:** PHR 205L
Course Title **:** Physiology and Anatomy-II Lab
Credit hours **:** 1

Specific Objectives:
To familiarize the students with basic laboratory experiments related to Physiology and Anatomy.

Course Contents:

1. Lung function test.
2. Determination of B.P. under normal and stressed (exercise-induced) condition
3. Behavioral analyses of animal (mice model) using Hole-board, Open-field, Elevated maze and Hole-cross test.
4. Determination of E.C.G. using animal model.
5. Routine examination of urine.

Learning Outcomes:
To enable the students to carry out the above experiments independently.

Assessment: As per the rules

Text books:
1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.

References:
1. Review of Medical Physiology- W.F. Ganong.
2. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
3. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 206 Cellular and Molecular Biology Credit Hr: 4

Course Number : PHR 206
Course Title : Cellular and Molecular Biology
Credit Hours : 4

Course Description:
Rapid advances in biology have had a major impact on our society. From the production of new drugs, to revolutionary advances in our understanding of how cells work, the areas of cell and molecular biology have contributed to our lives in a number of ways. Training in these areas is essential for careers in medicine, pharmacology, biochemistry, virology, immunology, developmental biology, and in a number of the high-tech industries. An understanding of biology is dependent upon an understanding of the diverse cellular components (structure and function) at a molecular level that compose multicellular organisms. In this course, we will examine the molecular mechanisms of eukaryotic cells. The relationship between structure and function at the molecular and cellular level will be discussed for topics ranging from transcription and translation to cellular communication. As we discuss and develop an understanding of cellular and molecular biology, we will integrate aspects of cytology, protein and nucleic acid chemistry, genetics, molecular genetics, pharmacology, enzymology, and immunology. This class will provide you with an understanding of cellular structure, synthesis and function of diverse macromolecules; mechanisms of nuclear control of cellular processes; and cellular communication and interactions.

Specific Objectives:

Upon successfully completing this course, students will be able to:

1. Understand the basic organization of the cell and the importance of the functions of basic macromolecules such as proteins, nucleic acids and lipids to maintain the structural and functional integrity of the cell.
2. Examine the relationships between the extracellular and intracellular transport systems. Besides the role of vesicular transport system for protein sorting and the mystery of energy source within the cell will be discussed in details.
3. Examine the intracellular and intercellular communication mechanism and the roles of cytoskeletons to shape the behavior of the cells.
4. Articulate the roles of different regulators in cellular growth, organ developments and cell divisions.
5. Understand the basic organization of cells within the tissue and role of different junctions and extracellular proteins to maintain the tissue integrity.
6. Examine the cellular and molecular basis for germ cell development, fertilization, multicellular organism development, role of stem cells and composition of stem cell niche.
7. Understand cancer as a model disease to appreciate the importance of the well-regulated cellular and molecular events as the core of maintaining life.

8. Develop an in-depth understanding of the cellular and molecular mechanisms that regulate immune responses, integrating core concepts of molecular biology with immune cell function, signaling pathways, and gene regulation, enabling students to critically analyze the role of the immune system in health and disease.

Course Contents:

1. **Membrane structure, transport and protein sorting:** a) Structures of different membrane proteins and molecular mechanisms of membrane transport: b) Intracellular compartments and protein sorting: the compartmentalization of cells, transport of molecules between nucleus and cytosol, transport of protein into mitochondria and chloroplast, peroxisomes, transport into endoplasmic reticulum.

2. **Vesicular transport and energy conversion:** a) Intracellular vesicular traffic: the endocytic and biosynthetic secretory pathway, vesicular transport, transport from ER through Golgi apparatus, transport from trans-Golgi network to lysosomes, transport into the cell from plasma membrane: endocytosis, transport from the trans-Golgi network to the cell exterior: exocytosis. b) Energy conversion, mitochondria and chloroplast: electron transport chain and their proton pumps.

3. **Cell communication and cytoskeletons:** a) Cell communication: general principle of cell communication, signaling through G-protein linked cell surface receptor, signaling through enzyme-linked cell surface receptor, signaling pathway that depend on regulated proteolysis, signaling through small G-proteins. b) The cytoskeleton: the self-assembly and dynamic structure of cytoskeleton filaments, regulation of cytoskeleton filaments, molecular motors, the cytoskeleton and cell behavior.

4. **Cell junctions and cell adhesions:** a) Cell junctions: functional classification of cell junctions, structure and the role of tight junctions in transcellular transport, current model of tight junction, septate junction, adherens junction, structure and function of anchoring junctions and gap junctions b) Cell-cell adhesions: mechanism by which cell assemble into tissues, structure and functions of cadherins, distribution of E and N-cadherins in nervous system, mechanism of cell-cell adhesions, linkage of classical cadherins to actin filaments, structure and functions of selectins, the cell adhesion molecule N-CAM.

5. **Extracellular matrix proteins and receptors:** a) Extracellular matrix: cell surrounded by spaces filled with extracellular matrix (ECM), fibroblast in connective tissue, different glycosaminoglycan (GAG) and their structure, linkage between the GAG chain and its core protein, decorin and aggrecan, structure of collagen and elastic fibers, structure of fibronectin dimer, organization of basal laminae b) Integrin: the subunit structure of an

integrin cell-surface matrix receptor, different types of integrins and their ligands, the gelation of integrin binding to ECM and integrin signaling pathways.

6. **Development of organism:** a) Germ cell and fertilization: the benefits of sex, meiosis, primordial germ cell and sex determination in mammals, egg, sperm and fertilization. b) Development of multicellular organism: four essential processes by which a multicellular organism is made, universal process of animal development, development from the perspective of individual cell, genesis of body plan, homeotic selector genes and the patterning of the anteroposterior axis, organogenesis and the patterning of appendages, cell movement and the shaping of the vertebrate body. c) The lives and deaths of cells in tissues: epidermis and its renewal by stem cells, sensory epithelia, the airways and the gut, blood vessels and endothelial cells, renewal by multipotent stem cells: blood formation, genesis, modulation and regeneration of skeletal muscle, fibroblast and their transformation, stem cell engineering.
7. **Cellular and molecular basis of immune responses:** Innate vs adaptive immune cells, molecular mechanisms of immune recognition: antigen processing and presentation, antigen recognition molecules: structure of antibodies and B-cell receptors (BCR), structure of T-cell receptors (TCR), major histocompatibility complex (MHC I and II); innate immunity at the molecular levels: pattern recognition receptors (PRRs): TLRs, NLRs, RLRs, signal transduction leading to inflammation (NF-κB pathway); Signaling pathways in immune cells: T cell receptor complex and T cell signaling, co-stimulatory/inhibitory signals in T-cell activation (CD28, CTLA-4, PD-1); Differentiation of activated T cells into effector cells, memory T cells. Properties, development and functions of $CD4^+$ and $CD8^+$ effector T subsets: Th1, Th2, Th17 and γδ T cells, NK cells, MAIT cells. helper T cells, role of cytokines; T cell exhaustion; the B lymphocyte antigen receptor complex and signaling, cytokine receptors and signaling, Antigen capture, delivery to B cells and B cells activation signal, role of CD40L:CD40 interaction in T-dependent B cell activation, class switching, B cell differentiation into antibody-secreting plasma cells, generation of memory B cells, regulation of humoral immune response by Fc receptors, antibody-mediated opsonization and phagocytosis, leukocyte Fc receptors, antibody-dependent cell-mediated cytotoxicity.

Learning outcomes: Students will be able to:

1. Appreciate the importance of sub-cellular organization and the role of basic macromolecules to maintain cellular integrity.
2. Differentiate the basic difference between the extracellular and intracellular transport systems. Besides will understand the importance of vesicular transport system for protein sorting in maintaining sub-cellular compartmentalization.
3. Correlate the relation between the intracellular and intercellular communication mechanism and the roles of cytoskeletons to maintain the integrity of the tissues and the cell itself.
4. Articulate the roles of different regulatory mechanism of cell growth, developments and divisions and its importance in disease process.

5. Learn the composition, organization and functions of different junction and extracellular protein and their mode of interaction to maintain cellular integrity within tissues.
6. Learn the regulatory mechanism of germ cell development, fertilization, multicellular organism development and the role of stem cells in the organ development and self-renewal process.
7. Study cancer as a model diseases and learn the underlying molecular events and cellular components causing cancer to further explore those knowledge to other disease process.
8. Explain the molecular basis of antigen recognition and signaling in B and T lymphocytes and describe how these processes contribute to immune specificity and diversity.

Assessment: As per the rules

Text Book:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell. 5th edition, New York, Garland Science.
2. A. K. Abbas, A. H. Litchman and S. Pillai. Cellular and Molecular Immunology. 7th edition, New York, Elsevier.

References:

2. Harvey Lodish , Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira. **Molecular Cell Biology. 8th edition, New York, W. H. Freeman and Company.**

PHR 207 Pharmacology-I Credit Hr: 4

Course Number **:** PHR 207

Course Title **:** Pharmacology-I

Credit hours **:** 4

Introduction:

The science of pharmacology is the study of drugs. Understanding how drugs affect physiological homeostatic mechanisms at the molecular level forms the basis for developing sound therapeutic strategies. Consequently, the use of therapeutic agents requires an understanding of basic pharmacological principles. These principles apply to all drugs and are predicated on pharmacodynamics and pharmacokinetic variables. This course is designed to develop an understanding of the theoretical concepts surrounding pharmacology, such as the pharmacokinetics and pharmacodynamics of drugs, and the concepts surrounding pharmacotherapy. It gives specific information about the agents used in cardiovascular diseases, blood related disorders, autacoids and others such as antihistamines, GI disturbances etc. With each classification of drugs covered, their mode of action, their clinical effects, and side effects will be emphasized.

Specific Objectives:

1. Identify the fundamental principles of pharmacokinetics and pharmacodynamics.
2. Apply the pharmacodynamics and pharmacokinetic principles that describe drug actions in humans.
3. Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically.
4. Identify the role of molecular genetics and genomic principles in pharmacotherapeutics and drug development.
5. Understand the basics of drugs used in cardiovascular disorders, blood related disorders, autacoids etc.

Course Contents:

2. **Introduction to Pharmacology**: Definition of pharmacology, drug, medicine and pro drug; pharmacokinetics, pharmacodynamics, agonist, synergism, side effect, toxicity, drug interaction, drug tolerance, drug dependence, drug abuse, idiosyncrasy, dose, dosage form, absorption, distribution, bioavailability, distribution, protein binding, metabolism & excretion, routes of drug administration.

3. **Basic concept of drug action**: Receptors, nature of receptors, drug antagonism, drugs specificity, SAR and drug design, Drugs interaction with receptors, Factors modifying drug actions, mechanism of drug action-GPCR, Ion channels, enzyme inhibition etc, relation between drug dose & clinical response.

4. **Drugs affecting blood related disorders:** Pharmacokinetics and pharmacodynamics of the following classes of drugs:
   a. Coagulation disorders-blood coagulation cascade, indirect and direct thrombin inhibitors, warfarin and the coumarin anticoagulants, fibrinolysin drugs, antiplatelet agents, drugs used in bleeding disorders
   b. **Anti-hyperlipidemics**-pathophysiology, dietary management, HMG-CoA reductase inhibitors (statins), niacin, fibrates etc.
   c. **Haematinics and antianemia drugs**- iron, vitamin B_{12}, folic acid, erythropoietin

5. **Autacoids:** Amine, lipid & peptide autacoids. eicosanoids, effect of prostaglandins and thromboxanes, effect of lipoxygenase and CYP-P450 derived metabolites.

6. **Drugs affecting Other Diseases**: Pharmacokinetics and pharmacodynamics of the following classes of drugs:

   a. Antihistamines- H1 receptor antagonists (sedating and non-sedating), mast cell stabilizers.

   b. Gastrointestinal and antiemetic drugs- H2-histamine receptor blocker, inhibitors of proton pump, misoprostol, antacids, mechanism of vomiting, drugs used in chemotherapy induced vomiting-ondansetron,

   c. Anti-inflammatory drugs- NSAIDs (e.g. aspirin, ibuprofen, aceclofenac, naproxen, indomethacin, piroxicam and paracetamol, etc.), Cox-2 inhibitors (e.g. celecoxib, rofecoxib, etc.

d. Vitamins: Detailed study of water (vitamin B complex and vitamin C) and fat-soluble vitamins (e.g. vitamin A, D, E and K).

Learning Outcomes:

1. The student will develop basic understanding of pharmacology in terms of pharmacokinetics and pharmacodynamics. Besides they will learn different other most commonly used pharmacological terms and their definition.
2. The student will learn fundamental concept of drug-receptor interactions and their kinetics.
3. The student will learn the mode of action of different classes of drugs used in peptic ulcer, blood related disorder such as anemia, coagulation etc.
4. The student will learn the role of different endogenous autacoids in both physiological and pathological conditions.
5. In addition, students will be able to role of different classes of drugs used in cardiovascular diseases.

Assessment: As per the rules

Text book:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition
The Pharmacological Basis of Therapeutics, 13th edition, 2011. Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:

1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 207L Pharmacology-I Lab Credit Hr: 1

Course Number : PHR 207L
Course Title : Pharmacology-I Lab
Credit hours : 1

Specific Objectives:
To familiarize the students with basic experimental procedures related to Pharmacology.
Course Contents:
1. Estimation of salicylic acid in blood after oral administration of aspirin by UV spectroscopic method
2. Estimation of salicylic acid in blood after oral administration of aspirin by colorimetric method
3. Estimation of paracetamol after oral administration by UV/visible spectroscopic method
4. Estimation of anti-histamine in blood after administration
5. Estimation of Vitamins by suitable method.

Assessment: As per the rules

Text book:
1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition
The Pharmacological Basis of Therapeutics, 13th edition, 2011. Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:
1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 208 Pharmaceutical Technology-II Credit Hr: 4

Course Number : PHR 208
Course Title : Pharmaceutical Technology-II
Credit hours : 4

Introduction:

The course addresses the principles of pharmaceutical pre-formulation, compatibility, and different dosage forms. The course is delivered through a combination of lecture, tutorials, self-directed learning activities.

Specific Objectives:

1. To make the students familiar with the theoretical knowledge of pre-formulation, excipients and its compatibility, different types of pharmaceutical formulations and dosage forms.
2. To evaluate the physico-chemical properties of pharmaceutical constituents; ensure quality of dosage forms and also point out processing problems with possible solution.

Course Contents:

1. **Pre-formulation**: Product life cycle, Product life cycle management, bulk characterization of the material crystallinity and polymorphism, hygroscopicity, particle characterization, bulk density, powder flow properties, solubility analysis, $_pK_a$ determination, pH solubility profile, solubilization, partition coefficient, dissolution, stability analysis, solution stability, solid state stability.
2. **Drug incompatibility**: Physical, Chemical and Therapeutic incompatibilities between APIs, excipients and packaging materials.
3. **Liquid Dosage Forms:** Definition and general characteristics, Advantages and limitations, Classification and types of liquid dosage forms (monophasic and biphasic)

   (a)Monophasic Liquid Dosage Forms- Solution: Definition and types: Solutions (Oral, Topical, Parenteral), Syrups, Elixirs, Tinctures and Drops and Mouthwashes, Solvents used: Purified water, alcohol, polyols, glycerin, Formulation components: Active pharmaceutical ingredients (API), Solubilizing agents, preservatives, flavoring, sweetening, and coloring agents, Theory of solution preparation, Techniques of preparation, Quality control parameters: Clarity, pH, specific gravity, microbial limit test, content uniformity, Packaging, Labeling, and Storage

   (b)Biphasic Liquid Dosage Forms – Suspensions: Definition and types: Flocculated vs. deflocculated, oral/topical/injectable, Ideal properties, theory of suspension, formulation components: Dispersed phase, suspending agents, wetting agents, flocculating agents, preservatives, Controlled flocculation, structured vehicle system,

Techniques of preparation, Evaluation parameters, Problems of suspension dosage forms. Packaging, Labeling, and Storage

(c)Biphasic Liquid Dosage Forms – Emulsions: Definition and types: Oil-in-water (O/W), Water-in-oil (W/O), Multiple emulsions and Microemulsion, Determination of emulsion types, Theory of emulsion, Theory of emulsification: Phase volume theory, Bancroft's theory, and oriented wedge theory, Formulation ingredients: Oil phase, aqueous phase, emulsifying agents (natural, synthetic, finely divided solids), HLB system and selection of emulsifiers, Techniques of preparation, Evaluation parameters, Instabilities and remedies, Packaging, Labeling, and Storage.

4. **Semisolids- Ointment, Cream, Paste, Gel:** Definition and classification of semisolid dosage forms, theoretical aspects of skin and its nature of penetration, formulation consideration of semisolid dosage forms, industrial manufacturing, evaluation and quality analysis, recent innovations in semisolid processing technology.
5. **Suppositories**: Drug absorption from colon, classification of suppositories, suppository bases, formulation of suppositories, manufacturing of suppositories, mold calibration, displacement value, testing of suppositories.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Analyze the significance of different parameters of pre-formulation study.
2. Analyze and differentiate among different incompatibility problems in pharmaceutical formulations.
3. Explain the concept of pharmaceutical compounding and dispensing.
4. Determine the process and different ingredients required to formulate liquid dosage forms.
5. Compare and contrast among different dispersion systems along with their formulation and manufacturing process.
6. Differentiate among ointment, paste, cream and gel based on their formulation and manufacturing process.
7. Classify suppositories and evaluate different characteristics of different bases used to formulate suppositories.

Assessment: As per the rules

Reference/recommended books:

1. The theory and practice of Industrial Pharmacy (4th edition) - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.

2. Remingtons' Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.
3. The basics of pharmaceutics- Aulton
4. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems – Loyd V. Allen
5. Aulton's Pharmaceutics: The Design and Manufacture of Medicines – Michael J. Rathbone, David Collett, and Alexander T Florence
6. Pharmaceutical Dosage Forms: Disperse Systems (Vol. 1–3) – Herbert Lieberman,
7. Pharmaceutical Pre-formulation and Formulation – Mark Gibson

PHR 208L Pharmaceutical Technology-II Lab Credit Hr: 1

Course Number : PHR 208L
Course Title : Pharmaceutical Technology-II Lab
Credit hours : 1

Specific Objectives:
The objectives of this course are to:
1. Determine the key ingredient to prepare different formulation
2. Evaluate the quality control parameters of different formulations.
3. Justify the use of different excipients to prepare dosage forms.

Course Contents:
Preparation and evaluation of the following dosage forms:
1. Solution
2. Suspension
3. Emulsion
4. Ointment
5. Suppository

Learning Outcomes:
Upon completion of the course, the students will be able to:
1. Calculate to prepare different percentage solution.
2. Compare and contrast among different dosage forms (solution, suspension, emulsion).
3. Prepare and assess different quality control parameters of a suspension.
4. Determine the key factors for preparing emulsion.

Assessment: As per the rules

Reference/recommended books:
1. The theory and practice of Industrial Pharmacy (4th edition) - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. Remingtons' Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.

3. The basics of pharmaceutics- Aulton
4. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems – Loyd V. Allen
5. Aulton's Pharmaceutics: The Design and Manufacture of Medicines – Michael J. Rathbone, David Collett, and Alexander T Florence
6. Pharmaceutical Dosage Forms: Disperse Systems (Vol. 1–3) – Herbert Lieberman,
7. Pharmaceutical Pre-formulation and Formulation – Mark Gibson

PHR 209 Pharmaceutical Microbiology-II Credit Hr: 2

Course Number : PHR 209
Course Title : Pharmaceutical Microbiology-II
Credit Hours : 2

Course Description:
This course intends to provide the students comprehensive knowledge on microbial assay of antibiotics, different sterilization techniques, disinfection, antisepsis and application of microbiology in pharmaceutical industry. The course will also cover different immunological products and bacterial resistance.

Specific Objectives:
1. Learn about the antimicrobial activity, factors affecting the measurement of antimicrobial activity, determination of MICs and different antibiotic assays e.g. biological and non-biological assays.
2. Gain information on principle of sterilization, different techniques of sterilization e.g. dry heat, filtration, radiation and gas. Upon completion of this course, the students should learn about a range of sterility testing procedure for powder, semisolid, and aqueous suspensions preparations.
3. This course also focuses on characteristics of disinfectants, evaluation tests, criteria for activity of different types of disinfectants and their modes of action.
4. This course includes the applications of micro-organisms to the industrial production of miscellaneous pharmaceutical products such as vitamins, amino acids, steroids, dextran etc. This course also provides knowledge about different immunological products as well as students will acquire knowledge about the mechanisms by which bacteria become resistant to drugs used to treat infections caused by them.

Course Content:

1. **Microbial assay of antibiotics:** Antimicrobial activity; antibiotic assays; determinations of MICs, challenge tests, microbiological quality of pharmaceutical materials with special reference to non-sterile and sterile products.
2. **Sterilization:**
   Sterilization by dry heat and autoclave
   Sterilization by filtration
   Sterilization by radiation
   Sterilization by gas
3. **Sterility testing:** Introduction to sterility testing; types and composition of media used in sterility testing; growth promotion test; LAL test and pyrogen tests.
4. **Disinfection and antisepsis:** Introduction to disinfection; factors influencing disinfection, chemical disinfectants, and their modes of action, microorganism management in hospital and industry.
5. **Aseptic Processing:** Laminar air flow; basic concept of clean area; microorganism control by aseptic processing

Learning outcomes:

Upon completion of the course, the students will be able to:

1) Explain the factors affecting the measurement of antimicrobial activity, antibiotic assays and be able to determine the MICs (Minimum Inhibitory Concentrations).
2) Describe the principle and methods of sterilization, pros and cons of sterilization by moist heat, stem under pressure, filtration, radiation and gas. They will also be able to discuss the applications of autoclave, testing the efficiency of autoclaves and validation of sterilizers.
3) Describe sampling techniques, types of media used in sterility testing, positive and negative controls. They will also be able to perform different sterility tests for aqueous solutions, aqueous suspensions, powders, semi solid preparations, oils and ointments. Explain immunological preparations and viral products.
4) Demonstrate procedures for disinfection and antisepsis, chemical disinfectants, and their modes of action. Be able to evaluate the function of disinfectant.
5) Learn about active antigenic products, attenuated, inactivated and extract, viral and bacterial products, passive products, gamma globulin and immunoglobulins.
6) Learn about new useful microorganisms and describe the beneficial aspects of microorganisms and their control use in pharmaceutical industries.
7) Describe the mechanisms by which bacteria and viruses become resistant to drugs.

Assessment: As per the rules

Reference/recommended books:

1. Prescott and Dunn: Industrial Microbiology
2. Tortora, Funkee and Case, Microbiology: An Introduction
3. Malcolm Harris, Pharmaceutical Microbiology
4. Pelczar, Kreig and Khan, Microbiology

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 209L Pharmaceutical Microbiology-II Lab Credit Hr: 1

Course Number : PHR 209L
Course Title : Pharmaceutical Microbiology-II Lab
Credit hours : 1

Specific Objectives:
The objectives of this course are:

To familiarize students with diverse techniques that form the basis of modern research in pharmaceutical industrial microbiology.

Course Contents:

1. Effects of various sterilizing conditions on microorganisms.
2. Sterility testing of pharmaceutical products.
3. Antibiotic sensitivity tests of microorganisms.
4. Efficiency testing of disinfectants and antiseptics.

Learning Outcomes:
At the end of the course the students will be able to culture, grow, identify, analyze & preserve bacteria.
Assessment: As per the rules

Reference/recommended books:

1. Prescott and Dunn: Industrial Microbiology
2. Hugo, W.B and Russell, A.D. 1983. Pharmaceutical Microbiology. 3rd Edition. Blackwell Scientific Publications, Oxford.

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 210 Cosmetic Sciences and Technology Credit Hr: 4

Course Number : PHR 210

Course Title **:** Cosmetic Sciences and Technology
Credit hours **:** 4
Introduction:

The course addresses the basic principle of cosmetic science including the formulation and manufacturing process as well as the quality control procedures of different cosmetics. The course is delivered through a combination of lecture, tutorials, critical thinking and group learning activities through presentation.

Specific Objectives:

1. To make the students familiar with the theoretical knowledge of cosmetics science and technology

2. To gain in-depth knowledge on the cosmetics to prove wisdom of pharmacists.

Course Contents:

1. **Skin physiology:** basic structure and functions, layers of skin, pigment system, glands, hair follicles, nerves and sense organs, common skin problems and aetiology.
2. **Current trends in cosmetic sciences:**
   a) Herbal cosmetics – use of herbs or botanicals in cosmetic products, types of herbs used along with their principle ingredients
   b) Neuro-cosmetics, Botox
   c) Aroma therapy – its applications and different product forms (diffusers, inhalers, bathing salts, body oils or creams)
3. **Skin care products:**
   a) Creams – Common ingredients and classification of creams, cold creams, vanishing creams, cleansing creams, night and massage creams, moisturizing creams, hand creams, hand-and-body creams, pro-aging and anti-aging creams, sunscreen cream. b) Body Lotions, c) Skin oils, d) Prickly heat powders, e) Depilatories, f) Manufacturing techniques of cream, lotion, oils, powder etc. and equipment, g) Quality controls and regulatory aspects.
4. **Hair care products:** Basic hair physiology, Hair growth cycle, Common hair and scalp problems, Classification of hair products, Hair oils, Shampoos and conditioners, common ingredients of shampoo, hair setting lotions (spray, gel), Beard oils, manufacturing techniques and equipment used, Quality controls and regulatory aspects.
5. **Shaving preparations:** Introduction and common ingredients, Before-shave: soap, cream, gel, aerosol, After-shave: lotion, cream, gel, powder, manufacturing techniques, Quality controls and regulatory aspects.
6. **Dental products:** Teeth structure and basic physiology, Common problems of gum, teeth and oral cavity, formulation and manufacturing of toothpaste and toothpowders, mouthwash, Quality controls and regulatory aspects.

7. **Other lifestyle products:** Soap, Hand wash, Hand sanitizer etc., Beauty and makeup products: Lip stick, Mascara, Eye liner etc. Quality controls and regulatory aspects.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Identify and evaluate different skin diseases and treatment options and pharmaceutical preparations for their ailment.
2. Identify and analyze the ingredients used to prepare different cosmetic products.
3. Analyze and utilize the basic concept on manufacturing different cosmetic products
4. Differentiate among different skin creams focusing on their ingredients and purpose.
5. Compare and evaluate different types of shaving preparations.
6. Detect different tooth diseases and associated treatment options.
7. Develop basic concept on different hair care products.

Assessment: As per the rules

Reference/recommended books:

1. Harry's Cosmeticology- J. B. Wilkinson & R. J. Moore, 7th edition, Longman Scientific & Technical.
2. Chemistry and Technology of the Cosmetics and Toileteries Industry- D. F., Williams and W. H.Schmitt, Hardcover 1992, Kluwer Academic Publications.
3. Modern Cosmetics~ Perfumes, Cosmetics and Soaps, Vol. 1, 11 and III- W. A. Poucher, 8th edition, Chapman & Hall, London
4. A Handbook of Cosmetics by B.M. Mithal
5. Handbook of Cosmetic Science and Technology by André O. Barel

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 210L Cosmetic Sciences and Technology Lab Credit Hr: 1

Course Number **:** PHR 210L
Course Title **:** Cosmetic Sciences and Technology Lab
Credit hours **:** 1

Specific Objectives:

1. Implement the theoretical knowledge
2. Prepare different types of cosmetic products
3. Identify and evaluate the quality control parameters to prepare cosmetics.

Course Contents:

1. Formulation and preparation of cold cream.
2. Formulation and preparation of vanishing cream.
3. Formulation and preparation of transparent shampoo.
4. Formulation and preparation of mouthwash.
5. Formulation and preparation of tooth powder.
6. Formulation and preparation of toothpaste.
7. Formulation and preparation of shaving cream.
8. Formulation and preparation of after shave lotion.
9. Formulation and preparation of hand sanitizer.
10. Formulation and preparation of lipstick.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Prepare cream and evaluate the quality control parameters.
2. Differentiate between cold cream and vanishing cream.
3. Identify the appropriate surfactant for preparing shampoo.
4. Compare between transparent shampoo and egg shampoo based on the ingredients.
5. Formulate talcum powder.
6. Evaluate the use of abrasive in tooth powder preparation and differentiate between tooth paste and powder.
7. Evaluate the appropriate use of ingredients for formulating after shave lotion.
8. Differentiate between shaving cream and aftershave lotion.

Assessment: As per the rules

Reference/recommended books:

1. Harry's Cosmeticology- J. B. Wilkinson & R. J. Moore, 7th edition, Longman Scientific & Technical.
2. Chemistry and Technology of the Cosmetics and Toileteries Industry- D. F., Williams and W. H.Schmitt, Hardcover 1992, Kluwer Academic Publications.
3. Handbook of Cosmetic Science and Technology by André O. Barel

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 211 Viva Voce Credit Hr: 1

Course Number : PHR 211

Course Title : Viva Voce

Credit hours : 1

Course Description:
The viva voce in the B. Pharm. (Hons) program evaluates students' knowledge and communication skills. It ensures readiness to apply pharmaceutical knowledge in real practice.

Specific Objectives:

1. Assess understanding of core pharmaceutical sciences and practice.
2. Evaluate application of knowledge in patient-centered scenarios.
3. Test problem-solving, decision-making and communication skills.
4. Build confidence, professionalism and ethical reasoning.

Course Contents: Total Syllabus of B. Pharm. (Hons) year-II

Learning Outcomes:
After the viva, students will be able to:

- Demonstrate subject knowledge and competence.
- Apply reasoning to solve therapeutic problems.
- Integrate multidisciplinary concepts effectively.
- Communicate clearly and confidently.
- Show professionalism and ethical awareness.

Assessment: As per the rules

B. Pharm. (Hons) Year-III

PHR 301 Pharmaceutical Analysis-I Credit Hr: 2

Course Number : PHR 301
Course Title : Pharmaceutical Analysis-I
Credit hours : 2

Introduction:
This is a core course that will provide the students a detail understanding on analysis of pharmaceutical products including their qualitative and quantitative analysis. Pharmaceutical analysis by definition deals with analysis of drugs, pharmaceutical substances and raw materials. It is devoted to stability testing, comparing related substances (essential similarity testing of generics), determination of impurities and developing, implementing and applying active assays for the pharmaceutical industry. The complex tasks of pharmaceutical analysis may also include development of new pharmacopoeial methods, stress testing to validate stability-indicating methods, impurity analysis and identification, herbal or animal material analysis, cleaning validations, degradation tests and stability studies. Briefly, this course includes introduction and techniques of pharmaceutical analysis, different quantitative chemical analysis like aqueous acid-base titration, Non aqueous acid-base titration, complexometric titration, aquametry, spectroscopic techniques like flurometry, HPLC, UV-visible spectrophotometry, chromatographic methods, and polarimetry

Specific Objectives:
The objectives of this course are to:

1. Offer a clear understanding on introduction and techniques of pharmaceutical analysis
2. Discuss in detail about the titrimetric method of analysis along with aquametry, fluometry, chromatographic methods, HPLC and UV-visible spectrophotometry.

Course Contents:

1. **Titrimetric method of pharmaceutical analysis:** Principles, procedures and application of different types of titrations-
   a) Aqueous acid-base titration:
   b) Non aqueous acid-base titration:
   c) Oxidation-reduction titration:
   d) Complexometric titration
2. **Aquametry**: Principle and scope, physical methods of water determination, chemical method of water determination, Karl-Fischer procedure–principle, chemistry, methodology, equipment, end point detection and limitation.
3. **Chromatographic methods**: Introduction, principles and theories, preparation, procedure, method of detection, applications of column chromatography, gel filtration techniques, thin layer chromatography, ion exchange chromatography.

4. **High performance liquid chromatography**: Introduction and theoretical considerations, instrumentation, characteristics of stationary and mobile phases, reversed phase high performance liquid chromatography, latest development -UPLC & UFLC, applications.
5. **Visible and ultraviolet spectrophotometry**: Introduction, electromagnetic radiation, units, electromagnetic spectra and absorption of radiation, Lambert's and Beer's law, deviations from Lambert-Beer law, instrumentation, colorimetry, chromophores and auxoochromes, analysis of mixtures, absorption and intensity shifts, applications of ultraviolet and visible spectroscopy in quantitative analysis of drugs.
6. **Fluorometry**: Introduction, principle, fluorescence and chemical structure, instrumentation, factors influencing intensity of fluorescence, comparison of fluorometry and uv-visible spectrophotometry, applications of fluorometry in pharmaceutical analysis.

Learning Outcomes:

Upon completion of the course, the students will be able to:

Analyze pharmaceutical products using titrimetric methods, aquametry, fluometry, chromatography, HPLC and UV-visible spectrophotometry.

Assessment: As per the rules

Text books:

1. Introduction to Spectroscopy- Donald L. Pavia., Gary M. Lampman, George S.
2. Pharmaceutical Chemistry - Leslie G Chatten.
3. A Textbook of Pharmaceutical Analysis- Kennth A. Connors.

References:

1. Instrumental Methods of Analysis- Willard.

PHR 301L	**Pharmaceutical Analysis-I Lab**	**Credit Hr: 1**

Course Number **:** PHR 301L
Course Title **:** Pharmaceutical Analysis-I Lab
Credit hours **:** 1

Introduction:

The main purpose of pharmaceutical drugs is to treat and cure diseases, and to promote health. For the medicine to serve its intended purpose they should be free from impurity or other interference which might harm humans. It should also contain desired amount of active ingredients to exert its therapeutic action. Pharmaceutical Analysis-I-Lab course is included in undergraduate pharmacy curriculum so that students will gain hands-on experience of analyzing drugs. Practical knowledge

can be achieved only by doing experimentation. Any course of Science which does not have opportunities for lab work is incomplete from the point of view of efficient teaching. Practical knowledge can often lead to a deeper understanding of a concept through the act of doing and personal experience. In Pharmaceutical Analysis-I-Lab the learning is very 'hands on' and classes are designed to allow students to practise and develop personal skills in analyzing different dosage forms.

Specific Objectives:

The objectives of this course are to offer students hands-on learning

1. to determine the amount of acetyl salicylic acid in aspirin tablets.
2. to analyze phenobarbitone tablets by non-aqueous titration.
3. to determine the potency of penicillin in penicillin tablets.
4. to determine the amount of calcium in solid and liquid dosage form by complexometric titration.
5. to estimate promethazine hydrochloride.
6. to estimate aluminium hydroxide gel
7. to assay magnesium and aluminium from antacid preparation
8. To determine the iodine value and saponification value of fats and oil.

Course Contents:

1. Assay of acetyl salicylic acid in aspirin tablets.
2. Assay of phenobarbitone tablets by non-aqueous titration.
3. Determination of potency of penicillin tablets.
4. Determination of calcium in solid and liquid dosage form by complexometric titration.
5. Assay of promethazine hydrochloride.
6. Assay of aluminium hydroxide gel.
7. Assay of magnesium and aluminium from antacid preparation.
8. Determination of iodine value and saponification value of fats and oils.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Determine the amount of acetyl salicylic acid in aspirin tablets.
2. Analyze phenobarbitone tablets by non-aqueous titration.
3. Determine the potency of penicillin in penicillin tablets.
4. Determine the amount of calcium in solid and liquid dosage form by complexometric titration.
5. estimate promethazine hydrochloride.
6. Assay aluminium hydroxide gel.
7. Assay magnesium and aluminium from antacid preparation
8. Determine the iodine value and saponification value of fats and oil.

Assessment: As per the rules

Text books:

1. Modern Methods of Pharmaceutical Analysis, 2nd edition, Vol. II By Rozer E. Schirmer,
2. Vogel's Textbook of Quantitative Chemical Analysis ,5th edition By G. H. Jeffrey, Bassett. J.,

References:

1. Quantitative Analytical Chemistry, 4th edition James S. Fritz and George H. Schenk Allyn and Bacon.
2. Pharmaceutical Drug analysis by Ashutosh Kar.

PHR 302 Medicinal Chemistry & Drug synthesis-I Credit Hr: 4

Course Number : PHR 302
Course Title : Medicinal Chemistry & Drug synthesis -I
Credit hours : 4

Introduction:

Medical chemistry is based on basic subjects such as organic chemistry, inorganic chemistry, physical chemistry and theoretical chemistry. You will combine your knowledge of chemistry with health science subjects such as physiology and cell biology. You will learn about the body's processes, how disease alters these processes, and how drugs can alleviate these changes. During the programme you will specialize in either analysis, structure and design, or in organic synthesis. The course is based on lectures, theoretical exercises, assignments and computer exercises. This is where you will learn how different chemical substances are produced and how it is to work with the structure and properties of these substances.

Specific Objectives: The objectives of this course are to:

1. Acquire knowledge from a wide variety of fields including organic chemistry, biochemistry, pharmacology, physiology and computing.
2. Design, synthesis and discovery of new compounds that are suitable for use as new drugs.
3. Development of testing methods and procedures to establish how a substance operates in the body and its suitability for use as a drug.
4. Trained in synthesis, reactivity and analysis of organic compounds.
5. Use of corresponding knowledge for the development of biologically and clinically active drugs. It will include advanced courses in natural products, organic synthesis, medicinal chemistry; fundamentals of cell biology, molecular biology, drug design, and analytical methods.

Course Contents:

1.**Heterocyclic chemistry**:

a. 5-membered heterocyclic compounds: Pyrrole, furan, thiophene, pyrazole, imidazole, oxazole, isoxazole, thiazole and Isothiazole- their preparations, reactions and pharmaceutical applications.

b. 6-membered heterocyclic compounds: Pyridine, piperidine, pyrimidine, pyradazine, pyrazine and triazine: their preparation- reaction and pharmaceutical applications.
c. Benzofused 5-membered heteroatomic compounds: Indole, benzofuran, benzothiaphene and carbazole- their chemistry, synthesis and pharmaceutical applications.
d. Benzofused 6-membered heteroatomic compounds: Quinoline and isoquinoline- their chemistry, synthesis and pharmaceutical applications.

2. **Combinatorial chemistry :** (a) Combinatorial synthesis- Introduction to drug discovery process (b) Library synthesis on resin beads – solid phase chemistry, resin beads, speeding up of peptide synthesis, mix and split library synthesis (c) Solution phase combinatorial synthesis, d) Encoded combinatorial synthesis-encoded requirements, examples of tagged libraries e) Solid phase library, chemistry of linkers, carboxylic acid linkers, carboxamide linkers, alcohol linkers, amine linkers, traceless linkers, light cleavable linkers, selected solid phase chemistry f) Combinatorial chemistry- applications and impact on drug discovery.
3. **Chemistry, SAR, mode of action and synthesis of the following groups of drugs**:
   a) Semisynthetic penicillins, cephalosporins, and quinolone derivatives
   b) Analgesics and anti-inflammatory agents
   c) Antidiabetic drugs
   e) Diuretics
4. **Formation of C-C bonds:** organometallic reagents; **Formation of aliphatic C-C bonds:** base-catalysed reaction; **Formation of aliphatic C-C bonds:** acid-catalysed reaction; **Pericyclic raction**; **Formation of aliphatic C-X bonds**; Cycloaddition Reactions, Acyclic Stereocontrol, Olefination, Synthesis of some naturally occurring compounds.
5. **Catalytic reactions in organic chemistry:** Concept of catalysis. Mechanistic implications: creating a catalytic cycle. Reactions using metal catalysis; palladium-catalysed cross-coupling reactions: Suzuki-Miyaura Coupling, Buchwald-Hartwig Amination, Heck, Sonogashira, Suzuki Cross coupling, Stille cross coupling; Pauson-Khand reaction. Small organic molecules as catalysts: Baylis Hillman reaction; olefin metathesis.

Learning Outcomes: Upon completion of the course, the students will be able to:

1. Demonstrate foundational and advanced understanding of heterocyclic chemistry
2. Apply the principles of combinatorial chemistry in modern drug discovery
3. Explain the chemistry, SAR, synthesis, and mode of action of selected drug classes
4. Understand and design carbon–carbon (C–C) and carbon–heteroatom (C–X) bond-forming reactions
5. Analyze and evaluate catalytic methods used in organic synthesis

Assessment: As per the rules

Text books:

1. An Introduction to Medicinal Chemistry- G. L. Patrick, Oxford University Press.
2. Wilson and Gisvold's Text Book of Organic, Medicinal and Pharmaceutical Chemistry- Edited by John Block and John M. Beale, Lippincott, Williams & Wilkins.
3. Advanced Organic Chemistry- Bernard Miller, Prentice Hall.
4. Advanced Organic Chemistry- M. B. Smith and Jerry March, Wiley Interscience.

References:

1. Mechanism and Theory of Organic Chemistry- T. H. Lowry and K. S. Richardson, Benjamin- Cummings publishing company.
2. Burger's Medicinal Chemistry and Drug Discovery- Edited by Donald J. Abraham, Wiley-Interscience.
3. Essentials of Medicinal Chemistry- Andrejus Korolkovas and Joseph. H. Burckhalter, John Wiley & Sons Inc.
4. Organic Chemistry- R. T. Morrison and R. N. Boyd, Allyn and Bacon.
5. Heterocyclic Chemistry- J. A. Joule and G. F. Smith, English Language Book Society.
6. Foye's Principles of Medicinal Chemistry- David A. Williams and Thomas L. Lemke, Lippincott, Williams & Wilkins.
7. Medicinal Chemistry: Principles and Practice- Frank D. King, The Royal Society of Chemistry.

PHR 302L Medicinal Chemistry & Drug synthesis-I Lab Credit Hr: 1

Course Number : PHR 302L
Course Title : Medicinal Chemistry & Drug synthesis-I Lab
Credit hours : 1

Introduction:

This course is based on the theoretical course Medicinal Chemistry-I (PHR-302) which provide a theoretical and practical knowledge about the synthesis and analytical procedures based on reflux method, recrystallization, UV-visible spectroscopy etc. At first, synthesis steps involve acetylation, reduction; esterification, acetylation methods and spectroscopic analysis involve absorption explanation of those synthetic compounds.

Specific Objectives: The objectives of this course are to -

1. Learn chemical characterizations of different compounds
2. Identify the compound by melting point determinations
3. Explain the spectral analysis based on UV-visible spectroscopy
4. Perform different purification procedures to improve the potency of those compound
5. Prepare the students for doing industrial synthesis procedures
6. Highlight the uses of paracetamol, aspirin, para-amino benzene, methyl salicylate etc.

Course Contents:

1 Laboratory synthesis, physical, chemical and spectral characterization of the following compounds:

a) Benzimidazole
b) Acetanilide
c) Aspirin
d) PABA (para amino benzoic acid).
e) Methyl salicylate

f) Synthesis of Barbituric acid
g) Phenytoin
h) Phenothiazine

2. The partition coefficient of succinic acid between ether and water.
3. The assay of:
   i. Chlorpromazine hydrochloride.
   ii. Ibuprofen
   iii. Aspirin.

Learning Outcomes: Upon completion of the course, the students will be able to –

1. Demonstrate Proficiency in Organic Synthesis Techniques
2. Perform Structural Characterization of Compounds
3. Apply Drug Assay Techniques
4. Evaluate Physicochemical Properties of Drugs
5. Develop Critical Laboratory Skills
6. Interpret Experimental Data and Spectral Results
7. Integrate Knowledge of Medicinal Chemistry in Practical Contexts

Assessment: As per the rules

Text books/ References:

1. Pavia, Donald, Gary Lampman and George Kriz. Introduction to Spectroscopy. New York: Sonders College Publishing, 1996.
2. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
3. Foye's Principles of Medicinal Chemistry.
4. Burger's Medicinal Chemistry, Vol I to IV.
5. Introduction to principles of drug design- Smith and Williams.
6. Remington's Pharmaceutical Sciences.
7. Martindale's extra pharmacopoeia.
8. Organic Chemistry by I.L. Finar, Vol. II.
9. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
10. Text book of practical organic chemistry- A.I.Vogel.

PHR 303 Pharmaceutical Biotechnology Credit Hr: 4

Course Number : PHR 303
Course Title : Pharmaceutical Biotechnology
Credit hours : 4.0

Introduction:
The course aims exposing students to various topics in biotechnology, including the pharmacist's role in biotechnology, criteria for regulatory approval for biotechnology drugs, technology in

genetic engineering and its application to pharmacy. It is designed to equip students with a basic knowledge of concepts directly relevant to working in the biopharmaceutical industry.

Specific Objectives: The objectives of this course are -

1. To provide basic concept of different biotechnological tools and techniques
2. To present an overview of the biotechnological sector of pharmaceutical industry, emphasizing biotechnological products approved for general medical use.
3. To provide an overview of different aspects of formulation, manufacturing, handling, storage and preservation of biotechnological products.
4. To provide an overview of the manufacture of a typical biotechnological product.
5. To overview the biochemistry and biotechnology of a representative range of biotechnological products.

Course Contents:

1. **Introduction of biotechnology:** Application of biotechnology in medicine, foods, forensic science, microbial and plant genetics; different dimension of biotechnology and pharmaceutical biotechnology.
2. **Fermentation technology:** definition, chemical versus biochemical process, principle of fermentation, types of fermentation, surface culture, solid state fermentations, microbial transformation, fermenter/bioreactor (design and control of different parameters), production of alcohol, antibiotics (penicillin, streptomycin, etc), vitamins, etc
3. **Enzyme technology:** Introduction to enzyme, commercial uses of enzyme, immobilization of enzymes, application of immobilized enzymes in manufacturing and preparation of streptokinase, urokinase, hyaluronidase.
4. **Immunology and antibody technology:** immunity, type of immunity, immunization and immunization method, antigens and haptens, immune system, immunological tolerance, antigen-antibody reactions and their applications. manufacturing and standardization of vaccines of bacterial, viral and rickettsial origin. Production of vaccine (BCG vaccine and other); Production of sera and immunoglobulin from viral origin, polio, rabbis, yellow fever and hepatitis; production and purification method of tetanus, diphtheria toxoids; maintenance of seed strains; Monoclonal antibody, hybridoma technology, production of monoclonal antibody.
5. **Recombinant DNA technology and production of biotech compounds**: Basic principle, genetic recombination/genetic engineering; applications of genetic engineering; cloning, gene expression and post-translational modification of protein; tools of genetic engineering: enzymes, cloning vectors & gene library (cDNA library and genomic library). Transformation/Transfection method, knock out and transgenic animals. Cultivation and downstream processing, issues to consider in production and purification of proteins.
6. **Formulation of biotech products:** Stability consideration, microbiological considerations, excipients used in parenteral formulations of biotech products, delivery of proteins, routes of administration and absorption enhancement.
7. **Delivery of protein drugs**: Approaches for rate controlled and target site specific delivery.

8. **Gene therapy:** Principle, genetic diseases, ex vivo versus in vivo gene therapy, potential target diseases for gene therapy, gene transfer methods, vectors used in gene therapy, non-viral gene transfer.
9. **Antisense therapy:** Principle, types of antisense therapy, advantages and disadvantages, synthesis of antisense oligonucleotides, commercially available antisense therapy.
10. **Dispensing of biotechnology products:** Storage-temperature requirements, storage in dosing and administration devices, light protection, handling, mixing and shaking, travel requirements, preparation and administration.
11. **Cells and tissue culture technology:** Applications, primary cell culture, cell lines, cell culture methods, 2D and 3D cell culture, setting of cell and tissue culture labs, cell counting, etc
12. **Mutation and protein engineering.**

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain the foundation of necessity of biotechnology in pharmaceutical sciences; understand the general definitions of important terminologies.
2. Classify and describe different types of protein structures; identify the analytical techniques.
3. Attain a complete understanding of tools of genetic engineering and process of recombinant DNA technology.
4. Have a well-rounded knowledge about different excipients used in biotech products and their routes of administration.
5. Use different approaches for rate controlled and target site specific delivery of proteinous drug.
6. Have basic knowledge on immunology and immunological products, antigens, antibodies, haptens, hybridoma technology, antiserum, monoclonal antibodies, vaccines, etc.
7. Know about different types of gene therapy methods and their clinical implications.
8. Have a thorough idea about the significance of application of biotechnology in pharmaceutical productions.

Assessment: As per the rules

Text books/ References:

1. Biopharmaceuticals: Biochemistry and Biotechnology 2nd Ed, Gary Walsh (John Wiley & Sons, Ltd, England, 2004).
2. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, Rodney J.Y. Ho, Milo Gibaldi (John Wiley & Sons, Ltd. Hoboken, New Jersey, USA, 2003)
3. Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists, 2nd Edition, Daan J. A. Crommelin and Robert D. Sindelar (2002) (Taylor & Francis, UK)

PHR 303L Pharmaceutical Biotechnology Lab Credit Hr: 1

Course Number : PHR 303L
Course Title : Pharmaceutical Biotechnology Lab
Credit hours : 1

Specific Objectives:
Specific objectives for a Pharmaceutical Biotechnology course generally aim for students to understand modern biotechnologies, learn the principles of drug development and manufacturing, apply knowledge of molecular and cellular mechanisms to disease, gain skills in techniques for developing and producing biological products, and evaluate the regulatory and ethical aspects of the pharmaceutical biotechnology industry.

Course Contents:

1. Bacterial Genomic DNA Extraction
2. Plasmid DNA Extraction
3. Extract of RNA
4. Quantification of RNA by spectrophotometer
5. Quantification of DNA by spectrophotometer
6. Restriction digestion of plasmid DNA and isolation by electrophoresis
7. Agarose gel electrophoresis of DNA
8. Separation of protein by SDS-PAGE
9. Demonstration on PCR Protocol, amplification of DNA by PCR and isolation of PCR product from gel
10. Screening of soil for organisms producing antibiotics
11. Preparation of primary cardiomyocytes/hepatocytes from rat heart/liver
12. Practicals based on bioinformatics: Primer design and sequence analysis.

Learning Outcomes:

1. To provide education that leads to comprehensive understanding of the principles and practices of biotechnology.
2. To developing a strong theoretical understanding of biotechnology principles and practical laboratory skills, such as performing genetic engineering techniques, using analytical instruments, and managing biological samples and chemicals safely.

Assessment: As per the rules

Text books/ References:

1. Biopharmaceuticals: Biochemistry and Biotechnology 2nd Ed, Gary Walsh (John Wiley & Sons, Ltd, England, 2004).

2. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, Rodney J.Y. Ho, Milo Gibaldi (John Wiley & Sons, Ltd. Hoboken, New Jersey, USA, 2003)
3. Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists, 2nd Edition, Daan J. A. Crommelin and Robert D. Sindelar (2002) (Taylor & Francis, UK)

PHR 304 Functional Foods and Herbal Medicines Credit Hr: 2

Course Number : PHR 304
Course Title : Functional Foods and Herbal Medicines
Credit hours : 2

Introduction:
This course will describe functional foods and nutraceuticals, including their health benefits, development, and regulation. This course will help student to understand the relevance of some phytochemicals present in food in the promotion of human health.

Specific Objectives: The objectives of this course are to -

1. Be knowledgeable of the chemical, physical and functional properties of bioactive food constituents that provide health benefits.
2. Be knowledgeable of the mechanisms for their biochemical and physiological activity.
3. Have a working knowledge of the legal aspects of formulating, marketing and labeling nutraceuticals, functional foods and dietary supplements.
4. To examine and assess the latest development in nutraceutical research
5. To apply the learned knowledge and develop functional foods for market

Course Contents:

1. **Introduction:** Definition of functional foods, nutraceutical and herbal medicine, their role in health care management
2. **Food Science and nutrition:** Overview on medical foods, nutraceuticals, functional foods and dietary supplements.
3. **Food components and nutrition**: Food composition, macronutrients, micronutrients, protein, carbohydrates, fats and oils vitamins, minerals, dietary fibers and fiber-like ingredients, trans fatty acids and omega 3,6,9 fatty acids, sugar and fat substitutes.
4. **Food, nutrition, health and diseases:** Relationship of nutrition and health, dietary guidelines/food pyramid, food habit and obesity, effects of trans and omega 3,6,9 fatty acids on health and diseases.

5. **Nutraceuticals in herbal products, fruits, vegetables and grains with health benefits:** Effects of nutraceutical on cancer, immune system; phytochemicals and their roles in prevention of specific diseases; antioxidant, antidiabetic, anti-inflammatory a hypolipedimic herbs and nutraceuticals.
6. **Food processing and food products developments**: Food preservation, food irradiation, fermentation, processing of dairy foods, confectionary foods, cereals and grains, beverages, special infant foods and formulas, microorganisms in food, food packaging.
7. **Food Biotechnology:** Genetic engineering in improving plant and animal products and improving food processing.
8. **Quality assurance of nutraceuticals, dietary supplements & herbal products**: GMPs, hazard and risk analysis, quality factors, toxicity analysis, shelf life of nutraceuticals, functional foods and dietary supplements, bioavailability and safety issues of functional foods and nutraceuticals.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand about functional foods, medical foods, nutraceutical and herbal medicine, their role in health care management
2. Explain the relationship of nutrition and health, effects of trans and omega 3,6,9 fatty acids on health and diseases, effects of nutraceuticals on cancer development
3. Know about the herbs and nutraceuticals having antioxidant, antidiabetic, anti-inflammatory, hypolipedimic and antiproliferative properties
4. Know about the basic techniques of food preservation, food fermentation and food packaging
5. Familiar with GMPs bioavailability and safety issues of functional foods and nutraceuticals

Assessment: As per the rules

Text books:

1. Handbook of Nutraceuticals and Functional Foods - by Robert E. C. Wildman.
2. Regulation of Functional Foods and Nutraceuticals: A Global Perspective - by Clare M. Hasler
3. Essentials of Food Science -by S. B. Cooper, Vickie Vaclavik, Elizabeth W. Christian.
4. Functional Food Ingredients and Nutraceuticals: Processing Technologies - by John Shi, Jerry W King.

References:

1. Food Technology: An Introduction - by Anita Tull.
2. Nutraceuticals: Developing, Claiming, and Marketing Medical Foods - by Stephen L. DeFelice
3. Handbook of Food Preservation - by M. Shafiur Rahman.
4. Food Packaging and Preservation - by M. Mathlouthi.

5. Food Law Handbook - by Harold William Schultz.
6. Manuals of Food Quality Control: Quality, Adulteration and Tests of Identity - by O P Dhamija.

PHR 305 Pharmacology-II Credit Hr: 4

Course Number **:** PHR 305

Course Title **:** Pharmacology-II

Credit hours **:** 4

Introduction:

Pharmacology-II course is an advanced pharmacodynamics and pharmacokinetic study of drugs that are related with infectious diseases, neoplastic diseases and metabolic disorders. This course is designed to learn about more effective treatment options for metabolic disorders, different cancers and discover how chemicals may modify the growth of microorganisms. The course is designed to learn about classification of chemotherapeutics with their mechanism of action, dose, side effects, contraindication etc. Besides, the course will describe about the cellular and molecular reasons of neoplastic disorder as well as with their treatment options such as immunobiological, chemotherapy etc. Fundamental study of drugs working on metabolic disorders such as diabetes, hormone related disorders and obesity with their probable management options.

Specific Objectives:

1. To identify the role of microorganisms in infectious diseases and their possible treatment options.
2. To know the basic cellular and molecular mechanism of developing neoplastic diseases and the drug options relevant with these diseases.
3. To understand the fundamentals of diabetes, hormone related disorders, obesity and the pharmacokinetic and pharmacokinetic study of the drugs manipulating those hormone disorders.
4. To illustrate the clinical cases related with infectious disorders, neoplastic disorders and metabolic disorders through problem-based learning.

Course Contents:

A. Chemotherapeutic agents:

1. Antibacterials: General principles of antimicrobial therapy

a) Drugs affecting folate synthesis-sulfonamide, trimethoprime, cotrimoxazole
b) β-lactam antibiotics-penicillin, cephalosporins, monobactams, vancomycin
c) Drugs affecting protein synthesis-tetracycline, chloramphenicol, macrolides, aminoglycosides
d) Drugs affecting Topoisomerase-I enzyme-fluoroquinolones
e) Glycopeptide, polymyxin, bacitracin and nitrofurantoin

f) Antitubercular agents: INH, rifampicin, ethambutol, pyrazinamide, PAS, capreomycin, cycloserine, ethionamide
g) Antileprotic drugs-dapsone, rifampicin, clofazimine

2. Antivirals: Viral life cycle, classifications, anti-herpes virus, antiretrovirus, anti-influenza virus, nonselective antiviral drugs, recent drug development in AIDS treatment.

3. Antiparasites: Causative organisms, Drugs used in fungal diseases-amphotericin B, flucytosine, Itraconazole, ketoconazole, fluconazole, nystatin, griseofulvin; helminthiasis, malaria, amebiasis, giardiasis, leishmaniasis and trichomoniasis.

4. Antineoplastic agents: Introduction of neoplastic disorders, causes of cancer, role of thymidylate synthase, p53 gene mutations, alkylating agents, antimetabolites, vinca alkaloids, Taxanes antibiotics, cisplatin, carboplatin, etoposide, monoclonal antibody, tyrosine kinase inhibitors, cytokines etc.

B. Drugs affecting Cardiovascular System: Pharmacokinetics and pharmacodynamics of the following classes of drugs:

5. Antihypertensive Agents: Hypertension and regulation of blood pressure, classification of antihypertensive agents, centrally acting sympathoplegic drugs, adrenergic neuron blocking agents, Adrenoreceptor antagonists-alpha and beta blockers, vasodilators, calcium channel blockers, inhibitors of angiotensin converting enzymes, angiotensin receptor blocker etc.

6. Diuretics: Introduction, renal tubule transport mechanism, classification of diuretics, carbonic anhydrase inhibitors, loop diuretics, thiazide diuretics, potassium sparing diuretics, osmotic diuretics, ADH antagonists, diuretics combination etc.

7. Drugs used in heart failure: Control of normal contractility, pathophysiology of heart failure, Digitalis, positive ionotropic agents, drugs without positive ionotropic agents, management of acute and chronic heart failure.

8. Anti-arrhythmics: Electrophysiology of normal cardiac rhythm, mechanisms of arrythmias, drugs classification, sodium channel blockers, beta adrenergic receptor blockers, drugs that prolong effective refractive periods, calcium channel blockers, miscellaneous etc.

9. Anti-anginal drugs: Pathophysiology of angina, nitrates and nitrites, other vasodilators

Learning Outcomes:

After completing the course, the student will be able to -

1. Get familiar with pathogenic mechanisms of infectious diseases caused by bacteria, virus and a large number of parasites such as helminths, fungus, malaria etc.
2. Learn the mode of action of chemotherapeutic agents, side effects, indications, dose guidelines, contraindication and drug-drug interactions of different chemotherapeutic agents such as antibacterial, antiviral, anti-parasites and antineoplastic etc.
3. Gain knowledge on the metabolic hormones such as insulin, glucagon, adrenocorticosteroids, thyroid, Adenohypophyseal etc. with their deficiency symptoms, agonists or antagonists and possible classes of therapeutic agents to overcome the situations.

4. Acquire introductory lessons on neoplasm, its causes, possible mechanistic pathways, role of different anticancer drugs, therapeutic uses of the drugs, development of new immunobiologics etc.
5. Achieve knowledge on recent development of new drug discovery required for untreatable diseases such as AIDS, Cancers and Diabetes etc.

Assessment: As per the rules

Text book:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:

1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 305L Pharmacology-II Lab Credit Hr: 1

Course Number : PHR 305L
Course Title : Pharmacology-II Lab
Credit hours : 1

Specific Objectives:
To familiarize the students with basic laboratory experiments related to Pharmacology.

Course Contents:

1. Estimation of blood glucose by chemical and enzymatic methods.

2. Estimation of blood uric acid level by enzymatic method.
3. Estimation of serum HbA1C (glycosylated hemoglobin) level by biochemical method.
4. Antimicrobial susceptibility testing for common antibiotic against susceptible and resistant strains of *E.coli*.
5. Exercising drug administration by different routes (viz. P.O., IV, IM, SC, ID, IP and IO) in animal (mice/rat) model.

Learning Outcome:

After completing the course, the student will be able to -

1. gain hands-on experience with experimental design, data collection, and analysis in living organisms or isolated systems.
2. perform in-vitro, in-vivo, and potentially ex-vivo experiments, evaluating drug disposition and pharmacodynamics, behavioral characterization techniques, and toxicological effects.

Assessment: As per the rules

Text book:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:

1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 306 Clinical Pathology and Toxicology Credit Hr: 4

Course Number : PHR 306

Course Title : Clinical Pathology

Credit hours : 4

Introduction:

Pathology is the study of disease. Clinical Pathology is designed to present students with essential concepts of pathological processes and altered health states. The course looks in depth at a wide variety of common pathological conditions. General topics covered include the nature and causes of cell injury and death; adaptive cellular changes; inflammation, healing and repair, thrombosis, infarction and hemodynamic disorders. More detailed attention is given to cardio and cerebrovascular pathology, infectious diseases and common nutritional diseases. Clinical scenarios within each module correlate the anatomical pathology with major clinical symptoms and signs. The course will provide an opportunity for students to examine macroscopic and microscopic specimens illustrating the pathology covered in lectures. Toxicology course covers the principles of body's response to drugs and toxic substances. Students will learn fundamentals of toxicology and mechanisms of toxic actions from acute and chronic exposure of xenobiotics derived from environmental, dietary, occupational and pharmaceutical sources.

Specific Objectives:

1. To obtain sufficient knowledge about basic disease reactions and organ specific reactions so that students can interpret signs and symptoms elicited in a patient's history and create a differential diagnosis.
2. To anticipate the natural course of disease and to continue to learn the pathophysiology of disease.
3. To provide sufficient knowledge of gross pathology and histopathology so that students can interpret pathology reports.
4. A basic understanding of diagnostic laboratory evaluation and of the relationship between laboratory and morphological changes in diseases states.
5. To describe how pathological analysis contributes to disease surveillance and the evaluation of therapeutic interventions.

Course Contents:

1. **Cellular adaptation, cell injury and cell death**: Hyperplasia, hypertrophy, atrophy, metaplasia, necrosis, apoptosis, intracellular accumulation, pathological calcification, cellular aging etc.

2. **Acute and Chronic inflammation:** Vascular changes, leukocyte extravasation and phagocytosis, chemical mediators of inflammation, outcomes of acute inflammation, morphologic patterns of acute inflammation, chronic inflammation and its causes, morphologic features, systemic effects of inflammation.

3. **Haemodynamic disorders**- Edema, hyperemia, congestion, hemorrhage, hemostasis, thrombosis, embolism, shock, infarction.

4. **Infectious diseases:** New and emerging infectious diseases, agents of bioterrorism, categories, transmission and dissemination of microbes, mechanism of diseases, immune invasion, special techniques for diagnosing infectious agents, Viral infections-mumps, poliovirus, measles, herpes simplex, Hepatitis B, HPV; Bacterial infections-Diphtheria, whooping cough, pseudomonas, tuberculosis, syphilis, staphylococcal and streptococcal infections; Fungal infections-candidiasis, aspergillosis; Parasitic infections-malaria, leishmaniasis, tapeworms, trichinosis etc.

5. **Environmental and Nutritional pathology:** Environment and disease, common environmental and occupational exposures-personal exposure, therapeutic drugs, air pollution, industrial exposures, agricultural hazards, natural toxins, radiation injury, physical environment; Nutrition and disease-Food safety, deficiencies of vitamins and minerals, protein energy malnutrition, anorexia nervosa and bulimia, obesity, diet and systemic diseases, chemoprevention of cancer.

6. **General Principles of Toxicology:** History and scope of Toxicology; different areas of toxicology; spectrum of undesired effects, animal toxicity tests: acute toxicity testing, skin and eye irritants, characteristics of toxic exposure: route and site of exposure, duration and frequency of exposure, principles of toxicology, dose-response relationships and dose-response curves, mechanism of toxicity and toxicological risk assessment, application of toxicology in food, forensic, clinical practice.

7. **Disposition of Toxicants and Reactive Metabolites:** Absorption, distribution, and excretion of toxicants, biotransformation of xenobiotics, toxicokinetics, nature and stability of reactive metabolites: ultra-short-lived metabolites, short-lived metabolites, long-lived metabolites; fate of reactive metabolites; factors affecting toxicity of reactive metabolites; examples of some reactive metabolites: parathion, vinyl chloride, methanol, aflatoxin B1, carbon tetrachloride, acetylaminofluorene, benzopyrene, acetaminophen, chloroform, heroin.

8. **Non-organ directed and Organ-directed Toxicity: a) Non-organ directed toxicity-** chemical carcinogenesis, genetic toxicology and development. **b) Organ specific toxicity-** blood and cardiovascular, dermatological, ocular, respiratory, reproductive, hepatic, renal, CNS and endocrine toxicity.

Learning Outcomes:

1. Understanding of essential basic pathological processes including cell death and injury, inflammation, thrombosis, stroke, atherosclerosis and infectious diseases.
2. Acquiring the ability to relate these essential basic pathological processes to the pathogenesis of common and important diseases and understanding of the predisposing factors, causes, pathogenesis, morphology and potential complications of such diseases.
3. Demonstrate an understanding of how knowledge of pathological processes can be utilized in the investigation, management and prevention of disease.
4. Students will learn the molecular and cellular pathogenesis from toxic exposure of chemicals.
5. They will understand toxicological aspects of xenobiotics or poisons in cases of both organ-directed and non-organ directed toxicity.
6. They will learn the essential application of food, forensic, clinical and occupational toxicology.
7. Students will be able to perform various toxicological experimentation using animals.

Assessment: As per the rules

Text books:

1. Robbins and Cotran Pathologic Basis of Disease-Seventh edition-Kumar, Abbas, Fausto.

2. Casarett and Doull's Toxicology: The Basic Science of Poisons, 8th Edition, 2018, Editor: Curtis D. Klaassen, McGraw-Hill Education.

References

1. A Textbook of Modern Toxicology, 4th Edition, 2010, Editor: Ernest Hodgson, John Wiley & Sons, Inc., Hoboken, New Jersey.

2. Introduction to Toxicology, Third Edition, 2002. By - John Timbrell, CRC Press, London, UK.

3. Animal Models in Toxicology, 3rd Edition, 2016, Editors: Shayne C. Gad, Shayne C. Gad, CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW.

4. The welfare of Animals used in Research: Practice and Ethics, 2014, editors: James K. Kirkwood and Robert C. Hubrecht, John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK.

5. Toxicological Chemistry and Biochemistry, Third Edition, 2003, by - Stanley E. Manahan, Lewis Publisheres (an imprint of CRC Press LLC), London, Newyork and Washington DC.

PHR 307 Hospital and Pharmacy Practice Credit Hr: 2

Course Number : PHR 307
Course Title : Hospital and Pharmacy Practice
Credit hours : 2

Introduction:

Appropriate use of medicines in the hospital is a multidisciplinary responsibility shared by physicians, nurses, pharmacists, administrators, support personnel, and patients. The hospital pharmacist should be an expert on medicines who advises on prescribing, administering, and monitoring, as well as a supply manager who ensures that medicines are available through procurement, storage, distribution, inventory control, and quality assurance. The course is designed to learn the basic understanding of hospital pharmacy practices so that students can learn the basic techniques and facilities required in a hospital pharmacy set up.

Specific Objectives:

1. To obtain sufficient knowledge about basic understanding on hospital pharmacy practices
2. To learn the role of pharmacists in pharmacy and therapeutic committee and formulary management.
3. To learn how to distribute medicines appropriately with prior consultation with physicians and other technical personnel.
4. A basic understanding on the role of pharmacists in controlling special classes of drugs specially prescription handling for in- and out-patient service, floor stock, ward stock, narcotics control etc.
5. To develop antibiotic policy development for the effective management of infectious patients
6. To describe how pharmacist can take care of pre-termed baby, cancer patients and unconscious patients by using appropriate total parenteral nutrition.

Course Content:

1. **Introduction of Hospital Pharmacy:** Goals and minimum standards for hospital pharmacy, Hospital as an organization, managements and administrations, different department and services, role of a pharmacists in the hospital pharmacy, personnel, pharmacy research and Job descriptions. Pharmacy and therapeutic committee purpose, description, functions, guiding principles, legal basis, advisory committee
2. **Control of special classes of drugs**: Use of samples, in patient drug orders, out-patient prescription, ward stock, narcotics and their control, classes and procurement and execution of order forms, dispensing, narcotic regulations, floor stock drugs, inspection of nursing drug cabinets
3. **Dispensing to in- and out-patients:** Drug distribution systems, dispensing of chare, non-floor stock drugs, mobile dispensing units, unit dose dispensing, locality of out-patient dispensing area, dispensing routine, record keeping, use of nursing supervisors, emergency boxes and night drug cabinets, pharmacist-on-call, drug charges in hospitals, pricing, break-even point pricing.

4. **Community pharmacy:** Concept and needs of community of pharmacy, implementation of accredited drug sellers as Model Pharmacy in Bangladesh, level of healthcare systems, elements and principle of primary healthcare, Role of community pharmacy in communicable disease control, nutritional problem, sanitation, indigenous systems of medicine, Infrastructure of community pharmacy, role of NGO's etc.
5. **Antibiotic Policy:** Choice of antibiotics, antibiotics in clean cut surgery, antibiotics uses in intra-operative surgery, prophylactic uses, Antibiotic usage guidelines in Bangladeshi hospitals, role of pharmacists and physicians in developing antibiotic policy for different hospitals.
6. **Total parenteral Nutrition (TPN):** Requirements for TPN, types of patients required TPN, calculation and preparation of TPN, TPN practice in the cases of pre-termed baby, cancer patients and unconscious patients

Learning outcomes:

1. By the end of the course students will be able to define the keywords and phrases emphasized in the lectures, course materials, and glossary.
2. Demonstrate an understanding of essential basic of hospital pharmacy practice and role of a pharmacist in hospital and community pharmacy
3. Acquire the ability to relate this essential knowledge to serve the in- and out-patients in the hospital as well as in community pharmacy settlement.
4. Acquire knowledge on antibiotic policy development process and special classes of drugs.
5. Demonstrate their acquired knowledge on the TPN requirements for different case groups.

Assessment system: As per the rules

References:

1. Hospital Pharmacy-William E Hassan, 6th Edition, Published by Lea & Febiger, Philadelphia, USA
2. Hospital Pharmacy--Martin Stephens, Second edition, Pharmaceutical Press from UK
3. Hospital and Clinical Pharmacy--N. Narayanan and S. Balasubramanian
4. Hospital and Clinical Pharmacy--Pratibha Nand and Roop K Khar, Birla Publication, India.

PHR 308 Pharmaceutical Technology-III Credit Hr: 4

Course Number : PHR 308
Course Title : Pharmaceutical Technology-III
Credit hours : 4

Introduction:

This course has been designed including topics of powder and granules properties, formulation and manufacturing of tablets, common tableting problems and evaluation of tablets, detail about tablet coating. This course focuses on soft and hard gelatin capsules including their properties, advantages, drawbacks, formulations, manufacturing procedures as well as capsule filling machines, tooling and accessories, common problems in capsule manufacturing, quality control

methods and packaging of capsules. In addition, this course is intended to provide an overview regarding the microencapsulation process.

Specific Objectives:

1. Principles and techniques involved in this course deal with the formulation, manufacturing, and evaluation of solid dosage forms
2. Will give students a complete understanding of tablet manufacturing. Upon completion of this course, the students should gain sound theoretical knowledge on tablet formulation, direct compression, dry and wet granulations.
3. Learn about some common tableting problems including weight variation, friability, hardness, sticking, picking, capping, laminating, chipping, mottling etc, and learn how to evaluate and assess tablet's chemical, physical and bioavailability properties.
4. Gain information on tablet coating, its classification, advantages, and disadvantages, coating materials, formulation and common problems associated with different types of coating.
5. Learn about soft and hard gelatin capsules
6. Acquire knowledge about microencapsulation techniques

Course Contents:

1. **Powders and granules:** Definitions, Properties of powders and granules such as particle size and flow property, reason for granulation, powder and granule dosage forms available for different administration route.

2. **Tablet dosage form:**
   (a) Formulation and manufacturing of tablets: Formulation and granulation of powders for tableting, manufacturing of tablets by wet granulation, dry granulation and direct compression, advantages and disadvantages of different process.
   (b) Tableting machineries and tools: Single punch and rotary tablet press – parts, design and functions; punch terminology, die terminology, tablet terminology, B and D tooling
   (c) Common tableting problems and their solutions: Tableting problems and solving approach; Definition, reasons, consequences and remedies of the following tableting problems: capping and lamination, sticking and picking, cracking and chipping, mottling and discoloration, excessive weight variation, hardness variation, double impression.
   (d) Evaluation of tablets: Quality control of tablets – introductory concepts, important QC tests for tablet dosage forms, in-process QC tests, weight variation test / uniformity of weight, content uniformity test / uniformity of content, breaking or crushing strength / hardness test, friability test, disintegration test: objective, apparatus, method, specifications, dissolution test: concept, importance / significance, objective, dissolution test apparatus, control of variables in dissolution testing, dissolution acceptance criteria – USP specifications; assay / potency test.

3. **Pharmaceutical Coating:** Objectives of coating, Historical background and significance, Types of dosage forms requiring coating, Overview and comparison of coating processes: Sugar, Film, Compression.
   (a) Film Coating: Introduction, Theory of film coating, Components of film coating formulation: Polymers (cellulose derivatives, acrylic polymers, etc.), Plasticizers, Colorants and opacifiers and Solvents (aqueous and non-aqueous), Process of film coating, Equipment used (pan coaters, fluid bed coaters), Common problems and remedies (e.g., peeling, picking, bridging, mottling)
   (b) Sugar Coating: Introduction, Basic process review, Stages of sugar coating (Sealing, Sub-coating, Smoothing, Coloring, Polishing and Printing), Materials and formulations, Advantages and limitations, Common problems and remedies, Time and cost comparison with film coating
   (c) Compression Coating: Introduction, Principles of compression coating, Techniques and equipment, Application, Common problems and remedies

4. **Capsules:** Definition and classification, advantages and limitations of capsule dosage form, gelatin and its manufacturing, properties of different types of gelatin, application of gelatin in pharmaceutical industry, evaluation of gelatin properties, HPMC based capsule and its manufacturing.
   (a) Hard gelatin capsules: Composition of hard gelatin capsule shell, manufacture of hard capsule shells, properties of capsule shells including shapes and design/types (snap-fit, coni-snap, coni-snap supro etc), sizes and selection, capsule fill volume, length, diameter, formulation of capsules, capsule filling machines, tooling and accessories, problems in capsule manufacturing, quality control methods of capsules, packaging and storage of capsules, comparison between HPMC based and gelatin based hard capsules.
   (b) Soft gelatin capsules: Definitions and classifications, advantages and limitations, properties of soft capsules including shape, size, volume, selection of appropriate shell size, formulation development and consideration of soft capsules, composition of soft capsule shells, manufacturing of soft capsules, problems in soft capsule manufacturing, quality control methods of soft capsules, packaging of soft capsules, examples of commercially available soft gelatin capsules.

5. **Pelletization:** Introduction, Mechanism of pelletization, Manufacturing process and pharmaceutical application

6. **Microencapsulation technology**: Microcapsule concepts, purpose, methods of preparation, evaluation, pharmaceutical and biological applications of microencapsulation processes.

Learning Outcomes:

After completing the course, the student will be able to -

1. Describe the properties of powders and granules

2. Develop a basic tablet formulation and be able to describe the role of each excipient in the formulation. Granulate a powder using wet and dry granulation methods. Identify the challenges in the formulation.
3. Explain the common tableting problems. Evaluate and assess a tablet's chemical, physical and bioavailability properties. Identify the key variables that controls the product quality
4. Demonstrate theory of tablet coating, coating types, methods and equipment for dry, sugar and film coating.
5. Describe the pros and cons of capsules as dosage forms. Prepare hard and soft gelatin capsule. Describe common equipment and excipients used for the preparation of capsules. Demonstrate different quality control methods of soft and hard gelatin capsules. Classify different materials used for packaging.
6. Describe the objectives of microencapsulation, materials used for microencapsulation, release and stability kinetics, various approaches for the preparation of microcapsules, evaluation & application of microencapsulation.

Assessment: As per the rules

Reference/recommended books:

1. The Theory and Practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. Encyclopedia ofPharmaceutical Technology. Editor: James Swarbrick. Informa Healthcare USA, Inc.
3. Pharmaceutical Preformulation and Formulation. Editor: Mark Gibson. IHS Health Group.
4. British Pharmacopoeia
5. United States Pharmacopoeia
6. Design and Manufacture of Pharmaceutical Tablets. Elsevier Inc.
7. Pharmaceutics: The Science of Dosage Form Design. Editor: Michael E. Aulton
8. Pharmaceutical Dosage Forms - Tablets: Manufacture and Process Control - Larry L. Augsburger, Stephen W. Hoag
9. Pharmaceutical coating technology. Graham Cole; John Hogan; Michael Aulton. Informa Health Care, New York, 2008
10. Quality control in the pharmaceutical industry. Murray S. Cooper, , 1, Academic, New York

PHR 308L Pharmaceutical Technology-III Lab Credit Hr: 1

Course Number **:** PHR 308L
Course Title **:** Pharmaceutical Technology-III Lab
Credit hours **:** 1

Specific Objectives:

1. Develop a basic solids, semisolids and liquid pharmaceutical dosage forms formulation and manufacturing
2. Learn the techniques used in the production of different dosage forms
3. Set up and operate a rotary tablet press
4. Wet and dry granulation of powder

Course Contents:

Preparation and evaluation of the following dosage forms:

1. Powders
2. Granules
3. Tablets
4. Capsules

Learning Outcomes:

Upon completion of the course, the students:

1. Will have fundamental knowledge in preparing conventional dosage forms
2. Will be able to learn preparation of different powders, granules, tablets and capsules and evaluate them for their quality
3. Will be able to describe the role of different excipients in the formulation
4. Will know stability study and standard evaluation procedure for better storage conditions.

Assessment: As per the rules

Reference/recommended books:

1. K. E. Avis, H. A. Lieberman, and L. Lachman, (eds.) (Pharmaceutical Dosage Forms: Parenteral Medications, Vol. I & II).
2. M. E. Aulton, Pharmaceutics, the Science of Dosage Form Design.
3. L. Lachman, H.A. Liebernan, J.L. Kanig, The Theory and Practice of Industrial Pharmacy.
4. S. J. Carter (Ed.), Cooper and Gunn's Dispensing for Pharmaceutical Students.
5. Loyd V Allen, Howard C Ansel. Pharmaceutical Dosage Forms and Drug Delivery Systems.
6. L.W. Dittert, Sprowl's American Pharmacy.
7. A. R. Gennaro, Remington, The Science and Practice of Pharmacy.

PHR 309 Biopharmaceutics and Pharmacokinetics-I Credit Hr: 4

Course Number : PHR 309
Course Title : Biopharmaceutics and Pharmacokinetics-I

Credit hours : 4

Introduction:

Therapeutic performance or efficacy of any drug depends on its dosage form, administration route, distribution within the body and its biochemical conversion i.e. metabolism or excretion from the body. Therefore, it is crucial for the undergraduate pharmacy students to understand the various basic pharmacokinetic terms, parameters and equations to quantify the drugin the body after a certain time of its administration. Understanding and designing the appropriate pharmacokinetic theories and applications will help the students to select the dosages or other adjustment further in clinical situations as well as advanced studies.

Specific Objectives:

To provide knowledge about

1. Absorption, distribution, excretion of drugs.
2. Bioavailability & bioequivalence related considerations in designing drug product.
3. Biopharmaceutical considerations in drug product design.

Course Contents:

1. **Introduction to biopharmaceutics and pharmacokinetics, Biopharmaceutical classification of drugs.**
2. **Gastrointestinal absorption of drugs**:
   (a) **Biological consideration**- Membrane physiology, gastrointestinal physiology, mechanism of absorption etc.
   (b) **Physicochemical consideration-** p^ka and gastrointestinal absorption, pH partition theory and other physicochemical factors.
   (c) **Dosage form consideration**- Role of different dosage forms like solution, suspension, tablet, capsule, emulsion etc. on gastrointestinal absorption.
   (d) **Drug Absorption Mechanisms**
   Passive diffusion, Facilitated diffusion and active transport, Endocytosis and pinocytosis, Carrier-mediated transporters (e.g., P-gp, OATP).
3. **Drug Dissolution and Release Mechanisms**
   Principles of Dissolution, Physicochemical and Physiological Factors Affecting Dissolution, Theories and Models of Drug Dissolution, Dissolution Testing, Drug Release Mechanisms from Dosage Forms, IVIVC (In vitro-in vivo correlation), Mathematical Models for Drug Release Kinetics.
4. **Physiologic Drug Distribution**
   Volume of distribution (Vd), Barriers to distribution, Factors affecting drug distribution, organ-specific distribution, and the impact of physiological and pathological conditions on drug disposition and therapeutic outcomes.
5. **Protein binding of drugs:** Theoretical aspects of protein-drug interaction, methods used for protein binding, identification of drug binding sites, kinetics of protein binding, determination of binding sites and association constant, factors affecting protein binding, effects of protein binding on drug distribution, elimination, and pharmacological effects of drugs.
6. **Concept of Clearance**:

Definition, units, and physiological significance of clearance; relationship with elimination rate, half-life, and volume of distribution; total body clearance and contribution of individual organs; factors influencing clearance (blood flow, protein binding, enzyme activity, disease states); application of clearance in dosage regimen design and therapeutic drug monitoring.

(a) **Renal Clearance**

Mechanisms of renal drug elimination: glomerular filtration, tubular secretion, and tubular reabsorption; measurement of renal clearance and clearance ratio; creatinine clearance as an index of renal function; factors affecting renal clearance; clinical importance in dose adjustment during renal impairment.

(b) **Hepatic Clearance**

Determinants of hepatic clearance: hepatic blood flow, intrinsic clearance, and plasma protein binding; well-stirred and parallel-tube models; hepatic extraction ratio and first-pass metabolism; influence of enzyme induction, inhibition, and genetic polymorphisms; impact of liver diseases on drug elimination and bioavailability.

7. **Drug Product Performance, *In Vivo***: Bioavailability and Bioequivalence: drug product performance, purpose of bioavailability studies, relative and absolute availability. Methods for assessing bioavailability, bioequivalence studies, design and evaluation of bioequivalence studies, study designs, evaluation of the data, Biopharmaceutics Classification System, methods. Permeability: In-vitro, in-situ and In-vivo methods. Generic biologics (biosimilar drug products), clinical significance of bioequivalence studies, special concerns in bioavailability and bioequivalence studies, and generic substitution

Learning Outcomes:

At the end of this section the students will be able to

1. Define and select various routes of drug administration, its absorption features in the body, quantify the drug's amount in the body at a certain time interval. The students also be able to identify various factors that can affect the drug's distribution within the body.
2. Design an absorption rate equation for a certain drug.
3. Calculate bioequivalence data, including absorption rate constants, half-life, elimination rate constant etc.
4. Analyze bioavailability and bioequivalence data.
5. Correlate in vitro and in vivo data and apply all the pharmacokinetic data in the form of equations and figures.

Assessment: As per the rules

Reference/recommended books:

1. Applied Biopharmaceutics & Pharmacokinetics, Leon Shargel, Andrew B.C. Yu
2. Basic Pharmacokinetics, Mohsen A. Hedaya
3. Biopharmaceutics and Clinical Pharmacokinetics, Milo Gibaldi

4. Modern Biopharmaceuticals, Jörg Knäblein
5. Essentials of Pharmacokinetics and Pharmacodynamics, Thomas N. Tozer and Malcolm Rowland

PHR 309 L Biopharmaceutics and Pharmacokinetics-I Lab Credit Hr: 1

Course Number : PHR 309L
Course Title : Biopharmaceutics and Pharmacokinetics-I Lab
Credit hours : 1

Specific Objectives:

The objectives of this course is to develop student's hands on skills on quality evaluations of various dosage forms, so that they can implement those knowledge and skill in their professional life to enhance their competence and ensure quality drugs' production and marketing.

Course Content:

1. Biopharmaceutical calculations.
2. Weight variation, hardness, friability, disintegration test.
3. Solubility assessment and partition coefficient analysis.
4. Preparation of different dissolution media.
5. Dissolution study.
6. Leakage test of packaging of tablets / capsules.

Learning outcomes:

At the end of this course the students will be able to

1. Design the evaluation protocols and methodologies (selection of reagent and/or apparatus, solvent or media, testing duration, other required laboratory set-up).
2. Use such laboratory set-up, methodologies and specifications to ensure the quality of various dosage forms especially tablets.

Assessment system: As per the rules

Reference/recommended books:

1. Applied Biopharmaceutics & Pharmacokinetics, Leon Shargel, Andrew B.C. Yu
2. Basic Pharmacokinetics, Mohsen A. Hedaya

PHR 310 Pharmaceutical Marketing and Management Credit Hr: 4

Course Number : PHR 310
Course Title : Pharmaceutical Marketing and Management
Credit Hours : 4
Course Description:

This course is designed to provide the students with an overview of the pharmaceutical marketing, including principles of marketing, marketing planning, consumer buying behavior, target marketing, market segmentation and marketing positioning strategies. This course also focuses on product promotional techniques, importance of advertising, advertising strategies, product management, brand building, brand management, pricing methods and strategies.

The pharmaceutical management course has been developed to build up the leadership and management capability of pharmacists in their professional life. This course includes principles of management, style of management, structures of organization, management of personnel, inventory control and purchasing.

Specific Objectives:

1. Provide information on pharmaceutical marketing, sales, management, and related fields within the health care industry.
2. Gain information on the principles of marketing, marketing process, role of marketing & environmental forces in our society. Discuss different strategic planning process, resources and opportunities affecting the planning process etc. which provide tactical knowledge for productive marketing.
3. Provide information on consumer market, consumer buying process and consumer behavior model. Introduce students with market segments, methods of advertising and product promotion techniques.

Course Contents:

Part A: Pharmaceutical Marketing

1. **Principles of marketing**: Definition and concepts of marketing, steps in the marketing process, role of marketing & environmental forces in our society, marketing mix and exchange relationships, marketing Management process, the selling concept, marketing concept and the societal concept, customer relationship management, demarketing.
2. **Product management mix:** Concept of a product, classification of products, product line and product mix, products planning and development, PLC, marketing strategies along the product life cycle, brand building and brand management.
3. **Strategic marketing:** Identifying market segments, factors for segmenting market, choosing a target marketing strategy, market positioning for maximum competitive advantages,
4. **Consumer markets and buying behavior:** Consumer market & business market, elements of a consumer behavior model & organizational buying behavior, consumer buying process, factors

affecting consumer behavior, types of buying behavior, buying decision process, consumer decision process for new products or adoption process.

5. **Product promotion:**Elements in the communication process, promotions mix (advertising, personal selling, sales promotion, public relation, direct marketing) and their roles in Integrated Marketing Communication (IMC), the promotions message and executions style, media choice, promotional objectives, representatives, physical distribution inventory and cost control, returns and claims, definition of pricing, basic factors influencing pricing decision, pricing methods and strategies.
6. **International marketing:** Basics of international marketing (IM), international marketing environment, social, political, legal, economic and cultural environment, Basic strategies of international marketing.
7. **Digital marketing:** Basics of digital marketing, channels of digital marketing, ethical/legal aspects of digital marketing, introduction of AI in pharmaceutical marketing.

Part B: Pharmaceutical Management

1. **Nature and principles of management:** Styles of management, the MBO system
2. **Organizational structures:** Social organization and legal organization, the sole proprietorship, the general partnership, private and public limited companies, their relative advantages and disadvantages.
3. **Organizational behavior and HR management:** Motivation, leadership style recruitment & training, performance evaluation.
4. **Supply chain management:**
   a) Inventory control: Methods-intuitive, systematic wantbook, perpetual inventory, open-to-buy, stock, record card, economic order quality, selection of optimum methods, effect of inventory control.
   b) Purchasing: Formulating effective buying policies, needs and desires, selecting the sources of supply, determining terms of purchase, receiving, marking and stocking of goods.

Learning outcomes: Upon completion of the course, the students will be able to:

1. Be able to analyze and explain specific issues within pharmaceutical marketing by using the concepts, theories, methods and models taught. Understand how to apply these marketing concepts over the pharmaceutical market.
2. Capable to describe modern market access, consumer behavior model, consumer buying process, factors affecting consumer behavior, types of buyer, behavior organizational buyer behavior and drug promotional methods including promotions mix, communication process and their roles in Integrated Marketing Communication.
3. Explain the importance of advertising, classification of advertising, advertising strategy, advertisement effectiveness, advantages and disadvantages of the primary media. Learn promotional and pricing techniques.
4. Being able to integrate different managerial functions. Understand the principles and style of management. Describe organization structures including social organization, the sole

proprietorship, private and public limited companies, their relative advantages and disadvantages.

5. Understand the importance, principles, methods of personnel management. Describe the basis of inventory management, inventory models and effective buying policies.

Assessment: As per the rules

Reference/recommended books:

1. Principles of Marketing by Philip Kotler and Gary Armstrong
2. Principles of Marketing by Stanton.
3. Quantitative Techniques for Managerial Decision Making, by U.K. Srivastava and S. C. Sharma.
4. Basic Principles of Marketing by Jeorge R. Terry.
5. Pharmaceutical Marketing by Smith.
6. Marketing, Management by Philip Kotler, 10"' edition, Printice Hall of India Pvt, Ltd.
7. Marketing Strategy: A Global Perspective by Vernon R. Stauble, The Dryden Press.
8. Principles of Management by Davis.
9. Principles and Methods of Pharmacy Management by H. A. Smith.
10. Management, A global Perspective by Weirich, Heinz & Koontz. Personnel management and Industrial Relations, by R. S. Davar.

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 310 L Pharmaceutical Marketing and Management Field Work/ Report — Credit Hr: 1

Course Number **:** PHR 310L
Course Title **:** Pharmaceutical Marketing and Management Field Work/ Report
Credit hours **:** 1

Specific Objectives:

The objectives of this course is to develop student's hands on skills on Pharmaceutical market, physician prescribing behavior and real life scenario on market campaigns. In addition, students can extrapolate market segments, methods of advertising and brand promotion techniques.

Course Content:

1. Prescription survey.
2. Case studies on marketing campaigns.
3. Digital marketing.

4. Survey on market positioning of different therapeutic classes.
5. International market and regulatory compliance.

Learning outcomes:

At the end of this course the students will be able to

1. Analyze and explain specific issues within Pharmaceutical marketing by using the concepts, theories, methods and models taught.
2. Understand physician prescribing behavior (consumer buying model), strategies of companies to obtain market share and international market regulations.
3. Explain the importance of product promotional practices commonly exercised in pharmaceutical companies.

Assessment: As per the rules

Reference/recommended books:

1. Principles of Marketing by Philip Kotler and Gary Armstrong
2. Basic Principles of Marketing by Jeorge R. Terry.
3. Pharmaceutical Marketing by Smith.
4. Marketing, Management by Philip Kotler, 10"' edition, Printice Hall of India Pvt, Ltd.
5. Marketing Strategy: A Global Perspective by Vernon R. Stauble, The Dryden Press.
6. Management, A global Perspective by Weirich, Heinz & Koontz. Personnel management and Industrial Relations, by R. S. Davar.

PHR 311 Computer Applications and Artificial Intelligence in Pharmacy Credit Hr: 4

Course Number **:** PHR 311
Course Title **:** Computer Applications and Artificial Intelligence in Pharmacy
Credit hours **:** 4

Course Description:
The importance of digital technologies in contemporary pharmacy practice is introduced to Pharm.D. students through Computer Applications and Artificial Intelligence in Pharmacy. Clinical decision support systems, pharmacy management software, drug databases, inventory systems, and electronic health records (EHR) are all covered in the course. Additionally, it examines cutting-edge subjects including bioinformatics, telepharmacy, and artificial intelligence in drug discovery. Moreover, students will learn about Artificial Intelligence (AI) and Machine learning (ML) and their applications in the pharmaceutical sector. The efficient use of technology in clinical and hospital pharmacy environments, regulatory standards, and data protection are all emphasized. Students who comprehend and use these resources will be better able to develop drugs, guarantee medication safety, improve patient care, and help create a more effective healthcare system. This course connects the quickly evolving field of digital health with pharmacy.

Specific Objectives:

This course will provide basic knowledge about computer application in pharmaceutical science with a view to meeting the following objectives:

1. Understanding the Role of Computer Technologies
2. Integrating Digital Tools in Pharmaceutical Practice
3. Applying Informatics in Drug Development and Regulatory Processes
4. Developing Practical Skills in Pharmacy-related Software
5. Learning Artificial Intelligence (AI) and Machine learning (ML)
6. Application of AI and ML in the pharmaceutical sector.
7. Modernization in Pharmaceutical Research and Discovery.

Course Contents:

1. **Introduction to Computer Applications in Pharmacy**

Role of computers in modern pharmacy, overview of pharmacy informatics, cloud computing and its role in healthcare, introduction to data analysis in pharmacy.

2. **Application of MS Office in Hospital Pharmacy and Pharmaceutical Industry**

Introduction to MS Office Suite, MS Word in hospital pharmacy and pharmaceutical industry, MS Excel applications, MS PowerPoint.

3. **Electronic Health Records (EHR) and Health Information Systems**

Components and types of EHR systems, role of pharmacists in EHR management, medication order entry systems (CPOE), clinical decision support systems (CDSS), patient privacy and data security (HIPAA/GDPR overview).

4. **Pharmaceutical Data Management and Software Tool**

Drug databases (e.g., Lexicomp, Micromedex), inventory management systems in hospital and retail pharmacy, barcode medication administration (BCMA), introduction to pharmacy management software (e.g., Marg, Liberty, Medisys), automation in dispensing and billing.

5. **Advanced Tools in Data Storing and Management**

Database management systems (DBMS) in pharmaceutical science, blockchain technology for secure data storage, data warehousing and big data analytics in pharmacy.

6. **Computer Application in Biological Data Analysis**

Introduction to biological data analysis, bioinformatics and its Applications, statistical software in biological data analysis, molecular modeling and simulation.

7. **Basics of AI and ML**

Introduction of Artificial Intelligence (AI) and Machine learning (ML), Brief History of Artificial Intelligence and Machine learning, Major component of Artificial Intelligence (AI) and Machine learning (ML), Supervised, Unsupervised and Reinforcement Learning, Deep Learning, Neural Networks, Artificial Neural Network, Data types and resources, Data management.

8. **AI and ML concepts in Pharmaceutical Sector**

Pharmaceutical Industry 4.0, Digital Technology trends in the pharmaceutical industry, Current implementation and application of Artificial Intelligence and Machine Learning in Pharmaceuticals, Artificial Intelligence and Machine Learning derived drug discovery Good machine learning practice (GMLP); Tools in AI and ML-driven drug discovery (de novo and re-purposing approach)

9. **Modern Pharmaceutical Sector**

Clinical Development (Trial design, trial start-up, trial conduct, trial closeout), CONSORT-AI (Consolidated Standards of Reporting Trials–Artificial Intelligence), Clinical evaluation of software, Manufacturing with quality of experience (QoE) and quality of service (QoS), supply chain management, Launch, commercialization, Post Market surveillance, Role of Artificial Intelligence and Machine learning in Diagnosing, Retail and Distribution, AI/ML based software as a medical device.

10. Challenges and Opportunities

Benefits and Opportunities of AI/ML in the Pharmaceutical Industry, Real-world performance (RWP) monitoring for AI/ML software, Digital Unfamiliar technology, Future with Covid-19 digital Opportunities and challenges, Technical and Logistical challenges, Modern Regulatory challenges in drug discovery, clinical trial, Product registration, Ethical consideration and Cyber security.

Learning Outcomes:

1. **Demonstrate proficiency in using specialized software** (e.g., pharmacy management systems, drug design tools, and data analysis platforms) for pharmaceutical applications.
2. **Apply computer-based tools** for drug discovery, molecular modeling, and pharmacokinetic/pharmacodynamic (PK/PD) analysis.
3. **Manage and analyze pharmaceutical data** using database systems, bioinformatics tools, and electronic health records (EHR).
4. **Evaluate and implement digital solutions** for quality control, supply chain management, and regulatory compliance in pharmaceutical industries.
5. **Understand the role of computer technologies** in improving patient care through telepharmacy, e-prescriptions, and clinical decision support systems.
6. **Use of Artificial Intelligence (AI) and Machine learning (ML)** in the pharmaceutical sector.

Assessment: As per the rules

Text books/References:

1. Pharmacy Informatics by Philip O. Anderson & Susan M. McGuinness
2. Introduction to Hospital and Health-System Pharmacy Practice by David A. Holdford
3. Microsoft Office 365: In Practice, 2021 Edition by Randy Nordell
4. Bioinformatics and Functional Genomics by Jonathan Pevsner
5. Health Informatics: Practical Guide by Robert Hoyt
6. Applied Clinical Informatics for Nurses by Susan Alexander
7. Research articles and case studies from journals like Journal of Biomedical Informatics, Journal of Pharmacy Practice, Journal of Pharmaceutical Innovation
8. A Handbook of Artificial Intelligence in Drug Delivery. Edited by Anil Philip, Aliasgar Shahiwala
9. Artificial Intelligence in Education: The Power and Dangers of ChatGPT in the Classroom by Amina Al-Marzouqi, Said A. Salloum, Mohammed Al-Saidat, Ahmed Aburayya, Babeet Gupta

PHR 312	**Project**	**Credit Hr: 2**

Course Number **:** PHR 312
Course Title **:** Project

Credit hours **:** 2

Introduction:
This course is designed to introduce students to independent research and scientific inquiry within the pharmaceutical sciences. This capstone component enables students to apply theoretical knowledge and laboratory skills gained during their coursework to real-world problems. Through literature review, experimental design, data collection, and analysis, students develop critical thinking, problem-solving, and communication skills. The project work fosters innovation, professional responsibility, and a deeper understanding of research methodologies, ethical practices, and documentation standards essential in pharmaceutical research and development. It culminates in a project report and oral defense, preparing students for higher studies or industry roles.

Course Objectives:
1. To develop the ability to design and conduct independent pharmaceutical research projects.
2. To enhance students' skills in data collection, statistical analysis, and scientific writing.
3. To promote critical thinking, creativity, and problem-solving in real-world pharmaceutical scenarios.
4. To inculcate ethical research practices and compliance with regulatory standards.

Course Contents: As per the instruction of the project supervisor.

Learning Outcomes:

1. Demonstrate the ability to plan, execute, and report a pharmaceutical research project.
2. Analyze experimental data using appropriate scientific and statistical methods.
3. Apply ethical and professional standards in the conduct of research.
4. Communicate research findings effectively through written reports and oral presentations.
5. Collaborate effectively in research teams and manage time and resources efficiently.

Assessment: As per the rules

PHR 313 Viva Voce Credit Hr: 1

Course Number **:** PHR 313

Course Title **:** Viva Voce

Credit hours **:** 1

Course Description:
The viva voce in the B. Pharm. (Hons) program evaluates students' knowledge and communication skills. It ensures readiness to apply pharmaceutical knowledge in real practice.

Specific Objectives:

1. Assess understanding of core pharmaceutical sciences and practice.
2. Evaluate application of knowledge in patient-centered scenarios.
3. Test problem-solving, decision-making and communication skills.
4. Build confidence, professionalism and ethical reasoning.

Course Contents: Total Syllabus of B. Pharm. (Hons) year-III

Learning Outcomes:
After the viva, students will be able to:

- Demonstrate subject knowledge and competence.
- Apply reasoning to solve therapeutic problems.
- Integrate multidisciplinary concepts effectively.
- Communicate clearly and confidently.
- Show professionalism and ethical awareness.

Assessment: As per the rules

B. Pharm. (Hons.) Year-IV

PHR 401 Pharmaceutical Analysis-II Credit Hr: 4

Course Number : PHR 401
Course Title : Pharmaceutical Analysis-II
Credit hours : 4

Introduction:
Pharmaceutical analysis deals with the analysis of drugs, pharmaceutical substances and raw materials. Since the primary purpose of manufacturing different dosage forms by a pharmaceutical company is to treat and manage diseases and disorders, these pharmaceuticals must be free from toxic materials and should contain desired amount of active ingredients. To serve this purpose, raw materials, excipients, as well as the finished products must be tested for their purity and potency. As a result, various chemical and instrumental methods are developed which include different titrimetric, chromatographic, spectroscopic and electrochemical methods. In Pharmaceutical Analysis-I (PHR-301), different titrimetric and chromatographic techniques, UV-visible spectrophotometry, fluorometry and polarimetry are included. These physical and chemical methods are primarily based on the chemical structure of a drug molecule. Therefore, in Pharmaceutical Analysis-II (PHR-401), Infrared, NMR spectroscopy and Mass spectrometry are included. Other advanced analytical techniques of this course are: Atomic absorption spectroscopy, Potentiometric Polarography and Amperometric titrations, Gas chromatography, Microbiological assay of antibiotics, electron microscopy and Scanning electron microscopy.

Specific Objectives: The objectives of this course are to -

1. Provide a comprehensive understanding of advanced analytical techniques that are essential for determining the potency, purity and safety of pharmaceuticals.
2. Determine the structure of organic molecule by knowing their functional groups, number and types of protons and carbons and their direct and long-range connectivities, molecular weight, molecular formula etc.
3. Give details of different electrochemical methods.
4. Carry out separation of mixtures of chemical compounds.
5. Discuss thoroughly the microbiological assay of antibiotics.
6. Perform analysis of metals and metalloids in trace amounts.
7. Update pharmacy students with importance of electron microscopy and scanning electron microscopy (SEM).

Course Contents:

1. **Atomic absorption spectroscopy**: Theory, instrumentation and application in quantitative analysis.
2. **Infrared spectroscopy:** Introduction, absorption spectroscopy, units of measurement, types of fundamental vibrations, fingerprint and functional group regions, Instrumentation: dispersive

infrared spectrometers and Fourier-transform infrared spectrometers (FTIR), preparation of samples for IR spectroscopy, applications of IR spectroscopy.

3. **Nuclear magnetic resonance spectroscopy**: ^{1}HNMR spectroscopy: Introduction and theory, relaxation process, instrumentation, chemical shift, spin-spin coupling, different spin systems, coupling constants, spin-spin decoupling, long range coupling; Two dimensional NMR spectroscopy, nuclear Overhauser effect, 2D correlated (COSY) and 2D Nuclear Overhauser enhancement spectroscopy (NOESY), HMBC, HMQC.
4. **^{13}C NMR spectroscopy**: Introduction, principle, chemical shift, spin-spin coupling, applications.
5. **Mass spectrometry**: Introduction, theory, the mass spectrum, recognition of molecular ion, isotopic peaks, ionization techniques- electron impact, chemical ionization, fast atom bombardment etc.; fragmentation pattern; aliphatic and aromatic hydrocarbons, alcohols, ethers, aldehydes, ketones, acids, esters, amines etc.; analyzing techniques: magnetic sector, quadrupole; determination of molecular formula, applications of mass spectrometry.
6. **Potentiometric titration**: Introduction, theory and principles, electrochemical cells and half-cells, electrodes, measurement of potential, application of potentiometric titration.
7. **Polarography and amperometric titration**: Introduction, theoretical considerations, instrumentation, general polarographic analysis, amperometric titration using one and two electrodes.
8. **Gas chromatography**: Introduction and principles, theoretical consideration, column technology, detectors, analytical application of gas chromatography.
9. **Microbiological assay of antibiotics**: Introduction, reference standard and units of activity, agar diffusion assay, theory of zone formation, factors affecting agar diffusion assay, dose response curve, large plate assay using Latin square design, statistical interpretation of microbiological assay results.
10. **Polarimetry**: Introduction, instrumentation and application, optical isomerism, origin of optical rotation, molecular requirements for optical rotatory power, specific rotation, calculation of specific rotation, circular dichroism (CD), optical rotatory dispersion (ORD).
11. **A brief study about electron microscopy and scanning electron microscopy (SEM).**

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Elucidate the structure of simple organic molecules by knowing, their chromophore, functional groups, types and number of protons and carbons, one bond and long range connectivity, molecular weight and molecular formula.
2. Identify any compound quickly by comparing its fingerprint region of IR spectrum with that of an authentic sample.
3. Analyze drug molecules and excipients by spectroscopic and electrochemical methods of analysis.
4. Analyze mixtures of chemical compounds by gas chromatography.
5. Ascertain the true biological activity of antibiotics using microbiological assay.
6. Determine trace amounts of metals and metalloids in a sample.
7. Evaluate topographical, morphological and compositional information of a sample and can detect and analyze surface fractures etc.

Assessment: As per the rules

Text books:

1. Spectroscopic Methods in Organic Chemistry. 4th Edition by Dudley H. Williams and Ian Fleming McGraw-Hill Book Company Limited, UK
2. Introduction to Spectroscopy, 3rd edition By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Thomson Learning, Inc. USA
3. Pharmaceutical Chemistry Edited by Leslie G. Chatten, Volume 2, Marcel Dekker, Inc, 95 Madison Avenue, New York

References:

1. Theory and application of Microbiological Assay,1st Edition By William Hewitt Academic Press.

PHR 401L Pharmaceutical Analysis-II Lab Credit Hr: 1

Course Number **:** PHR 401L
Course Title **:** Pharmaceutical Analysis-II Lab
Credit hours **:** 1

Introduction:
This course is based on the theoretical course Pharmaceutical Analysis-II (PHR-401). It will provide a practical idea about the use of spectroscopic analysis and titrimetric methods to determine potency of market preparations. Students will learn to quantitatively analyze potency of drugs in terms of BP limit. It also highlights the importance of quality control of drugs in pharmaceutical industry.

Specific Objectives: The objectives of this course are to -

1. Learn spectroscopic techniques like UV-Visible.
2. Learn titrimetric methods.
3. Determination of potency by means of calculation and graphs.
4. Compare outcomes with pharmacopeia.
5. Prepare the students for doing industrial quality control of preparations and highlight its importance.

Course Contents:

1. Estimation of ampicillin by UV spectrophotometric method.
2. Estimation of aspirin by UV spectrophotometric method.
3. Determination of protein concentration in tissue preparation by UV-Vis spectrometry.
4. Estimation of ferrous fumarate from iron capsule.
5. Determination of ampicillin by iodometric titration.
6. Determination of potency of atenolol in the tablet by volumetric and conductometric method.
7. Determination of captopril potency in the tablet by volumetric and conductometric method.

8. Compare the titration curves using conductometric method when (a) 0.05 M solution of HCl (b) 0.05M solution of oxalic acid (c) 0.05M solution of acetic acid and (d) 0.05 M solution of acetyl salicylic acid is conductometrically determined with a standard solution of sodium hydroxide.
9. Potentiometric determination of the concentrations of an iodide and a chloride sample in a mixture.

Learning Outcomes: Upon completion of the course, the students will be able to -

1. Learn spectroscopic techniques like UV-Visible.
2. Learn titrimetric methods.
3. Determination of potency by means of calculation.
4. Compare outcomes with pharmacopeia.

Assessment: As per the rules

Text books:

1. J H Block, F Roche, I O Soine and C O Wilson, Inorganic Medicinal and Pharmaceutical Chemistry, Lea and Febiger, Philadelphia, P A.
2. AH Beckett & Stenlake, Text book of Practical Pharmaceutical chemistry, Vol.I&II.
3. Kasture & Wadodkar, Text Book of Pharmaceutical analysis Vol.I & II.

References:

1. A. Day Under Wood, Text Book of Quantitative Analysis.
2. Connors, A Textbook of Pharmaceutical Analysis.
3. B.K. Sarma, Instrumental Chemical Analysis, Goel Publishers.
4. Chatwal & Anand, Instrumental Methods of Analysis.
5. R.M. Silvestein and G.C. Bassler. Spectrometric Identification of Organic Compounds.

PHR 402 Medicinal Chemistry and Drug synthesis-II Credit Hr: 4

Course Number : PHR 402
Course Title : Medicinal Chemistry and Drug synthesis-II
Credit hours : 4

Introduction:

This will introduce further chemical principles that are required to understand the action and behaviour of drug compounds and hence the relationship between the structure and stereochemistry of a compound and its chemical and therapeutic properties, and thus the chemical considerations in drug design: size, physico-chemical properties and ADME (absorption, distribution, metabolism, and excretion). Structure activity relationships - historical and current understandings - will be explored through case studies. Methods of drug discovery will be described, including the development of drugs from natural products, combinatorial synthesis, computer modelling and rational drug design.

Specific Objectives: The objectives of this course are -

1. General structural features of agents belonging to the therapeutic class
2. Relevant physicochemical properties
3. Relevant chemical reactions/synthetic pathways for selected drugs
4. Structural and chemical influences on mechanism of pharmacologic action (structure-activity relationship)
5. Chemical influences on pharmacologic /toxicological/therapeutic profiles

Course Contents:

1. **Drug discovery and development**

Drug targets, lead identification & pharmacodynamic optimization, drug design & pharmacokinetic optimization, Quantitative Structure-Activity Relationship (QSAR) & Computer-Aided Drug Design, pre-clinical and clinical testing.

2.**Chemistry, SAR, mode of action and synthesis of the following groups of drugs**:

i. Antihistamines (H_1 & H_2-blockers)
ii. Hypnotics and sedatives
iii. Psychotropic drugs and antidepressants
iv. Antihypertensive agents (β-blockers)
v. Cardiovascular agents
vi. Oral contraceptives and steroidal hormones

3. **Drugs metabolism:** Pathways of drugs metabolism, metabolism of various groups of drugs, factors affecting drugs metabolism, methods of studying drug metabolism, new aspect of drug metabolism, metabolic products of common drugs.

4. **Asymmetric synthesis:** Enantioselectivity: definitions and overview, chiral induction, chiral reagents and auxiliaries in organic synthesis, chiral catalysts in organic synthesis, the Sharpless asymmetric dihydroxylation reaction.

5. **Retrosynthetic analysis:** Terms, definitions and basic concepts; retrosynthetic analysis: aromatic compounds; retrosynthetic analysis: alcohols and carbonyl compounds; retrosynthetic analysis of 1,2-, 1,3-, 1,4- and 1,5-dicarbonyl compounds, α,β-unsaturated and 1,3-dihydroxy compounds; retrosynthetic analysis: carbocyclic and heterocyclic compounds.

Learning Outcomes: Upon completion of the course, the students are expected to -

1. Describe the overall process of drug discovery and the role of medicinal chemistry in this process.
2. Relate the structure and physical properties of drugs to their pharmacological activity.
3. Discuss detailed examples of pharmaceutical drug discovery and extrapolate patterns and lessons to new and unseen cases.
4. Demonstrate an understanding of drug metabolism, bioavailability, and pharmacokinetics, and the contribution of medicinal chemistry in enhancing these parameters.
5. Explain and design chemical syntheses of important target compounds.
6. Describe current challenges and opportunities in medicinal chemistry in the context of modern developments in drug discovery.

Assessment: As per the rules

Text books:

1. An Introduction to Medicinal Chemistry- G. L. Patrick, Oxford University Press.
2. Wilson and Gisvold's Text Book of Organic, Medicinal and Pharmaceutical Chemistry- Edited by John Block and John M. Beale, Lippincott, Williams & Wilkins.
3. Advanced Practical Organic Chemistry- J. Leonard *et al*. Academic press.

References:

1. Advanced Organic Chemistry- Bernard Miller, Prentice Hall.
2. Advanced Organic Chemistry- M. B. Smith and Jerry March, Wiley Interscience.
3. Mechanism and Theory of Organic Chemistry- T. H. Lowry and K. S. Richardson, Benjamin- Cummings publishing company.
4. Physicochemical Principles of Pharmacy- A. T. Florence and D. Attwood, Pharmaceutical Press.

PHR 402L Medicinal Chemistry and Drug synthesis-II Lab Credit Hr: 1

Course Number **:** PHR 402L
Course Title **:** Medicinal Chemistry and Drug synthesis-II Lab
Credit hours **:** 1

Introduction:
This course is based on the theoretical course Medicinal Chemistry-II (PHR-402) which provide a theoretical and practical knowledge about the synthesis and analytical procedures based on reflux method, recrystallization, UV-visible spectroscopy etc. At first, synthesis steps involve acetylation, reduction, esterification, condensation methods and spectroscopic analysis involve absorption explanation of those synthetic compounds.

Specific Objectives: The objectives of this course are to -

1. Learn chemical characterizations of different compounds
2. Identify the compound by melting point determinations
3. Explain the spectral analysis based on UV-visible spectroscopy
4. Perform different purification procedures to improve the potency of those compound
5. Prepare the students for doing industrial synthesis procedures
6. Highlight the uses of benzocaine, phenacetin, paracetamol, dibenzylideneacetone (DBA) etc.

Course Contents:

1. Laboratory synthesis, physical, chemical and spectral characterization of the following compounds:
    a) Paracetamol

b) Phenacetin
c) Benzocaine
d) Dibenzylideneacetone
e) Tolbutamide
f) Sulphanilamide
g) 7- Hydroxy -4- methyl coumarin

2. The assay of:
   a) Metronidazole
   b) Chlorpheniramine Maleate
   c) Benzyl Penicillin
3. Drawing structure and reaction using Chemdraw

Learning Outcomes: Upon completion of the course, the students will be able to -

1. Demonstrate proficiency in organic synthesis techniques
2. Develop competence in analytical assay methods
3. Apply modern laboratory techniques and safety practices
4. Enhance skills in chemical drawing and reaction mechanism elucidation
5. Integrate theoretical knowledge with practical applications
6. Promote innovation and problem-solving abilities
7. Demonstrate scientific communication and documentation skills

Assessment: As per the rules

Text books:

1. Pavia, Donald, Gary Lampman and George Kriz. Introduction to Spectroscopy. New York: Sonders College Publishing, 1996.

References:

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
2. Foye's Principles of Medicinal Chemistry.
3. Burger's Medicinal Chemistry, Vol I to IV.
4. Introduction to principles of drug design- Smith and Williams.
5. Remington's Pharmaceutical Sciences.
6. Martindale's extra pharmacopoeia.
7. Organic Chemistry by I.L. Finar, Vol. II.
8. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
9. Text book of practical organic chemistry- A.I.Vogel.

PHR 403 Quality Control and Quality Assurance Credit Hr: 4

Course Number : PHR 403
Course Title : Quality Control and Quality Assurance
Credit hours : 4

Introduction:

This is a core course advanced understanding of standardization of pharmaceuticals, spectroscopic performance verification, current validation practices, Applied practices of UV, theoretical context of NMR and Mass spectroscopy, screenings of herbal drugs tools and Statistical methods in data analysis quality control systems for drugs and pharmaceuticals, regulatory basis for process validation, validation of standard operating procedures (SOP), regulatory submission, detection of adulterants presence in API, HPLC, UV-Vis and IR spectroscopic performance verification.

Specific Objectives: The objectives of this course are to -

1. Provide quantitative and qualitative analytical knowledge with sampling techniques
2. Offer a clear understanding about HPLC, UV-Vis and IR spectroscopy.
3. Verify Karl fisher spectroscopic performance by identifying common problems and solutions.
4. Highlight the terminology, regulatory submission and quality system during laboratory development.
5. Explain performance verification of NMR and MS.
6. Perform screening of herbal drugs for impurities and pesticide residues.
7. Identify the current validation techniques and statistical methods in data analysis.

Course Contents:

1. Quality control overview: Introduction, general information & significance of quantitative and qualitative analyses in quality control, sampling techniques. Pharmacopoeia tests and specifications, standardization of pharmaceuticals and formulated products, quality control systems for drugs and pharmaceuticals, causes of poor quality, theory and basic concepts of GLP, ISO 9000, ISO 9001, ISO 17025, TQM and ICH.

2. Terminology and validation overview: Introduction, terminology used in the validation of analytical procedures, regulatory basis for process validation.

3. Validation of analytical methods: Strategy and parameters for the validation of methods, verification of standard methods, validation of non-routine methods, analytical validation within the pharmaceutical environment, validation of standard operating procedures (SOP).

4. Overview of pharmaceutical product development and its associated quality system: Discovery research, preclinical phase, clinical phases, regulatory submission, quality system for the analytical development laboratory.

5. Potency method validation: Validation practices, strategies and validation parameters, potency method revalidation, common problems and solutions.

6. Method validation for HPLC analysis: Introduction, background information, method validation experiments, common problems and solutions.

7. Performance verification

(a) Performance verification of HPLC: Introduction, performance verification practices, operation tips for HPLC performance verification.

(b) Performance verification of UV-Vis and IR spectrophotometers: Introduction, performance attributes, practical tips in UV-Vis and IR spectroscopic performance verification.

(c) Performance verification of NMR and MS: Introduction, calibration of spectra, internal standards, common problems and solutions.

(d) Karl Fischer apparatus and its performance verification: Introduction, instrumentation, performance verification, common problems and solutions.

8. **Bioanalytical method validation:** Definition of bioanalytical method validation, regulatory guidance on bioanalytical method validation, current validation practices, common problems and solutions.
9. **Quality control of herbal drugs:** Introduction, detection of adulterants including the presence of API, determination of foreign matters, development of standardization parameters, phytoconstituents and their analysis, analytical procedures for some bioactive materials, screenings of herbal drugs for pesticide residues and other potential contaminants.
10. **Statistical methods in data analysis**

Learning Outcomes: Upon completion of the course, the students will be able to -

1. Have basic knowledge about SOP, GLP, ISO 9000, ISO 17025, TQM and ICH
2. Define preclinical, clinical phases for pharmaceutical product development
3. Develop a research framework using HPLC, UV-Vis and IR spectroscopic method to calibrate spectra for method validation
4. Calibrate the spectra, identify common problems with their solutions regarding NMR & MS performance verification
5. Gain knowledge about instrumentation and performance verification of Karl Fischer apparatus
6. Determine foreign matters and develop standard parameters,
7. Detect phytoconstituents, their analysis and analytical procedures for bioactive compounds
8. Highlight current validation practices with their regulatory guidance
9. Have a detailed Knowledge about test of hypothesis, t-test, z-test, and ANOVA

Assessment: As per the rules

Text books:

1. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related Materials; Volume-1; World Health Organization, Geneva.
2. Analytical Method Validation and Instrument Performance Verification, Edited by C. C. Chan, H. Lam, Y. C. Lee and Xue-Ming Zhang, John Wiley & Sons Inc.
3. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, 5th Edition, Cengage Learning.

References:

1. Spectroscopic Methods in Organic Chemistry, Dudley H. Williams, Ian Fleming, 1996, McGraw-Hill
2. Herbalism: The Science and Practice of Herbal Medicine, by David Hoffmann, F.N. Hoffmann.

PHR 403L Quality Control and Quality Assurance Lab Credit Hr: 1

Course Number : PHR 403L
Course Title : Quality Control and Quality Assurance Lab
Credit hours : 1

Introduction:
This is a core course about advanced understanding of standardization of pharmaceuticals, spectroscopic performance verification, current validation practices and applied practices of UV. Assessment of the precision of quantitative measurements using HPLC, determination of the effects of slit width, scanning speed on UV absorption spectrum and detection of adulterants presence in API, HPLC, UV-Vis and IR spectroscopic performance verification.

Specific Objectives: The objectives of this course are to -

1. Provide quantitative and qualitative analytical knowledge with sampling techniques
2. Offer a clear understanding about HPLC, UV-Vis and IR spectroscopy
3. Highlight the terminology, regulatory submission and quality system during laboratory development
4. Identify the current validation techniques and statistical methods in data analysis
5. Assessment of the precision of quantitative measurements using HPLC

Course Contents:

1. UV-Visible Spectroscopic determination of amount of Paracetamol Syrup
2. UV-Visible Spectroscopic determination of potency of Paracetamol Tablet
3. Calibration of UV-Visible Spectrometer by using Paracetamol solution
4. Calibration of UV-Visible Spectrometer by using Aspirin solution
5. Calibration of Polarimeter by using Sugar solution
6. Stray light determination by Potassium Chloride
7. UV-Visible Spectroscopic determination of potency of Ciprofloxacin Tablet
8. Development and validation of a UV method for Ciprofloxacin determination in pharmaceutical dosage form
9. Instrumentation of HPLC

Learning Outcomes: Upon completion of the course, the students will be able to -

1. Determine the potency of paracetamol tablet and syrup by UV-Visible spectroscopy
2. Determine the amount of Ciprofloxacin tablet by UV-Visible spectroscopy

3. Calibrate the spectra, identify common problems with their solution regarding paracetamol and aspirin solution
4. Detect stray light of different solution like potassium chloride, sodium nitrite, sodium iodide
5. Determine foreign matters and develop standard parameters,
6. Highlight current validation practices with their regulatory guidance
7. Determination of potency of Ciprofloxacin tablet development and validation of a UV method for determination in pharmaceutical dosage form.
8. Have basic knowledge about the instrumentation of HPLC

Assessment: As per the rules

Text books:

1. Quality Assurance of Pharmaceuticals- A Compendium of Guidelines and Related Materials; Volume-1; World Health Organization, Geneva.
2. Analytical Method Validation and Instrument Performance Verification, Edited by C. C. Chan, H. Lam, Y. C. Lee and Xue-Ming Zhang, John Wiley & Sons Inc.

References:

1. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, 5th Edition, Cengage Learning.
2. Spectroscopic Methods in Organic Chemistry, Dudley H. Williams, Ian Fleming, 1996, McGraw-Hill.

PHR 404 Clinical Pharmacy Credit Hr: 4

Course Number : PHR 404
Course Title : Clinical Pharmacy
Credit hours : 4

Introduction:
This course is designed to educate students about clinical knowledge in optimizing drug therapy and develop problem-solving skills in healthcare practice. This course comprises six chapters, a mix of clinical, applied practice, public health and research units, giving students the knowledge and skills to be an excellent clinical pharmacist.

Specific Objectives:
Assigned course teachers will help students to:
1. Understand importance and application of clinical pharmacy in healthcare settings.
2. Learn current therapy approach for neonates, children, elderly and complicated diseased patients.

3. Explore the clinical practice for over-the counter and contraceptives pharmaceutical preparations.
4. Learn clinical management of different types of common poisoning and their remedies.
5. Understand clinical use of blood and blood related products.

Course Contents:

1. **General Consideration:** Scope, importance and application of clinical pharmacy, clinical hematology, blood bank techniques etc., organ function tests, clinical pathology, manifestation of diseases, drug or hospital acquired diseases, cautionary and advisory notes for drug therapy.

2. **Guidance for Special Clinical Practices:** Pharmacokinetic and pharmacodynamic variations along with the diseases affected to various special cases: Neonates, paediatrics, geriatrics, terminal care, liver disease, renal impairment. Off-label and unlicensed use of drugs in children, Medication error and ADR in children, Investigations for liver diseases.

3. **Guidance for Gynecologic and Obstetric Practices:** Condition prevalent in pregnancy and lactation, nausea and vomiting, constipation, heartburn, urinary tract infection, preterm labor, gestational diabetes, mastitis, preeclampsia, miscarriage and stillbirth**,** postpartum complications, and access to antenatal and postnatal care, teratogenicity, pregnancy category medications, reducing risk to breast feed infants.

4. **Contraception:** Advantage and disadvantages of combined oral contraception (COC); symptoms including the need to stop taking COC immediately; advice when stopping or changing the COC; advice given to a patient who forgets to take a progestogen only pill (POP) or the COC pill; other forms of contraception available to women where COC and POP are unsuitable or are not their first choice; male contraception, the role of the pharmacist in the supply of emergency hormonal contraception.

5. **OTC Preparation and Essential Drugs:** Antacids and anti-flatulence, antidiarrhoeals, laxatives, emetics and antiemetics, antihistamines and anti-allergen, analgesics, contraceptives, ear-nose-throat preparations, dermatological preparations.
6. **Blood and Related Products:** Whole blood and blood components, plasma expanders and intravenous fluids, antibodies and iso-agglutinins, agents affecting blood coagulation, anticoagulants, electrolytes and systemic buffers, drugs affecting blood production.

7. **Therapeutic Drug Monitoring (TDM) and Drug Interactions:** Objectives and indications of TDM, clinical benefits of TDM, examples of drugs commonly monitored, steps in TDM process, clinical parameters monitored during TDM, limitations of TDM, and role of pharmacist in TDM.

8. **Clinical Signs, Symptoms and Management of Poisoning:** Poisons and related information, Role of poison centers, adverse reactions and poisoning incidences, analysis of poisoning situations, poison information sources, assessment of poison exposure, case

with pesticides, fumigants, solvents, vapors, gases, food toxins, cyanides poison, cosmetics, toxins of animal origin, over-doses of drugs, drug interactions etc.

Learning Outcomes:

Students will be able:

1. To learn general consideration in the practice of clinical pharmacy.
2. To learn clinical considerations for specialized patients including pediatric, geriatric and terminally-ill patients.
3. To know how clinical management of OTC products and contraceptives.
4. To understand clinical consideration during use of blood and blood related products.
5. To know the poisoning and toxicological aspects in clinical pharmacy.

Assessment: As per the rules

Text books:

1. Clinical Pharmacy and Therapeutics. E. T. Herfindal, D. R. Gourley and L. L. Hart, Fifth Edition, Williams & Wilkins publications, 1992.
2. Clinical Pharmacy and Therapeutics. Roger Walker and Cate Whittlesea, Fifth Edition, Churchill Livingstone, Elsevier publications, 2012.

References:

1. Davidson's Principles and Practices of Medicines. N. R. Colledge, B. R. Walker and S. H. Ralston, Twenty third Edition, Churchill Livingstone, Elsevier publications, 2018.
2. Clinical Pharmacology and Therapeutics. J. M. Ritter, L. D. Lewis, T. G. K. Mant and A. Ferro, Fifth Edition, Hodder Arnold Publications, UK, 2008.
3. Oxford Handbook of Clinical Pharmacy, P. Wiffen, M. Mitchell, M. Snelling and N. Stoner, Third Edition, Oxford University Press, 2017.

PHR 405 Pharmacovigilance Credit Hr: 2

Course Number : PHR 405
Course Title : Pharmacovigilance
Credit Hours : 2
Course Description:

This course is designed to familiarize the students with the fundamental concepts as well as potential applications of Pharmacovigilance in the clinical settings. The course will focus on the basic understandings of Pharmacovigilance, relevant terminologies, regulatory issues or ethical considerations and other important aspects in this emerging clinical and application-based subject.

Specific Objectives:

The specific objectives of the course will be –

1. To provide basic ideas about Pharmacovigilance to the students.
2. To highlight the importance of Pharmacovigilance in Clinical Pharmacy.
3. To elucidate how patients will be benefitted by the clinical applications of Pharmacovigilance study.
4. To explore the fundamental aspects of Pharmacovigilance, how it works and about the Pharmacovigilance reporting system.

Course Contents:

1. **Adverse Drug Reactions and Adverse Drug Events**: Classification of adverse drug reactions (ADR) and adverse drug events (ADE), differences between ADR and ADE, causes and risk factors, consequences of ADR and ADE in drug therapy.

2. **Principles of Pharmacovigilance:** Introduction, history, and scope of pharmacovigilance, pharmacovigilance system, pharmacovigilance center, Good Pharmacovigilance Practice (GVP); development of GVP, diagnosing adverse drug reactions, concept of safety.
3. **Current Methods of Pharmacovigilance -** Spontaneous ADR reporting, case reports and case series, cohort studies, case-control studies, randomized control trials, meta-analysis and systematic reviews, patient-reported outcomes, active surveillance, prescription event monitoring, causality assessment in pharmacovigilance, adverse drug events reporting system to DGDA.
4. **The Process of Pharmacovigilance:** Risk of management; signal detection; evaluation and investigation; taking action; communication; measuring the effectiveness of the risk minimization process, crisis management, risk management planning

5. **Regulatory Aspects of Pharmacovigilance:** Global pharmacovigilance regulatory frameworks, key regulatory requirements under ICH guidelines, GVP modules, types of regulatory documents in pharmacovigilance, responsibilities of marketing authorization holders, adverse event reporting requirements, obligations of pharmaceutical companies.

Learning Outcomes: After finishing the course, the students will be able to –

1. Comprehend the basic goals of studying Pharmacovigilance.
2. Explain the basic concepts underlying Pharmacovigilance studies.
3. Understand the potential applications of Pharmacovigilance studies in the settings of Clinical Pharmacy practice.
4. Demonstrate the fundamental principles and regulatory aspects of Pharmacovigilance.
5. Explain how the Pharmacovigilance reporting systems work alongside its regulatory basis.

Assessment: As per the rules

Text Books:

1. An introduction to pharmacovigilance, 2nd Edition, 2017. Edited by- Patrick Waller and Mira Harrison-Woolrych. Publisher- Wiley Blackwell.
2. Pharmacovigilance: A Practical Approach, 2nd Edition, 2023. Edited by- Thao Doan, Fabio Lievano, Linda Scarazzini, Charles Schubert, Barbara Hendrickson. Publisher- Elsevier.
3. Mann's Pharmacovigilance, 3rd Edition, 2014. Edited By – Elizabeth B. Andrews and Nicholas Moore. Publisher – Wiley Blackwell.

References:

1. A Practical Handbook on the Pharmacovigilance of Antiretroviral Medicines. World Health Organization, 2013.

PHR 406 Pharmacology-III Credit Hr: 4

Course Number **:** PHR 406

Course Title **:** Pharmacology-III

Credit hours **:** 4

Introduction:

Pharmacology-III course covers the principles of drug action for several important classes of drugs. Understanding a wide class of drugs will be helpful for the students to learn basic pharmacology at year-IV of their professional course.

Specific Objectives:

By the end of this course, students will be able:

1. To explore the underlying mechanism or mode of action, therapeutic uses and adverse reactions of the pharmacotherapeutic agents that are used in the management of epilepsy, viral and fungal infections, ocular diseases and psychiatric diseases.
2. To learn mechanism and techniques and limitations of gene therapy.
3. To understand the therapeutic potentials and applications of various immunotherapeutic agents and to explore how they modulate the functions of the immune system.
4. To discuss the wide range of therapeutic agents that are used against various types and forms of cancer, their mode of action, molecular mechanisms of resistance and therapeutic options in the event of relapse and metastasis.
5. To understand the therapeutic application of drugs acting of uterine motility and labor induction.
6. To learn about the pharmacological basis of hormone therapy.

Course Contents:

1. Drugs affecting nervous system:

a. Anti-psychotic Drugs: first generation and second-generation antipsychotic drugs.

b. Antidepressant Drugs: serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, atypical antidepressants, tricyclic antidepressants, monoamine oxidase inhibitors.

c. Anxiolytic and Hypnotic Agents: benzodiazepines, benzodiazepine antagonist, other anxiolytic, barbiturates and other hypnotic drugs.

d. Antiepileptic Drugs: benzodiazepines, carbamazepine, eslicarbazepine, ethosuximide, gabapentin, lacosamide, lamotrigine, phenytoin, pregabalin, tiagabine, valproic acid, vigabatrin.

e. CNS Stimulants: methylxanthines, nicotine, varenicline, cocaine, amphetamine, methylphenidate.

f. Drugs for Neurodegenerative Disorders: Anti-parkinson drugs, anti-alzheimer drugs,

g. Opioids: agonists and antagonists.

h. Anesthetics: general anesthetics (intravenous and inhaled), local anesthetics (amides and esters).

i. Drugs Affecting Cholinergic System: cholinergic agonists, antimuscarinic agents, ganglionic blockers, neuromuscular blockers.

j. Drugs Affecting Adrenergic System: adrenergic agonists and antagonists.

k. Drugs for Urological Disorders: phosphodiesterase-5 inhibitors, α_1 adrenergic blockers, 5-α reductase inhibitors.

2. Drugs affecting metabolic disorders

i. Antidiabetic agents: Introduction, classification, complications and treatment of diabetes, hypoglycemia, causes and treatment, relationship between stroke and diabetes, causes of stroke, different types of antihyperglycemic agents with structures, mechanisms, uses, toxicity; Insulin resistance, management of diabetes, glucagon-structure, mechanism, uses, Insulin-structure, preparations, properties, uses etc.

ii. Hormone replacement therapy:

a) Adrenocorticosteroids and adrenocortical antagonists: natural and synthetic corticosteroids, treatment of disturbed adrenal function; Mineralocorticoids-aldosterone, deoxycorticosterone, fludrocortisone; Antagonists of adrenocortical agents-metyrapone, aminoglutethimide, mifepristone; Antagonists of mineralocorticoids-spironolactone.

b) Adenohypophyseal hormones: Anterior pituitary hormones and their hypothalamic regulators, Growth hormones and its antagonists, the gonadotropins-FSH, LH, HCG; Prolactin.

c) Thyroid and antithyroid drugs: Thyroid hormones and their mechanism of action, antithyroid agents-thioamides, anion inhibitors, management of thyroid disorders.

3. Agents affecting mineral ion homeostasis and bone turnover: Hormonal regulation of calcium and phosphate homeostasis, Calcitonin, calcitriol, treatment of disorders of mineral ion

homeostasis-hypercalcemia, hypocalcemia, Vitamin D, Bisphosphonates, PTH, calcium sensor mimetics, Denosumab etc.

Learning Outcomes:

1. Students will understand the mechanism or mode of action, therapeutic uses and adverse reactions of the pharmacotherapeutic agents.
2. They will learn the molecular and cellular mechanisms of antineoplastic agents.
3. They will understand the therapeutic potentials and applications of various immunosuppressive agents.
4. Students will be able to discuss the wide range of therapeutic agents that are used against various types and forms of cancer, their mode of action, molecular mechanisms of resistance and therapeutic options in the event of relapse and metastasis.
5. They will learn the pharmacology of ocular drugs.

Assessment: As per the rules

Text book:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:

1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarkar. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 406L Pharmacology-III Lab Credit Hr: 1

Course Number : PHR 406L

Course Title : Pharmacology-III Lab

Credit hours : 1

Specific Objectives:

To familiarize the students with advanced laboratory experiments related to Pharmacology.

Course Contents:

1. Study of drugs acting on CNS:
   (a) CNS stimulant drugs (e.g. strychnine, ephedrine, amphetamine).
   (b) CNS depressant drugs (e.g. ketamine and xylazine and barbiturates induced sleeping time).
2. Effect of local anesthetics on rat's tail.
3. Effect of pilocarpine on saliva secretion of rat and/or mice.
4. Study of mydriatic and myotic effect on rabbit eye (e.g. pilocarpine, atropine, physostigmine etc.).
5. Hemodynamic study of cardioactive drugs using animal (mice/rat) model.

Learning Outcomes:

Assessment: As per the rules

Text book:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12th Edition, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.

References:

1. Lippincott Illustrated Reviews: Pharmacology, 6th edition, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
2. Principles of Immunopharmacology, 3rd edition, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 9th edition, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 24th Edition, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarkar. Elsevier India.
5. Basic and Clinical Pharmacology, 14th Edition. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 8th Edition, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 8th edition, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 407 Pharmaceutical Technology-IV Credit Hr: 4

Course Number : PHR 407
Course Title : Pharmaceutical Technology-IV
Credit hours : 4

Introduction:

The course addresses the design principles of pharmaceutical formulation, dosage forms, different drug delivery systems, packaging technology and current industrial manufacturing practices for common dosage forms. The course is delivered through a combination of lecture, tutorials, self-directed learning activities.

Specific Objectives:

1. To make the students familiar with the theoretical knowledge associated with the compression of powdered materials and its applications in tablet technology.
2. To be familiar with the concepts of sterility as well as clean room technology required for sterile pharmaceutical production.
3. To learn about the concepts, formulation, manufacturing packaging and quality control of parenteral products.
4. To learn about the concepts, formulation, manufacturing packaging and quality control of ophthalmic products.
5. To learn about the concepts, formulation, preparation and evaluation of sustained release drug delivery systems with emphasis on oral sustained drug delivery.
6. To learn about the science and technology associated with pharmaceutical packaging.
7. To be acquainted with the aerosol science and technology with emphasis on pharmaceutical applications, focusing on pulmonary drug delivery systems.

Course Contents:

1. **Compression and compaction of powder:** Physics of tablet compression, mechanism of tablet formation, bonding to tablets, factors influencing bonding in tablets, effect of moisture content on tablet properties, the effect of compressional force on tablet properties, effect of lubricants on tablet compression and binding, instrumented tablet machines and tooling, problems associated with large scale manufacturing of tablets.

2. **Sustained release drug delivery systems:** Definition and concepts of sustained release (SR); different terminologies related with sustained release; advantages and disadvantages / limitations of SR dosage forms; development of SR pharmacokinetic model from IR model, calculation of drug release rate on the basis of biopharmaceutical considerations; parameters to be considered for formulation / product development of SR products; poor drug candidate and good drug candidate for SRDF; design and fabrication of oral controlled / sustained release dosage forms; types of SR systems and release mechanisms; prominent drug release kinetic models of SR products; SR product evaluation and testing; formulation and manufacturing technologies of SRDFs.

3. **Pulmonary drug delivery system & aerosol technology- pMDI, DPI, Nebulizer:** Drug delivery to the lungs, Physiological consideration of pulmonary drug delivery, Formulations and manufacturing consideration, QC of pulmonary drug delivery, Definition and classification of aerosols, Propellants for aerosol manufacturing, components of aerosol formulations, containers and valves for aerosols, metered dose delivery of aerosols, manufacturing of aerosols, testing and quality assurance of aerosols.

4. **Parenteral products:** Basics of clean room technology and its application of sterile product manufacturing, definition and classification of parenteral products, routes of administration, formulation considerations, vehicles and additives, manufacturing procedures, BFS technology, selection of packaging materials for parenteral products (glass, plastic, rubber), quality control of parenteral products.

5. **Ophthalmic products:** Anatomy of eye, absorption of drugs in the eye, properties, advantages and limitations of ophthalmic products, different routes of ocular administration, classification of ophthalmic products, safety considerations of ophthalmic products, physiological barriers to ocular drug delivery, factors affecting ocular drug absorption, formulation development and considerations, novel ocular dosage forms including inserts, multicompartment systems, powders, sprays and contact lens solution, vehicles, preservatives and additives, safety and manufacturing considerations, environment, manufacturing techniques, Evaluation parameters, quality control of ophthalmic products, packaging of ophthalmic products.

6. **Pharmaceutical packaging science and technology:** Purpose of packaging, package labeling, properties of packaging materials, factors influencing choice of package, advantages and disadvantages of different packaging materials, glass and glass containers, metal and metal containers, plastic and plastic containers, films, foils and laminates, rubber based materials, closures, tamper resistant packaging, blister packaging technology, testing and quality assurance of packaging materials, different packaging machines and accessories, organization of packaging line,

7. **Novel drug delivery systems:** A brief overview on the design and applications of some novel / advanced drug delivery systems (DDS): Implants, Transdermal DDS, Mucoadhesive DDS, Protein & peptide DDS, Gastro-retentive DDS, Intrauterine DDS, Nanotechnology based DDS: Liposomes, Dendrimers; Nanoparticles and Nanocapsules, Solid lipid nanoparticles.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Analyze the mechanism and identify the factors affecting tablet formation.
2. Classify and analyze different sustained release drug delivery systems.
3. Evaluate the mechanism and quality control parameters of aerosol technology.

4. Compare and evaluate different types of parenteral products along with their quality control parameters.
5. Evaluate the different ingredients and the safety parameters for formulating the ophthalmic products.
6. Identify the appropriate packaging material for specific pharmaceutical product.

Assessment: As per the rules

Books recommended:

1. The theory and practice of Industrial Pharmacy (4th edition) - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. American Pharmacy by Sprowl.
3. Pharmaceutics by Aulton.
4. Remingtons' Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.
5. Dispensing of medication by Husa and Martin.
6. Pharmaceutical Practice by Aulton.
7. An Introduction to Pharmaceutical Formulations by Fishburn.
8. An Introduction of Pharmaceutical Productions by Fishburn.
9. The Extra Pharmacopeia by Martindale.

PHR 407 L Pharmaceutical Technology-IV Lab Credit Hr: 1

Course Number **:** PHR 407L
Course Title **:** Pharmaceutical Technology-IV Lab
Credit hours **:** 1

Specific Objectives:

1. Determine the key ingredient to prepare different formulation.
2. Evaluate the quality control parameters of different formulations.
3. Justify the use of different excipients to prepare dosage forms.

Course Content:

1. Preparation and evaluation of modified release dosage forms
2. Preparation of film coating tablets
3. Effect of glidants and lubricants on the flow properties and compressibility of powders and granules (Carr's index, angle of repose etc)
4. Identification and quality control of different types of pharmaceutical packaging

Learning outcomes:

To enable the students to carry out the above experiments independently.

Assessment system: As per the rules

Recommended books:

1. The theory and practice of Industrial Pharmacy (4th edition) - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. Remingtons' Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.

PHR 408 Pharmaceutical Process Engineering Credit Hr: 4

Course Number : PHR 408
Course Title : Pharmaceutical Process Engineering
Credit hours : 4

Introduction:

Production of quality pharmaceutical products largely depends on well-planned and facilitated pharmaceuticals industry. This course mainly focuses on the insight about the key steps of manufacturing. This course also introduces the location selection and layout of an ideal pharmaceutical plant and manufacturing rules guidelines.

Specific Objectives:

1. To be acquainted with the activities occurring inside a pharmaceutical plant.
2. To become familiar with various unit operations of industrial processing.
3. To get a generalized knowledge about the machineries used in the manufacturing of pharmaceutical products.
4. To know about the utility services required within the pharmaceutical plant with their proper use.

Course Contents:

1. **The fundamentals of unit operations:** Heat transfer, mass transfer fluid flow. Generation and uses of steam in pharmaceutical industries.

2. **Mixing:** Objectives, applications & factors affecting 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, change-can mixer,

change-can mixer with planetary motion, change-can mixer with rotating turntable, troy angular mixer, duplex mixer, stationary-tank mixer, kneader, mullers, three-roll mill, selections of process and mixer.

3. **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.

4. **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, membrane filters and Seitz filter.

5. **Centrifugation:** Objectives, theory & applications of centrifugation; principles, construction, working, uses, merits and demerits of perforated basket centrifuge, non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.

6. **Size reduction and separation**: Designation and expression of particle size, size reduction and separation operations in pharmaceutical industries, related machineries and applications.

7. **Pharmaceutical clean room technology:** Source of contamination, classification of clean rooms, airflow systems- conventional flow, unidirectional flow, laminar airflow units; air filtration mechanisms, fibrous filters and HEPA filters, HVAC systems, building design, construction and use, personnel, protective clothing, cleaning and disinfection, commissioning tests of clean and aseptic rooms, routine monitoring tests, the operation of clean and aseptic rooms, key factors in clean room operations.

8. **Plant design:** Plant layout, types of layout, objectives, selection criteria for pharmaceutical plant, layout for production of different dosage forms, lay out of pilot plant, materials of pharmaceutical plant construction**.**

Learning Outcomes:

1. Use the appropriate drying process and equipment for maintaining the moisture content of granules to the desired level.
2. Apply the appropriate mixing process and equipment for obtaining a uniform blend for tablet or powder for suspension production.
3. Select the appropriate materials of fabrication which is suitable for production but can avoid process related corrosion or erosion.

Assessment: As per the rules

Recommended books:

1. Pharmaceutical process engineering, Anthony J Hickey, and David Ganderton
2. Pharmaceutical engineering, K. Sambamurthy
3. Chemical engineering in the pharmaceutical industry: R&D to manufacturing, David j. Am Ende
4. Essentials of pharmaceutical engineering, Derle Deeliprao & Bele
5. Pharmaceutical engineering, CVS Subrahmanyam

PHR 408L Pharmaceutical Process Engineering Lab Credit Hr: 1

Course Number : PHR 408 L
Course Title : Pharmaceutical Process Engineering Lab
Credit hours : 1

Specific Objectives:

1. Develop student's practical knowledge about various techniques as well as equipment used in pharmaceutical plant.
2. Acquire skill about humidity controlling, refrigeration, and air-conditioning in storehouse for controlled products and the warehouses.

Course Contents:

1. Particle size measurement by sieve method and sedimentation method.
2. To study the effect of filter aids on rate of filtration.
3. To study the performance of laboratory fluid bed dryer.
4. Determination of humidity of air by dew point method.
5. Determination of moisture content on drying and LOD.

Learning Outcomes:

1. Learn practical knowledge different engineering procedures applied in pharmaceutical plants e.g., dryers, mixers.
2. Gain practical knowledge by discussion with the experts/ employees working in the plant.

Assessment: As per the rules

Recommended books:

1. Pharmaceutical process engineering, Anthony J Hickey, and David Ganderton
2. Pharmaceutical engineering, K. Sambamurthy

PHR 409 Biopharmaceutics and Pharmacokinetics-II Credit Hr: 4

Course Number : PHR 409
Course Title : Biopharmaceutics and Pharmacokinetics-II
Credit hours : 4

Introduction:

This course aims to discuss different compartment models and pharmacokinetic parameters for drug absorption. Moreover, it focuses to teach drug accumulation and dose adjustment in diseased condition.

Specific Objectives:

1. To be acquainted with the compartmental concepts of biopharmaceutics.
2. To learn about the determination of pharmacokinetic parameters based on single and multiple compartment models.
3. To study about the pharmacokinetics of drug absorption.
4. To learn about the clinical aspects of multiple dosage regimens.
5. To learn about the biopharmaceutical aspects of IV infusion therapy.

Course Contents:

1. **Compartmental Pharmacokinetics**
   a) **Introduction to the compartment**
   b) **One-compartment open model**: Determination of plasma concentration from one compartment open model, elimination rate constant, apparent volume of distribution, calculation of K from urinary data.
   c) **Multiple compartment models**: (i) Two-compartment open model, method of residuals, apparent volumes of distribution, drug in tissue compartment, elimination rate constant (ii) Three-compartment open model, method of residuals, determination of area under curve, apparent volumes of distribution, elimination rate constant.
   d) **Non-compartmental analysis**: Physiologic-pharmacokinetic model, statistical moment, mean residence time, etc.
2. **Pharmacokinetics of Intravenous and Oral Drug Absorption:**
   Zero-order absorption model, first-order absorption model, determination of absorption rate constant from oral absorption data.
3. **Multiple Dosage Regimen (MDR):** Drug accumulation, superposition principle, repetitive intravenous injection, multiple oral dosage regimens, loading dose, and determination of bioavailability and bioequivalence from MDR.
4. **Intravenous Infusion**: Concept and principles of intravenous infusion; constant rate and variable rate infusion; relationship between infusion rate, clearance, and steady-state plasma concentration; time to reach steady state and role of half-life. Mathematical models of IV infusion: equations for drug concentration during infusion and after discontinuation; one-compartment and multi-compartment models; concentration–time profiles and graphical interpretation; effect of infusion rate on drug accumulation and toxicity. Clinical applications of IV infusion in therapy (antibiotics, anesthetics, chemotherapy, etc.); factors influencing

infusion kinetics (drug properties, age, weight, renal/hepatic function); dosage regimen design, therapeutic drug monitoring, and dose adjustment in special populations

5. **Dosage Adjustment in Renal and Hepatic Diseases**: Pharmacokinetic considerations, general approaches for dose adjustment in renal and hepatic diseases, dose adjustment based on drug clearance, dose adjustment based on the elimination rate constant, and measurement of glomerular filtration rate (GFR).
6. **Biopharmaceutics in Drug Delivery Systems:** Role of biopharmaceutics in designing controlled-release formulations, Pharmacokinetics of novel drug delivery systems, Biopharmaceutics classification system (BCS) and its applications, Biowaivers and their regulatory considerations, Relationship between pharmacokinetics and pharmacodynamics.
7. **The Role of Pharmacogenetics/Pharmacogenomics in Drug Development and Regulatory Review**; Biopharmaceuticals Used in Molecular Medicine: From Genome to Clinic-Correlation between Genes, Diseases and Biopharmaceuticals: a brief study.

8. **Application of Pharmacokinetics**: Modified-Release Drug Products, Targeted Drug Delivery Systems and Biotechnological Products. Pharmacokinetics and pharmacodynamics of biotechnology drugs. Proteins and peptides, Monoclonal antibodies, Oligonucleotides, Vaccines (immunotherapy), Gene therapies.

Learning Outcomes:

Upon completion of this course, the students will be able to-

1. Describe the significance of compartmental and non-compartmental model in pharmacokinetics.
2. Apply pharmacokinetic principles to determine appropriate dosage regimens for patients.
3. Critically evaluate the impact of patient-specific factors on pharmacokinetics.

Assessment: As per the rules

Recommended books:

1. Applied Biopharmaceutics & Pharmacokinetics
   Leon Shargel, Andrew B.C. Yu
2. Basic Pharmacokinetics
   Mohsen A. Hedaya
3. Biopharmaceutics and Clinical Pharmacokinetics
   Milo Gibaldi
4. Modern Biopharmaceuticals
   Jörg Knäblein
5. Essentials of Pharmacokinetics and Pharmacodynamics
   Thomas N. Tozer and Malcolm Rowland

PHR 409L Biopharmaceutics and Pharmacokinetics-II Lab Credit Hr: 1

Course Number : PHR 409 L
Course Title : Biopharmaceutics and Pharmacokinetics-II Lab
Credit hours : 1

Specific Objectives:

1. Determine the relationship between dosage form and its *in-vitro* dissolution.
2. Evaluate the dissolution rate and time of different formulations.
3. To understand the different pharmacokinetic parameters with supplied data.

Course Contents:

1. Dissolution profiling of solid dosage form.
2. Dissolution study of extended release dosage form.
3. *In vitro* evaluation of different dosage forms for drug release.
4. Experiments designed for the estimation of various pharmacokinetic parameters with given data.
5. Statistical analysis of pharmaceutical data.

Learning Outcomes:

1. To enable the students to carry out the above experiments independently.
2. Differentiate between a one-compartment and a multi-compartment model.
3. Identify and analyse the pharmacokinetic parameters of drug absorption.
4. Analyse and utilise the basic concept of multiple dosage regimens.
5. Outline the parameters and pharmacokinetic models of intravenous infusion.
6. Identify and evaluate different dosage adjustment factors for renal diseases.
7. Evaluate physiologic-pharmacokinetic models.
8. Determine the relationship between pharmacokinetic and pharmacologic responses.

Assessment: As per the rules

Recommended books:

6. Applied Biopharmaceutics & Pharmacokinetics
   Leon Shargel, Andrew B.C. Yu
7. Basic Pharmacokinetics
   Mohsen A. Hedaya

8. Biopharmaceutics and Clinical Pharmacokinetics
   Milo Gibaldi
9. Modern Biopharmaceuticals
   Jörg Knäblein
10. Essentials of Pharmacokinetics and Pharmacodynamics
    Thomas N. Tozer and Malcolm Rowland

PHR 410	Pharmaceutical Regulatory Affairs	Credit Hour: 4

Course Number : PHR 410
Course Title : Pharmaceutical Regulatory Affairs
Credit Hours : 4

Course Description:
This course focuses on the regulatory frameworks governing pharmaceutical industries in Bangladesh and globally. Students will explore laws, policies, and regulatory guidelines related to drug discovery, development, manufacturing, approval, marketing, and post-marketing surveillance. Special emphasis will be given to both local (DGDA, national policies) and international (FDA, EMA, WHO, ICH) perspectives to ensure comprehensive understanding of pharmaceutical regulatory affairs.

Specific Objectives:
Upon completion of this course, students should be able to describe the national laws and regulations governing pharmacy practice in Bangladesh, including drug manufacture, distribution, registration, approval, advertising and marketing; explain the role and functions of the DGDA, including pharmacovigilance and GMP compliance; and compare national regulations with international standards, including requirements for biosimilars, vaccines and post-marketing surveillance.

Course Contents:

1) Introduction to Regulatory Affairs (RA):

Definition of regulation, why it is needed, Definition and scope of regulatory affairs, importance of RA in drug discovery and development, overview of product lifecycle management, role of regulatory authorities in the product lifecycle, rules and regulations in each stage of drug development, approval & marketing, key definitions (pharmacovigilance,

BE studies, safety and toxicology studies, clinical vs. non-clinical testing, CMC documentation)

2) Legal Provisions (National):

Pharmaceutical Laws in Bangladesh (with latest amendments)
The Drug Act 1940 (XXIII of 1940), The Drug Ordinance 1982, The National Drug Policy 1982**,** The Drug (Control) Ordinance 1982 (Ordinance No. VIII of 1982), Drug Control Ordinance 2006, The Narcotics (control) Act 1990, The National drug policy 2005 and 2016, The Poisons Act 1919 and related amendments; Drug act 2022; Patent act 2023, Product Patent vs. Process Patent; TRIPS Agreement.

3) Regulatory Provisions (National):

A. Regulatory Authority (DGDA):
Organogram, committees and functions of DGDA, local drug registration/licensing process, Drug Control Committee (DCC) approval, recipe, annexure, MA, lot release etc., regulatory guidelines for advertisement, pricing, intellectual property (IP) and maximum retail price (MRP).

B. Licensing (Manufacturing) and Compliance:
New project approval process (new plants), manufacturing license and GMP requirements, GMP inspections, toll manufacturing, contract manufacturing, technology transfer, good documentation practices (GDP), quality management system (QMS-OOS, Deviation, change control, Risk assessment etc.), standard operating procedures (SOP), batch manufacturing record (BMR), batch packaging record (BPR), marketing ethics (rational use of drugs, ADR reporting, patient confidentiality).

C. Pharmacy Practice and Distribution:
Role of hospital and community pharmacies, DGDA licensing procedures for retail and wholesale pharmacies, good distribution practices (GDP) in Bangladesh.

4) Legal Provisions (International):

Regulatory bodies including US FDA, EMA, UK MHRA, TGA, WHO and others, US FDA 21, CFR, EU directives and regulations, ICH mission, definition and guidelines (QSEM). PIC/S. Patent vs Exclusivity.

5) Regulatory Provisions (International):

A. Product Approval Pathways (SRA – Stringent Regulatory Authorities):
Overview of the product Approval process in SRA (Stringent regulatory authorities); Regulatory requirements for product approvals obtaining Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA) for generic drugs, BLA, WHO pre-qualifications (CTD Modules: ICH M4).

B. Biosimilar and Vaccines:

Regulatory requirements for biosimilar and vaccines, biosimilarity assessment method, clinical trial requirements for biosimilar and vaccines.

C. Lifecycle & Post-Approval Activities:

Product lifecycle management and variations, product registration renewal, product license renewal, post marketing surveillance (pharmacovigilance).

Learning Outcomes:

Upon completion of the course, the students will be able to:

1) Explain the laws, policies and regulations governing pharmacy practice in Bangladesh and the role of the pharmacy community.
2) Describe the regulatory framework for the manufacture, possession, distribution, sale and import/export of pharmaceutical products.
3) Explain the approval process, registration procedures, and documentation requirements for pharmaceuticals in Bangladesh, including the role of DGDA.
4) Understand the regulatory control of drug advertisements, pricing, intellectual property rights, patented and proprietary medicines, cosmetics and poisons.
5) Interpret the schedules of drugs and poisons and their regulatory implications.
6) Compare national regulatory requirements with international standards, including pharmacovigilance, biosimilars, vaccines and post-marketing surveillance.

Assessment: As per the rules

Recommended books / references:

1. Original laws and legislations published by the Ministry of Law, Govt. of the Bangladesh.
2. Good Manufacturing Practice Rationale and compliance by John Sharp
3. The process of new drug discovery and development. I and II Edition by Charles G. Smith, James T and O. Donnell.
4. Establishing a CGMP laboratory audit system- A Practical guide by David M. Bliesner.
5. Good manufacturing practices: A plan total quality control: S.H.Wilhing, M.M. Tuckerman, S.Hitchings, Marcel Deckker, Inc. NewYork
6. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices and Biologics, 2nd ed. – Douglas J. Pisano and David S. Mantus
7. The Pharmaceutical Regulatory Process, 2nd ed. – Ira R. Berry, Robert P. Martin Medical
8. Good Drug Regulatory Practices: a Regulatory Affairs Quality Manual (Good Drug Development Series) – Helene I. Dumitriu.
9. ICH Quality Guidelines: An Implementation Guide-Andrew Teasdale, David Elder, Raymond W. Nims
10. Laboratory Auditing for Quality and Regulatory Compliance, by Donald C.Singer, Stefan and Stedan, Drugs and Pharmaceutical Sciences, Vol.150

***Specific references other than those mentioned above will be given by the respective teachers.**

PHR 411	Industrial Training	Non-credit

Course Number **:** PHR 411
Course Title **:** Industrial Training
Credit hours **:** Non-credit

Introduction:
Industrial Training is designed to expose B. Pharm. (Hons) students to practical aspects of the pharmaceutical industry. It bridges theoretical knowledge with industrial applications, enabling students to understand manufacturing processes, quality assurance, regulatory requirements and industrial ethics.

Specific Objectives:
1. To familiarize students with industrial drug manufacturing and quality control processes.
2. To understand Good Manufacturing Practices (GMP) and regulatory guidelines.
3. To gain hands-on experience with pharmaceutical formulation, packaging and distribution.
4. To develop professional skills, discipline and workplace ethics.

Course Contents:
1. Manufacturing Unit: Solid dosage forms, liquid orals, parenterals.
2. Quality Control & Quality Assurance: Analytical testing, validation, documentation.
3. Regulatory Affairs: SOPs, GMP compliance, documentation requirements.
4. Packaging & Labeling: Techniques, stability and patient safety considerations.
5. Research & Development: New formulation and product development exposure.

Learning Outcomes:

After completion of Industrial Training, students will be able to:
1. Demonstrate knowledge of industrial pharmacy operations and regulatory standards.
2. Apply GMP, quality assurance and quality control principles in practice.
3. Identify and describe unit operations in pharmaceutical production.
4. Analyze challenges in drug formulation, packaging, and stability.
5. Exhibit professional behavior, teamwork and ethical responsibility in an industrial setting.

Assessment: As per the rules

PHR 412 Viva Voce Credit Hr: 1

Course Number : PHR 412
Course Title : Viva Voce
Credit hours : 1

Course Description:
The viva voce in the B. Pharm. (Hons) program evaluates students' knowledge and communication skills. It ensures readiness to apply pharmaceutical knowledge in real practice.

Specific Objectives:

1. Assess understanding of core pharmaceutical sciences and practice.
2. Evaluate application of knowledge in patient-centered scenarios.
3. Test problem-solving, decision-making and communication skills.
4. Build confidence, professionalism and ethical reasoning.

Course Contents: Total Syllabus of B. Pharm. (Hons) year-IV

Learning Outcomes:
After the viva, students will be able to:

- Demonstrate subject knowledge and competence.
- Apply reasoning to solve therapeutic problems.
- Integrate multidisciplinary concepts effectively.
- Communicate clearly and confidently.
- Show professionalism and ethical awareness.

Assessment: As per the rules