General information:

i) This syllabus is applicable to all universities offering 5 (five) years Doctor of Pharmacy (Pharm. D.) Program in semester system.
ii) Toral credits: 196
iii) There is no open credit system.
iv) A department can select the course codes.

Name of the Degree

Doctor of Pharmacy (Pharm. D.)

The courses of study for the degree of doctor of Pharmacy (Pharm. D.), an undergraduate program, shall extend over five academic years, comprising of 10 six monthly semesters, including 6 months of residency in hospitals and clinics.

Project: Students are required to complete at least one year 3 credits project within fourth year of Pharm.D. Program

Industrial Training: Students are required to complete at least 4 weeks of mandatory 1 (one) credit in-plant training in reputed pharmaceutical industries at the end of fourth years of study.

Hospital Training: As part of the requirement of Pharm. D. Program., all Students are required to complete at least 6 months of residency in reputed hospitals and clinics at the end of 9th semester final examination.

Duration of theory and practical classes and mid-term and semester final examinations:

Theory Class For 3 credit courses- 45 hours For 2 credit courses- 30 hours	**Practical Class** 30 Hours for 1 credit laboratory courses
Duration of Mid-term Theory Examination For 3 credit courses – 1.5 hours For 2 credit courses – 1.0 hours **Duration of Semester Final Theory Examination** For 3 credit courses – 3.0 hours For 2 credit courses – 2.0 hours	**Duration of Practical Examination** 6 Hours for 1 credit courses.
Assignment of Marks 3 Credit theory course: 100 2 Cred it theory course: 50	1 Credit practical course: 25 1 & 2 Credit viva voce: 25 & 50

Semester-wise distribution of courses

First Year First Semester

Course code	Course titles	Credits
PHR 111	Fundamentals of Pharmacy	2
PHR 112	Inorganic Pharmaceutical Chemistry-I	3
PHR 112L	Inorganic Pharmaceutical Chemistry-I Lab	1
PHR 113	Physical Pharmaceutical Chemistry-I	3
PHR 113L	Physical Pharmaceutical Chemistry-I Lab	1
PHR 114	Physiology and Anatomy-I	3
PHR 114L	Physiology and Anatomy-I Lab	1
PHR 115	Computer Applications in Pharmacy	2
PHR 116	Basic English	3
	Total credit hours	**19**

First Year Second Semester

Course code	Course titles	Credits
PHR 121	Organic Pharmaceutical Chemistry-I	2
PHR 122	Pharmacognosy and Natural Product Chemistry-I	2
PHR 123	Biochemistry	3
PHR 123L	Biochemistry Lab	1
PHR 124	Pharmaceutical Technology-I	2
PHR 124 L	Pharmaceutical Technology-I Lab	1
PHR 125	Pharmaceutical Microbiology-I	3
PHR 125L	Pharmaceutical Microbiology-I Lab	1
PHR 126	Basic Mathematics and Statistics	3
PHR 127	Viva Voce	1
	Total credit hours	**19**

Second Year First Semester

Course code	Course titles	Credits
PHR 211	Inorganic Pharmaceutical Chemistry-II	2
PHR 212	Organic Pharmaceutical Chemistry-II	3
PHR 212L	Organic Pharmaceutical Chemistry-II Lab	1
PHR 213	Physical Pharmaceutical Chemistry -II	3
PHR 213L	Physical Pharmaceutical Chemistry -II Lab	1
PHR 214	Pharmacognosy and Natural Product Chemistry-II	3
PHR 214L	Pharmacognosy and Natural Product Chemistry-II Lab	1
PHR 215	Physiology and Anatomy-II	3
PHR 215L	Physiology and Anatomy-II Lab	1
PHR 216	Pharmaceutical Microbiology-II	2
PHR 216L	Pharmaceutical Microbiology-II Lab	1
	Total credit hours	**21**

Second Year Second Semester

Course code	Course titles	Credits
PHR 221	Cellular and Molecular Biology	3
PHR 222	Pharmacology-I	3
PHR 222L	Pharmacology-ILab	1
PHR 223	Pharmaceutical Technology-II	3
PHR 223L	Pharmaceutical Technology-II Lab	1
PHR 224	Cosmetic Sciences and Technology	3
PHR 224L	Cosmetic Sciences and Technology Lab	1
PHR 225	Pharmaceutical Process Engineering-I	2
PHR 226	Pharmaceutical Management	3
PHR 227	Viva Voce	1
	Total credit hours	**21**

Third Year First Semester

Course code	Course titles	Credits
PHR 311	Pharmaceutical Analysis-I	2
PHR 311L	Pharmaceutical Analysis-I Lab	1
PHR 312	Medicinal Chemistry and Drug Synthesis-I	3
PHR 312L	Medicinal Chemistry and Drug Synthesis -I Lab	1
PHR 313	Pharmaceutical Biotechnology	3
PHR 313L	Pharmaceutical Biotechnology Lab	1
PHR 314	Hospital and community Pharmacy	3
PHR 315	Pharmacology-II	3
PHR 315L	Pharmacology-II Lab	1
PHR 316	Biopharmaceutics and Pharmacokinetics-I	3
PHR 316L	Biopharmaceutics and Pharmacokinetics-I Lab	1
	Total credit hours	**22**

Third Year Second Semester

Course code	Course titles	Credits
PHR 321	Functional Foods, Nutraceuticals and Herbal Medicines	3
PHR 322	Clinical Pathology and Toxicology	3
PHR 323	Pharmaceutical Technology-III	3

PHR 323L	Pharmaceutical Technology-III Lab	1
PHR 423	Pharmaceutical Process Engineering	3
PHR 423L	Pharmaceutical Process Engineering Lab	1
PHR 324	Pharmaceutical Marketing	3
PHR 324L	Pharmaceutical Marketing Field Work/Report	1
PHR 325	Artificial Intelligence and Machine Learnings in Pharmacy	3
PHR 326	Viva Voce	1
	Total credit hours	**22**

Fourth Year First Semester

Course code	Course titles	Credits
PHR 411	Medicinal Chemistry and Drug Synthesis-II	3
PHR 412L	Medicinal Chemistry and Drug Synthesis-II Lab	1
PHR 413	Quality Control and Analytical Method Validation	3
PHR 413L	Quality Control and Analytical Method Validation Lab	1
PHR 414	Clinical Pharmacy	3
PHR 415	Pharmacovigilance	3
PHR 416	Pharmaceutical Technology-IV	3
PHR 416L	Pharmaceutical Technology-IV Lab	1
PHR 417	Pharmaceutical Regulatory Affairs	3
	Total credit hours	**21**

Fourth Year Second Semester

Course code	Course titles	Credits
PHR 421	Pharmaceutical Analysis-II	3
PHR 421L	Pharmaceutical Analysis-II Lab	1
PHR 422	Pharmacology-III	3
PHR 422L	Pharmacology-III Lab	1
PHR 424	Biopharmaceutics and Pharmacokinetics-II	3
PHR 424L	Biopharmaceutics and Pharmacokinetics-II Lab	1
PHR 425	Pharmacy Practice	3
PHR 426	Viva Voce	1
PHR 427	Project	3
PHR 428	Industrial Training	1
	Total credit hours	**20**
		165

Fifth Year First Semester

Course code	Course titles	Credits
PHR 511	Cellular and Bioanalytical Chemistry	3
PHR 512	Disease Management	3

PHR 513	Pharmacogenetics and Personalized Medicine	2
PHR 514	Pharmacotherapy	3
PHR 514L	Pharmacotherapy Lab	1
PHR 515	Biostatistics and Bioinformatics	3
PHR 516	Medical Devices and Hospital Instrumentations	3
PHR 517	Chemistry and Quality Control of Biologics and Biosimilars	3
	Total credit hours	**21**

Fifth Year Second Semester

Course code	**Course titles**	**Credits**
PHR 521	Hospital and Clinical Residency	8
PHR 522	Viva Voce	2
	Total credit hours	10
		196

Detailed description and Course contents of Pharm.D. (Five years) Program

Pharm.D. Year-I (First Semester)

PHR 111 Fundamentals of Pharmacy Credit Hr: 2

Course number **:** PHR 111
Course title **:** Fundamentals of Pharmacy
Credit hours **:** 2

Introduction:
This foundation course introduces students to the basic concepts, scope and professional characteristics of pharmacy. It familiarizes learners with the historical development of pharmacy, major branches of the profession, introductory drug concepts, dosage forms, prescription handling and essential pharmacy information resources. The course prepares students for subsequent theoretical and practical courses in the B. Pharm. (Hons)/Pharm.D. program.

Course contents:

1. **Definition:** Definition of drugs, sources and classification of drugs, official, non-official and un-official drugs, definition and classifications of different types of dosage forms, routes of drug administration.
2. **The history and evolution of pharmacy:** The drug-taking animal, prehistoric pharmacy, antiquity, the Middle ages, the renaissance and early modern Europe, the era of count and pour, the emergence of clinical pharmacy, a chronology for pharmacists.
3. **Pharmacy profession**: An introductory study of the pharmacy profession, scopes of pharmacy profession in different areas, such as community, industry, government sector, etc.
4. **Pharmacy profession & ethics:** Professionalism, the pledge of professionalism, code of ethics, content of ethics, etc.
5. **Organization and association related to pharmacy practice:** Pharmacy Council of Bangladesh (PCB), Directorate General of Drug Administration (DGDA), Bangladesh Pharmaceutical Society (BPS), Bangladesh Chemists and Druggist Society (BCDS), etc.
6. **Complementary & alternative medicine:** Modern, Ayurvedic, Unani, Herbal, Homeopathic and other systems of medicines.
7. **Information resources:** Information resources for pharmaceutical science, sources of drug information, the Pharmacopoeias, Formularies, Codex, etc.
8. **Internet resources on pharmaceutical and drug information:** Sources of information from different websites, USFDA, WHO, etc.
9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Fundamentals of Pharmacy and Pharmacy Practice- M. A. Mazid & M. A. Rashid
2. Introduction to Pharmacy- M. S. Amran
3. Pharmacognosy- V. E. Tyler, L. R. Brady & J. E. Robbers
4. Pharmacognosy- E. P. Claus, V. E. Tyler
5. Textbook of Pharmacognosy- T. E. Wallis
6. Practical Pharmacognosy- R. Zafar
7. Trease & Evans Pharmacognosy- W.C. Evans

PHR 112 Inorganic Pharmaceutical Chemistry-I Credit Hr: 3

Course number : PHR 112
Course title : Inorganic Pharmaceutical Chemistry-I
Credit hours : 3

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 Pharm.D. 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.

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).
9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Introduction to Modern Inorganic Chemistry- S. Z. Haider, Friends International.
2. Modern Inorganic Chemistry- Madan, S. Chard & Company Ltd.
3. Introduction to Modern Inorganic Chemistry-J. D. Lee, Blackwells.
4. Bentley and Driver's Textbook of Pharmaceutical Chemistry-Bentley, Arthur Owen, 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.

Recommended books:

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

PHR 112L Inorganic Pharmaceutical Chemistry-I Lab Credit Hr: 1

Course number : PHR 112L
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 analyse qualitatively different cations and anions or free radicals. It also highlights the importance of ions 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.

Recommended 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.

4. Inorganic Chemistry: Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Hardcover: 964 pages, Publisher: Benjamin Cummings.

5. Principles of Descriptive Inorganic Chemistry by Gary Wulfsberg, Hardcover: 461 pages, Publisher: University Science Books.

PHR 113 Physical Pharmaceutical Chemistry-I Credit Hr: 3

Course number : PHR 113
Course title : Physical Pharmaceutical Chemistry-I
Credit hours : 3

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.

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.
6. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Patrick J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Sciences, 2010, 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, (McGRAYV-Hill Medical Publishing Division, 1325 Avenue of the Americas, New York.
3. Howard C. Ansel, *Pharmaceutical Calculations*, 2012, Wolters Kluwer Health z Lippincott Williams & Wilkins.
4. Arun Bahl, Essentials of Physical Chemistry. 2021, S. Chand Publishing, 7361, Qutab Road, Ram Nagar, Paharganj, New Delhi, 110055, India.

PHR 113L Physical Pharmaceutical Chemistry-I Lab Credit Hr: 1

Course number : PHR 113L
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.

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

Recommended books:

1. Martin's Physical Pharmacy and Pharmaceutical Sciences
2. Applied Physical Pharmacy by Mansoor M. Amiji and Beverly
3. J. Sandmann (McGRAYV-Hill Medical Publishing Division)

PHR 114 Physiology and Anatomy-I Credit Hr: 3

Course number : PHR 114
Course title : Physiology and Anatomy-I
Credit hours : 3

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 favourable 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.

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.

8. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.
2. Review of Medical Physiology- W.F. Ganong.
3. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
4. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 114L Physiology and Anatomy-I Lab Credit Hr: 1

Course number **:** PHR 114L
Course title **:** Physiology and Anatomy-I Lab
Credit hours **:** 1

Course contents:

1. Study of compound microscope and observation of blood cells (R.B.C., W.B.C. and platelets)
2. Estimation of haemoglobin 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.

Recommended books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.
2. Review of Medical Physiology- W.F. Ganong.
3. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
4. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 115 Computer Applications in Pharmacy Credit Hr: 2

Course number : PHR 115
Course title : Computer Applications in Pharmacy
Credit hours : 2

Introduction:
This course introduces the fundamental concepts of computers and their applications in the pharmaceutical field. Students will learn the basic structure of computer systems, widely used software, data handling and essential digital tools relevant to pharmacy practice, education and research. Emphasis is placed on developing practical computer literacy needed for subsequent professional courses.

Course contents:
1. **Introduction to computers:** Basic concepts, hardware components (input/output devices, memory, storage), software types, operating systems.
2. **Office applications:** Word processing (reports, formatting); spreadsheets (data entry, formulas, tables); presentation software (slides, animations), graphics management (adobe photoshop).
3. **Internet & digital communication:** Internet browsing; email communication; online safety; cloud storage; introduction to online learning platforms.
4. **Databases & pharmaceutical information systems:** Basics of databases; search strategies; use of PubMed, Google Scholar; introduction to hospital information systems, electronic health records.
5. **Applications in pharmacy practice:** Computer use in dispensing, inventory control, prescription processing, dosage calculations, compounding records and pharmacovigilance data entry.
6. **Introduction to statistical software (basic level):** Familiarity with simple data analysis tools (excel functions, charts, basic descriptive statistics).
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:
1. Kalicharan, N. (1988). An Introduction to Computer Studies. UK: Cambridge University Press.
2. Capron, H.L. (2003). Computers. Pearson College Div.
3. Peter, N. (2010). Introduction to Computers. India: McGraw Hill.

PHR 116	Basic English	Credit Hr: 3

Course number : PHR 116
Course title : Basic English
Credit hours : 3

Introduction:
This course aims to strengthen students' foundational English skills essential for effective communication in academic and professional settings. Emphasis is placed on grammar, vocabulary, reading comprehension, writing skills and oral communication. The course prepares learners to read scientific texts, write clearly and communicate confidently in the pharmacy profession.

Course contents:
1. **English grammar essentials:** Parts of speech, subject-verb agreement, modals, prepositions, common errors, articles, numbers, tense, right form of verbs, pronouns, punctuation, phrasal verbs, modifiers, sentence formation and fragmentation, question formation, transformation of sentence, simple passive voice construction, conditionals.
2. **Vocabulary building:** General and scientific vocabulary; synonyms, antonyms, word formation, commonly used pharmacy-related terms.
3. **Reading skills:** Comprehension of academic texts, identifying main ideas, supporting details, inference, reading scientific articles (basic level).
4. **Writing skills:** Paragraph writing; essays, note-taking, summarizing, writing emails, basic report writing, introduction to referencing styles.
5. **Listening & speaking skills:** Listening for gist and details, oral presentations, group discussions, pronunciation and fluency practice.
6. **Communication for pharmacy students:** Language used in prescriptions, patient counseling dialogues, professional communication and documentation.
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:
1. Haque, A. (2017). English writing skills. Friends Book Corner.
2. Hacking, T.N., & Oslen, L.A. (1992). Technical Writing and Professional Communication. McGraw-Hill Publishing Co.
3. Jordon, R.R. (1992). Academic Writing Course. Thomas Nelson and Sons Ltd.
4. Bockever, K., & Brown, C.P. (2001). Oxford English for Computing. Student's Book. Cornelsen & Oxford University Press.
5. Oxford- Advanced Learner's Dictionary. Oxford University Press.

6. Swan, M., & Walter, C. (1990). The New Cambridge English Course 1. Cambridge University press.
7. Swan, M., & Walter, C. (1991). The New Cambridge English Course 2 Practice Book with Key. Cambridge University Press.
8. Langan, J. (2013). College Writing Skills with Readings. Gujarat 380014, India: Tata McGraw-Hill Education.

Pharm.D. Year-I (Second Semester)

PHR 121 Organic Pharmaceutical Chemistry-I Credit Hr: 2

Course number : PHR 121
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.

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.
3. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Robert T. Morrison & Robert N. Boyd. Organic Chemistry, 1992. Prentice-Hall Inc., Upper Saddle River, NJ, USA.
2. Ralph J. Fessenden & Joan S. Fessenden. Organic Chemistry, 1993, Brooks Cole Publisher, 511 Forest Lodge Rd, Pacific Grove, California, 93950, United States.
3. Jonathan Clayden, Nick Greeves & Stuart Warren. Organic Chemistry, 2012. Oxford University Press Inc., New York, USA.
4. 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 122 Pharmacognosy and Natural Product Chemistry-I Credit Hr: 2

Course number : PHR 122
Course title : Pharmacognosy and Natural Product Chemistry-I

Credit hours **:** 2

Introduction:

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.

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
   (b) Carbohydrate and related compounds: Sugars and sugar containing drugs- dextrose, fructose, sucrose, lactose etc. Microbiota accessible carbohydrates, starches. Gums and mucilages- tragacanth, acacia. Oil, linseed oil, coconut oil, olive oil, peanut oil, chaulmoogra oil and bees wax.
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. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. William Charles Evans. Trease and Evans' Pharmacognosy, Saunders, 2009.
2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. Pharmacognosy, Philadelphia: Lea & Febiger, 1998.
3. Text Book of Pharmacognosy by T.E. Wallis
4. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. Fundamentals of Pharmacognosy and Phytotherapy, Churchill Livingstone, Elsevier, 2012.

5. Mohammad Ali. Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.

6. Text book of Pharmacognosy by C.K. Kokate, Purohit, Gokhlae (2007), Nirali Prakashan, New Delhi.

7. Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhlae

PHR 123 Biochemistry Credit Hr: 3

Course number : PHR 123
Course title : Biochemistry
Credit hours : 3

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 cell.

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, peptide structure, ionization behaviour, 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.
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Lehninger's Principle of Biochemistry. Albert L. Lehninger, 2008.
2. Biochemistry. J. M. Berg, John L. Tymoczko, Lubert Stryer, 2002.
3. Harper's Illustrated Biochemistry. Murray, Bender, Botham, Kennelly, Rodwell and Weil, 2009.
4. Lippincott's Illustrated Reviews: Biochemistry. Richard A. Harvey, PhD and Denise R. Ferrier, PhD, 2011.

PHR 123L Biochemistry Lab Credit Hr: 1

Course number : PHR 123L
Course title : Biochemistry Lab
Credit hours : 1

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.

Recommended books:

1. Lehninger Principle of Biochemistry. Albert L. Lehninger, 2008.
2. Biochemistry. J. M. Berg, John L. Tymoczko, Lubert Stryer, 2002.
3. Harper's Illustrated Biochemistry. Murray, Bender, Botham, Kennelly, Rodwell and Weil, 2009.
4. Lippincotts's Illustrated Reviews: Biochemistry. Richard A. Harvey, PhD and Denise R. Ferrier, PhD, 2011

PHR 124 Pharmaceutical Technology-I Credit Hr: 2

Course number : PHR 124
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.

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.

5. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Pharmaceutical Compounding and Dispensing: Chris Langley and Dawn Belcher.
2. Cooper and Gunn's: Dispensing for Pharmaceutical Students.
3. The Theory and Practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
4. Remington's Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.
5. Pharmaceutics: The Science of Dosage Form Design – Aulton
6. Pharmaceutical Calculations – Howard C. Ansel

PHR 124L Pharmaceutical Technology-I Lab Credit Hr: 1

Course number : PHR 124L
Course title : Pharmaceutical Technology-I Lab
Credit hours : 1

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.

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

PHR 125 Pharmaceutical Microbiology-I Credit Hr: 3

Course number **:** PHR 125
Course title **:** Pharmaceutical Microbiology-I
Credit hours **:** 3

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.
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 mould; 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.).
9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Pelczar, M.J., Chan E.C.S & Krieg N.R. 1997. Microbiology. 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. The Macmillan Press Ltd., London.
3. Choudhury, M.R. 1999. Modern Medical Microbiology. Ganim Printing & Packages, Dhaka.
4. Levinson, W. & Jawetz, E. 1989. Medical Microbiology & Immunology. McGraw Hill.
5 Hugo, W.B and Russell, A.D. 1983. Pharmaceutical Microbiology. Blackwell Scientific Publications, Oxford.

PHR 125L Pharmaceutical Microbiology-I Lab Credit Hr: 1

Course number : PHR 125L
Course title : Pharmaceutical Microbiology-I Lab
Credit hours : 1

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

Recommended books:

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

PHR 126	**Basic Mathematics and Statistics**	**Credit Hr: 3**

Course number **:** PHR 126
Course title **:** Basic Mathematics and Statistics
Credit hours **:** 3

Introduction:
This course introduces the fundamental concepts of mathematics and biostatistics needed in pharmaceutical sciences. Students will learn basic calculus, graphical presentation of data, descriptive statistics, probability distributions and introductory hypothesis testing. Emphasis is placed on developing analytical and quantitative skills essential for drug calculations, data interpretation and research methods in pharmacy.

Course contents:

Section A: Basic Mathematics

1. **Calculus fundamentals:** Rates of change, rules of differentiation, partial and successive differentiation, derivatives of inverse functions, basic applications in pharmaceutical calculations.
2. **Introduction to integration:** Concept of integration as summation, basic rules of integration, area under a curve, integration by partial fractions, graphical integration and simple applications.

Section B: Biostatistics

3. **Presentation of data:** Frequency tables, graphical and diagrammatic representation: histograms, bar diagrams, line charts, pie charts.
4. **Measures of central tendency:** Arithmetic, geometric and harmonic means, median, mode, applications in biological and pharmaceutical data.
5. **Measures of dispersion:** Range, variance, standard deviation, standard error, coefficient of variation, mean deviation, quartiles, interquartile range.
6. **Moments, skewness & kurtosis:** Definition and interpretation, Sheppard's correction, Pearson's and Bowley's coefficients, use of moments.
7. **Correlation analysis:** Concepts and types of correlation, calculation of Karl Pearson's correlation coefficient, Spearman's rank correlation, interpretation in health sciences.
8. **Regression analysis:** Basic ideas; regression lines, regression coefficients, simple linear regression and prediction.
9. **Probability & common distributions:** Basic probability concepts, introduction to normal, binomial and Poisson distributions and their relevance in pharmacy.
10. **Introduction to hypothesis testing:** Level of significance, Type I & Type II errors; one-tailed vs. two-tailed tests; parametric and non-parametric tests; t-test, Chi-square test, f-test/ANOVA; confidence intervals.
11. **Basic experimental design:** Completely randomized design (CRD), randomized block design (RBD), homogeneity of variances, concept of factorial experiments, relevance to pharmaceutical research.
12. **Sampling methods:** Population vs. sample, random and non-random sampling, advantages and disadvantages, introduction to sample size estimation.
13. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Bolton, S., & Bon, C. (2014). *Pharmaceutical statistics*. Boca Raton: Taylor and Francis Group.
2. Hannan, J.M.A. (2007). *Medical and pharmaceutical statistics*. Dhaka: Apex Publications.
3. Anton, H., Bivens, I., & Davis, S. (2015). *Calculus: early transcendental*. New Jersey, USA: John Willy & Sons, Inc.
4. Kirkwood, B.R., & Sterne, J.A.C. (2003). *Essential medical statistics*. USA: Wiley-
5. Blackwell Das, B.C., & Mukherjee, B.N. (2014). *Integral calculus differential equations*. Kolkata, India: U.N. Dhur and Sons Private Ltd.

PHR 127 Viva Voce Credit Hr: 1

Course number : PHR 127
Course title : Viva Voce
Credit hours : 1

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

Course contents: Total syllabus of Pharm.D. year-I

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Pharm.D. Year-II (First Semester)

PHR 211 Inorganic Pharmaceutical Chemistry-II Credit Hr: 2

Course number : PHR 211
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.

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.

6. Any additional topics deemed appropriate by the course teacher.

Recommended books:

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

PHR 212 Organic Pharmaceutical Chemistry-II Credit Hr: 3

Course number : PHR 212
Course title : Organic Pharmaceutical Chemistry-II
Credit hours : 3

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.

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.

7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Robert T. Morrison & Robert N. Boyd. *Organic Chemistry*, 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.

4. Jonathan Clayden, Nick Greeves & Stuart Warren. *Organic Chemistry*, 2012. Oxford University Press Inc., New York, USA.

5. John M. Beale & John H. Block, *Wilson & Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry*, 2010. Lippincott Williams & Wilkins, Philadelphia, Pennsylvania, USA.

PHR 212L Organic Pharmaceutical Chemistry-II Lab Credit Hr: 1

Course number **:** PHR 212L
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.

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)
    a. Acid value,
    b. Saponification value,
    c. Iodine value
4. Preparation of compounds
    a. Benzanilide/phenyl benzoate/acetanilide from aniline/ phenol /aniline by acylation reaction.
    b. 2,4,6-Tribromo aniline/para bromo acetanilide from aniline/nitro benzene by nitration reaction.
    c. Benzoic acid from benzyl chloride by oxidation reaction.
    d. Benzoic acid/ salicylic acid from alkyl benzoate/ alkyl salicylate by hydrolysis reaction.

Recommended books:

1. Organic Chemistry by Morrison and Boyd
2. Organic Chemistry by I.L. Finar, Volume-I
3. Textbook of Organic Chemistry by B.S. Bahl & Arun Bahl.
4. Organic Chemistry by P.L. Soni
5. Practical Organic Chemistry by Mann and Saunders.
6. Vogel's text book of Practical Organic Chemistry
7. Advanced Practical organic chemistry by N.K. Vishnoi.

PHR 213 Physical Pharmaceutical Chemistry-II Credit Hr: 3

Course number : PHR 213
Course title : Physical Pharmaceutical Chemistry-II

Credit hours **:** 3

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.

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 behaviours, 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; Donnan membrane 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.
7. Any additional topics deemed appropriate by the course teacher.

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

PHR 213L Physical Pharmaceutical Chemistry-II Lab Credit Hr: 1

Course number **:** PHR 213L
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.

Course contents:

1. Viscosity determinations:

   (a) Determination of viscosity of pure liquids such as glycerine, 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.

Recommended books:

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 214 Pharmacognosy and Natural Product Chemistry-II Credit Hr: 3

Course number **:** PHR 214
Course title **:** Pharmacognosy and Natural Product Chemistry-II
Credit hours **:** 3

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.

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 group:**

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, rosemary
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, tobacco, poppy, pyrethrum flower, derris and lanchocarpus, red squill, etc.
5. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. William Charles Evans. *Trease and Evans' Pharmacognosy*, Saunders, 2009.
2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. *Pharmacognosy*, Philadelphia: Lea & Febiger, 1998.
3. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. *Fundamentals of Pharmacognosy and Phytotherapy*, Churchill Livingstone, Elsevier, 2012.

PHR 214L Pharmacognosy and Natural Product Chemistry-II Lab Credit Hr: 1

Course number **:** PHR 214L
Course title **:** Natural Product Chemistry-II Lab

Credit hours **:** 1

Introduction:
This course 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.

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.

Recommended books:

1. William Charles Evans. *Trease and Evans' Pharmacognosy*, Saunders, 2009.
2. Tyler, Varro E.; Brady, Lynn R.; Robbers, James E. *Pharmacognosy*, Philadelphia: Lea & Febiger, 1998.
3. Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia, Simon Gibbons, Elizabeth Williamson. *Fundamentals of Pharmacognosy and Phytotherapy*, Churchill Livingstone, Elsevier, 2012.

PHR 215 Physiology and Anatomy-II Credit Hr: 3

Course number **:** PHR 215
Course title **:** Physiology and Anatomy-II
Credit hours **:** 3

Introduction:
This course 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.

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.
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.
2. Review of Medical Physiology- W.F. Ganong.
3. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
4. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 215L Physiology and Anatomy-II Lab Credit Hr: 1

Course number : PHR 215L
Course title : Physiology and Anatomy-II Lab
Credit hours : 1

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.

Recommended books:

1. A Textbook of Medical Physiology- Arther C. Guyton, John E. Hall.
2. Review of Medical Physiology- W.F. Ganong.
3. Ross & Wilson Anatomy and Physiology in Health and Illness- Anne Waugh and Allison Grant.
4. Gray's Anatomy-Spalding Gray (International Student Edition).

PHR 216 Pharmaceutical Microbiology-II Credit Hr: 2

Course number : PHR 216
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.

Course Content:

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

PHR 216L Pharmaceutical Microbiology-II Lab Credit Hr: 1

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
6. Any additional topics deemed appropriate by the course teacher.

Course number **:** PHR 216L
Course title **:** Pharmaceutical Microbiology-II Lab
Credit hours **:** 1

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

Reference/Recommended books:

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

Pharm.D. Year-II (Second Semester)

PHR 221 Cellular and Molecular Biology Credit Hr: 3

Course number : PHR 221
Course title : Cellular and Molecular Biology
Credit hours : 3

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.

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 signalling, cytokine receptors and signalling, 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.
8. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell. New York, Garland Science.
2. A. K. Abbas, A. H. Litchman and S. Pillai. Cellular and Molecular Immunology, New York, Elsevier.
3. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Molecular Cell Biology. New York, W. H. Freeman and Company.

PHR 222 Pharmacology-I Credit Hr: 3

Course number : PHR 222
Course title : Pharmacology-I
Credit hours : 3

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.

Course contents:

1. **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.

2. **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.

3. **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

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

5. **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).

6. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics.
2. The Pharmacological Basis of Therapeutics, 13th edition, 2011. Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
3. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
4. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
5. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
6. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
7. Basic and Clinical Pharmacology, By - Bertram G. Katzung. Lange.
8. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
9. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 222L Pharmacology-I Lab Credit Hr: 1

Course number **:** PHR 222L
Course title **:** Pharmacology-I Lab
Credit hours **:** 1

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.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics.
2. The Pharmacological Basis of Therapeutics, 2011. Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
3. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
4. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
5. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
6. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
7. Basic and Clinical Pharmacology. By - Bertram G. Katzung. Lange.
8. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
9. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 223 Pharmaceutical Technology-II Credit Hr: 3

Course number : PHR 223
Course title : Pharmaceutical Technology-II
Credit hours : 3

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.

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, labelling, 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, labelling, 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.

6. Any additional topics deemed appropriate by the course teacher.

Reference/Recommended books:

1. The theory and practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.

2. Remington's 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 223L Pharmaceutical Technology-II Lab Credit Hr: 1

Course number **:** PHR 223L
Course title **:** Pharmaceutical Technology-II Lab
Credit hours **:** 1

Course contents:

Preparation and evaluation of the following dosage forms:

1. Solution
2. Suspension
3. Emulsion
4. Ointment
5. Suppository

Reference/Recommended books:

1. The theory and practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.

2. Remington: 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 224 Cosmetic Sciences and Technology Credit Hr: 3

Course number **:** PHR 224
Course title **:** Cosmetic Sciences and Technology
Credit hours **:** 3

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.

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.
8. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Harry's Cosmeticology- J. B. Wilkinson & R. J. Moore, 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, Chapman & Hall, London
4. A Handbook of Cosmetics by B.M. Mithal
5. Handbook of Cosmetic Science and Technology by André O. Barel

PHR 224L Cosmetic Sciences and Technology Lab Credit Hr: 1

Course number : PHR 224L
Course title : Cosmetic Sciences and Technology Lab
Credit hours : 1

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

Reference/Recommended books:

1. Harry's Cosmeticology- J. B. Wilkinson & R. J. Moore, 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

PHR 225 Pharmaceutical Process Engineering-I Credit Hr: 2

Course number **:** PHR 225
Course title **:** Pharmaceutical Process Engineering-I
Credit hours **:** 2

Introduction

This course introduces students to the essential principles of pharmaceutical process engineering used in modern drug manufacturing. It covers foundational concepts such as material and energy balances, fluid flow, heat and mass transfer, and key unit operations relevant to pharmaceutical production. The course prepares students for advanced learning in pharmaceutics, biopharmaceutics, industrial pharmacy, and pharmaceutical quality systems.

Course contents

1. **Introduction to pharmaceutical process engineering:** Definition, scope, importance in the pharmaceutical industry, relationship with GMP and quality systems.

2. **Material & energy balances (basic):** Principle of conservation of mass and energy, simple balance calculations for mixing, drying, dilution, and heating processes.
3. **Fluid flow and mixing:** Newtonian and non-Newtonian flow, Reynolds number, laminar vs. turbulent flow, pumps (centrifugal, positive displacement), agitation and mixing equipment in liquid and semi-solid processing.
4. **Heat transfer in pharmaceutical processes:** Modes of heat transfer, heat exchangers, conduction and convection principles, applications in sterilization, evaporation, distillation, and drying.
5. **Mass transfer fundamentals:** Concepts of diffusion, evaporation, extraction and leaching, introduction to mass transfer coefficients.
6. **Unit operations in pharmacy (overview):** Filtration, centrifugation, drying, milling, size reduction, mixing, granulation, compression—importance and simple operational principles.
7. **Industrial equipment (introductory):** Basic structure and working of reactors, dryers (tray, fluid-bed), granulators, mills, homogenizers, tablet presses.
8. **Safety and environmental considerations:** Safe handling of chemicals, industrial hygiene, waste management, spill control, environmental protection in pharmaceutical plants.
9. Any additional topics deemed appropriate by the course teacher.

PHR 226	**Pharmaceutical Management**	**Credit Hr: 3**

Course number **:** PHR 226
Course title **:** Pharmaceutical Management
Credit hours **:** 3

Introduction
This course provides an understanding of management principles and their application in pharmacy practice, hospital pharmacy, community pharmacy and pharmaceutical organizations. It covers organizational behavior, human resources, operations, supply chain, financial basics, regulatory requirements, and professional ethics, preparing students to manage pharmacy operations efficiently.

Course contents

1. **Foundations of management:** Definition, nature and scope, management functions (planning, organizing, staffing, directing, controlling), managerial roles in hospital, community, and industrial pharmacy.
2. **Organizational structure & behavior:** Types of organizational structures, communication systems, teamwork, leadership styles, motivation, conflict management, professional behavior in pharmacy.
3. **human resource management (basic concepts):** Recruitment, selection, training, staff development, performance appraisal, roles of pharmacists in HR activities.
4. **pharmacy operations management:** Workflow in hospital, community, and industrial pharmacies, resource allocation, process standardization, quality assurance, documentation, and record-keeping.
5. **supply chain & inventory management:** Procurement, storage, distribution, stock management, basic inventory control techniques (ABC, VED, FIFO/FEFO), safety stock, stock-out prevention.
6. **financial management basics:** Budgeting, cost components, simple cost control, resource allocation, basic financial record-keeping.
7. **regulatory & administrative aspects:** Roles of regulatory authorities, licensing, compliance, audit processes, documentation, introduction to pharmacovigilance.
8. **professionalism & ethics:** Ethical decision-making, responsibilities of pharmacy managers, professional behavior, accountability, patient-centered and socially responsible practices.
9. Any additional topics deemed appropriate by the course teacher.

PHR 227 Viva Voce Credit Hr: 1

Course number : PHR 227
Course title : Viva Voce
Credit hours : 1

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

Course contents: Total Syllabus of Pharm.D. year-II

Pharm.D. Year –III (1ST SEMESTER)

PHR 311 Pharmaceutical Analysis-I Credit Hr: 2

Course number : PHR 311
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 fluorometry, HPLC, UV-visible spectrophotometry, chromatographic methods, and polarimetry

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 auxochromes, 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.
7. Any additional topics deemed appropriate by the course teacher.

Recommended 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.
4. Instrumental Methods of Analysis- Willard.

PHR 311L Pharmaceutical Analysis-I Lab Credit Hr: 1

Course number : PHR 311L
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.

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.

Recommended books:

1. Modern Methods of Pharmaceutical Analysis, Vol. II By Rozer E. Schirmer,

2. Vogel's Textbook of Quantitative Chemical Analysis By G. H. Jeffrey, Bassett. J.,

3. Quantitative Analytical Chemistry, James S. Fritz and George H. Schenk Allyn and Bacon.

4. Pharmaceutical Drug analysis by Ashutosh Kar.

PHR 312 Medicinal Chemistry and Drug synthesis-I Credit Hr: 3

Course number : PHR 312
Course title : Medicinal Chemistry and Drug synthesis -I
Credit hours : 3

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.

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

reaction; 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.

6. Any additional topics deemed appropriate by the course teacher.

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

PHR 312L Medicinal Chemistry & Drug synthesis-I Lab Credit Hr: 1

Course number : PHR 312L
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.

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.

Recommended books:

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 313 Pharmaceutical Biotechnology Credit Hr: 3

Course number : PHR 313
Course title : Pharmaceutical Biotechnology
Credit hours : 3

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.

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.
11. **Dispensing of biotechnology products:** Storage-temperature requirements, storage in dosing and administration devices, light protection, handling, mixing and shaking, travel requirements, preparation and administration.
12. **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
13. **Mutation and protein engineering.**
14. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Biopharmaceuticals: Biochemistry and Biotechnology, 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, Daan J. A. Crommelin and Robert D. Sindelar (2002) (Taylor & Francis, UK)

PHR 313L Pharmaceutical Biotechnology Lab Credit Hr: 1

Course number : PHR 313L
Course title : Pharmaceutical Biotechnology Lab
Credit hours : 1

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.

Recommended books:

1. Biopharmaceuticals: Biochemistry and Biotechnology, 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, Daan J. A. Crommelin and Robert D. Sindelar (2002) (Taylor & Francis, UK)

PHR 314 Hospital and Community Pharmacy Credit Hr: 3

Course number : PHR 314
Course title : Hospital and Community Pharmacy
Credit hours : 3

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.

Course contents:

1. **Introduction:** Goals, minimum standards, abilities required for a hospital pharmacist, hospital as an organization, classification, organizational patterns, management and administration, different departments and services, role of a pharmacist in the hospital, hospital pharmacy, organizational and personnel, supportive personnel, pharmacy education, job description.

2. **Pharmacy and therapeutics committee:** Description and purpose, membership and functions, hospital formulary, guiding principles, legal basis, principles for admission or deletion of drugs, selection of text, investigational use of drugs, description, principles involved, classification, control, identification, role of hospital pharmacist, advisory committee.
3. **Purchasing and inventory control:** Purchasing agent, purchasing procedure, control on purchase, storage, perishable inventory, physical inventory, perpetual inventory.
4. **Control of special classes of drugs:** Use of samples, in-patient drug orders, out-patient prescriptions, ward stock drugs, label symbols, narcotics and their control, classes, procurement and execution of order forms, dispensing, hospital narcotic regulations, new systems, floor stock drugs, selection, charge and non-charge, labeling, regulations concerning narcotics, inspection of nursing drug cabinets.
5. **Dispensing to in- and out-patients:** Drug distribution systems, dispensing of charge, non-floor stock drugs, mobile dispensing unit, unit dose dispensing, new concepts, dispensing to out-patients, locality of out-patient dispensing area, dispensing routine, record keeping, dispensing during off-hours, use of nursing supervisors, emergency boxes and night drug cabinets, pharmacist-on-call, drug charges in hospitals, pricing, break-even point pricing.
6. **Manufacturing– bulk and sterile:** Control and budget, manufacturing facility and capacity, operating costs, quality control.
7. **Drug information center and library:** Physical facilities, selection of contents, methods of dissemination, role in educational and training program, professional education, internal teaching program, external teaching program.
8. **Community Pharmacy:** Concept of community health care, health needs of the community, different level of health care, elements of primary health care, principles of primary health care: equitable distribution, community participation, intersectoral coordination, appropriate technology, health manpower, health care delivery at different levels, community pharmacy in dealing with communicable diseases problem, nutritional problems, environmental sanitation problems and indigenous systems of medicine, development of community pharmacy infrastructure, participation of Non-governmental voluntary health agencies.
9. **Rational use of drugs:** Background of rational use of drugs, definition, factors underlying irrational use of drugs: patients, prescribers, drug supply system; drug regulation and drug promotion, impact of irrational use of drugs with examples, disease-specific indicators, drug use patterns in developing countries, changing drug use patterns, factors effecting drug use, strategies to improve prescribing, experiences with interventions to change drug use in developing countries, strengths and weaknesses of different interventions to change drug use patterns, international network for rational use of drugs.
10. **Forensic pharmacy:** Definition, epidemiology of poisoning, influential factors, substances most frequently involved in accidental ingestions among children, first-aid treatment for poisoning, treatment, antidotes- locally acting and systemic, prevention of poisoning, poison control, poison control act, schedules, poison treatment centers, poison prevention packaging, national and community awareness, centralization of poison information, role of pharmacist at different levels.
11. Any additional topics deemed appropriate by the course teacher.

References:

1. Hospital Pharmacy-William E Hassan, Published by Lea & Febiger, Philadelphia, USA
2. Hospital Pharmacy--Martin Stephens, 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 315	**Pharmacology-II**	**Credit Hr: 3**

Course number **:** PHR 315

Course title **:** Pharmacology-II

Credit hours **:** 3

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.

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.

10. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, Edited By Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
2. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.
3. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
4. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
5. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala

Rege and SD Bhandarka. Elsevier India.
6. Basic and Clinical Pharmacology. By - Bertram G. Katzung. Lange.
7. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
8. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.

PHR 315L Pharmacology-II Lab Credit Hr: 1

Course number : PHR 315L
Course title : Pharmacology-II Lab
Credit hours : 1

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.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
2. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarka. Elsevier India.
5. Basic and Clinical Pharmacology. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme

Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.
8. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.

PHR 316 Biopharmaceutics and Pharmacokinetics-I Credit Hr: 3

Course number : PHR 316
Course title : Biopharmaceutics and Pharmacokinetics-I
Credit hours : 3

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.

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
8. Any additional topics deemed appropriate by the course teacher.

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 316L Biopharmaceutics and Pharmacokinetics-I Lab Credit Hr: 1

Course number : PHR 316L
Course title : Biopharmaceutics and Pharmacokinetics-I Lab
Credit hours : 1

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.

Reference/Recommended books:

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

Pharm.D. Year –III (2ND SEMESTER)

PHR 321 Functional Foods, Nutraceuticals and Herbal Medicines Credit Hr: 3

Course number : PHR 321
Course title : Functional Foods, Nutraceuticals and Herbal Medicines
Credit hours : 3

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.

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.
9. Any additional topics deemed appropriate by the course teacher.

Recommended 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.
5. Food Technology: An Introduction - by Anita Tull.
6. Nutraceuticals: Developing, Claiming, and Marketing Medical Foods - by Stephen L. DeFelice
7. Handbook of Food Preservation - by M. Shafiur Rahman.
8. Food Packaging and Preservation - by M. Mathlouthi.

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

PHR 322 Clinical Pathology and Toxicology Credit Hr: 3

Course number : PHR 322

Course title : Clinical Pathology and Toxicology

Credit hours : 3

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.

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.
9. Any additional topics deemed appropriate by the course teacher.

Recommended 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, 2018, Editor: Curtis D. Klaassen, McGraw-Hill Education.
3. Animal Models in Toxicology, 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.

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

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

PHR 323 Pharmaceutical Technology-III Credit Hr: 3

Course number **:** PHR 323
Course title **:** Pharmaceutical Technology-III
Credit hours **:** 3

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.

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.
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. The Theory and Practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. Encyclopedia of Pharmaceutical 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 323L Pharmaceutical Technology-III Lab Credit Hr: 1

Course number : PHR 323L
Course title : Pharmaceutical Technology-III Lab

Credit hours **:** 1

Course contents:

Preparation and evaluation of the following dosage forms:

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

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 423 Pharmaceutical Process Engineering Credit Hr: 3

Course number **:** PHR 423
Course title **:** Pharmaceutical Process Engineering
Credit hours **:** 3

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.

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**.**

9. Any additional topics deemed appropriate by the course teacher.

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 423L Pharmaceutical Process Engineering Lab Credit Hr: 1

Course number : PHR 423 L
Course title : Pharmaceutical Process Engineering Lab
Credit hours : 1

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.

Recommended books:

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

PHR 324 Pharmaceutical Marketing Credit Hr: 3

Course number : PHR 324
Course title : Pharmaceutical Marketing
Credit Hours : 3

Introduction:

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.

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.
8. Any additional topics deemed appropriate by the course teacher.

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.
5. Any additional topics deemed appropriate by the course teacher.

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, 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 324 L Pharmaceutical Marketing Field Work/ Report Credit Hr: 1

Course number **:** PHR 324L
Course title **:** Pharmaceutical Marketing Field Work/ Report
Credit hours **:** 1

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.

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, 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 325 Artificial Intelligence and Machine Learnings in Pharmacy Credit Hr: 3

Course number **:** PHR 325
Course title **:** Artificial Intelligence and Machine Learnings in Pharmacy
Credit hours **:** 3

Introduction:
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.

Course contents:

1. **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.
2. **AI and ML concepts in pharmaceutical:** 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 repurposing approach).
3. **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.

4. **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.
5. Any additional topics deemed appropriate by the course teacher.

Recommended books:

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 326 Viva Voce — Credit Hr: 1

Course number : PHR 326

Course title : Viva Voce

Credit hours : 1

Course Description:

The viva voce in the Pharm.D. program evaluates students' knowledge and communication skills. It ensures readiness to apply pharmaceutical knowledge in real practice.

Course contents: Total Syllabus of Pharm.D. year-III

Pharm.D. Year-IV (1ST SEMESTER)

PHR 411 Medicinal Chemistry and Drug synthesis-II Credit Hr: 3

Course number : PHR 411
Course title : Medicinal Chemistry and Drug synthesis-II
Credit hours : 3

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.

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.
6. Any additional topics deemed appropriate by the course teacher.

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

PHR 412L Medicinal Chemistry and Drug synthesis-II Lab Credit Hr: 1

Course number : PHR 412L
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.

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

Recommended books:

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 413	Quality Control and Analytical Method Validation	Credit Hr: 3

Course number : PHR 413
Course title : Quality Control and Analytical Method Validation
Credit hours : 3

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.

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**
11. Any additional topics deemed appropriate by the course teacher.

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

PHR 413L	Quality Control and Analytical Method Validation Lab	Credit Hr: 1

Course number : PHR 413L
Course title : Quality Control and Analytical Method Validation 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.

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

Recommended 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, Cengage Learning.
4. Spectroscopic Methods in Organic Chemistry, Dudley H. Williams, Ian Fleming, 1996, McGraw-Hill.

PHR 414 Clinical Pharmacy Credit Hr: 3

Course number : PHR 414
Course title : Clinical Pharmacy
Credit hours : 3

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.

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.

9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Clinical Pharmacy and Therapeutics. E. T. Herfindal, D. R. Gourley and L. L. Hart, Williams & Wilkins publications, 1992.

2. Clinical Pharmacy and Therapeutics. Roger Walker and Cate Whittlesea, Churchill Livingstone, Elsevier publications, 2012.

3. Davidson's Principles and Practices of Medicines. N. R. Colledge, B. R. Walker and S. H. Ralston, Churchill Livingstone, Elsevier publications, 2018.

4. Clinical Pharmacology and Therapeutics. J. M. Ritter, L. D. Lewis, T. G. K. Mant and A. Ferro, Hodder Arnold Publications, UK, 2008.

5. Oxford Handbook of Clinical Pharmacy, P. Wiffen, M. Mitchell, M. Snelling and N. Stoner, Oxford University Press, 2017.

PHR 415 Pharmacovigilance Credit Hr: 3

Course number : PHR 415
Course title : Pharmacovigilance
Credit hours : 3

Introduction:

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.

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.

6. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. An introduction to pharmacovigilance, 2017. Edited by- Patrick Waller and Mira Harrison-Woolrych. Publisher- Wiley Blackwell.
2. Pharmacovigilance: A Practical Approach, 2023. Edited by- Thao Doan, Fabio Lievano, Linda Scarazzini, Charles Schubert, Barbara Hendrickson. Publisher- Elsevier.
3. Mann's Pharmacovigilance, 2014. Edited By – Elizabeth B. Andrews and Nicholas Moore. Publisher – Wiley Blackwell.
4. A Practical Handbook on the Pharmacovigilance of Antiretroviral Medicines. World Health Organization, 2013.

PHR 416 Pharmaceutical Technology-IV Credit Hr: 3

Course number : PHR 416
Course title : Pharmaceutical Technology-IV
Credit hours : 3

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.

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.

Books recommended:

1. The theory and practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. American Pharmacy by Sprowl.
3. Pharmaceutics by Aulton.

4. Remington: 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 416 L Pharmaceutical Technology-IV Lab Credit Hr: 1

Course number **:** PHR 416L
Course title **:** Pharmaceutical Technology-IV Lab
Credit hours **:** 1

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

Recommended books:

1. The theory and practice of Industrial Pharmacy - Leon Lachman, Herbert A. Lieberman, Joseph L. Kanig.
2. Remington: Essentials of Pharmaceutics - Edited by Linda Felton, Published by Pharmaceutical Press, London, UK.

PHR 417 Pharmaceutical Regulatory Affairs Credit Hour: 3

Course number **:** PHR 417
Course title **:** Pharmaceutical Regulatory Affairs
Credit hours **:** 3

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.

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, Drugs and Cosmetics 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).

6) Any additional topics deemed appropriate by the course teacher.

Recommended books:

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, – Douglas J. Pisano and David S. Mantus
7. The Pharmaceutical Regulatory Process– 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.**

Pharm.D. Year-IV (2ND SEMESTER)

PHR 421 Pharmaceutical Analysis-II Credit Hr: 3

Course number : PHR 421
Course title : Pharmaceutical Analysis-II
Credit hours : 3

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.

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}H NMR 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).**
12. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Spectroscopic Methods in Organic Chemistry. by Dudley H. Williams and Ian Fleming McGraw-Hill Book Company Limited, UK
2. Introduction to Spectroscopy 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
4. Theory and application of Microbiological Assay by William Hewitt Academic Press.

PHR 421L Pharmaceutical Analysis-II Lab Credit Hr: 1

Course number : PHR 421L
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.

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 condutometrically determined with a standard solution of sodium hydroxide.
10. Potentiometric determination of the concentrations of an iodide and a chloride sample in a mixture.

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

PHR 422 Pharmacology-III Credit Hr: 3

Course number : PHR 422

Course title : Pharmacology-III

Credit hours : 3

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.

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.

4. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
2. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarkar. Elsevier India.
5. Basic and Clinical Pharmacology. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.
8. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.

PHR 422L Pharmacology-III Lab Credit Hr: 1

Course number : PHR 422L

Course title : Pharmacology-III Lab

Credit hours : 1

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 anaesthetics 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.

Recommended books:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics, Edited By - Laurence L. Brunton, Bruce A. Chabner and Björn C. Knollmann. McGraw-Hill.
2. Principles of Immunopharmacology, 2011. By - Frans P Nijkamp. Springer.
3. Cellular and Molecular Immunology, 2017. By - Abul Abbas Andrew H. and Lichtman Shiv Pillai. Elsevier.
4. Pharmacology and Pharmacotherapeutics, 2015. By - RS Satoskar, Nirmala Rege and SD Bhandarkar. Elsevier India.
5. Basic and Clinical Pharmacology. By - Bertram G. Katzung. Lange.
6. Rang & Dale's Pharmacology, 2016. By - James Ritter Rod Flower Graeme Henderson Humphrey Rang. Churchill Livingstone.
7. Essentials of Medical Pharmacology, 2018, Edited by KD Tripathi, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India.
8. Lippincott Illustrated Reviews: Pharmacology, 2014, Edited by Karen Whalen, Publisher: Wolters Kluwer Health.

PHR 424 Biopharmaceutics and Pharmacokinetics-II Credit Hr: 3

Course number : PHR 424

Course title **:** Biopharmaceutics and Pharmacokinetics-II
Credit hours **:** 3

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.

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.
9. Any additional topics deemed appropriate by the course teacher.

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 424L Biopharmaceutics and Pharmacokinetics-II Lab Credit Hr: 1

Course number **:** PHR 424 L
Course title **:** Biopharmaceutics and Pharmacokinetics-II Lab
Credit hours **:** 1

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.

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 425 Pharmacy Practice Credit Hr: 3

Course number : PHR 425
Course title : Pharmacy Practice
Credit hours : 3

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.

Course contents:

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
7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Hospital Pharmacy-William E Hassan, 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 426 Viva Voce Credit Hr: 1

Course number : PHR 426
Course title : Viva Voce
Credit hours : 1

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

Course contents: Total Syllabus of Pharm.D. year-IV

PHR 427	Project	Credit Hr: 3

Course number : PHR 427
Course title : Project
Credit hours : 3

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 content: As per instruction of supervisor.

PHR 428	Industrial Training	1

Course number : PHR 428
Course title : Industrial Training
Credit hours : 1

Introduction:
Industrial Training is designed to expose Pharm.D. 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.

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.

Pharm.D. Year-V (1st SEMESTER)

PHR 511 Cellular and Bioanalytical Chemistry Credit Hr: 3

Course number : PHR 511
Course title : Cellular and Bioanalytical Chemistry
Credit hours : 3

Introduction:

Cellular and Bioanalytical Chemistry syllabus will cover the principles and techniques of growing cells in a controlled environment, along with the analytical methods used to study them. This would include cell culture techniques like aseptic techniques, media preparation, cell separation, and characterization. Bioanalytical chemistry would focus on techniques like chromatography, spectroscopy, and electrochemistry, applied to biological samples with a view to diagnostic application.

Course contents:

Section A: Cell culture in pharmaceutical research

1. **Introduction to cell culture:** Basic principles, types of cell cultures (primary, secondary, cell lines), cell growth phases, and cell line characterization.
2. **Cell culture techniques:** Aseptic techniques, media preparation, cell counting, subculturing, cryopreservation, and cell separation techniques.
3. **Specialized cell culture:** Stem cell culture, organ culture, and cell culture applications in biotechnology.
4. **Application of techniques**: Integration of cell culture and bioanalytical chemistry:
    - Using cell culture as a model system to study the effects of drugs or other substances on cells.
    - Applying bioanalytical techniques to analyze cellular products or biomarkers.
    - Characterizing cell behavior and function using a combination of cell culture and analytical methods.
    - Analyzing biological molecules (proteins, nucleic acids), drug discovery, and understanding cellular processes.

Section B: Bioanalytical chemistry and diagnostics

1. **Spectroscopy and chromatography**

   NMR, UV-Vis, fluorescence spectroscopy, GC, GC-MS, LC-MS, TLC in drug and biomarker quantification.

2. **Electrophoresis**

   SDS-PAGE and agarose gel electrophoresis: DNA, RNA, protein profiling.

3. **Immunoassays and cell-based diagnostics**
   - ELISA, western blotting for interpretation of protein expression.
   - Cell-based assays for diabetes (glucose uptake), cancer (MTT, SRB).
   - Cytokine profiling using immunoassays and culture supernatants.

4. **Molecular and advanced diagnostic techniques**
   - PCR, qPCR, RT-PCR in infectious and genetic diagnostics
   - Flow cytometry in immunophenotyping of cells and apoptosis detection.
   - Biosensors applications.

5. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Nelson & Cox – *Lehninger Principles of Biochemistry*
2. R. Ian Freshney – *Culture of Animal Cells*
3. Tietz – *Fundamentals of Clinical Chemistry*
4. FDA Guidelines on Bioanalytical Method Validation
5. Remington – *Pharmaceutical Sciences* (Drug Delivery & Diagnostics)
6. Databases: PubChem, ClinVar, COSMIC (Cancer Mutations)

PHR 512 Disease Management Credit Hr: 3

Course number **:** PHR 512
Course title **:** Disease Management
Credit hours **:** 3

Introduction:

This course is designed for pharmacy students to advance their understanding of contemporary issues in disease management. Students will learn the prevention and treatment of various diseases with both pharmacotherapy and non-pharmacologic therapy.

Course contents:

1. **Basic principles of disease management:** signs and symptoms, clinical laboratory test, patient-centered care, evidence-based interventions, integrated healthcare services, patient education and self-management, monitoring and follow-up, pharmacological and non-pharmacological management, proactive and preventive approach.
2. **Management of renal and urological disorders:** Disease characteristics, etiology, clinical manifestation, pathophysiology, pharmacological and non-pharmacological management of acute and chronic kidney injury, hematuria, erectile dysfunction, and prostatic hyperplasia.
3. **Management of neurological disorders:** Signs and symptoms, etiology, clinical manifestation and management of neurological disorders including Alzheimer's disease, Parkinson's disease, epilepsy, and pain.
4. **Management of psychiatric disorders:** Signs and symptoms, etiology, clinical manifestation and management of psychiatric disorders including schizophrenia, generalized anxiety disorder, panic disorder, bipolar disorder, sleep disorder, and substance related disorders.
5. **Management of metabolic disorders:** Signs and symptoms, etiology, clinical manifestation and management of metabolic disorders including thyroid disorders, diabetic mellitus, and obesity.
6. **Management of oncologic disorders:** Signs and symptoms, etiology, clinical manifestation and management of oncologic disorders, chemotherapy, and supportive care.
7. **Management of the diseases of infectious origin:** Antimicrobial regimen selection, signs and symptoms, etiology, clinical manifestation and management of some infectious diseases including sexually transmitted infections, upper and lower respiratory tract infection, and urinary tract infection.
8. **Drug Compliance:** (a) Reasons for noncompliance: poor standards of labelling, social relations, complex therapeutic regimen, nature of medication, side effects, lack of doctor/ patient– pharmacist rapport, inadequate patient education. (b) Strategies for improving compliance: adequate labelling, simplification of therapeutic regimens, patient counselling, patient education, use of warning cards, package inserts.
9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Textbook of Therapeutics: Drug and Disease Management, by Richard A. Helms, David J. Quan, 2006, Lippincott Williams & Wilkins.
2. Chronic Disease Management, Editor Jim Nuovo, 2007, Springer-Verlag New York.

3. Disease Management: A Guide to Clinical Pharmacology, by Dr Karen E. Neil (Author), Michael Randall (Author), (2016), Pharmaceutical Press, USA, by Dr Michael D. Randall (Author), Dr Karen E. Neil (Author).
4. Diagnostic and Statistical Manual of Mental Disorders, The American Psychiatric Association.
5. Current Medical Diagnosis & Treatment by Maxine A. Papadakis, Stephen J. McPhee, Michael W. Rabow, 2017, McGraw-Hill Education.

PHR 513 Pharmacogenetics and Personalized Medicine Credit Hr: 2

Course number **:** PHR 513
Course title **:** Pharmacogenetics and Personalized Medicine
Credit hours **:** 2

Introduction:

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

Course contents:

1. **Principles of pharmacogenetics:** Introduction, concepts and components of pharmacogenetics, terminology used to describe effects of genetic variation, identification of treatment response genes, methods of genotyping, potential social, ethical, and legal issues related to pharmacogenetics.

2. **Genetic variations in drug response:** Types of genetic variations that alter drug response, polymorphisms in genes for drug-metabolizing enzymes, polymorphisms in drug transporter genes, polymorphisms in drug target genes, immune system genes.

3. **Genetic polymorphism and diseases:** Association of gene polymorphism and susceptibility of developing diseases including cardiovascular diseases, neurological disorders, metabolic disorders, cancer, and cellular aging.

4. **Clinical application of pharmacogenetics:** Tailoring treatment based on genetic profile, early intervention for high-risk individuals, adjusting therapy to reduce toxicity and improve efficacy, lifestyle modification for genetically susceptible populations, prevention of adverse drug events.

5. **Personalized medicine:** concepts of personalized medicine; components of personalized medicine; role of genomics, pharmacogenomics, biomarkers and data integration in personalized medicine; predictive and preventive healthcare benefits of personalized medicine; challenges in personalized medicine; strategies for application of pharmacogenomics to customized therapy.

6. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Pharmacogenetics, 2006. Edited By - Ian P. Hall University Hospital of Nottingham Nottingham, U.K. Munir Pirmohamed University of Liverpool Liverpool, U.K. Publisher – Taylor & Francis, New York and London.
2. Pharmacotherapy: A Pathophysiologic Approach, 2014. Edited By - Joseph T. DiPiro, Robert L. Talbert, Gary C. Yee, Gary R. Matzke, Barbara G. Wells, L. Michael Posey. McGraw-Hill Education.
3. Mann's Pharmacovigilance, 2014. Edited By – Elizabeth B. Andrews and Nicholas Moore. Publisher – Wiley Blackwell.
4. Textbook of Personalized Medicine, 2015. Kewal K. Jain, MD, FRACS, FFPM Jain PharmaBiotech, Basel, Switzerland. Humana Press, Springer Science. ISBN 978-1-4939-2552-0 ISBN 978-1-4939-2553-7 (eBook) DOI 10.1007/978-1-4939-2553-7.
5. Pharmacogenomics, 2005. Werner Kalow University of Toronto Toronto, Ontario, Canada Urs A. Meyer University of Basel Basel, Switzerland Rachel F. Tyndale Centre for Addiction and Mental Health University of Toronto Toronto, Ontario, Canada Taylor & Francis Group, LLC.
6. Pharmacogenomics, 2019. Yui-Wing Francis Lam Stuart Scott. Hardcover ISBN: 9780128126264, eBook ISBN: 9780128126271. Academic Press, Elsevier Inc.
7. A Practical Handbook on the Pharmacovigilance of Antiretroviral Medicines. World Health Organization, 2013.

PHR 514	**Pharmacotherapy**	**Credit Hr: 3**

Course number **:** PHR 514

Course title **:** Pharmacotherapy

Credit hours **:** 3

Introduction:

Pharmacotherapy course is designed to equip students with essential knowledge and practical skills necessary for the effective management of various diseases through drug therapy. The course provides in-depth understanding of the pathophysiology, clinical presentation, and treatment goals for a wide range of conditions, including gastrointestinal disorders, respiratory disorders, bone and joint disorders, diseases of the eye and lids, dermatological disorders, and cardiovascular disorders. These area of learning encourages critical thinking and decision-making in selecting, applying, and monitoring appropriate pharmacotherapy based on patient-specific factors and current treatment guidelines. By the end of the course, students will be proficient in evaluating treatment outcomes and making informed adjustments to improve patient care and therapeutic efficacy.

Course contents:

1. **Basic concepts of pharmacotherapy**: Key components of pharmacotherapy, drug selection criteria, types of pharmacotherapies, correct diagnosis and indications, individualization of therapy, therapeutic goals and monitoring, safety and minimizing harm, evidence-based practice, cost effectiveness in treatment, patient involvement and adherence to treatment.
2. **Pharmacotherapy in gastrointestinal disorders:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in gastrointestinal disorders including gastroesophageal reflux disease, peptic ulcer disease, inflammatory bowel disease, constipation and diarrhea.
3. **Pharmacotherapy in respiratory disorders:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in respiratory disorders including asthma and chronic obstructive pulmonary disease.
4. **Pharmacotherapy in bone and joint disorders:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in bone and joint disorders including osteoporosis, rheumatoid arthritis, gout and musculoskeletal disorders.
5. **Pharmacotherapy in the disorders of the eyes and lids:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in disorders of the eyes and lids including chalazion, conjunctivitis, keratitis, glaucoma, and retinopathy.
6. **Pharmacotherapy in dermatological disorders:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in dermatological disorders including acne, contact dermatitis, eczema, tinea, vitiligo, psoriasis.
7. **Pharmacotherapy in the disorders of the cardiovascular system:** Etiology, clinical findings, pathophysiology, diagnosis and pharmacotherapy in the disorders of the cardiovascular system including hypertension, ischemic heart disease, heart failure, stroke and dyslipidemia.
8. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Pharmacotherapy: A Pathophysiologic Approach by Joseph DiPiro, Robert Talbert, Gary Yee, Gary Matzke, Barbara Wells, L. Michael Posey. 2016, Publisher: McGraw-Hill.
2. Goodman and Gilman's The Pharmacological Basis of Therapeutics, by Laurence Brunton, Bjorn Knollmann, Randa Hilal-Dandan. 2017 Publisher: McGraw-Hill.
3. Pharmacotherapy Principles and Practice by Marie Chisholm-Burns, Terry Schwinghammer, Patrick Malone, Jill Kolesar, Kelly C. Lee, P. Brandon Bookstaver. 2019, Publisher: McGraw-Hill
4. Pharmacotherapy Casebook: A Patient-Focused Approach by Terry Schwinghammer, Julia Koehler, Jill Borchert, Douglas Slain, Sharon Park. 2017, Publisher: McGraw-Hill

PHR 514 L Pharmacotherapy Lab Credit Hr: 1

Course number : PHR 514L
Course title : Pharmacotherapy Lab
Credit hours : 1

Course contents:

1. To prepare and discuss notes on subjective, objective, assessment and plan for hypertension.
2. To prepare and discuss notes on subjective, objective, assessment and plan for peptic ulcer disease.
3. To prepare and discuss notes on subjective, objective, assessment and plan for asthma and chronic obstructive pulmonary disease.
4. To prepare and discuss notes on subjective, objective, assessment and plan for osteoarthritis
5. To prepare and discuss notes on subjective, objective, assessment and plan for diabetes mellitus.
6. To prepare and discuss notes on subjective, objective, assessment and plan for cancer therapy.

Recommended books:

1. Pharmacotherapy: A Pathophysiologic Approach by Joseph DiPiro, Robert Talbert, Gary Yee, Gary Matzke, Barbara Wells, L. Michael Posey. 2016, Publisher: McGraw-Hill.
2. Goodman and Gilman's The Pharmacological Basis of Therapeutics, by Laurence Brunton, Bjorn Knollmann, Randa Hilal-Dandan. 2017 Publisher: McGraw-Hill.
3. Pharmacotherapy Principles and Practice by Marie Chisholm-Burns, Terry Schwinghammer, Patrick Malone, Jill Kolesar, Kelly C. Lee, P. Brandon Bookstaver. 2019, Publisher: McGraw-Hill
4. Pharmacotherapy Casebook: A Patient-Focused Approach by Terry Schwinghammer, Julia Koehler, Jill Borchert, Douglas Slain, Sharon Park. 2017, Publisher: McGraw-Hill

PHR 515 Biostatistics and Bioinformatics Credit Hr: 3

Course number **:** PHR 515
Course title **:** Biostatistics and Bioinformatics
Credit Hours **:** 3

Introduction:

Biostatistics and bioinformatics is a blending of two subjects that will be offered as two section A and section B. Section A will comprise Biostatistics and section B will incorporate topics from Bioinformatics. Biostatistics covers the topics that are essential in order to present, record and analyze data obtained from pharmaceutical research. This will also help the students to design and conduct clinical research and help in deciding which method will be appropriate to conduct research involving animal as well as human samples. Research involving Bioinformatics is now considered as dry lab research work that is crucial before one can actually start working in the laboratory using appropriate research methodology. Therefore, Bioinformatics will be offered as a separate section that will include the information and use of various useful online resources and databases for enabling the students to facilitate their wet lab research.

Course contents:

Section A: Biostatistics

1. **Introduction, scope and application:** Definition of biostatistics and its application in pharmaceutical sciences. a) **Sources and presentation of data**- Definition of data, types of data, collection of data, presentation of data, frequency distribution, cross tabulation, graphical/diagrammatic presentation of data, variables, population, sample. **b) Statistical inference:** Introduction, standard error, p-value, test of significance/hypothesis, types of hypotheses, one-tailed & two-tailed tests, type I & type II errors, degrees of freedom, confidence interval.
2. **Hypothesis testing and selection of appropriate testing method:** Rationale for using statistical tests, parametric versus nonparametric tests, which test to apply in which situation? choosing an appropriate post hoc test.
   a) Parametric tests: Z-test, t-test, analysis of variance (ANOVA), repeated measures split-plot design, Pearson's correlation co-efficient, simple linear regression, multiple linear regression, logistic regression. **b) Nonparametric tests:** Introduction, ranking, Mann-Whitney U test, Wilcoxon test, Kruskal-Wallis test, Friedman's test, Chi square test, relative risk & odds ratio, sensitivity and specificity, the Spearman's rank correlation. **c) Multiple comparison tests:** Introduction, Bonferroni test, Dunnett's test, LSD test, Tukey's test, Scheffe test.
3. **Study design, types of study and application in bioequivalence: a) Types of study-**Defining objectives & proposal formulation, types of study, descriptive case studies, cross sectional studies, case control studies, cohort studies, parallel designs, cross-over designs, pre-test/post-test studies, quasi-experimental designs. **b) Sampling & sample size determination:** Steps in sampling design, sampling methods, simple random sampling, stratified sampling, systematic sampling, cluster sampling, multistage sampling, purposive sampling, convenience sampling, quota sampling, determination of sample size. **c) Statistical test for bioequivalence:** Introduction, bioequivalence, experimental designs, statistical analysis for bioequivalence, dissolution testing.
4. Any additional topics deemed appropriate by the course teacher.

Section B: Bioinformatics

1. **Introduction, scope and databases of bioinformatics: a) Introduction and scope:** Definition of bioinformatics, basic concepts of protein and nucleic acid, sequence, structure and function. **b) Bioinformatics databases:** Introduction, nucleotide sequence databases, primary nucleotide sequence databases, secondary nucleotide sequence databases, protein sequence databases, sequence motif databases, protein structure databases.
2. **Sequence comparisons and sequence-based database searching: a) Sequence alignments-** Single sequence alignments, biological motivation, pairwise and multiple sequence comparisons and alignments, database searching including BLAST, multiple sequence alignments. **b) Protein structure alignments:** Definition of structure superposition, structure alignment, different alignment algorithms, and number of protein folds in PDB. **c) Database searches-** database searches with

nucleotide and protein sequences, important algorithms for database searching, software for sequence analysis.

3. **Molecular phylogenetics, metabolism and networks:** Phylogenetics basics, phylogenetic tree construction methods and programs, sequence-based taxonomy, from multiple alignment to phylogeny, computer tools for phylogenetic analysis.
4. **Application of structural bioinformatics in drug designing: a) Structural bioinformatics-** Protein structure visualization, comparison, and classification, protein secondary structure prediction, protein tertiary structure prediction, RNA structure prediction**. b) Structure-** based rational drug design- analyses of protein structures, protein modelling, the determination of protein structures by high throughput methods, molecular docking (flexible and rigid) and molecular dynamics study for structure-based rational drug design, pharmacophore modelling, software used in docking.
5. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Clinical Pharmacist's Guide to Biostatistics and Literature Evaluation. Robert DiCenzo, Pharm.D., FCCP, BCPS. ISBN: 978-1-939862-17-4, 2015.

2. Basic Statistics and Pharmaceutical Statistical Applications. Book by James E. De Muth.

3. Medical and Pharmaceutical Statistics. JMA Hannan. Apex Publications, 2007.

4. Essential Bioinformatics. JIN XIONG. Cambridge University Press, 2006.

5. Applied Bioinformatics: An Introduction. P.M. Selzer, R.J. Marhöfer and A. Rohwer. Springer, 2004.

6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis and B. F. Francis Ouellette. Wiley Interscience, 2002.

7. Structural Bioinformatics. Philip E. Bourne and Helge Weissig. Vol. 44. Wiley-Liss, 2003.

PHR 516 Medical Devices and Hospital Instrumentation Credit Hr: 3

Course number **:** PHR 516
Course title **:** Medical Devices and Hospital Instrumentation
Credit hours **:** 3

Introduction:

The use of biomedical instruments is increasing day by day in health care. Now a days advanced, complex and precision biomedical instruments are being used in most of the hospitals. Therefore, to know about the biomedical instrumentation fundamentals, it is important for the students to learn about these devices and instruments.

Course contents:

1. **Medical devices – definitions, classification, design and development**
   Definitions and classification systems of medical devices as per FDA, EU and international perspectives, along with examples of different device classes. The design and development process of medical devices, starting from concept generation and prototype development to preclinical testing, ergonomic design, material biocompatibility, software integration, and the innovation of patient-friendly drug delivery devices.

2. **Verification, validation, clinical trials, evaluation and safety considerations of medical devices:**
   Principles and processes of verification and validation of medical devices, focusing on testing methodologies, case studies and their relevance to Pharm D practice. Preclinical studies, pilot and pivotal trials, post-market surveillance and safety assessments related to biocompatibility, mechanical and electrical risks. Regulatory approval pathways and the role of Pharm D programme in safety monitoring, reporting adverse device-related events and counselling patients regarding safe and effective device use.

3. **Marketing and regulation of medical devices:**
   The marketing aspects of medical devices, including customer communication, product promotion, user feedback and post-market surveillance, harmonized international standards and ethical considerations that ensure device safety and efficacy, regulations of medical devices in Bangladesh.

4. **Instruments and machines used in hospitals:**
   Diagnostic equipment, surgical equipment, treatment equipment, life support equipment, medical monitors, medical laboratory equipment, physical therapy machines, miscellaneous instruments, basic principles of MRI, CT scan, ECG, Echo and their uses.

5. **Management of medical devices in hospital & community pharmacy settings:**
   Responsibilities of hospital pharmacists in ensuring the correct procurement, storage, calibration and maintenance of medical devices & healthcare instruments, role of pharmacist in providing counselling on the correct use of devices & healthcare instruments (e.g. thermometer, glucometer, oximeter, inhalation & insulin devices etc.) to the patient and healthcare professionals, integration of pharmacovigilance with device utilization, efficiency and safety in hospital, outpatients and patients staying at home, specialty pharmacists and their expanding demand in the home-based care to patients.

6. **Basic concepts of biomedical engineering & future trends in medical devices:**
   Fundamentals of biomedical engineering, including biomechanics, biomaterials, bioinstrumentation and medical imaging, with applications in the development of prosthetics, biosensors and organ-on-chip technologies, future trends in the medical device sector, such as

wearable health monitors, nanotechnology-enabled devices, AI-driven diagnostics and smart hospital systems.

7. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Handbook of Biomedical Instrumentation by R. S. Khandpur
2. Introduction to Biomedical Equipment Technology by Carr Joseph J., Brown J.M
3. Medical Instrumentation Application & Design by John G. Webster

PHR 517	Chemistry and Quality Control of Biologics and Biosimilars	Credit Hr: 3

Course number : PHR 517
Course title : Chemistry and Quality Control of Biologics and Biosimilars
Credit hours : 3

Introduction

This course provides an integrated understanding of biologics and biosimilars, emphasizing their molecular design, structure–function relationship, analytical characterization, regulatory pathways, and clinical use. From a pharmaceutical chemistry standpoint, students will learn how biologics differ from small-molecule drugs in terms of synthesis, stability, degradation pathways, and quality attributes. From a clinical pharmacy standpoint, the course will focus on therapeutic interchangeability, immunogenicity, pharmacovigilance, and pharmacist roles in optimizing biologic therapy.

Course contents

1. **Foundations of biologic pharmaceutical chemistry:** Structural hierarchy in proteins (primary → quaternary), chemical bonds and interactions governing protein folding, post-translational modifications (PTMs): glycosylation, phosphorylation, disulfide formation, structure–function relationships, chemical differences between small molecules vs. biologics, concept of microheterogeneity and batch variability.

2. **Biotechnological processes & molecular production chemistry:** Expression systems (CHO, HEK, *E. coli*): chemical consequences on PTMs, fermentation process chemistry, downstream purification chemistry: (affinity chromatography, ion exchange, size-exclusion), protein refolding, solubility, and aggregation chemistry, chemical contaminants & impurities: host cell proteins, DNA residuals, endotoxins, impact of production chemistry on critical quality attributes (CQAs)
3. **Stability & degradation chemistry of biologics:** Physical degradation: aggregation, precipitation, denaturation, chemical degradation (oxidation, deamidation, isomerization, hydrolysis, disulfide scrambling), protein–excipients interactions, effect of temperature, pH, light, agitation (cold chain chemistry), forced degradation studies, stabilization strategies: buffers, sugars, surfactants, lyophilization chemistry,
4. **Analytical chemistry of biologics and biosimilars:** Electrophoresis & chromatography: SDS-PAGE, capillary electrophoresis, HPLC/UPLC (RP-HPLC, SEC, IEX), glycan profiling techniques; spectroscopy & mass spectrometry: circular dichroism (CD), FTIR, fluorescence spectroscopy, MALDI-TOF, ESI-MS, peptide mapping, high-resolution MS for PTM analysis; bioactivity assays: ELISA, surface plasmon resonance (SPR), cell-based bioassays and potency assessment; comparability & similarity testing: analytical similarity tiers, fingerprint-like similarity profiles, establishing similarity margins.
5. **Chemistry–manufacturing–controls (CMC) of biosimilars:** Stepwise demonstration of biosimilarity, selecting reference products, Identifying CQAs: structural, functional, stability-related, release testing & specifications, formulation development for biosimilars, glycosylation pattern comparisons, shelf-life assignment and stability chemistry, device compatibility (prefilled syringes, auto-injectors),
6. **Regulatory & quality chemistry:** WHO, EMA, FDA guidelines focusing on **analytical & CMC requirements,** quality by design (QbD) in biologics, comparability after manufacturing changes, ICH guidelines relevant to biologics: Q5, Q6B, Q8–Q11, traceability, labeling, naming, country-specific challenges (Bangladesh, LMIC context).
7. **Applied pharmaceutical chemistry in biologic formulations:** Protein formulation design, role of excipients: sugars, amino acids, surfactants, chelators, lyophilization cycle development, controlled release systems for biologics, container closure integrity, impact of silicone oil, leachables, extractables, subvisible and visible particulate analysis, formulation case studies: monoclonal antibodies, insulin analogs, erythropoietin.
8. **Selected clinical implications relevant to chemistry:** Impact of chemical instability on immunogenicity, PK/PD variations due to protein chemistry, substitution, switching, interchangeability based on chemistry, chemistry-related adverse events: aggregation-induced reactions, storage, handling, reconstitution: chemical rationale.
9. Any additional topics deemed appropriate by the course teacher.

Recommended books:

1. Biopharmaceuticals: Biochemistry and Biotechnology — Gary Walsh
2. Pharmaceutical Biotechnology: Fundamentals and Applications — Daan J. A. Crommelin, Robert D. Sindelar, and Bernd Meibohm
3. Remington: The Science and Practice of Pharmacy
4. Formulation and Process Development Strategies for Manufacturing Biopharmaceuticals — Feroz Jameel, Susan Hershenson, David Davis, Shangraw
5. Therapeutic Proteins: Methods and Protocols — Edited by C. Mark Smyth, John M. Walker (Methods in Molecular Biology Series)
6. Methods for Structural Analysis of Protein Pharmaceuticals — D. J. Houde & Steven A. Berkowitz
7. Biopharmaceutical Characterization: The NIST–FDA Initiative — Edited by John E. Schiel, Daniel S. Simón, and Lee-Xieng Wong
8. Biosimilars: Regulatory, Clinical, and Analytical Considerations — Sarfaraz K. Niazi
9. Quality by Design for Biopharmaceutical Drug Product Development — Editors: Feroz Jameel, Krishnakumar K. (Springer)
10. Goodman & Gilman's The Pharmacological Basis of Therapeutics
11. Biotechnology Operations: Principles and Practices — Michael Hopkin, Michael Priebe
12. USP–NF & European Pharmacopoeia (EP) Chapters on Biologics and Biosimilars

Pharm.D. Year-V (2ND SEMESTER)

PHR 521	Hospital and Clinical Residency	Credit Hr: 8

Course number : PHR 521
Course title : Hospital and Clinical Residency
Credit hours : 8

Course Description:
Students will be more focused on career planning and assessment in the final year of their B. Pharm Professional training. This year is reserved for advanced pharmacy practice experiences (APPEs), in which students rotate for a minimum of 600 hours at 7 often unique practice sites of Dhaka Medical College and Hospital such as medicine, surgery, paediatric, nephrology, cardiology, emergency and pharmacy under the guidance of a preceptor (professor, consultant, registrar) and additional staff. Throughout this year, the students are exposed to many different aspects of pharmacy including community, ambulatory care, hospital/health system, inpatient/acute care, and rotations.

Course contents:
Practical residency training will be conducted under the direct supervision of a preceptor (professor, consultant, registrar) in the Dhaka Medical College and Hospital.

PHR 522	Viva Voce	Credit Hr: 2

Course number : PHR 522
Course title : Viva Voce
Credit hours : 2