BANASTHALI VIDYAPITH

Bachelor of Pharmacy

Curriculum Structure

First Semester Examination, December-2019
Second Semester Examination, April/May-2020
Third Semester Examination, December-2020
Fourth Semester Examination, April/May-2021
Fifth Semester Examination, December-2021
Sixth Semester Examination, April/May-2022
Seventh Semester Examination, December-2022
Eighth Semester Examination, April/May-2023

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2019

50

No. F. 9-6/81-U.3

Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Programme Educational Objectives

Pharmacy programme deals with various aspects of modern drug design, drug development, production and quality assurance that are the basis for expertise in all domains of medicine. Pharmacy professionals being a member of healthcare team are unique in their detailed and comprehensive understanding of physical, chemical and biological interactions on the outcomes of drug therapy. They require an understanding of drug entities chemistry, delivery characteristics of dosage formulations, physiological and pharmacological outcomes of drug interactions.Pharmacy curriculum incorporate components of problem solving, case study and project work in the areas of specialization.The main objectives of the Pharmacy programme are:

- To provide exemplary education in a stimulating environment where delivery of pharmaceutical knowledge is integrated with nationally and internationally recognized research to conduct and publish cutting-edge multidisciplinary research in the discovery, utilization and evaluation of therapeutic agents.
- To prepare competent pharmacists at various levels for India.
- To raise sensitivity to professional ethical codes of conduct and social values.
- To prepare globally recognized pharmacy professionals.
- To demonstrate standards of digital literacy that would support professional needs in manufacture, patient care, hospital administration etc.
- To create awareness in society for rationale usage of medicines.
- To create awareness about environmental hazards in relation to GMP & GLP.
- To develop gender-neutral attitudes and practices; respect for all races, nations, religions, cultures, languages and traditions.
- To nurture a temperament that would enable individuals to set and work towards self-driven performance-goals, entrepreneurial ventures and overall leadership.

Programme Outcomes

PO1: **Pharmacy Knowledge:** Possess knowledge and comprehension of the core and basic knowledge associated with the profession of pharmacy, including biomedical sciences; pharmaceutical science and technology; behavioral, social, and administrative pharmaceutical sciences; and manufacturing practices.

PO2: **Planning abilities:** Demonstrate effective planning abilities including time management, resource management, delegation skills and organizational skills. Develop and implement plans and organize work to meet deadlines.

PO3: **Problem analysis:** Utilize the principles of scientific enquiry, thinking analytically, clearly and critically, while solving problems and making decision during daily practice. Find, analyze, evaluate and apply information systematically and shall make defensible decisions.

PO4: **Modern tool usage:** Learn, select, and apply appropriate methods and procedures, resources, and modern pharmacy-related computing tools with an understanding of the limitations.

PO5: **Leadership skills:** Understand and consider the human reaction to change, motivation issues, leadership and team building when planning changes required for fulfillment of practice, professional and societal responsibilities. Assume participatory roles as responsible citizen or leadership roles when appropriate to facilitate improvement in health and well-being.

PO6: **Professional Identity:** Understand, analyze and communicate the value of their professional roles in society (e.g. health care professionals, promoters of health, educators, managers, employers, employees).

PO7: **Pharmaceutical Ethics:** Honor personal values and apply ethical principles in professional and social contexts. Demonstrate behavior that recognizes cultural and personal variability in values, communication and lifestyles. Use ethical frameworks; apply ethical principles while making decisions and take responsibility for the outcomes associated with the decisions.

PO8: **Communication:** Communicate effectively with the pharmacy community and with society at large, such as, being able to comprehend and write effective, make effective presentations and documentation, and give and receive clear instructions.

PO9: **The Pharmacist and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety and legal issues and the consequent responsibilities relevant to the professional pharmacy practice.

PO10: **Environment and sustainability:** Understand the impact of the professional pharmacy solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO11: **Life- long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Self-access and use feedback effectively from others to identify learning needs and to satisfy theses needs on an ongoing basis.

Curriculum Structure
Bachelor of Pharmacy
First Year

Semester - I

Course	Code	Course Name	L	T	P	C*
BVF	011/	General English /सामान्य हिन्दी	2	0	0	2
BVF	014					
		Core Foundation Course - I	2	0	0	2
PHAR	102	Human Anatomy and Physiology-I	4	0	0	4
PHAR	104	Pharmaceutical Analysis - I	4	0	0	4
PHAR	105	Pharmaceutical Inorganic Chemistry	4	0	0	4
PHAR	107	Pharmaceutics - I	4	0	0	4
PHAR	108/	Remedial Biology[@]/ Remedial Mathematics	3	0	0	3
MATH	110					
PHAR	102L	Human Anatomy and Physiology - I Lab	0	0	4	2
PHAR	104L	Pharmaceutical Analysis - I Lab	0	0	4	2
PHAR	105L	Pharmaceutical Inorganic Chemistry Lab	0	0	4	2
PHAR	107L	Pharmaceutics - I Lab	0	0	4	2
		Semester Total:	**23**	**0**	**16**	**31**

@ : Only for students who have been admitted from mathematics background (10+2)

Semester - II

Course	Code	Course Name	L	T	P	C*
BVF	014/	सामान्य हिन्दी/General English	2	0	0	2
BVF	011					
		Core Foundation Course - II	2	0	0	2
CS	102	Computer Applications in Pharmacy	3	0	0	3
PHAR	101	Biochemistry	4	0	0	4
PHAR	103	Human Anatomy and Physiology - II	4	0	0	4
PHAR	106	Pharmaceutical Organic Chemistry - I	4	0	0	4
PHAR	212	Pathophysiology	4	0	0	4
CS	102L	Computer Applications in Pharmacy Lab	0	0	4	2
PHAR	101L	Biochemistry Lab	0	0	4	2
PHAR	103L	Human Anatomy and Physiology - II Lab	0	0	4	2
PHAR	106L	Pharmaceutical Organic Chemistry - I Lab	0	0	4	2
		Semester Total:	**23**	**0**	**16**	**31**

Second Year

Semester - III

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
PHAR 204	Pharmaceutical Microbiology	4	0	0	4
PHAR 205	Pharmaceutical Organic Chemistry - II	4	0	0	4
PHAR 213	Pharmaceutical Engineering	4	0	0	4
PHAR 217	Physical Pharmaceutics - I	4	0	0	4
PHAR 219	Pharmaceutical Physical Chemistry	3	0	0	3
PHAR 204L	Pharmaceutical Microbiology Lab	0	0	4	2
PHAR 205L	Pharmaceutical Organic Chemistry - II Lab	0	0	4	2
PHAR 213L	Pharmaceutical Engineering Lab	0	0	4	2
PHAR 217L	Physical Pharmaceutics - I Lab	0	0	4	2
	Semester Total:	**23**	**0**	**16**	**31**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
PHAR 211	Medicinal Chemistry - I	4	0	0	4
PHAR 214	Pharmaceutical Organic Chemistry - III	4	0	0	4
PHAR 215	Pharmacognosy and Phytochemistry - I	4	0	0	4
PHAR 216	Pharmacology - I	4	0	0	4
PHAR 220	Physical Pharmaceutics - II	3	0	0	3
PHAR 211L	Medicinal Chemistry - I Lab	0	0	4	2
PHAR 215L	Pharmacognosy and Phytochemistry - I Lab	0	0	4	2
PHAR 216L	Pharmacology - I Lab	0	0	4	2
PHAR 218L	Physical Pharmaceutics - II Lab	0	0	4	2
	Semester Total:	**23**	**0**	**16**	**31**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/ Elective Foundation Course - III	2	0	0	2
PHAR 313	Industrial Pharmacy-I	4	0	0	4
PHAR 403	Medicinal Chemistry-II	4	0	0	4
PHAR 317	Pharmacology-II	4	0	0	4
PHAR 316	Pharmacognosy and phytochemistry-II	4	0	0	4
PHAR 315	Pharmaceutical Jurisprudence	4	0	0	4
PHAR 313L	Industrial Pharmacy-I Lab	0	0	4	2
PHAR 317L	Pharmacology-II Lab	0	0	4	2
PHAR 316L	Pharmacognosy and Phytochemistry-II Lab	0	0	4	2
	Semester Total:	**24**	**0**	**12**	**30**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/ Core Foundation Course - V	2	0	0	2
PHAR 311	Biopharmaceutics and Pharmacokinetics	4	0	0	4
PHAR 312	Herbal Drug Technology	3	0	0	3
PHAR 404	Medicinal Chemistry-III	4	0	0	4
PHAR 318	Pharmacology-III	4	0	0	4
PHAR 314	Pharmaceutical Biotechnology	3	0	0	3
PHAR 319	Quality Assurance	3	0	0	3
PHAR 312L	Herbal Drug Technology Lab	0	0	4	2
PHAR 404L	Medicinal Chemistry-III Lab	0	0	4	2
PHAR 318L	Pharmacology-III Lab	0	0	4	2
	Semester Total:	**25**	**0**	**12**	**31**

Fourth Year

Semester - VII

Course	Code	Course Name	L	T	P	C*
PHAR	416	Instrumental Methods of Analysis	4	0	0	4
PHAR	415	Industrial Pharmacy-II	4	0	0	4
PHAR	417	Novel Drug Delivery System	4	0	0	4
PHAR	414	Dosage Form Design	4	0	0	4
PHAR	421	Pharmacy Practice	4	0	0	4
PHAR	416L	Instrumental Methods of Analysis Lab	0	0	4	2
PHAR	414L	Dosage Form Design Lab	0	0	4	2
PHAR	422L	Practice School	0	0	8	4
		Semester Total:	**20**	**0**	**16**	**28**

Semester - VIII

Course	Code	Course Name	L	T	P	C*
PHAR	412	Biostatistics and Research Methodology	4	0	0	4
PHAR	425	Social and Preventive Pharmacy	4	0	0	4
PHAR	423P	Project Work	0	0	16	8
		Discipline Elective - I	4	0	0	4
		Discipline Elective - II	4	0	0	4
		Open Elective	4	0	0	4
		Semester Total:	**20**	**0**	**16**	**28**

List of Discipline Elective

Course	Code	Course Name	L	T	P	C
PHAR	411	Advanced Instrumentation Techniques	4	0	0	4
PHAR	419	Pharmaceutical Regulatory Science	4	0	0	4
PHAR	424	Quality Control and Standardization of Herbals	4	0	0	4
PHAR	420	Pharmacovigilance	4	0	0	4
PHAR	413	Cosmetic Science	4	0	0	4
PHAR	418	Pharmaceutical Marketing	4	0	0	4

List of Core Foundation Course						
Course Code		**Course Name**	**L**	**T**	**P**	**C**
BVF	002	Environment Studies	2	0	0	2
BVF	013	Indian Cultural Heritage	2	0	0	2
BVF	017	Selected Writings of Great Authors - I	2	0	0	2
BVF	015	Parenthood and Family Relation	2	0	0	2
BVF	020	Women in Indian Society	2	0	0	2

List of Elective Foundation Course						
Course Code		**Course Name**	**L**	**T**	**P**	**C***
BVF	010	Design Thinking	2	0	0	2
BVF	012	Human Body and Health	2	0	0	2
BVF	016	Science of Happiness	2	0	0	2
BVF	019	Universal Human Values	2	0	0	2
BVF	018	Selected Writings of Great Authors - II	2	0	0	2

List of Vocational Course

Course Code		Course Name	L	T	P	C
VOC	011L	Basic Dress Making	0	0	4	2
VOC	005L	Dress Designing	0	0	4	2
VOC	014	Entrepreneurship - I	2	0	0	2
VOC	015	Entrepreneurship - II	2	0	0	2
VOC	020	Radio Production - I	2	0	0	2
VOC	021	Radio Production - II	2	0	0	2
VOC	022	Web Designing and Internet Technology-I	1	0	0	1
VOC	022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC	023	Web Designing and Internet Technology-II	1	0	0	1
VOC	023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC	009	Library Science - I	1	0	0	1
VOC	009L	Library Science - I Lab	0	0	2	1
VOC	010	Library Science - II	1	0	0	1
VOC	010L	Library Science - II Lab	0	0	2	1
VOC	018	Photography - I	0	0	4	2
VOC	019	Photography - II	0	0	4	2
VOC	016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC	017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC	012	Computer Assisted Learning and Teaching	1	0	0	1
VOC	012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC	013	Emerging Technologies for Learning and Teaching	2	0	0	2

*** L - Lecture hrs/week; T - Tutorial hrs/week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C - Credit Points of the Course**

Student can opt open (Generic) elective from any discipline of the Vidyapith with prior permission of respective heads and time table permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

Five Fold Activities

Fine Arts		Physical Education and Sports	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
		BVFF 213	Hockey
Social Service and Extension Activities		BVFF 214	Judo
BVFF 301	Banasthali Sewa Dal	BVFF 215	Kabaddi
BVFF 302	Extension Programs for Women Empowerment	BVFF 216	Karate – Do
BVFF 303	FM Radio	BVFF 217	Kho-Kho
BVFF 304	Informal Education	BVFF 218	Net Ball
BVFF 305	National Service Scheme	BVFF 219	Rope Mallakhamb
BVFF 306	National Cadet Corps	BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis
		BVFF 225	Throwball
		BVFF 226	Volleyball
		BVFF 227	Weight Training
		BVFF 228	Yoga

Evaluation Scheme and Grading System

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max. Marks)	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ----+ CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ----+ CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.

Division	CGPA
Distinction	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

CGPA to % Conversion Formula: % of Marks Obtained = CGPA * 10

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First Semester

PHAR 102 Human Anatomy and Physiology-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Gross morphology, structure and functions of cell, skeletal, muscular, lymphatic cardiovascular system of the human body
- Various homeostatic mechanisms and their imbalances
- Different types of bones and joints in human body
- Various tissues of different systems of human body
- Various experimental techniques related to physiology
- Various techniques like blood group determination, blood pressure measurement, blood cells counting.
- Structure and functions of special senses and PNS

Section-A

Introduction to human body: Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology.

Cellular level of organization: Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signaling pathway activation by extracellular signal molecule, Forms of intracellular signaling: a) Contact-dependent b) Paracrine c) Synaptic d) Endocrine

Tissue level of organization: Classification of tissues, structure, location and functions of epithelial, muscular and nervous and connective tissues.

Section-B

Integumentary system: Structure and functions of skin

Skeletal system: Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system. Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction.

Joints: Structural and functional classification, types of joints movements and its articulation

Body fluids and blood: Body fluids, composition and functions of blood, hemopoeisis, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood, Reticulo endothelial system.

Lymphatic system: Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system

Section-C

Peripheral nervous system: Classification of peripheral nervous system, Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves.

Special senses: Structure and functions of eye, ear, nose and tongue and their disorders.

Cardiovascular system: Heart – anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heartbeat, its regulation by autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart.

Books recommended:

1. Sembulingam, K., Sembulingam, P. (2012). *Essentials of Medical Physiology*, 6th Ed., New Delhi: Jaypee Brothers' medical publisher.
2. Kathleen, J.W. (1992). *Anatomy and Physiology in Health and Illness*, 7th Ed., New York: Churchill Livingstone.
3. Tandon, O.P., Tripathi, Y. (2011). *Physiological basis of Medical Practice*- Best and Tailor, Wolters Kluwer India Pvt. Ltd.
4. Hall, J.E. (2010). *Guyton and Hall Textbook of Medical Physiology*, 11th Ed., Saunders.
5. Tortora, G.J., Grabowski S.R. (2000). *Principles of Anatomy and Physiology*, 9th Ed., New York: Wiley.
6. Singh, I. (2011). *Textbook of Human Histology*, 6thEd., New Delhi: Jaypee brother's medical publishers.
7. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8thEd., New Delhi: Jaypee brother's medical publishers.

8. Srinageswari, K., Sharma, R. (2015). *Practical workbook of Human Physiology*, New Delhi: Jaypee brother's medical publishers.

9. Chatterrje, C.C. (2005). *Human Physiology*, vol 1-2. Kolkatta: Academic Publishers.

Suggested e-material:

1. www.opentextbc.ca
2. www.study.com
3. www.getbodysmart.com
4. www.kenhub.com

PHAR 104 Pharmaceutical Analysis-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Different types of analysis
- Principles, instrumentation and applications of various types of titration
- Impurities in medicinal agents

Section-A

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

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

Pharmacopoeia, sources of impurities in medicinal agents, limit tests.

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

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

Section-B

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

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

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

Basic principles, methods and application of diazotisation titration.

Redox titrations: Concepts of oxidation and reduction, types of redox titrations (Principles and applications), cerimetry, iodimetry, iodometry, bromatometry, dichrometry, titration with potassium iodate

Section-C

Conductometry: Introduction, conductivity cell, conductometric titrations, applications.

Potentiometry: Electrochemical cell, construction and working of reference (Standard hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine end point of potentiometric titration and applications.

Polarography: Principle, Ilkovic equation, construction and working of dropping mercury electrode and rotating platinum electrode, applications

Books recommended:

1. Beckett, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*, 4thEd., vol 1-2. London: Stahlone Press.

2. Mendham, (2019). Vogel,s AI- *Text Book of Quantitative Inorganic analysis*, 6thEd.,Pearson.

3. Rao, P.G. (2006). *Inorganic Pharmaceutical Chemistry*, 3rdEd.,Pharma Med Press.

4. Atherden, L.M. (2004). *Bentley and Driver's Textbook of Pharmaceutical Chemistry*, Oxford University Press.

5. Kennedy, J.K. (1990). *Analytical chemistry principles*, 3rdEd.,Brooks/ Cole.

6. *Indian Pharmacopoeia*, (2014). Addendum 2016.

Suggested e-material:

1. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118695425.ch10

2. https://www.researchgate.net/publication/280224434_Handbook_of_Inorganic_Impurities_in_Pharmaceuticals

3. http://www.rroij.com/open-access/a-review-on-impurity-profile-in-pharmaceutical-substances.php?aid=34989

4. https://www.scribd.com/doc/101354608/Chapter-5-Gastro intestinal-Agents- Reviewer

5. https://www.who.int/medicines/publications/pharmacopoeia/Radgen mono

PHAR 105 Pharmaceutical Inorganic Chemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Principles of limit tests
- Preparation, assay, properties and medicinal uses different inorganic compounds
- Identification of different anions, cations and different inorganic pharmaceuticals.
- Sources of impurities and methods to determine the impurities in pharmaceuticals

Section-A

Impurities in pharmaceutical substances: History of Pharmacopoeia, Sources and types of impurities, principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals, modified limit test for Chloride and Sulphate.

General methods of preparation, assay for the compounds superscripted with asterisk (*), properties and medicinal uses of inorganic compounds belonging to the following classes.

Acids, Bases and Buffers: Buffer equations and buffer capacity in general, buffers in pharmaceutical systems, preparation, stability, buffered isotonic solutions, measurements of tonicity, calculations and methods of adjusting isotonicity.

Major extra and intracellular electrolytes: Functions of major physiological ions, Electrolytes used in the replacement therapy: Sodium chloride*, Potassium chloride, Calcium gluconate* and Oral Rehydration Salt (ORS), Physiological acid base balance.

Section-B

Dental products: Dentifrices, role of fluoride in the treatment of dental caries, Desensitizing agents, Calcium carbonate, Sodium fluoride, and Zinc eugenol cement.

Acidifiers: Ammonium chloride* and Dil. HCl

Antacid: Ideal properties of antacids, combinations of antacids, SodiumBicarbonate*, Aluminum hydroxide gel, Magnesium hydroxide mixture Cathartics: Magnesium sulphate, Sodium orthophosphate, Kaolin and Bentonite

Antimicrobials: Mechanism, classification, Potassium permanganate, Boric acid, Hydrogen peroxide*, Chlorinated lime*, Iodine and its preparations

Section-C

Expectorants: Potassium iodide, Ammonium chloride*.

Emetics: Copper sulphate*, Sodium potassium tartarate

Haematinics: Ferrous sulphate*, Ferrous gluconate

Poison and Antidote: Sodium thiosulphate*, Activated charcoal, Sodium nitrite

Astringents: Zinc Sulphate, Potash Alum

Radiopharmaceuticals: Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations, Half-life, radio isotopes and study of radio isotopes - Sodium iodide I^{131}, Storage conditions, precautions & pharmaceutical application of radioactive substances.

Books recommended:

1. Beckett, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*,4thEd., vol 1-2. London: Stahlone Press.
2. Mendham, (2019). *Vogel's AI- Text Book of Quantitative Inorganic Analysis*, 6thEd., Pearson.
3. Rao, P.G. (2006). *Inorganic Pharmaceutical Chemistry*, 3rdEd., Pharma med press.
4. Schroff, M.L. (1968). *Inorganic Pharmaceutical Chemistry*, Calcutta: National book centre.
5. Atherden, L.M. (2004). *Bentley and Driver's Textbook of Pharmaceutical Chemistry*,Oxford University Press.
6. Chatwal, G.R. (2010). *Pharmaceutical Chemistry Inorganic*, Himalaya Publishing House.
7. Indian Pharmacopoeia, (2014). Addendum 2016.

Suggested e-material:

1. http://www.sciencedirect.com/science/book/9780123851109
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118695425.ch10
3. https://www.researchgate.net/publication/280224434_Handbook_of_Inorganic_Impurities_in_Pharmaceuticals
4. http://www.rroij.com/open-access/a-review-on-impurity-profile-in-pharmaceutical-substances.php?aid=34989
5. https://www.scribd.com/doc/101354608/Chapter-5-Gastro intestinal-Agents-Reviewer
6. https://www.who.int/medicines/publications/pharmacopoeia/Radgen mono

PHAR 107 Pharmaceutics - I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Importance of IP, BP, USP and Extra Pharmacopoeia
- Definition, preparation, classification, advantages and disadvantages of different dosage forms
- Pharmaceutical incompatibilities and calculations
- Professional handling of prescription

Section-A

Historical background and development of profession of pharmacy: Historyof profession of Pharmacy in India in relation to pharmacy education, industryand organization, Pharmacy as a career, Pharmacopoeias: Introduction to IP, BP, USP and Extra Pharmacopoeia.

Dosage forms: Introduction to dosage forms, classification and definitions

Prescription: Definition, Parts of prescription, handling of Prescription and

Errors in prescription.

Posology: Definition, Factors affecting posology. Pediatric dose calculationsbased on age, body weight and body surface area.

Pharmaceutical calculations: Weights and measures – Imperial & Metric system, Calculations involving percentage solutions, alligation, proof spirit and isotonic solutions based on freezing point and molecular weight.

Section-B

Powders: Definition, classification, advantages and disadvantages, Simple & compound powders – official preparations, dusting powders, effervescent, efflorescent and hygroscopic powders, eutectic mixtures. Geometric dilutions.

Liquid dosage forms: Advantages and disadvantages of liquid dosage forms. Excipients used in formulation of liquid dosage forms. Solubility enhancementtechniques

Monophasic liquids: Definitions and preparations of Gargles, Mouthwashes, Throat Paint, Eardrops, Nasal drops, Enemas, Syrups, Elixirs, Liniments and Lotions.

Suspensions: Definition, advantages and disadvantages, classifications, Preparation of suspensions; Flocculated and Deflocculated suspension & stability problems and methods to overcome.

Section-C

Emulsions: Definition, classification, emulsifying agent, test for the identification of type of Emulsion, Methods of preparation & stability problems and methods to overcome.

Suppositories: Definition, types, advantages and disadvantages, types of bases, methods of preparations. Displacement value & its calculations, evaluation of suppositories.

Pharmaceutical incompatibilities: Definition, classification, physical, chemicaland therapeutic incompatibilities with examples.

Semisolid dosage forms: Definitions, classification, mechanisms and factors influencing dermal penetration of drugs. Preparation of ointments, pastes, creams and gels. Excipients used in semi solid dosage forms. Evaluation of semi solid dosages forms

Books recommended:

1. Allen, I.V., Popovich, J.N.G. Ansel, H.C. (2005). *Ansel's Pharmaceutical Dosage Form and Drug Delivery System*, 8thEd., New Delhi: Lippincott Williams and Walkins.

2. Carter, S.J. (2008). *Cooper and Gunn's-Dispensing for Pharmaceutical Students*, 12thEd., New Delhi: CBS publishers.

3. Aulton, M.E. (2002). *Pharmaceutics, The Science & Dosage Form Design*, 2ndEd., Edinbrg: Churchill Livingstone.

4. *Indian Pharmacopoeia* (2014). Addendum 2016.

5. *British pharmacopoeia* (2019).

6. Lachmann, L., Lieberman, H.A., Kaing, J.L. (2009). *Theory and Practice of Industrial Pharmacy, Lea and Febiger Publisher.*

7. Remington, J.P.,Gennaro, A.R.,Remington, A.R.G. (2005). *The Science and Practice of Pharmacy*, 21stEd., New Delhi: Lippincott Williams and willikins.

8. Carter, S.J. (2005). *Cooper and Gunn's-Dispensing for Pharmaceutical Students*, 12thEd., New Delhi: CBS publishers.

9. Rawlins. (2010). *Bentley's Text Book of Pharmaceutics*, Elsevier.

10. Bodmier, R. (1989). *Pharmaceutical Pelletization Technology,* New York: Marcel Dekker.

11. Pareekh, D.M. (2005). *Handbook of Pharmaceutical Granulation Technology*, 2ndEd., New York: Marcel Dekker.

12. Nieloud, F., Mestres, G.M. (2000) Pharmaceutical Emulsions and Suspensions, New York: Marcel Dekker, INC.

Suggested e-material:

1. https://health.sbmu.ac.ir/uploads/Remington_Essentials_of_Pharmaceutics_-_Felton,_Linda.pdf

2. http://gmpua.com/Process/EncyclopediaPT.pdf

3. http://pharmacentral.in/wp-content/uploads/2018/05/INDIAN%20PHARMACOPOEIA%202007.pdf

4. https://www.pdfdrive.com/pharmacy-calculations-for-pharmacy-technicians-d58957811.html

5. http://file.akfarmahadhika.ac.id/E-BOOK/12-1213-akfarmahad-6-1-fasttrac-g.pdf

PHAR 108 Remedial Biology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Evolutionary biology and behavior.
- Anatomy, physiology and regulation of various body system
- Plant physiology

Section-A

Living world:

Definition and characters of living organisms, Diversity in the living world, Binomial nomenclature, Five kingdoms of life and basis of classification. Salient features of Monera, Potista, Fungi, Animalia and Plantae, Virus.

Morphology of Flowering plants:

Morphology of different parts of flowering plants – Root, stem, inflorescence, flower, leaf, fruit and seed.

General Anatomy of root, stem, leaf of monocotyledons & Dicotylidones.

Body fluids and circulation:

Composition of blood, blood groups, coagulation of blood, Composition and functions of lymph, Human circulatory system, Structure of human heart and blood vessels, Cardiac cycle, cardiac output and ECG.

Digestion and Absorption:

Human alimentary canal and digestive glands, Role of digestive enzymes, Digestion, absorption and assimilation of digested food

Section-B

Breathing and respiration:

Human respiratory system, Mechanism of breathing and its regulation, Exchange of gases, transport of gases and regulation of respiration, Respiratory volumes.

Excretory products and their elimination:

Modes of excretion, Human excretory system- structure and function, Urine formation, Rennin angiotensin system.

Neural control and coordination:

Definition and classification of nervous system, Structure of a neuron,

Generation and conduction of nerve impulse, Structure of brain and spinal cord, Functions of cerebrum, cerebellum, hypothalamus and medulla oblongata.

Chemical coordination and regulation:

Endocrine glands and their secretions, Functions of hormones secreted by endocrine glands.

Section-C

Human reproduction:

Parts of female reproductive system, Parts of male reproductive system, Spermatogenesis and Oogenesis, Menstrual cycle.

Plants and mineral nutrition:

Essential mineral, macro and micronutrients, Nitrogen metabolism, Nitrogen cycle, biological nitrogen fixation

Photosynthesis:

Autotrophic nutrition, photosynthesis, Photosynthetic pigments, Factors affecting photosynthesis.

Plant respiration:

Respiration, glycolysis, fermentation (anaerobic). Plant growth and development, Phases and rate of plant growth, Condition of growth,Introduction to plant growth regulators

Cell - The unit of life:

Structure and functions of cell and cell organelles. Cell division

Tissues:

Definition, types of tissues, location and functions.

Books recommended:

1. Gokhale, S.B., Kokate, C.K., Bidarkar, D.S. (2007). *Pharmaceutical Biology*, 5th Ed., Pune: Nirali Prakashan.

2. Thulajappa, Y., Seetaram, P.I. (2005). *New Expert Biology*, vol 2, Expert educational publisher.

Suggested e-material:

1. www.opentextbc.ca
2. www.study.com
3. www.getbodysmart.com
4. www.kenhub.com
5. www.apchute.com
6. www.openstax.cnx.org

MATH 110 Remedial Mathematics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Mathematical concepts and principles to perform various calculations in Pharmacy
- mathematical expressions and mathematical relationships
- Abstract mathematical reasoning

Section-A

Partial fraction: Introduction, Polynomial, Rational fractions, Proper and Improper fractions, Partial fraction, Resolving into Partial fraction, Application of Partial Fraction in Chemical Kinetics and Pharmacokinetics

Logarithms: Introduction, Definition, Theorems/Properties of logarithms, Common logarithms, Characteristic and Mantissa, worked examples, application of logarithm to solve pharmaceutical problems.

Function: Real Valued function, Classification of real valued functions.

Limits and continuity: Introduction, Limit of a function, Definition of limit of a function (definition), $\lim xa\ x^n - a^n/x-a = na^{n-1}$, lim =1

Section-B

Matrices and Determinant: Introduction matrices, Types of matrices, Operation on matrices, Transpose of a matrix, Matrix Multiplication, Determinants, Properties of determinants , Product of determinants, Minors and co-Factors, Adjoint or adjugate of a square matrix , Singular and non-singular matrices, Inverse of a matrix, Solution of system of linear of equations using matrix method, Cramer's rule, Characteristic equation and roots of a square matrix, Cayley–Hamilton theorem, Application of Matrices in solving Pharmacokinetic equations

Differentiation: Introductions, Derivative of a function, Derivative of a constant, Derivative of a product of a constant and a function , Derivative of the sum or difference of two functions, Derivative of the product of two functions (product formula), Derivative of the quotient of two functions (Quotient formula) – Without Proof, Derivative of *xn w.r.t*x,where *n* is any rational number, Derivative of *ex*,, Derivative of loge *x* , Derivative of *ax* ,Derivative of trigonometric functions from first principles (without Proof), Successive Differentiation, Conditions for a function to be a maximum or a minimum at a point.

Section-C

Analytical Geometry

Introduction: Signs of the Coordinates, Distance formula, Straight Line : Slope or gradient of a straight line, Conditions for parallelism and perpendicularity of two lines, Slope of a line joining two points, Slope – intercept form of a straight line

Integration: Introduction, Definition, Standard formulae, Rules of integration, Method of substitution, Method of Partial fractions, Integration by parts, definite integrals, application

Differential Equations: Some basic definitions, Order and degree, Equations in separable form, Homogeneous equations, Linear Differential equations, Exact equations, Application in solving

Pharmacokinetic equations

Laplace Transform: Introduction, Definition, Properties of Laplace transform, Laplace Transforms of elementary functions, Inverse Laplace transforms, Laplace transform of derivatives, Application to solve Linear differential equations**,** Application in solving Chemical kinetics and Pharmacokinetics equations

Books Recommended:

1. Narayan, S., Mittal, P.K. (2005). *Differential Calculus*, S Chand Publisher.
2. Panchaksharappa, G.D.H. (2014). *Pharmaceutical Mathematics with application to Pharmacy*, New Delhi: CBS Publishers and Distributors.
3. Narayan, S. (2005). *Integral Calculus*, S ChandPublisher.
4. Grewal, B.S. (2001). *Higher Engineering Mathematics*, 36th Ed., Khanna Publisher.

Suggested e-material:

1. www.openculture.com/free-math-textbooks
2. E-Books | mathematics.library.cornell.edu

PHAR 102L Human Anatomy and Physiology - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Practical physiology is complimentary to the theoretical discussions in physiology. Practical's allow the verification of physiological processes discussed in theory classes through experiments on living tissue, intact animals or normal human beings. This is helpful for developing an insight on the subject.

1. Study of compound microscope.
2. Microscopic study of epithelial and connective tissue
3. Microscopic study of muscular and nervous tissue
4. Identification of axial bones
5. Identification of appendicular bones
6. Introduction to hemocytometry.
7. Enumeration of white blood cell (WBC) count
8. Enumeration of total red blood corpuscles (RBC) count
9. Determination of bleeding time
10. Determination of clotting time
11. Estimation of hemoglobin content
12. Determination of blood group.
13. Determination of erythrocyte sedimentation rate (ESR).
14. Determination of heart rate and pulse rate.
15. Recording of blood pressure.

PHAR 104L Pharmaceutical Analysis - I Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	4	2

I Limit Test of the following

(1) Chloride

(2) Sulphate

(3) Iron

(4) Arsenic

II Preparation and standardization of

(1) Sodium hydroxide

(2) Sulphuric acid

(3) Sodium thiosulfate

(4) Potassium permanganate

(5) Ceric ammonium sulphate

III Assay of the following compounds along with Standardization of Titrant

(1) Ammonium chloride by acid base titration

(2) Ferrous sulphate by Cerimetry

(3) Copper sulphate by Iodometry

(4) Calcium gluconate by complexometry

(5) Hydrogen peroxide by Permanganometry

(6) Sodium benzoate by non-aqueous titration

(7) Sodium Chloride by precipitation titration

IV Determination of Normality by electro-analytical methods

(1) Conductometric titration of strong acid against strong base

(2) Conductometric titration of strong acid and weak acid against strong base

(3) Potentiometric titration of strong acid against strong base

PHAR 105L Pharmaceutical Inorganic Chemistry Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

I Limit tests for following ions

Limit test for Chlorides and Sulphates

Modified limit test for Chlorides and Sulphates

Limit test for Iron

Limit test for Heavymetals

Limit test for Lead

Limit test for Arsenic

II Identification test

Magnesium hydroxide

Ferrous sulphate

Sodium bicarbonate

Calcium gluconate

Copper sulphate

III Test for purity

Swelling power of Bentonite

Neutralizing capacity of aluminum hydroxide gel

Determination of potassium iodate and iodine in potassium Iodide

IV Preparation of inorganic pharmaceuticals

Boric acid

Potash alum

Ferrous sulphate

PHAR 107L Pharmaceutics - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Syrups

a) Syrup IP'66

b) Compound syrup of Ferrous Phosphate BPC'68

2. Elixirs

a) Piperazine citrate elixir

b) Paracetamol pediatric elixir

3. Linctus

a) Terpin Hydrate Linctus IP'66

b) Iodine Throat Paint (Mandles Paint)

4. Solutions

a) Strong solution of ammonium acetate

b) Cresol with soap solution

c) Lugol's solution

5. Suspensions

a) Calamine lotion

b) Magnesium Hydroxide mixture

c) Aluminimum Hydroxide gel

6. Emulsions

a) Turpentine Liniment

b) Liquid paraffin emulsion

7. Powders and Granules

a) ORS powder (WHO)

b) Effervescent granules

c) Dusting powder

d) Divided powders

8. Suppositories

a) Glycero gelatin suppository

b) Coca butter suppository

c) Zinc Oxide suppository

9. Semisolids

a) Sulphur ointment

b) Non staining-iodine ointment with methyl salicylate

c) Carbopol gel

10. Gargles and Mouthwashes

a) Iodine gargle

b) Chlorhexidine mouthwash

Second Semester

CS 102 Computer Applications in Pharmacy

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Mathematics and computing fundamentals used in pharmaceutical applications
- Analyzing pharmaceutical problems using computers
- Integration and application of contemporary IT tools in Pharmaceutical related activities
- Ethics, social, cultural and regulations with regard to Pharmacy

Section-A

Number system: Binary number system, Decimal number system, Octal number system, Hexadecimal number systems, conversion decimal to binary, binary to decimal, octal to binary etc, binary addition, binary subtraction – One's complement, Two's complement method, binary multiplication, binary division

Concept of Information Systems and Software: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project

Section-B

Web technologies: Introduction to HTML, XML,CSS and Programming languages, introduction to web servers and Server Products Introduction to databases, MYSQL, MS ACCESS, Pharmacy Drug database

Application of computers in Pharmacy – Drug information storage and retrieval, Pharmacokinetics, Mathematical model in Drug design, Hospital and Clinical Pharmacy, Electronic Prescribing and discharge (EP) systems, barcode medicine identification and automated dispensing of drugs, mobile technology and adherence monitoring. Diagnostic System, Lab-diagnostic System, Patient Monitoring System, Pharma Information System.

Section-C

Bioinformatics: Introduction, Objective of Bioinformatics, Bioinformatics Databases, Concept of Bioinformatics, Impact of Bioinformatics in Vaccine Discovery

Computers as data analysis in Preclinical development: Chromatographic dada analysis (CDS), Laboratory Information management System (LIMS) and Text Information Management System (TIMS)

Books Recommended:

1. Fassett, W.E., Christensen, D.B. (2015). *Computer Application in Pharmacy*. Lea & Febiger
2. Ekins, S. (2006). *Computer Application in Pharmaceutical Research and Development*, Wiley-Interscience.
3. Rastogi, S.C. (2006). *Bioinformatics (Concept, Skills and Applications)*, New Delhi: CBS Publishers and Distributors.
4. Prague, C.N., Irwin, M.R., Reardon, J. (2003). *Microsoft office Access - 2003, Application Development Using VBA, SQL Server, DAP and Infopath*, New Delhi: Wiley India (P) Ltd.

Suggested e-material:

1. https://www.ebooks.com/subjects/computers
2. https://bookboon.com/en/it-programming-ebooks

PHAR 101 Biochemistry

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Fundamentals roles of biomolecules
- Various metabolic pathways and regulations of biological/ biochemical processes
- Introduction, properties, nomenclature, classification, therapeutic and diagnostic applications of enzymes

Section-A

Biomolecules: Introduction, classification, chemical nature and biological role of carbohydrate, lipids, nucleic acids, amino acids and proteins.

Bioenergetics: Concept of free energy, endergonic and exergonic reaction, Relationship between free energy, enthalpy and entropy; Redox potential. Energy rich compounds; classification; biological significances of ATP and cyclic AMP

Carbohydrate metabolism: Glycolysis – Pathway, energetics and significance Citric acid cycle- Pathway, energetics and significance HMP shunt and its significance; Glucose-6-Phosphate dehydrogenase (G6PD) deficiency Glycogen metabolism Pathways and glycogen storage diseases (GSD) Gluconeogenesis- Pathway and its significance. Hormonal regulation of blood glucose level and Diabetes mellitus

Section-B

Biological oxidation: Electron transport chain (ETC) and its mechanism. Oxidative phosphorylation & its mechanism and substrate phosphorylation. Inhibitors ETC and oxidative phosphorylation/Uncouplers

Lipid metabolism: â-Oxidation of saturated fatty acid (Palmitic acid). Formation and utilization of ketone bodies; ketoacidosis.De novo synthesis of fatty acids (Palmitic acid). Biological significance of cholesterol and

conversion of cholesterol into bile acids, steroid hormone and vitamin D. Disorders of lipid metabolism: Hypercholesterolemia, atherosclerosis, fatty liver and obesity.

Amino acid metabolism: General reactions of amino acid metabolism: Transamination, deamination & decarboxylation, urea cycle and its disorders. Catabolism of phenylalanine and tyrosine and their metabolic disorders (Phenyketonuria, Albinism, alkeptonuria, tyrosinemia).Synthesis and significance of biological substances; 5-HT, melatonin, dopamine, noradrenaline, adrenaline. Catabolism of heme; hyperbilirubinemia and jaundice

Section-C

Nucleic acid metabolism and genetic information transfer: Biosynthesis of purine and pyrimidine nucleotides. Catabolism of purine nucleotides and Hyperuricemia and Gout disease.Organization of mammalian genome.Structure of DNA and RNA and their functions.DNA replication (semi conservative model).Transcription or RNA synthesis.Genetic code, Translation or Protein synthesis and inhibitors.

Enzymes: Introduction, properties, nomenclature and IUB classification of enzymes. Enzyme kinetics (Michaelis plot, Line Weaver Burke plot).Enzyme inhibitors with examples. Regulation of enzymes: enzyme induction and repression, allosteric enzymes regulation. Therapeutic and diagnostic applications of enzymes and isoenzymes. Coenzymes –Structure and biochemical functions.

Books Recommended:

1. Nelson, D.L., Cox, M.M. (2012). *Lehninger-Principles of Biochemistry*, 6th Ed., W. H. Freeman & Co.

2. Murry, R.K., Bender, D.K., Bothom, K.A., Kennely, P.J., Well, P.A., Rodwell, V.W. (2009). *Harper's Biochemistry*, 28th Ed., New York: McGraw-Hill.

3. Chakrapani, U., Satyanarayan, U. (2012). *Biochemistry*, Books and Allied PVT.

4. Rao, A.V.S.S.R. (2008). *Textbook of Biochemistry*, UBS Publishers Distributors Pvt. Ltd.

5. Conn, E.E.,Stumpf, P.K.,Bruening, G., Doi R.Y. (2009). *Outlines of Biochemistry*, 5th Ed., New York: John Wiley & Sons.

6. Gupta, R.C., Bhargavan, S.(2019). *Practical Biochemistry*, 5th Ed., New Delhi: Jaypee brother's medical publishers

7. Plummer, D.T. (1987). *An Introduction of Practical Biochemistry*, 3rd Ed., McGraw-Hill.

Suggested e-material:

1. http://lib.myilibrary.com/?id=276871
2. http://lib.myilibrary.com/?id=527025
3. http://onlinelibrary.wiley.com/book/10.1002/9783527622023 (Enzyme Kinetics: Principles and Methods, Second Edition Hans Bisswanger Wiley publisher)
4. http://www.sciencedirect.com/science/book/9780123851109

PHAR 103 Human Anatomy and Physiology-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Anatomy and physiology of various body systems
- Principles of body energetics
- Concept of genetic material

Section-A

Nervous system: Organization of nervous system, neuron, neuroglia, classification and properties of nerve fiber, electrophysiology, action potential, nerve impulse, receptors, synapse, neurotransmitters.

Central nervous system: Meninges, ventricles of brain and cerebrospinal fluid. Structure and functions of brain (cerebrum, brain stem, cerebellum), spinal cord (gross structure, functions of afferent and efferent nerve tracts,reflex activity)

Digestive system: Anatomy of GI Tract with special reference to anatomy and functions of stomach, (Acid production in the stomach, regulation of acid production through parasympathetic nervous system, pepsin role in protein digestion) small intestineand large intestine, anatomy and functions of salivary glands, pancreas and liver, movements of GIT, digestion and absorption of nutrients and disorders of GIT.

Energetics: Formation and role of ATP, Creatinine Phosphate and BMR.

Section-B

Respiratory system: Anatomy of respiratory system with special reference to anatomy of lungs, mechanism of respiration, regulation of respiration Lung Volumes and capacities transport of respiratory gases, artificial respiration, and resuscitation methods.

Urinary system: Anatomy of urinary tract with special reference to anatomy of kidney and nephrons, functions of kidney and urinary tract, physiology of urine formation, micturition reflex and role of kidneys in acid base balance, role of RAS in kidney and disorders of kidney.

Section-C

Endocrine system: Classification of hormones, mechanism of hormone action, structure and functions of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas, pineal gland, thymus and their disorders.

Reproductive system: Anatomy of male and female reproductive system, Functions of male and female reproductive system, sex hormones, physiology of menstruation, fertilization, spermatogenesis, oogenesis, pregnancy and parturition

Introduction to genetics: Chromosomes, genes and DNA, protein synthesis, genetic pattern of inheritance.

Books Recommended:

1. Sembulingam, K., Sembulingam, P. (2012). *Essentials of Medical Physiology*, 6th Ed., New Delhi: Jaypee Brothers' medical publisher.
2. Kathleen, J.W. (1992). *Anatomy and Physiology in Health and Illness*, 7th Ed., New York: Churchill Livingstone.
3. Tandon, O.P., Tripathi, Y. (2011). *Physiological basis of Medical Practice*- Best and Tailor, Wolters Kluwer India Pvt. Ltd.
4. Hall, J.E. (2010). *Guyton and Hall Textbook of Medical Physiology*, 11th Ed., Saunders.
5. Tortora, G.J., Grabowski S.R. (2000). *Principles of Anatomy and Physiology*, 9th Ed., New York: Wiley.
6. Singh, I. (2011). *Textbook of Human Histology*, 6thEd., New Delhi: Jaypee brother's medical publishers.
7. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8thEd., New Delhi: Jaypee brother's medical publishers.
8. Srinageswari, K., Sharma, R. (2015). *Practical workbook of Human Physiology*, New Delhi: Jaypee brother's medical publishers.
9. Chatterrje, C.C. (2005). *Human Physiology*, vol 1-2. Kolkatta: Academic Publishers.

Suggested e-material:

1. www.apchute.com
2. www.openstax.cnx.org
3. www.wesnorman.com

PHAR 106 Pharmaceutical Organic Chemistry – I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Types, classification, principles/mechanisms, applications of isomerism in organic compounds
- General methods of preparation and reactions types, principles/ mechanisms, applications of alkanes, alkenes, conjugated dienes, alkyl halides, alcohols, carbonyl compounds (aldehydes and ketones), carboxylic acids & aliphatic amines

General methods of preparation and reactions of compounds superscripted with asterisk (*) to be explained. To emphasize on definition, types, classification, principles/mechanisms, applications, examples and differences

Section-A

Classification, nomenclature and isomerism: Classification of Organic Compounds. Common and IUPAC systems of nomenclature of organic compounds (up to 10 Carbons open chain and carbocyclic compounds). Structural isomerisms in organic compounds

Alkanes*, Alkenes* and Conjugated dienes*: SP^3 hybridization in alkanes, Halogenation of alkanes, uses of paraffins. Stabilities of alkenes, SP^2 hybridization in alkenes.E_1 and E_2 reactions – kinetics, order of reactivity of alkyl halides, rearrangement of carbocations, Saytzeffs orientation and evidences. E_1 verses E_2 reactions, Factors affecting E_1 and E_2 reactions. Ozonolysis, electrophilic addition reactions of alkenes, Markownikoff's orientation, free radical addition reactions of alkenes, Anti Markownikoff's orientation. Stability of conjugated dienes, Diel-Alder, electrophilic addition, free radical addition reactions of conjugated dienes, allylic rearrangement

Section-B

Alkyl halides*: SN_1 and SN_2 reactions - kinetics, order of reactivity of alkyl halides, stereochemistry and rearrangement of carbocations. SN_1 versus SN_2 reactions, Factors affecting SN1 and SN2 reactions.Structure and uses of ethylchloride, Chloroform, trichloroethylene, tetrachloroethylene, dichloromethane, tetrachloromethane and iodoform.

Alcohols*: Qualitative tests, Structure and uses of Ethyl alcohol, Methyl alcohol, chlorobutanol, Cetosteryl alcohol, Benzyl alcohol, Glycerol, Propylene glycol

Carbonyl compounds* (Aldehydes and ketones): Nucleophilic addition, Electromeric effect, aldol condensation, Crossed Aldol condensation, Cannizzaro reaction, Crossed Cannizzaro reaction, Benzoin condensation, Perkin condensation, qualitative tests, Structure and uses of Formaldehyde, Paraldehyde, Acetone, Chloral hydrate, Hexamine, Benzaldehyde, Vanilin, Cinnamaldehyde.

Section-C

Carboxylic acids*: Acidity of carboxylic acids, effect of substituents on acidity, inductive effect and qualitative tests for carboxylic acids , amide and ester. Structure and Uses of Acetic acid, Lactic acid, Tartaric acid, Citric acid, Succinic acid. Oxalic acid, Salicylic acid, Benzoic acid, Benzyl benzoate, Dimethyl phthalate, Methyl salicylate and Acetyl salicylic acid.

Aliphatic amines*: Basicity, effect of substituent on Basicity. Qualitative test, Structure and uses of Ethanolamine, Ethylenediamine, Amphetamine.

Books Recommended:

1. Boyd, M. (2010). *Organic Chemistry*, 7thEd., Pearson.
2. Finar, I.L. (2002). *Organic Chemistry*, Vol. 1, 6thEd.,Pearson Education Ltd.

Suggested e-material:

1. http://lib.myilibrary.com?id=527161
2. http://lib.myilibrary.com?id=527192
3. http://lib.myilibrary.com?id=527020

PHAR 212 Pathophysiology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Basic principles of cell injury and adaptation

- Etiology and pathogenesis of the various disease
- Signs, symptoms and complications of various diseases

Section-A

Basic principles of cell injury and adaptation:Introduction, definitions, homeostasis, components and types of feedback systems, causes of cellular injury, pathogenesis (cell membrane damage, mitochondrial damage, ribosome damage, nuclear damage), morphology of cell injury - Adaptive changes (atrophy, hypertrophy, hyperplasia, metaplasia, dysplasia), cell swelling, intra cellular accumulation, calcification, enzyme leakage and cell death acidosis & alkalosis, electrolyte imbalance.

Basic mechanism involved in the process of inflammation and repair:Introduction, clinical signs of inflammation, different types of inflammation, mechanism of inflammation - Alteration in vascular permeability and blood flow, migration of WBC's, mediators of inflammation, basic principles of wound healing in the skin.

Cardiovascular System: Hypertension, congestive heart failure, ischemic heart disease (angina, myocardial infarction, atherosclerosis and arteriosclerosis) Respiratory system: Asthma, chronic obstructive airways diseases.

Renal System: Acute and chronic renal failure.

Section-B

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

Endocrine System: Diabetes, thyroid diseases, disorders of sex hormones. Nervous system: Epilepsy, Parkinson's disease, stroke, psychiatric disorders: depression, schizophrenia and Alzheimer's disease.

Section-C

Gastrointestinal System: Peptic ulcer, inflammatory bowel diseases, jaundice, hepatitis (A, B,C,D,E,F) alcoholic liver disease.

Disease of bones and joints: Rheumatoid arthritis, osteoporosis and gout.

Principles of Cancer: Classification, etiology and pathogenesis of cancer.

Infectious Diseases: Meningitis, typhoid, leprosy, tuberculosis, urinary tract infections. Sexually transmitted diseases: AIDS, syphilis, gonorrhea.

Recommended Books:

1. Kumar, V., Abas, A.K. Aster, J.C. (2014). Robbins &Cotran Pathologic Basis of Disease, South Asia edition, Elsevier.
2. Mohan, H. (2010). *Text book of Pathology*, 6th Ed., Jaypee Publications.
3. Laurence, B., Bruce, C., Bjorn, K. (2011). *Goodman Gilman's the Pharmacological Basis of Therapeutics*, 12th Ed., New York: McGraw-Hill.
4. Herbert, C., Taylor, Burke, N. (2011). *Best and Taylor's Physiological basis of medical practice*, 13th Ed., Wolters Kluwer India Pvt. Ltd.
5. Colledge, N.R., Walker, B.R., Stuart, H.R. (2010). *Davidson's Principles and Practice of Medicine*, 21st Ed., London: ELBS/Churchill Livingstone.
6. Guyton, A.J., Hall, E. (2010). *Textbook of Medical Physiology*, 12th Ed., WB Saunders Company.
7. Piro, J.D., Talbert, R.L., Yee, G., Wells, B., Michael, L., Posey, (2014). *Pharmacotherapy: A Pathophysiological Approach*, 9th Ed., London: McGraw-Hill Medical.
8. Kumar, V., Cotran, R.S., Robbins, S.L. (1997). *Basic Pathology*, Philadelphia, WB Saunders Company.
9. Walker, R., Edwards, C. (2003). *Clinical Pharmacy and Therapeutics*, 3rd Ed., London: Churchill Livingstone publication.

Suggested e-material:

1. www.wesnorman.com

2. www.pharmacologyeducation.org
3. www.pharmacology2000.com
4. www.healthline.com
5. www.mayoclinic.org

CS 102L Computer Applications in Pharmacy Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Design a questionnaire using a word processing package to gather information about a particular disease.
2. Create a HTML web page to show personal information.
3 Retrieve the information of a drug and its adverse effects using online tools
4 Creating mailing labels Using Label Wizard, generating label in MS WORD
5 Create a database in MS Access to store the patient information with the required fields using access
6. Design a form in MS Access to view, add, delete and modify the patient record inthe database
7. Generating report and printing the report from patient database
8. Creating invoice table using – MS Access
9. Drug information storage and retrieval using MS Access
10. Creating and working with queries in MS Access
11. Exporting Tables, Queries, Forms and Reports to web pages
12. Exporting Tables, Queries, Forms and Reports to XML pages

PHAR 101L Biochemistry Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Qualitative analysis of carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose and starch)
2. Identification tests for Proteins (albumin and Casein)
3. Quantitative analysis of reducing sugars (DNSA method) and Proteins (Biuret method)
4. Qualitative analysis of urine for abnormal constituents
5. Determination of blood creatinine
6. Determination of blood sugar
7. Determination of serum total cholesterol
8. Preparation of buffer solution and measurement of pH
9. Study of enzymatic hydrolysis of starch
10. Determination of Salivary amylase activity
11. Study the effect of Temperature on Salivary amylase activity.
12. Study the effect of substrate concentration on salivary amylase activity.

PHAR 103L Human Anatomy and Physiology - II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Practical physiology is complimentary to the theoretical discussions in physiology. Practicals allow the verification of physiological processes discussedin theory classes through experiments on living tissue, intact animals or normalhuman beings. This is helpful for developing an insight on the subject.

1. To study the integumentary and special senses using specimen, models etc.
2. To study the nervous system using specimen, models, etc.
3. To study the endocrine system using specimen, models, etc
4. To demonstrate the general neurological examination
5. To demonstrate the function of olfactory nerve
6. To examine the different types of taste.
7. To demonstrate the visual acuity
8. To demonstrate the reflex activity
9. Recording of body temperature
10. To demonstrate positive and negative feedback mechanism.
11. Determination of tidal volume and vital capacity.
12. Study of digestive, respiratory, cardiovascular systems, urinary and reproductive systems with the help of models, charts and specimens.
13. Recording of basal mass index.
14. Study of family planning devices and pregnancy diagnosis test.
15. Demonstration of total blood count by cell analyser
16. Permanent slides of vital organs and gonads.

PHAR 106L Pharmaceutical Organic Chemistry - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Systematic qualitative analysis of unknown organic compounds like

i. Preliminary test: Color, odour, aliphatic/aromatic compounds, saturation and unsaturation, etc.

ii. Detection of elements like Nitrogen, Sulphur and Halogen by Lassaigne's test

iii. Solubility test

iv. Functional group test like Phenols, Amides/ Urea, Carbohydrates, Amines, Carboxylic acids, Aldehydes and Ketones, Alcohols, Esters, Aromatic and Halogenated Hydrocarbons, Nitro compounds and Anilides.

v. Melting point/Boiling point of organic compounds

vi. Identification of the unknown compound from the literature using melting point/ boiling point.

vii. Preparation of the derivatives and confirmation of the unknown compound by melting point/ boiling point.

viii. Minimum 5 unknown organic compounds to be analysed systematically.

2. Preparation of suitable solid derivatives from organic compounds

3. Construction of molecular models

Third Semester

PHAR 204 Pharmaceutical Microbiology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Methods of identification, cultivation and preservation of various microorganisms
- The importance and implementation of sterilization in pharmaceutical processing and industry
- Sterility testing of pharmaceutical products
- Microbial standardization of pharmaceuticals
- Cell culture technology and its applications in pharmaceutical industries

Section-A

Introduction, history of microbiology, its branches, scope and its importance.Introduction to Prokaryotes and Eukaryotes. Study of ultra-structure and morphological classification of bacteria, nutritional requirements, raw materials used for culture media and physical parameters for growth, growth curve, isolation and preservation methods for pure cultures, cultivation of anaerobes, quantitative measurement of bacterial growth (total & viable count). Study of different types of phase contrast microscopy, dark field microscopy and electron microscopy.

Section-B

Identification of bacteria using staining techniques (simple, Gram's &Acid fast staining) and biochemical tests (IMViC). Study of principle, procedure, merits, demerits and applications of physical, chemical gaseous,radiation and mechanical method of sterilization. Evaluation of the efficiency of sterilization methods. Equipments employed in large scale sterilization.

Sterility indicators.Study of morphology, classification, reproduction/ replication and cultivation of Fungi and Viruses.

Classification and mode of action of disinfectants.Factors influencing disinfection, antiseptics and their evaluation. Evaluation of bactericidal & Bacteriostatic.Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.

Section-C

Designing of aseptic area, laminar flow equipments; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification.

Principles and methods of different microbiological assay.

Methods for standardization of antibiotics, vitamins and amino acids.Assessment of a new antibiotic.

Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage.

Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations.

Growth of animal cells in culture, general procedure for cell culture, Primary, established and transformed cell cultures. Application of cell cultures in pharmaceutical industry and research.

Books Recommended:

1. Hugo, W.B., Russel A.D. (2004). *Pharmaceutical Microbiology*, 7th Ed., London: Blackwell Scientific publications.
2. Reed, G (2004). *Prescott and Dunn Industrial Microbiology*. 4th Ed., Delhi: CBS Publishers & Distributors.
3. Pelczar, M.J., Chan, E.C.S, Kreig, N.R. (2002). *Microbiology*. 5th Ed., New Delhi: Tata McGraw Hill.
4. Harris, M., Tindall, B. (2000). *Pharmaceutical Microbiology*. London.

5. Rose, A.H. (1961). *Industrial Microbiology*. London: Butterworths.

6. Frobisher, M., Hinsdill, R., Crabtree, K.T., Goodheart, C.R. (1968). *Fundamentals of Microbiology*. 9th Ed., WB Saunders Co.

7. Carter, S.J. (2005). *Cooper and Gunn's: Tutorial Pharmacy*. 12th Ed., New Delhi: CBS Publisher and Distributors.

8. Peppler, H.J., Perlman, D. (1979). *Microbial Technology*. 2nd Ed., Wisconsin: Elsevier.

9. I.P., B.P., U.S.P. - latest editions.

10. Ananthnarayan, R. (1990). *A Text Book of Microbiology*. 4th Ed., Hyderabad: Orient Longman Limited.

11. Edward, A.I. (1983). *Fundamentals of Microbiology*. 4th Ed., Addison Wesley Publishing Company.

12. Jain, N.K. (2005). *Pharmaceutical Microbiology*. 2nd Ed., Delhi: Vallabh Prakashan.

13. Bergey, D.H., Holt, J.G. (1994.) Bergeys manual of systematic bacteriology. 2nd Ed., Baltimore: Williams and Wilkins.

Suggested e-material:

1. https://www.elsevier.com/books/pharmaceutical-microbiology/
2. moscmm.org/pdf/Ananthanarayan%20microbio.pdf

PHAR 205 Pharmaceutical Organic Chemistry - II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- General methods of preparation and reactions of various organic compounds

- Classification, reaction principles/mechanisms, properties and applications of various organic compounds

General methods of preparation and reactions of compounds superscripted with asterisk (*) to be explained. To emphasize on definition, types, classification, principles/mechanisms, applications, examples and differences.

Section-A

Benzene and its derivatives

I. Analytical, synthetic and other evidences in the derivation of structure of benzene, orbital picture, resonance in benzene, aromatic characters, Huckel's rule.

II. Reactions of benzene - nitration, sulphonation, halogenation, Friedel crafts alkylation- limitations and Friedel crafts acylation.

III. Type of substituents, effect of substituents on reactivity and orientation of mono substituted benzene compounds towards electrophilic substitution reaction.

IV. Structure and uses of DDT (Dichloro diphenyl trichloroethane), Saccharin, BHC (Benzene hexachloride) and Chloramine.

Section-B

Phenols* - Acidity of phenols, effect of substituents on acidity, qualitative tests, structure and uses of phenol, cresols, resorcinol, naphthols

Aromatic Amines* - Basicity of amines, effect of substituents on basicity and synthetic uses of aryl diazonium salts.

Aromatic Acids* - Acidity, effect of substituents on acidity and important reactions of benzoic acid.

Fats and Oils-

I. Fatty acids reactions- Hydrolysis, Hydrogenation, Saponification and Rancidity of oils, Drying oils.

II. Analytical constants - Acid value, Saponification value, Ester value, Iodine value, Acetyl value, Reichert Meissl (RM) value - significance and principle involved in their determination.

Section-C

Polynuclear hydrocarbons: Synthesis, reactions, structure and medicinal uses of Naphthalene, Phenanthrene, Anthracene, Diphenylmethane, Triphenylmethane & their derivatives (1-naphthol, 1-hydroxyphenanthrene, 1-hydroxyanthracene, diphenylmethanol, triphenylmethanol)

Cyclo alkanes*: Stabilities - Baeyer's strain theory, limitation of Baeyer's strain theory, Coulson and Moffitt's modification, Sachse Mohr's theory (Theory of strainless rings), reactions of cyclopropane and cyclobutane only.

Books Recommended:

1. Morrison, R.T., Boyd, R.T. (1992). *Organic Chemistry*. 6th Ed., New York:Prentice Hall.
2. Finar, I.L. (1963). *Organic Chemistry*. 4th Ed., London: Longsman.
3. Bahl, A., Bahl, B.S. (2014). *Textbook of Organic Chemistry*. 5th Ed., New Delhi: S Chand and Company Ltd.
4. Soni, P.L., Chawla, H.M. (2012). *Textbook of Organic Chemistry*. 29th Ed., New Delhi: S Chand & Sons.
5. Mann, F.G., Saunders, B.C. (2009). *Practical Organic Chemistry*. 4th Ed., London: Pearson. 2009.
6. Vogel, A.I., Tatchell, A.R., Furnis, B. S., Hannaford, A.J., Smith, P.W.G. (1989). *Vogel's text book of Practical Organic Chemistry*. 5th Ed., London: Pearson.
7. Vishnoi, N.K. (2009). *Advanced Practical organic chemistry*. 3rd Ed., New Delhi: Vikas Publishing House.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. (1998). *Introduction to Organic Laboratory techniques*. 3rd Ed..

Suggested e-material:

1. http://lib.myilibrary.com?id=527383
2. http://lib.myilibrary.com?id=527192
3. http://lib.myilibrary.com?id=527184

PHAR 213 Pharmaceutical Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Various type of flow and flow meter
- Various objectives, applications and functions of various processes used in pharmaceutical industries.
- Various preventive methods used for corrosion control in pharmaceutical industries.
- Different types of conveyors
- Various material used in plant construction

Section-A

Flow of fluids: Types of manometers, reynolds number and its significance, bernoulli's theorem and its applications, energy losses, orifice meter, venturimeter, pitot tube and rotometer.

Mixing: Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, construction, working, uses, merits and demerits of double cone blender, twin shell blender, ribbon blender, sigma blade mixer, planetary mixers, propellers, turbines, paddles & silverson emulsifier.

Heat Transfer: Objectives, applications & heat transfer mechanisms. Fourier's law, Heat transfer by conduction, convection & radiation. Heat interchangers & heat exchangers.

Section-B

Evaporation: Objectives, applications and factors influencing evaporation, differences between evaporation and other heat process. principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator, multiple effect evaporator& Economy of multiple effect evaporator.

Distillation: Basic Principles and methodology of simple distillation, flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation.

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.

Section-C

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 Seidtz filter.

Centrifugation: Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & supercentrifuge.

Materials of pharmaceutical plant construction, corrosion and its prevention: Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and there prevention. Ferrous and nonferrous metals, inorganic and organic non-metals, basic of material handling systems.

Books Recommended:

1. Badger, W.L., Banchero, J.T. (1955). *Introduction to chemical engineering*. New York: McGraw- Hill.
2. Simpson, N.J.K. (2000). *Solid phase extraction, Principles, techniques and applications*. 1st Ed., California: CRC Press.
3. McCabe, W., Smith, J., Harriott, P. (2017). *Unit operation of chemical engineering.* 7th Ed., New York: McGraw- Hill.
4. Subrahmanyam, C.V.S., Setty, J.T., Sarasija, S., Kussum, D.V. (2009). *Pharmaceutical engineering principles and practices*. New Delhi: Vallabh Publication.
5. Martin, E.W., Cook, E.F. (2005). *Remington practice of pharmacy*. 21st edition. Philadelphia: Lippincott Williams and Wilkins.
6. Lachman, L., Lieberman, H.A., Kanig, J.L. (1990). *Theory and practice of industrial pharmacy*. 3th Ed., New Delhi: Varghese Publishing House.
7. Carter, S.J. (2005). *Cooper and Gunn's Tutorial pharmacy*. 6th Ed., New Delhi: CBS Publication.

Suggested e-material:

1. gmpua.com/Process/ProcessEngineering

PHAR 217 Physical Pharmaceutics - I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Various physicochemical properties of drug molecules
- Various aspects in pre formulation studies
- Surface and interfacial phenomenon on formulation

- Various aspects of size reduction and size separation pertaining to dosage preparation

Section-A

Solubility of drugs: Solubility expressions, mechanisms of solute solvent interactions, ideal solubility parameters, solvation & association, quantitative approach to the factors influencing solubility of drugs, diffusion principles in biological systems. Solubility of gas in liquids, solubility of liquids in liquids (Binary solutions, ideal solutions).Raoult's law, real solutions.Partially miscible liquids, critical solution temperature and applications.Distribution law, its limitations and applications.

States of matter and properties of matter: State of matter, changes in the state of matter, latent heats, vapour pressure, sublimation critical point, eutectic mixtures, gases, aerosols - inhalers, relative humidity, liquid complexes, liquid crystals, glassy states, solid crystalline, amorphous & polymorphism.

Section-B

Physicochemical properties of drug molecules: Refractive index, optical rotation, dielectric constant, dipole moment, dissociation constant, determinations and applications.

Surface and interfacial phenomenon: Liquid interface, surface & interfacial tensions, surface free energy, measurement of surface & interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB scale, solubilisation, detergency, adsorption at solid interface.

Complexation and protein binding: Introduction, classification of complexation, applications, methods of analysis, protein binding, complexation and drug action, crystalline structures of complexes and thermodynamic treatment of stability constants.

Section-C

pH, buffers and isotonic solutions: Sorensen's pH scale, pH determination (electrometric and calorimetric), applications of buffers, buffer equation,

buffer capacity, buffers in pharmaceutical and biological systems, buffered isotonic solutions.

Size reduction: Objectives, mechanisms & laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of hammer mill, ball mill, fluid energy mill, edge runner mill & end runner mill.

Size separation: Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation. Principles, construction, working, uses, merits and demerits of sieve shaker, cyclone separator, air separator, bag filter & elutriation tank.

Books Recommended:

1. Martin, A., Swarbrick, J. (1993). *Physical Pharmacy*. 3rd Ed., Marryland: Lippincott Williams and Wilkins.
2. Parott, L.E., Saski, W. (1977). *Experimental Pharmaceutics*. 4th Ed., Minneapolis: Burgess Publishers.
3. Cater, S.J. (2005). *Tutorial Pharmacy*. 6th Ed., New Delhi: CBS publishers.
4. Stocklosam, M.J., Ansel, H.C. (1986). *Pharmaceutical Calculations*. 8th Ed., Philadelphia: Lippincott Williams and Wilkins.
5. Liberman, H.A., Lachman, C., Schwartz, J.B. (1990). *Pharmaceutical Dosage forms*, Tablets, 2nd Ed., New York: Marcel Dekkar Inc.
6. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms. Disperse systems,* 2nd Ed., New York: Marcel Dekkar Inc.
7. Ramasamy, C., Manavalan, R. (2015). *Physical Pharmaceutics*. 2nd Ed., Chenniai: Vignesh Publisher.
8. Subramanyam, C.V.S., Settee, T.J. (2014). *Laboratory Manual of Physical Pharmaceutics.* 2nd Ed., New Delhi: Vallabh Publication.
9. Subramanyam, C.V.S. (2000). *Text book of Physical Pharmaceutics*. 2nd Ed., New Delhi: Vallabh publication.

10. Jain, G., Khar, R.K., Ahmad, F.J. (2012). *Theory and practice of Physical Pharmacy*. 1st Ed., New Delhi: Elsevier India.

Suggested e-material:

1. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
2. https://www.pdfdrive.com/pharmaceutical-books.html
3. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
4. http://202.74.245.22:8080/xmlui/handle/123456789/39
5. www.elsevier.com/books/
6. https://accesspharmacy.mhmedical.com/book.aspx?bookid=513

PHAR 219 Pharmaceutical Physical Chemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Different states of matter and their properties
- Principle of thermodynamics and their pharmaceutical applications
- Various aspects of chemical kinetics and quantum mechanics.

Section-A

Behavior of gases: Kinetic theory of gases, deviation from behaviors and explanation.

Liquid state: Physical properties (vapour pressure, surface tension, viscosity, refractive index, optical rotation, dipole moment) and their role in chemical constitution determination.

Solutions: Ideal and real solutions, solutions of gases in liquids, colligative properties, partition coefficient, conductance and its measurement, Debye Huckel theory.

Section-B

Thermodynamics: Definition of thermodynamic terms: system, surroundings etc, types of system, intensive and extensive properties, state and path functions, thermodynamic equilibrium, heat and work.

First law: Postulates, limitations, brief account of heat capacity and enthalpy.

Second law: Postulates, need of law, reversible and irreversible processes, Carnot cycle, Carnot theorem, thermodynamic temperature scale, brief account of entropy.

Third law: Criteria for spontaneity, residual entropy.

Adsorption: Freudlich and Gibbs adsorption, isotherms, Langmuir theory of adsorption.

Photochemistry: Consequences of light absorption, Jablonski diagram, Lambert-Beer Law, Quantum efficiency.

Section-C

Chemical kinetics: General consideration and concepts, Zero, first and second order reactions, complex reactions, theories of reaction kinetics, half-life determination, influence of temperature, light, solvent, catalytic species and other factors, characteristics of homogeneous and heterogeneous catalysis, acid base and enzyme catalysis.

Quantum mechanics: Postulates of quantum mechanics, operators in quantum mechanics, the Schrodinger wave equation.

BooksRecommended:

1. Bahl, B.S., Tuli, G.D., Bahl, A. (2009). *Essential of Physical Chemistry*. 1st Ed., New Delhi: S. Chand & Company Pvt Ltd.

2. Negi, A.S., Anand, S.C. (1985). *Textbook of Physical Chemistry*, 5th Ed., New Delhi: Wiley Eastern Ltd.

3. Glasstone, S., Lewis, D. (1993). *Elements of Physical Chemistry*, 2nd Ed., London: Macmillan Education.

4. Shoemaker, M., David, P., Garland, D.P., Carl, W. (1975). Experiments of Physical Chemistry. 3rd Ed., New York: McGraw Hill.

Suggested e-material:

1. https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry
2. https://www.acs.org/content/acs/en

PHAR 204L Pharmaceutical Microbiology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Introduction and study of different equipments and processing, e.g., B.O.D. incubator, laminar flow, aseptic hood, autoclave, hot air sterilizer, deep freezer, refrigerator, microscopes used in experimental microbiology.
2. Sterilization of glassware, preparation and sterilization of media.
3. Sub culturing of bacteria and fungus. Nutrient stabs and slants preparations.
4. Staining methods- Simple, Grams staining and acid fast staining (Demonstration with practical).
5. Isolation of pure culture of micro-organisms by multiple streak plate technique and other techniques.
6. Microbiological assay of antibiotics by cup plate method and other methods
7. Motility determination by Hanging drop method.
8. Sterility testing of pharmaceuticals.
9. Bacteriological analysis of water
10. Biochemical test.

PHAR 205L Pharmaceutical Organic Chemistry - II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

I Experiments involving laboratory techniques

- Recrystallization
- Steam distillation

II Determination of following oil values (including standardization of reagents)

- Acid value
- Saponification value
- Iodine value

III Preparation of compounds

- Benzanilide/Phenyl benzoate/Acetanilide from Aniline/ Phenol/Aniline by acylation reaction.
- 2,4,6-Tribromo aniline/Para bromo acetanilide from Aniline/Acetanilide by halogenation (Bromination) reaction.
- 5-Nitro salicylic acid/Meta di nitro benzene from Salicylic acid/Nitro benzene by nitration reaction.
- Benzoic acid from Benzyl chloride by oxidation reaction.
- Benzoic acid/ Salicylic acid from alkyl benzoate/ alkyl salicylate by hydrolysis reaction.
- 1-Phenyl azo-2-napthol from Aniline by diazotization and coupling reactions.
- Benzil from Benzoin by oxidation reaction.
- Dibenzal acetone from Benzaldehyde by Claisen Schmidt reaction
- Cinnammic acid from Benzaldehyde by Perkin reaction
- P-Iodo benzoic acid from P-amino benzoic acid

PHAR 213L Pharmaceutical Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Determination of radiation constant of brass, iron, unpainted and painted glass.
2. Steam distillation - To calculate the efficiency of steam distillation.
3. To determine the overall heat transfer coefficient by heat exchanger.
4. Construction of drying curves (for calcium carbonate and starch).
5. Determination of moisture content and loss on drying.
6. Determination of humidity of air - i) From wet and dry bulb temperatures -use of Dew point method.
7. Description of Construction working and application of Pharmaceutical Machinery such as rotary tablet machine, fluidized bed coater, fluid energy mill,de humidifier.
8. Size analysis by sieving - To evaluate size distribution of tablet granulations-Construction of various size frequency curves including arithmetic and logarithmic probability plots.
9. Size reduction: To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.
10. Demonstration of colloid mill, planetary mixer, fluidized bed dryer, freeze dryerand such other major equipment.
11. Factors affecting Rate of Filtration and Evaporation (Surface area, concentration and Thickness/ viscosity
12. To study the effect of time on the rate of crystallization.
13. To calculate the uniformity Index for given sample by using double cone blender.

PHAR 217L Physical Pharmaceutics - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Determination the solubility of drug at room temperature
2. Determination of pKa value by half neutralization/ Henderson Hasselbalch equation.
3. Determination of Partition co-efficient of benzoic acid in benzene and water
4. Determination of Partition co- efficient of Iodine in CCl4 and water
5. Determination of % composition of NaCl in a solution using phenol-water system by CST method
6. Determination of surface tension of given liquids by drop count and drop weight method
7. Determination of HLB number of a surfactant by saponification method
8. Determination of Freundlich and Langmuir constants using activated charcoal
9. Determination of critical micellar concentration of surfactants
10. Determination of stability constant and donor acceptor ratio of PABA-Caffeine complex by solubility method
11. Determination of stability constant and donor acceptor ratio of Cupric-Glycine complex by pH titration method

Fourth Semester

PHAR 211 Medicinal Chemistry - I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Various aspects of medicinal chemistry
- Classification, synthesis, SAR, mechanism of action and uses of various drugs

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

Section-A

Introduction to medicinal chemistry: History and development of medicinal chemistry. Physicochemical properties in relation to biological action (Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation).Effect of bioisosterism, optical and geometrical isomerism on biological activity.

Drugs acting on autonomic nervous system:

Sympathomimetic Agents: SAR of Sympathomimetic agents.

Direct acting: Nor-epinephrine, epinephrine, phenylephrine*, dopamine, methyldopa, clonidine, dobutamine, isoproterenol, terbutaline, salbutamol*, bitolterol, naphazoline, oxymetazoline and xylometazoline.

Indirect acting agents: Hydroxyamphetamine, pseudoephedrine, propylhexedrine.

Agents with mixed mechanism: Ephedrine, Metaraminol.

Adrenergic Antagonists:

Alpha adrenergic blockers: Tolazoline*, phentolamine, phenoxybenzamine, prazosin, dihydroergotamine, methysergide.

Beta adrenergic blockers: SAR of beta blockers, propranolol*, metibranolol, atenolol, betazolol, bisoprolol, esmolol, metoprolol, labetolol, carvedilol.

Parasympathomimetic agents: SAR of Parasympathomimetic agents.

Direct acting agents: Acetylcholine, carbachol*, bethanechol, methacholine, pilocarpine.

Indirect acting/ Cholinesterase inhibitors (Reversible & Irreversible): Physostigmine, neostigmine*, pyridostigmine, edrophonium chloride, tacrine hydrochloride, ambenonium chloride, isofluorphate, echothiophate iodide, parathione, malathion.

Cholinesterase reactivator: Pralidoxime chloride.

Cholinergic blocking agents: SAR of cholinolytic agents

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

Synthetic cholinergic blocking agents: Tropicamide, cyclopentolate hydrochloride, clidinium bromide, dicyclomine hydrochloride*, glycopyrrolate, methantheline bromide, propantheline bromide, benztropine mesylate, orphenadrine citrate, biperidine hydrochloride, procyclidine hydrochloride*, tridihexethyl chloride, isopropamide iodide, ethopropazine hydrochloride.

Section-B

Drugs acting on central nervous system

General anesthetics:

Inhalation anesthetics: Halothane*, Methoxyflurane, enflurane, sevoflurane, isoflurane, desflurane.

Ultra-short acting barbitutrates: Methohexital sodium*, thiamylal sodium, thiopental sodium.

Dissociative anesthetics: Ketamine hydrochloride.*

Narcotic and Non-Narcotic Analgesics:

Morphine and related drugs: SAR of morphine analogues, morphine sulphate, codeine, meperidine hydrochloride, anilerdine hydrochloride, diphenoxylate hydrochloride, loperamide hydrochloride, fentanyl citrate*, methadone hydrochloride*, propoxyphene hydrochloride, pentazocine, levorphanol tartarate.

Narcotic antagonists: Nalorphine hydrochloride, levallorphan tartarate, naloxone hydrochloride.

Anti-inflammatory agents: Sodium salicylate, aspirin, mefenamic acid*, meclofenamate, indomethacin, sulindac, tolmetin, zomepriac, diclofenac, ketorolac, ibuprofen*, naproxen, piroxicam, phenacetin, acetaminophen, antipyrine, phenylbutazone.

Section-C

Drugs acting on central nervous system:

Sedatives and Hypnotics:

Benzodiazepines: SAR of benzodiazepines, chlordiazepoxide, diazepam*, oxazepam, chlorazepate, lorazepam, alprazolam, zolpidem

Barbiturtes: SAR of barbiturates, barbital*, phenobarbital, mephobarbital, amobarbital, butabarbital, pentobarbital, secobarbital

Miscelleneous:

Amides & imides: Glutethmide.

Alcohol & their carbamate derivatives: Meprobomate, ethchlorvynol.

Aldehyde & their derivatives: Triclofos sodium, paraldehyde.

Antipsy chotics

Phenothiazeines: SAR of Phenothiazeines - Promazine hydrochloride, chlorpromazine hydrochloride*, triflupromazine, thioridazine hydrochloride, piperacetazine hydrochloride, prochlorperazine maleate, trifluoperazine hydrochloride.

Ring analogues of phenothiazeines: Chlorprothixene, thiothixene, loxapine succinate, clozapine.

Flurobuterophenones: Haloperidol, droperidol, risperidone.

Beta amino ketones: Molindone hydrochloride.

Benzamides: Sulpieride.

Anticonvulsants: SAR of anticonvulsants, mechanism of anticonvulsant action.

Barbiturates: Phenobarbitone, methabarbital.

Hydantoins: Phenytoin*, Mephenytoin, ethotoin

Oxazolidinediones: Trimethadione, paramethadione

Succinimides: Phensuximide, methsuximide, ethosuximide*

Urea and monoacylureas: Phenacemide, carbamazepine*

Benzodiazepines: Clonazepam

Miscellaneous: Primidone, valproic acid, gabapentin, felbamate.

Drug metabolism: Drug metabolism principles- Phase I and Phase II. Factors affecting drug metabolism including stereo chemical aspects

Books Recommended:

1. Beale, J.M., Block, J., Wilson, G. (2010). *Organic medicinal and Pharmaceutical Chemistry*, 12th Ed., Philadelphia: Lippincott Williams and Wilkins.

2. Lemke, T.L., Williams, D.A., Rocho, V.F., Zito, S.W. (2012). *Foye's Principles of Medicinal Chemistry*, 7th Ed., Philadelphia: Lippincott Williams and Wilkins.

3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7th Ed., New York: John Wiley and Sons.

4. Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3rd Ed., Harwood academic publishers.

5. Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences*, 21st Ed., Philadelphia: Lippincott Williams and Wilkins.

6. Finar, I.L. (2002). *Organic Chemistry:* Volume 2. Stereochemistry and the Chemistry Natural Products. 5th Ed., London: Pearson.

7. Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5th Ed., New York: John Wiley and Sons Ltd.

8. *Indian Pharmacopoeia*, (2014). Addendum 2016.

9. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. (2009). *Vogel's Tatchell: Text book of practical organic chemistry*, 5th Ed., London: Pearson.

Suggested e-material:

1. https://books.google.co.in/books/about/Foye_s_Principles_of_Medicinal_Chemistry.html?id=R0W1ErpsQpkC

2. https://www.wiley.com/en-us/Burger%27s+Medicinal+Chemistry%2C+Drug+Discovery%2C+and+Development%2C+7th+Edition-p-9780470278154

PHAR 214 Pharmaceutical Organic Chemistry - III

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Nomenclature and classification. Synthesis, reactions and medicinal uses of heterocyclic compounds
- Stereo chemical aspects of organic compounds and stereo chemical reactions

Section-A

Stereo isomerism:

Optical isomerism - Optical activity, enantiomerism, diastereo-isomerism, meso- compounds, elements of symmetry, chiral and achiral molecules. DL system of nomenclature of optical isomers, sequence rules, RS system of nomenclature of optical isomers. Racemic modification and resolution of racemic mixture.Asymmetric synthesis (partial and absolute) & reactions of chiral molecules.

Geometrical isomerism: Nomenclature of geometrical isomers (Cis-Trans, E-Z, Syn-Anti systems), methods of determination of configuration of geometrical isomers. Conformational isomerism in ethane, n-butane and cyclohexane. Stereo isomerism in biphenyl compounds (Atropisomerism) and conditions for optical activity. Stereospecific and stereoselective reactions.

Section-B

Heterocyclic compounds: Nomenclature and classification. Synthesis, reactions and medicinal uses of following compounds - Pyrrole, Furan, Thiophene Pyrazole, Imidazole, Oxazole, Thiazole, Pyridine, Quinoline, Isoquinoline, Acridine, Indole and their derivatives (pyrrolidine, furfural, 2,2'- bithiophene, N-phenyl pyrazole, imidazoline, 2-alkyloxazole, 4-hydroxy-1,3-thiazole, 2-methyl pyridine, 8-hydroxylquinoline, 1,2,3,4-tetrahydroisoquinoline, proflavin, indole-3-acetic acid).

Section-C

Synthesis and medicinal uses of Pyrimidine, Purine, azepines and their derivatives (6-amino purine, pyrimidine-2,4 (1H, 3H)- dione, benzazepine).

Reactions of synthetic importance: Metal hydride reduction (NaBH4 and

LiAlH4), Clemmensen reduction, Birch reduction, Wolff Kishner reduction.

Oppenauer-oxidation and Dakin reaction.Beckmanns rearrangement and Schmidt rearrangement. Claisen-Schmidt condensation.

Books Recommended:

1. Finar, I.L. (2002). *Organic chemistry*, 6th Ed., Pearson Education.
2. Bahl, B.S., Bahl, A. (2014). *A text book of organic chemistry*, 5th Ed., S. Chand and Company Ltd.
3. Bansal, R.K. (2017). *Heterocyclic Chemistry*, 5th Ed., New Age International Private Ltd.
4. Morrison, R.T., Boyd, R.M., Bhattacharjee, S.K. (2011) *Organic Chemistry*, 7th Ed., Pearson Publishers.
5. Gilchrist, T.L. (1997). *Heterocyclic Chemistry*, 3rd Ed., Prentice Hall.

Suggested e-material:

1. http://lib.myilibrary.com?id=527192
2. http://lib.myilibrary.com?id=527161
3. http://www.sciencedirect.com/science/book/978012801699

PHAR 215 Pharmacognosy and Phytochemistry - I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- History, scope and development of Pharmacognosy
- Quality control of natural products
- Role of the plant tissue culture in enhancing the production of secondary metabolites
- Standardization of crude drug on the basis of different standardization parameters

Section-A

Introduction to Pharmacognosy:

(a) Definition, history, scope and development of Pharmacognosy

(b) Sources of Drugs - Plants, Animals, Marine & Tissue culture

(c) Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins).

Classification of drugs: Alphabetical, morphological, taxonomical, chemical, pharmacological, chemo and sero taxonomical classification of drugs

Quality control of Drugs of Natural Origin: Adulteration of drugs of natural origin. Evaluation by organoleptic, microscopic, physical, chemical and biological methods and properties.Quantitative microscopy of crude drugs including lycopodium spore method, leafconstants, camera lucida and diagrams of microscopic objects to scale with camera lucida.

Section-B

Cultivation, Collection, Processing and storage of drugs of natural origin:

Cultivation and Collection of drugs of natural origin.Factors influencing cultivation of medicinal plants.Plant hormones and their applications.Polyploidy, mutation and hybridization with reference to medicinal plants. Conservation of medicinal plants

Plant tissue culture: Historical development of plant tissue culture, types of cultures, Nutritional requirements, growth and their maintenance. Applications of plant tissue culture in pharmacognosy.Edible vaccines.

Section-C

Pharmacognosy in various systems of medicine: Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha, Homeopathy and Chinese systems of medicine.

Introduction to secondary metabolites: Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids,

Tannins, Volatile oil and Resins Study of biological source, chemical nature and uses of drugs of natural origin containing following drugs

Plant Products: Fibers - Cotton, Jute, Hemp, Hallucinogens, Teratogens, Natural allergens.

Primary metabolites: General introduction, detailed study with respect to chemistry, sources, preparation, evaluation, preservation, storage, therapeutic uses and commercial utility as Pharmaceutical Aids and/or Medicines for the following primary metabolites:

Carbohydrates: Acacia, Agar, Tragacanth, Honey

Proteins and Enzymes: Gelatin, casein, proteolytic enzymes (Papain, romelain,

serratiopeptidase, urokinase, streptokinase, pepsin).

Lipids (Waxes, fats, fixed oils): Castor oil, Chaulmoogra oil, Wool Fat, Bees Wax

Marine Drugs: Novel medicinal agents from marine sources.

Books Recommended:

1. Evans, W.C. (2009). *Trease and Evans. Pharmacognosy*, 16th Ed., London: W.B. Sounders & Co.
2. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9th Ed., Philadelphia: Lea and Febiger.
3. Wallis, T.E., Churchill, A. (2005). *Text Book of Pharmacognosy*, 5th Ed., New Delhi: CBS Publishers.
4. Mohammad, A. (2012). *Pharmacognosy and Phytochemistry*, 2nd Ed., New Delhi: CBS Publishers and Distribution.
5. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37th Ed., Pune: Nirali Prakashan.
6. Choudhary, R.D. (1996). *Herbal drug industry*, 1st Ed., New Delhi: Eastern Publisher.

7. Ansari, S.H. (2007). *Essentials of Pharmacognosy*, 2nd Ed. New Delhi: Birla publications.

8. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18th Ed. Pune: Nirali Prakashan.

9. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12th Ed., PharmaMed Press.

Suggested e-material:

1. http://nsdl.niscair.res.in
2. http://www.herbs4youth.eu/files/workbook_processingtransf.pdf
3. https://biot202.files.wordpress.com
4. http://www.naturaldatabase.com.
   http://www.nlm.nih.gov/medlineplus/druginfo/herb_All.html
5. http://dietarysupplements.nlm.nih.gov/dietary/ingred.jsp
6. http://ods.od.nih.gov/
7. http://nccam.nih.gov/
8. http://apps.who.int/medicinedocs/en/d/Js2200e/
9. www.fda.gov/medwatch
10. http://apps.who.int/medicinedocs/documents/h1791e/h1791e.pdf
11. http://ayush.gov.in/sites/default/files/File779%20%20%204.pdf
12. www.ayurveda.hu/api/API-Vol-1.

PHAR 216 Pharmacology - I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Various principles of pharmacology
- Classification and mode of actions of different categories of drugs
- Effect of drug action at organ system/sub cellular/ macromolecular level
- Transduction mechanism of various receptors
- Structure, organization and pharmacology of drugs acting on ANS, PNS and CNS
- Applications of basic pharmacological knowledge in the prevention and treatment of various diseases

Section-A

General Pharmacology

a. Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists(competitive and non-competitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy.

b. Pharmacokinetics- Membrane transport, absorption, distribution, metabolism and excretion of drugs .Enzyme induction, enzyme inhibition, kinetics of elimination

Section-B

General Pharmacology

a. Pharmacodynamics- Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors. drug receptors interactions signal transduction mechanisms, G-protein-coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK-STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.

b. Adverse drug reactions.

c. Drug interactions (pharmacokinetic and pharmacodynamic)

d. Drug discovery and clinical evaluation of new drugs -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance.

Pharmacology of drugs acting on peripheral nervous system

a. Organization and function of ANS.

b. Neurohumoral transmission,co-transmission and classification of neurotransmitters.

c. Parasympathomimetics, parasympatholytics, sympathomimetics, sympatholytics.

d. Neuromuscular blocking agents and skeletal muscle relaxants (peripheral).

e. Local anesthetic agents.

f. Drugs used in myasthenia gravis and glaucoma.

Section-C

Pharmacology of drugs acting on central nervous system

a. Neurohumoral transmission in the C.N.S.special emphasis on importance of various neurotransmitters like with GABA, Glutamate, Glycine, serotonin, dopamine.

b. General anesthetics and pre-anesthetics.

c. Sedatives, hypnotics and centrally acting muscle relaxants.

d. Anti-epileptics

e. Alcohols and disulfiram

f. Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics and hallucinogens.

g. Drugs used in Parkinson's disease and Alzheimer's disease.

h. CNS stimulants and nootropics.

i. Opioid analgesics and antagonists

j. Drug addiction, drug abuse, tolerance and dependence.

Books Recommended:

1. Rang, H., MacEwan, D., Ritter, J., Flower, R., Henderson, G., Loke, Y.K. (2019). *Rang and Dale's Pharmacology*, 9th Ed., London: Churchil Livingstone Elsevier.

2. Katzung, B.G., Masters, S.B., Trevor, A.J. (2010). *Basic and clinical pharmacology*, 11th Ed., New York: Mc Graw-Hill.

3. Brunton, L.L., Knollmann, B., Dandan, R.H. (2017). *Goodman and Gilman's, The Pharmacological Basis of Therapeutics,* 13th Ed., New York: McGraw-Hill Education.

4. Marry, A.K.K., Lloyd, Y.Y., Brian, K. A., Robbin, L.C., Joseph, G.B., Wayne, A.K., Bradley, R.W. (2008). *Applied Therapeutics, The Clinical use of Drugs*, 9th Ed., Philadelphia: Lippincott Williams &Wilkins.

5. Tripathi, K.D. (2018). *Essentials of Medical Pharmacology*, 8th Ed., New Delhi: Jaypee Brothers Medical Publishers Ltd.

6. Sharma, H. L., Sharma, K.K. (2012). *Principles of Pharmacology*, 2nd Ed., Ahmedabad: Paras Medical Publisher.

7. Craig, C.R., Sitzel, R.E. (2003). *Modern Pharmacology with clinical Applications*, 6th Ed., Philadelphia: Lippincott Williams &Wilkins.

8. Ghosh, M.N. (2012). *Fundamentals of Experimental Pharmacology*, 6th Ed., Kolkata: Hilton & Company.

9. Kulkarni, S.K. (2005). *Handbook of experimental pharmacology*. 3rd Ed., New Delhi: Vallabh Prakshan.

Suggested e-material:

1. www.cvpharmacology.com

2. www.treatment4addiction.com

3. www.medicalnewtoday.com
4. www.edvivas.com
5. www.pharmafactz.com
6. www.ausmed.com
7. www.medicinenet.com

PHAR 220 Physical Pharmaceutics - II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of the course, the student shall be able to know

- Principles of chemical kinetics & to use them in assigning expiry date for formulation
- Rheology principles and their applications on formulations
- Various aspects of drug stability

Section-A

Colloidal dispersions: Classification of dispersed systems & their general characteristics, size & shapes of colloidal particles, classification of colloids & comparative account of their general properties. Optical, kinetic & electrical properties.Effect of electrolytes, coacervation, peptization & protective action.

Rheology: Newtonian systems, law of flow, kinematic viscosity, effect of temperature, non-Newtonian systems, pseudoplastic, dilatant, plastic, thixotropy, thixotropy in formulation, determination of viscosity, capillary, falling Sphere, rotational viscometers.

Deformation of solids: Plastic and elastic deformation, Heckel equation, stress, strain, elastic modulus.

Section-B

Coarse dispersion: Suspension, interfacial properties of suspended particles, settling in suspensions, formulation of flocculated and deflocculated suspensions. Emulsions and theories of emulsification, microemulsion and multiple emulsions; Stability of emulsions, preservation of emulsions, rheological properties of emulsions and emulsion formulation by HLB method.

Micromeretics: Particle size and distribution, mean particle size, number and weight distribution, particle number, methods for determining particle size by different methods, counting and separation method, particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

Section-C

Drug stability: Reaction kinetics: zero, pseudo-zero, first & second order, units of basic rate constants, determination of reaction order. Physical and chemical factors influencing the chemical degradation of pharmaceutical product: temperature, solvent, ionic strength, dielectric constant, specific & general acid base catalysis, Simple numerical problems. Stabilization of medicinal agents against common reactions like hydrolysis & oxidation.Accelerated stability testing in expiration dating of pharmaceutical dosage forms.Photolytic degradation and its prevention.

Books Recommended:

1. Martin, A., Swarbrick, J. (1993). *Physical Pharmacy*, 3rd Ed., Marryland: Lippincott Williams and Wilkins.

2. Parott, L.E., Saski, W. (1977). *Experimental Pharmaceutics*, 4th Ed., Minneapolis: Burgess Publishers.

3. Cater, S.J. (2005). *Tutorial Pharmacy*, 6th Ed., India: CBS publishers.

4. Stocklosam, M.J., Ansel, H.C. (1986). *Pharmaceutical Calculations*, 8th Ed., Philadelphia: Lippincott Williams and Wilkins.

5. Liberman, H.A., Lachman, C., Schwartz, J.B. (1990). *Pharmaceutical Dosage forms*, Tablets, 2nd Ed., New York: Marcel Dekkar Inc.

6. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms. Disperse systems.* 2nd Ed., New York: Marcel Dekkar Inc.

7. Ramasamy, C., Manavalan, R. (2015). *Physical Pharmaceutics*. 2nd Ed., Chennai: Vignesh Publisher.

Suggested e-material:

1. https://accesspharmacy.mhmedical.com/book.aspx?bookid=513
2. http://www.pharmtech.com/
3. https://www.ncbi.nlm.nih.gov/pmc/
4. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
5. https://www.pdfdrive.com/pharmaceutical-books.html
6. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
7. http://202.74.245.22:8080/xmlui/handle/123456789/39/browse?type=subject
8. www.elsevier.com/books/

PHAR 211L Medicinal Chemistry - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

I Preparation of drugs/ intermediates

- 1,3-pyrazole
- 1,3-oxazole
- Benzimidazole
- Benztriazole
- 2,3- diphenyl quinoxaline

- Benzocaine
- Phenytoin
- Phenothiazine
- Barbiturate

II Assay of drugs

- Chlorpromazine
- Phenobarbitone
- Atropine
- Ibuprofen
- Aspirin
- Furosemide

III Determination of Partition coefficient for any two drugs

PHAR 215L Pharmacognosy and Phytochemistry - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Analysis of crude drugs by chemical tests: (i)Tragaccanth (ii) Acacia (iii)Agar (iv) Gelatin (v) starch (vi) Honey (vii) Castor oil
2. Determination of stomatal number and index
3. Determination of vein islet number, vein islet termination and paliside ratio.
4. Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer
5. Determination of Fiber length and width
6. Determination of number of starch grains by Lycopodium spore method

7. Determination of Ash value
8. Determination of Extractive values of crude drugs
9. Determination of moisture content of crude drugs
10. Determination of swelling index and foaming

PHAR 216L Pharmacology - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Introduction to experimental pharmacology.
2. Commonly used instruments in experimental pharmacology.
3. Study of common laboratory animals.
4. Maintenance of laboratory animals as per CPCSEA guidelines.
5. Common laboratory techniques. Blood withdrawal, serum and plasma separation, anesthetics and euthanasia used for animal studies.
6. Study of different routes of drugs administration in mice/rats.
7. Study of effect of hepatic microsomal enzyme inducers on the phenobarbitone sleeping time in mice.
8. Effect of drugs on ciliary motility of frog oesophagus
9. Effect of drugs on rabbit eye.
10. Effects of skeletal muscle relaxants using rota-rod apparatus.
11. Effect of drugs on locomotor activity using actophotometer.
12. Anticonvulsant effect of drugs byMES and PTZ method.
13. Study of stereotype and anti-catatonic activity of drugs on rats/mice.

14. Study of anxiolytic activity of drugs using rats/mice.

15. Study of local anesthetics by different methods

Note: All laboratory techniques and animal experiments are demonstrated by simulated experiments by softwares and videos

PHAR 218L Physical Pharmaceutics - II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Determination of particle size, particle size distribution using sieving method

2. Determination of particle size, particle size distribution using Microscopic method

3. Determination of bulk density, true density and porosity

4. Determine the angle of repose and influence of lubricant on angle of repose

5. Determination of viscosity of liquid using Ostwald's viscometer

6. Determination sedimentation volume with effect of different suspending agent

7. Determination sedimentation volume with effect of different concentration of single suspending agent

8. Determination of viscosity of semisolid by using Brookfield viscometer

9. Determination of reaction rate constant first order.

10. Determination of reaction rate constant second order

11. Accelerated stability studies

Fifth Semester

PHAR 313 Industrial Pharmacy-I

	L	T	P	C
Max. Marks : 60				
(CA: 20 + ESA: 40)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Various pharmaceutical dosage forms and their manufacturing techniques.
- Various considerations in development of pharmaceutical dosage forms.
- Evaluation quality of solid, liquid and semisolid dosage forms.

Section-A

Tablets: Introduction, ideal characteristics of tablets, classification of tablets. Excipients, Formulation of tablets, granulation methods, compression and processing problems.Equipments and tablet tooling.

Tablet coating: Types of coating, coating materials, formulation of coating composition, methods of coating, equipment employed and defects in coating.

Quality control tests: In process and finished product tests

Liquid orals: Formulation and manufacturing consideration of syrups and elixirs suspensions and emulsions; Filling and packaging; evaluation of liquid orals official in pharmacopoeia

Section-B

Capsules:

Hard gelatin capsules: Introduction, Production of hard gelatin capsule shells. size of capsules, Filling, finishing and special techniques of formulation of hard gelatin capsules, manufacturing defects. In process and final product quality control tests for capsules.

Soft gelatin capsules: Nature of shell and capsule content, size of capsules,importance of base adsorption and minim/gram factors, production, in process and final product quality control tests. Packing, storage and stability testing of soft gelatin capsules and their applications.

Parenteral Products: Definition, types, advantages and limitations. Preformulation factors and essential requirements, vehicles, additives.Production procedure, production facilities and controls, aseptic processing.Formulation of injections, sterile powders, large volume parenterals and lyophilized products. Filling and sealing of ampoules, vials and infusion fluids. Quality control tests of parenteral products.

Section-C

Pellets: Introduction, formulation requirements, pelletization process, equipments for manufacture of pellets.

Ophthalmic Preparations: Introduction, formulation considerations; formulation of eye drops, eye ointments and eye lotions; methods of preparation; labeling, containers; evaluation of ophthalmic preparations

Pharmaceutical Aerosols: Definition, propellants, containers, valves, types of aerosol systems; formulation and manufacture of aerosols; Evaluation of aerosols; Quality control and stabilitystudies.

Packaging materials Science: Materials used for packaging of pharmaceutical products, factors influencing choice of containers, legal and official requirements for containers, stability aspects of packaging materials, quality control tests.

Books recommended:

1. Troy, D.B. (2006). *Remington: The Science and Practice of Pharmacy*, 21st Ed., vol 1-2, Easton Pennsylvania: Mack Publishing Co.
2. Cooper, J.W. Gunn, G. (1986). *Tutorial Pharmacy*, London: Petman Books Ltd.
3. Lachman, L. (1986). *Theory and Practice of Industrial Pharmacy*, Philadelphia: Lea & Febiger

4. Ansel, HC. *Allen, L.V. (2014). Introduction to Pharmaceutical Dosage Forms*, Philadelphia: Wolters Kluwer.
5. Juliano, R.L. (1981) *Drug Delivery Systems,* Oxford: Oxford University Press.
6. Harrys. (2000). *Cosmetology,Art and Science of Formulating Cosmetic Products,* 9th edition, Palm Springs: Chemical Publishing Company.
7. Balsam, M.S., Sagarin, E., (2008) *Cosmetics: Science and Technology,* 2nd Ed.,Krieger Publishing Company.

Suggested e-material:

1. https://accesspharmacy.mhmedical.com/book.aspx?bookid=513
2. http://www.pharmtech.com/
3. https://www.ncbi.nlm.nih.gov/pmc/
4. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
5. https://www.pdfdrive.com/pharmaceutical-books.html
6. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/

   http://202.74.245.22:8080/xmlui/handle/123456789/39/browse?pe=subject www.elsevier.com/books/

PHAR 403 Medicinal Chemistry-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Chemistry of drugs with respect to their pharmacological activity
- The drug metabolic pathways, adverse effect and therapeutic value of drugs.

- Structural Activity Relationship of different class of drugs.
- Chemical synthesis of selected drugs

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

Section-A

Antihistaminic agents: Histamine, receptors and their distribution in the human body.

H_1-antagonists: Diphenhydramine hydrochloride*, Dimenhydrinate, Doxylamines cuccinate, Clemastine fumarate, Diphenylphyraline hydrochloride,

Tripelenamine hydrochloride, Chlorcyclizine hydrochloride, Meclizine hydrochloride, Buclizine hydrochloride, Chlorpheniramine maleate, Triprolidine hydrochloride*, Phenidamine tartarate, Promethazine hydrochloride*, Trimeprazine tartrate, Cyproheptadine hydrochloride, Azatidine maleate, Astemizole, Loratadine, Cetirizine, Levocetrazine, Cromolyn sodium.

H_2-antagonists: Cimetidine*, Famotidine, Ranitidine.

Gastric Proton pump inhibitors: Omeprazole, Lansoprazole, Rabeprazole, Pantoprazole

Anti-neoplastic agents:

Alkylating agents: Meclorethamine*, Cyclophosphamide, Melphalan, Chlorambucil, Busulfan, Thiotepa

Antimetabolites: Mercaptopurine*, Thioguanine, Fluorouracil, Floxuridine, Cytarabine, Methotrexate*, Azathioprine

Antibiotics: Dactinomycin, Daunorubicin, Doxorubicin, Bleomycin

Plant products: Etoposide, Vinblastine sulphate, Vincristine sulphate
Miscellaneous: Cisplatin, Mitotane.

Section-B

Antianginal:

Vasodilators: Amyl nitrite, Nitroglycerine*, Pentaerythritol tetranitrate, Isosorbide dinitrite*, Dipyridamole.

Calcium channel blockers: Verapamil, Bepridil hydrochloride, Diltiazem hydrochloride, Nifedipine, Amlodipine, Felodipine, Nicardipine, Nimodipine.

Diuretics:

Carbonic anhydrase inhibitors: Acetazolamide*, Methazolamide, Dichlorphenamide.

Thiazides: Chlorthiazide*, Hydrochlorothiazide, Hydroflumethiazide, Cyclothiazide, Loop diuretics: Furosemide*, Bumetanide, Ethacrynic acid. Potassium sparing Diuretics: Spironolactone, Triamterene, Amiloride.

Osmotic Diuretics: Mannitol

Anti-hypertensive Agents: Timolol, Captopril, Lisinopril, Enalapril, Benazepril hydrochloride, Quinapril hydrochloride, Methyldopate hydrochloride,* Clonidine hydrochloride, Guanethidine monosulphate, Guanabenz acetate, Sodium nitroprusside, Diazoxide, Minoxidil, Reserpine, Hydralazine hydrochloride.

Anti-arrhythmic Drugs: Quinidine sulphate, Procainamide hydrochloride, Disopyramide phosphate*, Phenytoin sodium, Lidocaine hydrochloride, Tocainide hydrochloride, Mexiletine hydrochloride, Lorcainide hydrochloride, Amiodarone, Sotalol.

Anti-hyperlipidemic agents: Clofibrate, Lovastatin, Cholesteramine and Cholestipol

Coagulant & Anticoagulants: Menadione, Acetomenadione, Warfarin*, Anisindione, clopidogrel

Drugs used in Congestive Heart Failure: Digoxin, Digitoxin, Nesiritide, Bosentan, Tezosentan.

Section-C

Drugs acting on Endocrine system: Nomenclature, Stereochemistry and metabolism of steroids

Sex hormones: Testosterone, Nandralone, Progestrones, Oestriol, Oestradiol,

Oestrione, Diethyl stilbestrol.

Drugs for erectile dysfunction: Sildenafil, Tadalafil.

Oral contraceptives: Mifepristone, Norgestril, Levonorgestrol

Corticosteroids: Cortisone, Hydrocortisone, Prednisolone, Betamethasone, Dexamethasone

Thyroid and antithyroid drugs: L-Thyroxine, L-Thyronine, Propylthiouracil, Methimazole.

Antidiabetic agents:

Insulin and its preparations Sulfonyl ureas: Tolbutamide*, Chlorpropamide, Glipizide, Glimepiride. Biguanides: Metformin. Thiazolidinediones: Pioglitazone, Rosiglitazone. Meglitinides: Repaglinide, Nateglinide. Glucosidase inhibitors: Acrabose, Voglibose.

Local Anesthetics: SAR of Local anesthetics

Benzoic Acid derivatives; Cocaine, Hexylcaine, Meprylcaine, Cyclomethycaine,

Piperocaine.

Amino Benzoic acid derivatives: Benzocaine*, Butamben, Procaine*, Butacaine,Propoxycaine, Tetracaine, Benoxinate.

Lidocaine/Anilide derivatives: Lignocaine, Mepivacaine, Prilocaine, Etidocaine.

Miscellaneous: Phenacaine, Diperodon, Dibucaine.*

Books recommended:

1. Beale, J.M., Block, J., Wilson, G. (2010). *Organic medicinal and Pharmaceutical Chemistry*, 12th Ed., Philadelphia: Lippincott Williams and Wilkins.
2. Lemke, T.L., Williams, D.A., Rocho, V.F., Zito, S.W. (2012). *Foye's Principles of Medicinal Chemistry*, 7th Ed., Philadelphia: Lippincott Williams and Wilkins.
3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7th Ed., New York: John Wiley and Sons.
4. Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3rd Ed., Australia: Harwood academic publishers.
5. Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences*, 21st Ed., Philadelphia: Lippincott Williams and Wilkins.
6. Buckley, G. (1988). *Martindale's extra pharmacopoeia,* 29th Ed., British journal of general practice.
7. Finar, I.L. (2002). Organic Chemistry: Stereochemistry and the Chemistry Natural Products, vol 2, 5th Ed., London: Pearson.
8. Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5th Ed., New York: John Wiley and Sons Ltd.
9. Indian Pharmacopoeia, (2014). Addendum 2016.
10. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. (2009). *Vogel's Tatchell: Text book of practical organic chemistry*, 5th Ed., London: Pearson.

Suggested e-material:

1. https://books.google.co.in/books/about/Foye_s_Principles_of_Medicinal_Chemistry.html?id=R0W1ErpsQpkC
2. https://www.wiley.com/en-us/Burger%27s+Medicinal+Chemistry%2C+Drug+Discovery%2C+and+Development%2C+7th+Edition-p-9780470278154

PHAR 317 Pharmacology-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Pharmacological actions of different categories of drugs
- Details about mechanism of drug action at organ system/sub cellular/ macromolecular levels
- Applications of basic pharmacological knowledge in the prevention and treatment of various diseases
- Correlation of pharmacology with other bio medical sciences.
- Signal transduction mechanism of various receptors.
- structure, organization and pharmacology of drugs acting on ANS, PNS and CNS

Section-A

Pharmacology of drugs acting on cardio vascular system: Introduction to hemodynamic and electrophysiology of heart. Drugs used in congestive heart failure, anti-hypertensive drugs, anti-anginal drugs, anti-arrhythmic drugs and anti-hyperlipidemic drugs.

Pharmacology of drugs acting on cardio vascular system: Drug used in the therapy of shock, hematinics, coagulants, anticoagulants, fibrinolytics, anti-platelet drugs and plasma volume expanders

Pharmacology of drugs acting on urinary system: Diuretics and anti-diuretics.

Section-B

Autocoids and related drugs: Introduction to autacoids and classification, histamine, 5-HT and their antagonists. Prostaglandins, thromboxanes and leukotrienes, angiotensin, bradykinin and substance P. Non-steroidal anti-inflammatory agents, anti-gout drugs and anti-rheumatic drugs

Pharmacology of drugs acting on endocrine system: Basic concepts in endocrine pharmacology. Anterior pituitary hormones- analogues and their inhibitors.Thyroid hormones- analogues and their inhibitors.Hormones regulating plasma calcium level- parathormone, calcitonin and vitamin-D.Insulin, oral hypoglycemic agents and glucagon.ACTH and corticosteroids.

Section-C

Pharmacology of drugs acting on endocrine system: Androgens and anabolic steroids. Estrogens, progesterone and oral contraceptives.Drugs acting on the uterus.

Bioassay: Principles and applications of bioassay, types of bioassay, bioassay of insulin, oxytocin, vasopressin, ACTH, d-tubocurarine, digitalis, histamine and 5-HT.

Books recommended:

1. Ghosh, M.N., (2007). *Fundamentals of Experimental Pharmacology*, Calcutta: Scientific Book Agency.
2. Grover, J.K., (1990). *Experiments in Pharmacy & Pharmacology*, New Delhi: CBS Publishers.
3. Kulkarni, S.K., (2005). *Hand Book of Experimental Pharmacology*Delhi: Vallabh Prakashan.
4. Barar, F.S.K., (2013). *Text Book of Pharmacology*, New Delhi: S Chand.
5. Hardman, J.D., Limbird, L.E., Molinos, B.P., Ruddon, R.W., Gil, A.G., (1996). *Goodman & GilmanThe Pharmacological basis of Therapeutics*, Pergamon press.
6. Katzung, B.G. (2010). *Basic & Clinic Pharmacology*, Prentice Hall, International.
7. Laurence, D.R., Bennet, P.N. (1998). *Clinical Pharmacology*, Churchill: Livingstone.

8. Rang, M.P., Dale, M.M., Riter, J.M., (2015). *Pharmacology*, Churchill: Livingstone.

9. Tripathi, K.D., (2013). *Essentials of Medical Pharmacology*, New Delhi: Jaypee Publishers.

10. Satoskar, R.S., Nirmala, N.R., Bhandarkar, S.D., (2013). *Pharmacology & Pharmacotheropeutics*, Bombay: Popular Prakashan Pvt. Ltd.

Suggested e-material:

1. www.cvpharmacology.com
2. www.treatment4addiction.com
3. www.medicalnewtoday.com
4. www.edvivas.com
5. www.pharmafactz.com
6. www.ausmed.com

PHAR 316 Pharmacognosy and Phytochemistry-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Glycosides as secondary metabolite, their classification, chemical structure and properties
- Use of different categories of glycosides in different diseases
- How ayurvedic formulations are prepared and stored?
- Use of the traditional medicine in curing different ailments

Section-A

Metabolic pathways in higher plants and their determination: Brief study of basic metabolic pathways and formation of different secondary metabolites through these pathways- Shikimic acid pathway, Acetate pathways and Amino acid pathway. Study of utilization of radioactive isotopes in the investigation of Biogenetic studies.

Basics of Phytochemistry: Modern methods of extraction, application of latest techniques like Spectroscopy, chromatography and electrophoresis in the isolation, purification and identification of crude drugs.

Section-B

General introduction, composition, chemistry & chemical classes, biosources, therapeutic uses and commercial applications of following secondary metabolites:

Alkaloids: Vinca, rauwolfia, belladonna, opium, phenylpropanoids

Flavonoids: Lignans, tea, ruta steroids, cardiac glycosides

Triterpenoids: Liquorice, dioscorea, digitalis

Volatile oils: Mentha, clove, cinnamon, fennel, coriander

Tannins: Catechu, pterocarpus

Resins: Benzoin, guggul, ginger, asafoetida, myrrh, colophony

Glycosides: Senna, aloes, bitter almond iridoids, other terpenoids **Naphthaquinones:** Gentian, artemisia, taxus, carotenoids.

Section-C

Isolation, Identification and Analysis of Phytoconstituents

a) Terpenoids: Menthol, Citral, Artemisin

b) Glycosides: Glycyrhetinic acid & Rutin

c) Alkaloids: Atropine, Quinine, Reserpine, Caffeine

d) Resins: Podophyllotoxin, Curcumin

Industrial production, estimation and utilization of the following phytoconstituents: Forskolin, sennoside, artemisinin, diosgenin, digoxin, atropine, podophyllotoxin, caffeine, taxol, vincristine and vinblastine.

Books recommended:

1. Evans, W.C. (2009). *Trease and Evans. Pharmacognosy*, 16th Ed., London: W.B. Sounders & Co.
2. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9th Ed., Philadelphia: Lea and Febiger.
3. Wallis, T.E., Churchill, A. (2005). *Text Book of Pharmacognosy*, 5th Ed., New Delhi: CBS Publishers.
4. Mohammad, A. (2012). *Pharmacognosy and Phytochemistry*, 2nd Ed., New Delhi: CBS Publishers and Distribution.
5. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37th Ed., Pune: Nirali Prakashan.
6. Choudhary, R.D. (1996). *Herbal drug industry*, 1st Ed., New Delhi: Eastern Publisher.
7. Ansari, S.H. (2007). *Essentials of Pharmacognosy*, 2nd Ed. New Delhi: Birla publications.
8. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18th Ed. Pune: Nirali Prakashan.

Suggested e-material:

1. http://nsdl.niscair.res.in
2. http://www.herbs4youth.eu/files/workbook_processingtransf.pdf
3. https://biot202.files.wordpress.com
4. http://www.naturaldatabase.com
5. http://www.nlm.nih.gov/medlineplus/druginfo/herb_All.html
6. http://dietarysupplements.nlm.nih.gov/dietary/ingred.jsp
7. http://ods.od.nih.gov/

8. http://nccam.nih.gov/

9. www.fda.gov/medwatch

10. http://apps.who.int/medicinedocs/documents/h1791e/h1791e.pdf

11. http://ayush.gov.in/sites/default/files/File779%20%20%204.pdf

12. www.ayurveda.hu/api/API-Vol-1

PHAR 315 Pharmaceutical Jurisprudence

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Pharmaceutical legislations and their implications in the development and marketing of pharmaceuticals.
- Various Indian pharmaceutical Acts and Laws
- Regulatory authorities and agencies governing the manufacture and sale of pharmaceuticals
- Code of ethics during the pharmaceutical practice

Section-A

Drugs and Cosmetics Act, 1940 and its rules 1945: Objectives, Definitions, Legal definitions of schedules to the Act and Rules Import of drugs – Classes of drugs and cosmetics prohibited from import, Import under license or permit. Offences and penalties. Manufacture of drugs – Prohibition of manufacture and sale of certain drugs, Conditions for grant of license and conditions of license for manufacture of drugs, Manufacture of drugs for test, examination and analysis, manufacture of new drug, loan license and repacking license.

Drugs and Cosmetics Act, 1940 and its rules 1945: Detailed study of Schedule G, H, M, N, P, T, U, V, X, Y, Part XII B, Sch F & DMR (OA).

Sale of Drugs – Wholesale, Retail sale and restricted license. Offences and penalties Labeling & Packing of drugs- General labeling requirements and specimen labels for drugs and cosmetics, List of permitted colors. Offences and penalties. Administration of the Act and Rules – Drugs Technical Advisory Board, Central drugs Laboratory, Drugs Consultative Committee, Government drug analysts, licensing authorities, controlling authorities, Drugs Inspectors.

Section-B

Pharmacy Act 1948: Objectives, definitions, pharmacy council of India, its constitution and functions, education regulations, state and joint state pharmacy councils, constitution and functions, registration of pharmacists, offence and penalties.

Medicinal and toilet preparation act 1955: Objectives, definitions, licensing, manufacture in bond and outside bond, export of alcoholic preparations, manufacture of ayurvedic, homeopathic, patent & proprietary preparations. Office and penalties.

Narcotic drugs and psychotropic substances act 1985 and rules: Objectives, definitions, authorities and officers, constitution and functions of narcotic and psychotropic consultative committee, national fund for controlling the drug abuse, prohibition, control and regulation, opium poppy cultivation and production of poppy straw, manufacture, sale and export of opium, offences and penalties.

Section-C

Study of salient features of drugs and magic remedies act and its rules: Objectives, definitions, prohibition of certain advertisements, classes of exempted advertisements, offences and penalties.

Prevention of cruelty to animals act 1960: Objectives, definitions, Institutional animal ethics committee, CPCSEA guidelines for breeding and stocking of animals, performance of experiments, transfer and acquisition of animals for experiment, records, power to suspend or revoke registration, offences and penalties.

National pharmaceutical pricing authority: Drugs price control order (DPCO) 2013. Definitions, sale prices of bulk drugs, retail price of formulations, retail price and ceiling price of scheduled formulations, national list of essential medicines.

Pharmaceutical legislations: A brief review, introduction, study of drugs enquiry committee, health survey and development committee, Hathi committee and Mudaliar committee.

Code of pharmaceutical ethics: Definition, pharmacist in relation to his job, trade, medical profession and his profession, Pharmacist's oath.

Medical termination of pregnancy act.

Right to information act.

Introduction to Intellectual Property Rights (IPR).

Books recommended:

1. Mittal, B.M., (1899). *Textbook of Forensic Pharmacy*, Calcutta: National Book Centre.
2. *Relevant Acts & Rules*, (2006). Delhi: Publishing by the Govt. of India.
3. Jain, N.K., (2018). *A Textbook of Forensic Pharmacy*, Delhi: Vallabh Prakashan.

Suggested e-material:

1. www.imedpub.com/.../pharmaceutical-jurisprudence-journals-articles-ppts-list.php
2. https://cdsco.gov.in

PHAR 313L Industrial Pharmacy - I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Preparation and evaluation of Paracetamol tablets
2. Preparation and evaluation of Aspirin tablets
3. Coating of tablets- film coating of tables/granules
4. Preparation and evaluation of Tetracycline capsules

5. Preparation of Calcium Gluconate injection
6. Preparation of Ascorbic Acid injection
7. Quality control test of (as per IP) marketed tablets and capsules
8. Preparation of Eye drops/ and Eye ointments
9. Preparation of Creams (cold / vanishing cream)
10. Evaluation of Glass containers (as per IP)

PHAR 317L Pharmacology-II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Introduction to in-vitro pharmacology and physiological salt solutions.
2. Effect of drugs on isolated frog heart.
3. Effect of drugs on blood pressure and heart rate of dog.
4. Studyof diuretic activity of drugs using rats/mice.
5. DRC of acetylcholine using frog rectus abdominis muscle.
6. Effect of physostigmine and atropine on DRC of acetylcholine using frog rectus abdominis muscle and rat ileum respectively.
7. Bioassay of histamine using guinea pig ileum by matching method.
8. Bioassay of oxytocin using rat uterine horn by interpolation method.
9. Bioassay of serotonin using rat fundus strip by three point bioassay.
10. Bioassay of acetylcholine using rat ileum/colon by four point bioassay.
11. Determination of PA_2 value of prazosin using rat anococcygeus muscle (by Schilds plot method).

12. Determination of PD_2 value using guinea pig ileum.

13. Effect of spasmogens and spasmolytics using rabbit jejunum.

14. Anti-inflammatory activity of drugs using carrageenan induced paw-edema model.

15. Analgesic activity of drug using central and peripheral methods

Note: All laboratory techniques and animal experiments are demonstrated by simulated experiments by softwares and videos

PHAR 316L Pharmacognosy and Phytochemistry-II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Morphology, histology and powder characteristics & extraction & detection of: Cinchona, Cinnamon, Senna, Clove, Ephedra, Fennel and Coriander

2. Exercise involving isolation & detection of active principles a. Caffeine - from tea dust. b. Diosgenin from Dioscoreac. Atropine from Belladonna d. Sennosides from Senna

3. Separation of sugars by Paper chromatography

4. TLC of herbal extract

5. Distillation of volatile oils and detection of phytoconstitutents by TLC

6. Analysis of crude drugs by chemical tests: (i) Asafoetida (ii) Benzoin (iii) Colophony (iv) Aloes (v) Myrrh

Sixth Semester

PHAR 311 Biopharmaceutics and Pharmacokinetics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Biopharmaceutics and pharmacokinetics, their role in formulation, development and clinical testing.
- Compartment modelling and plasma concentration measurement.
- Dosage adjustment in clinical & pathological conditions and pharmacokinetic drug interaction.
- Bioavailability – bioequivalence (BA-BE) study.

Section-A

Introduction to Biopharmaceutics: Absorption; Mechanisms of drug absorption through GIT, factors influencing drug absorption though GIT, absorption of drug from Non per oral extra-vascular routes,

Distribution: Tissue permeability of drugs, binding of drugs, apparent, volume of drug distribution.

Plasma and tissue protein binding of drugs: factors affecting protein-drug binding. Kinetics of protein binding, Clinical significance of protein binding of drugs.

Section-B

Elimination: Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Non renal routes of drug excretion of drugs

Bioavailability and Bioequivalence: Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, *in-vitro* drug dissolution models, *in-vitro-in-vivo*

correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.

Section-C

Pharmacokinetics: Definition and introduction to Pharmacokinetics, Compartment models, Non compartment models, physiological models, One compartment open model. Intravenous Injection (Bolus), Intravenous infusion and Extravascular administrations. Pharmacokinetics parameters - K, $t_{1/2}$, Vd, AUC, Ka, Cl_T and CL_{RE} - definitions methods of eliminations, understanding of their significance and application.

Multi-compartment models: Two compartment open model, IV bolus.

Multiple dosage regimen: Kinetics of multiple dosing, steady state drug levels, calculation of loading and maintenance doses and their significance in clinical settings.

Nonlinear Pharmacokinetics: Introduction, Factors causing Non-linearity, Michaelis-menton method of estimating parameters, Explanation with example of drugs.

Books Recommended:

1. Notari, R.E. (1987). Biopharmaceutics and Clinical Pharmacokinetics, An Introduction, 4th edition, revised and expanded, New York: Marcel Dekker.

2. Rowland, M. Tozer, T.N. (1995). Clinical Pharmacokinetics, Concepts and Application, 3rd edition, Philadelphia: Lippincott Williams and Wilkins.

3. Wagner, J.G. Pemarowski, M. (1971). Biopharmaceutics and Relevant Pharmacokinetics, 1st edition, Illinois: Drug Intelligence Publications.

4. Shargel, L., Yu, A., Pong, S.W. (2012). Applied Biopharmaceutics and Pharmacokinetics. 6th Ed. New York: Mcgraw Hill Publication.

5. Jambhekar, S.S. Breen, P.J. (2009). Basic Pharmacokinetics, 1st edition: Pharmaceutical press, RPS Publishing.

Suggested e-material:

1. http://202.74.245.22:8080/xmlui/handle/123456789/39/browse?type=subject
2. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics
3. https://www.pdfdrive.com/pharmaceutical-books.html

PHAR 312 Herbal Drug Technology

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of this course student will have an understanding of:

- alkaloidal drugs ,their classification, chemical tests and uses
- various enzymes and functions
- worldwide trade affecting the national economy
- role of the plant tissue culture in enhancing the accumulation of secondary metabolites
- chromatography helps in identification and quantification of mixture of chemical constituents present in the drugs

Section-A

Herbs as raw materials: Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation, source of herbs selection, identification and authentication of herbal materials, processing of herbal raw material. Biodynamic agriculture good agricultural practices in cultivation of medicinal plants including organic farming**.**

Pest and Pest management in medicinal plants: Biopesticides/ Bioinsecticides.

Indian Systems of Medicine: Preparation and standardization of Ayurvedic formulations viz Aristas and Asawas, Ghutika,Churna, Lehya and Bhasma

Section-B

Nutraceuticals: General aspects, market, growth, scope and types of products available in the market. Health benefits and role of nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastro intestinal diseases.

Study of following herbs as health food: Alfa-alfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ginseng, Ashwagandha, Spirulina

Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions- Hypercium, kava-kava, Ginkobiloba, Ginseng, Garlic, Pepper & Ephedra.

Herbal Cosmetics: Herbal Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products.

Herbal excipients: Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors & perfumes.

Herbal formulations: Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosomes

Section-C

Evaluation of Drugs: WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs.

Patenting and Regulatory requirements of natural products: Definition of the terms- Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy.

Patenting aspects of Traditional Knowledge and Natural Products.Case study of Curcuma & Neem.

Regulatory Issues - Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs - Schedule Z of Drugs & Cosmetics Act for ASU drugs.

General Introduction to Herbal Industry: Herbal drugs industry, Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India.

Schedule T: Good Manufacturing Practice of Indian systems of medicineComponents of GMP (Schedule-T) and its objectives.Infrastructural requirements, working space, storage area, machinery and equipments, standard operating procedures, health and hygiene, documentation and records.

Books Recommended:

1. Evans, W.C. (2009). *Trease and Evans. Pharmacognosy*, 16th Ed., London: W.B. Sounders & Co.
2. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9th Ed., Philadelphia: Lea and Febiger.
3. Wallis, T.E., Churchill, A. (2005). *Text Book of Pharmacognosy*, 5th Ed., India: CBS Publishers.
4. Mohammad, A. (2012). *Pharmacognosy and Phytochemistry*, 2nd Ed., New Delhi: CBS Publishers and Distribution.
5. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37th Ed., New Delhi: Nirali Prakashan.
6. Choudhary, R.D. (1996). *Herbal drug industry*, 1st Ed., New Delhi: Eastern Publisher.
7. Ansari, S.H. (2007). *Essentials of Pharmacognosy*, 2nd Ed. New Delhi: Birla publications.
8. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18th Ed. New Delhi: Nirali Prakashan.
9. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12th Ed., PharmaMed Press.

Suggested e-material:

1. http://nsdl.niscair.res.in
2. http://www.herbs4youth.eu/files/workbook_processingtransf.pdf
3. https://biot202.files.wordpress.com
4. http://www.naturaldatabase.com
5. http://www.nlm.nih.gov/medlineplus/druginfo/herb_All.html
6. http://dietarysupplements.nlm.nih.gov/dietary/ingred.jsp
7. http://ods.od.nih.gov/
8. http://nccam.nih.gov/
9. http://apps.who.int/medicinedocs/en/d/Js2200e/
10. www.fda.gov/medwatch
11. http://apps.who.int/medicinedocs/documents/h1791e/h1791e.pdf
12. http://ayush.gov.in/sites/default/files/File779%20%20%204.pdf
13. www.ayurveda.hu/api/API-Vol-1

PHAR 404 Medicinal Chemistry-III

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Correlation between pharmacology of a disease and its mitigation or cure.
- Drug metabolic pathways, adverse effect and therapeutic value of drugs
- Structural activity relationship of different class of drugs.

- Synthesis of some important class of drugs.
- chemistry of drugs with respect to their pharmacological activity

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

Section-A

Antibiotics: Historical background, Nomenclature, Stereochemistry, Structure activity relationship, Chemical degradation classification and important products of the following classes.

β-Lactam antibiotics: Penicillin, Cepholosporins, **β**-Lactamase inhibitors, Monobactams

Aminoglycosides: Streptomycin, Neomycin, Kanamycin

Tetracyclines: Tetracycline, Oxytetracycline, Chlortetracycline, Minocycline, Doxycycline.

Macrolide: Erythromycin Clarithromycin, Azithromycin.

Miscellaneous: Chloramphenicol*, Clindamycin.

Prodrugs: Basic concepts and application of prodrugs design.

Antimalarials: Etiology of malaria.

Quinolines: SAR, Quinine sulphate, Chloroquine*, Amodiaquine, Primaquine phosphate, Pamaquine*, Quinacrine hydrochloride, Mefloquine.

Biguanides and dihydro triazines: Cycloguanil pamoate, Proguanil. **Miscellaneous:** Pyrimethamine, Artesunete, Artemether, Atovoquon

Section-B

Anti-tubercular Agents

Synthetic anti tubercular agents: Isoniozid*, Ethionamide, Ethambutol, Pyrazinamide, Para amino salicylic acid.*

Anti-tubercular antibiotics: Rifampicin, Rifabutin, Cycloserine Streptomycine, Capreomycin sulphate.

Urinary tract anti-infective agents Quinolones: SAR of quinolones, Nalidixic Acid,Norfloxacin, Enoxacin, Ciprofloxacin*, Ofloxacin, Lomefloxacin, Sparfloxacin, Gatifloxacin, Moxifloxacin

Miscellaneous: Furazolidine, Nitrofurantoin*, Methanamine.

Antiviral agents: Amantadine hydrochloride, Rimantadine hydrochloride, Idoxuridine trifluoride, Acyclovir*, Gancyclovir, Zidovudine, Didanosine, Zalcitabine, Lamivudine, Loviride, Delavirding, Ribavirin, Saquinavir, Indinavir, Ritonavir.

Antifungal agents:

Antifungal antibiotics: Amphotericin-B, Nystatin, Natamycin, Griseofulvin.

Synthetic Antifungal agents: Clotrimazole, Econazole, Butoconazole, Oxiconazole Tioconozole, Miconazole*, Ketoconazole, Terconazole, Itraconazole, Fluconazole, Naftifine hydrochloride, Tolnaftate*.

Section-C

Anti-protozoal Agents: Metronidazole*, Tinidazole, Ornidazole, Diloxanide, Iodoquinol, Pentamidine Isethionate, Atovaquone, Eflornithine.

Anthelmintics: Diethylcarbamazine citrate*, Thiabendazole, Mebendazole*, Albendazole, Niclosamide, Oxamniquine, Praziquantal, Ivermectin.

Sulphonamides and Sulfones: Historical development, chemistry, classification and SAR of Sulfonamides: Sulphamethizole, Sulfisoxazole, Sulphamethizine, Sulfacetamide*, Sulphapyridine, Sulfamethoxaole*, Sulphadiazine, Mefenide acetate, Sulfasalazine.

Folate reductase inhibitors: Trimethoprim*, Cotrimoxazole.

Sulfones: Dapsone*.

Introduction to Drug Design Various approaches used in drug design. Physicochemical parameters used in quantitative structure activity

relationship (QSAR) such as partition coefficient, Hammet's electronic parameter, Tafts steric parameter and Hansch analysis. Pharmacophore modeling and docking techniques.

Combinatorial Chemistry: Concept and applications of combinatorial chemistry: solid phase and solution phase synthesis.

Books Recommended:

1. Beale, J.M., Block, J., Wilson, G. (2010). *Organic medicinal and Pharmaceutical Chemistry*, 12th Ed., Philadelphia: Lippincott Williams and Wilkins.
2. Lemke, T.L., Williams, D.A., Rocho, V.F., Zito, S.W. (2012). *Foye's Principles of Medicinal Chemistry*, 7th Ed., Philadelphia: Lippincott Williams and Wilkins.
3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7th Ed., New York: John Wiley and Sons.
4. Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3rd Ed., Harwood Academic Publishers.
5. Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences,* 21st Ed., Philadelphia: Lippincott Williams and Wilkins.
6. Buckley, G. (1988). *Martindale's extra pharmacopoeia,* 29th Ed., British journal of general practice.
7. Finar, I.L. (2002). Organic Chemistry: Stereochemistry and the Chemistry Natural Products, vol 2, 5th Ed., London: Pearson.
8. Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5th Ed., New York: John Wiley and Sons Ltd.
9. Indian Pharmacopoeia, (2014). Addendum 2016.
10. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. (2009). *Vogel's Tatchell: Text book of practical organic chemistry*, 5th Ed., London: Pearson.

Suggested e-material:

1. https://books.google.co.in/books/about/Foye_s_Principles_of_Medicinal_Chemistry.html?id=R0W1ErpsQpkC
2. https://www.wiley.com/en-us/ Burger %27s+ Medicinal+Chemistry%2C+Drug+Discovery%2C+and+Development%2C+7th+Edition-p-9780470278154

PHAR 318 Pharmacology-III

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Mechanism of drug action and its relevance in the treatment of different diseases
- Various receptor actions using isolated tissue preparation.
- Cell communication mechanism
- Newer targets of several disease conditions for treatment
- Structure, organization and pharmacology of drugs acting on cvs, git, hemopoeitic system, respiratory system, endocrine system, diuretics and autacoids

Section-A

Pharmacology of drugs acting on Respiratory system: Anti -asthmatic drugs, Drugs used in the management of COPD, Expectorants and antitussives, Nasal decongestants, Respiratory stimulants.

Pharmacology of drugs acting on the Gastrointestinal Tract: Antiulcer agents, Drugs for constipation and diarrhea, Appetite stimulants and suppressants. Digestants and carminatives.Emetics and anti-emetics.

Chemotherapy: General principles of chemotherapy. Sulfonamides and cotrimoxazole. Antibiotics- Penicillins, cephalosporins, chloramphenicol, macrolides, quinolones and fluoroquinolins, tetracycline and aminoglycosides.

Section-B

Chemotherapy: Antitubercular agents, Antileprotic agents, Antifungal agents, Antiviral drugs, Anthelmintics, Antimalarial drugs, Antiamoebic agents.

Chemotherapy: Urinary tract infections and sexually transmitted diseases. Chemotherapy of malignancy.

Immunopharmacology: Immunostimulants, Immunosuppressant, Protein drugs, monoclonal antibodies, target drugs to antigen, biosimilars.

Section-C

Principles of toxicology: Definition and basic knowledge of acute, subacute and chronic toxicity. Definition and basic knowledge of genotoxicity, carcinogenicity, teratogenicity and mutagenicity. General principles of treatment of poisoning, Clinical symptoms and management of barbiturates, morphine, organophosphosphorus compound and lead, mercury and arsenic poisoning.

Chronopharmacology: Definition of rhythm and cycles. Biological clock and their significance leading to chronotherapy.

Recommended books:

1. Kulkarni, S.K. (2013). *Handbook of Experimental Pharmacology*, Vallabh Prakashan.
2. Ghosh, M.N. (2008). *Fundamentals of Experimental Pharmacology*, 5thEd., Kolkata: Hilton & Company Publishers.
3. *Handbook on GLP, Quality Practices for Regulated Non-Clinical Research and Development*, World Health Organization, 2nd Ed., 2008.

4. *Schedule Y, Guideline: Drugs and cosmetics (second amendment) Rules*, CDSCO, 1945.

5. *Annual Report to the People on Health*, Ministry of Health and Family Welfare, New Delhi, 2005

6. Rick, N.G. (2015). *Drugs from Discovery to Approval*, 3rdEd., New York: Wiley-Blackwell Publishers.

7. Gad, C.S. (2015). *Animal Models in Toxicology*, 3rdEd., New York: CRC Press.

8. *OECD (452) guidelines for the Testing of Chemicals*, 2018

9. Stine, E.R., Brown, M.T. (2015). *Principles of toxicology*, 3rdEd., New York: CRC Press.

Suggested e-material:

1. www.cvpharmacology.com
2. www.treatment4addiction.com
3. www.medicalnewtoday.com
4. www.edvivas.com
5. www.pharmafactz.com
6. www.ausmed.com

PHAR 314 Pharmaceutical Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Importance of genetic engineering & enzyme immobilization in pharmaceutical industries

- Production and application of monoclonal antibodies in health care.
- Use of fermentation technology in pharmaceutical field.

Section-A

Brief introduction to Biotechnology with reference to Pharmaceutical Sciences.

Enzyme Biotechnology: Methods of enzyme immobilization and applications.

Biosensors: Working and applications of biosensors in Pharmaceutical Industries.

Brief introduction to Protein Engineering.

Use of microbes in industry.Production of Enzymes- General consideration -Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase.

Basic principles of genetic engineering.

Study of cloning vectors, restriction endonucleases and DNA ligase.

Recombinant DNA technology: Application of genetic engineering in medicine. Application of r DNA technology and genetic engineering in the production of: Interferon; Vaccines- hepatitis- B; Hormones-Insulin. Brief introduction to PCR

Section-B

Immunity: Types of immunity- humoral immunity, cellular immunity. Structure of Immunoglobulins.Structure and Function of MHC.Hypersensitivity reactions, Immune stimulation and Immune suppressions.General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity.Storage conditions and stability of official vaccines.

Hybridoma technology: Production, Purification and Applications. **Immuno blotting techniques:** ELISA, Western blotting, Southern blotting.

Section-C

Genetic organization of Eukaryotes and Prokaryotes.Microbial genetics including transformation, transduction, conjugation, plasmids and transposons.

Microbial biotransformation: Introduction and its applications. **Mutation**: Types of mutation/mutants.

Fermentation: methods and general requirements, study of media, equipments, sterilization methods, aeration process, stirring. Large scale production fermenter design and its various controls.Study of the production of - penicillins, citric acid, Vitamin B12, Glutamic acid, Griseofulvin.

Recommended books (Latest editions):

1. Vyas, S.P., Dixit, V.K. (2010). *Pharmaceutical Biotechnology*, New Delhi: CBS Publication.
2. Prescott, Dunn's, (2004). *Industrial Microbiology*, Delhi: CBS Publishers and Distributors.
3. Stanbury, P.F., Ahhitar, A., (2008). *Principles of Fermentation Technology*, Elsevier.
4. Kieslich, K. (1984). *Biotechnology, v*ol. 69, Verleg Chernie.
5. Standury, P.F., Whitaker, A., Hall, S.J. (1990). *Principles of Fermentation*, New Delhi: Aditya Book Private Limited.
6. Crueger, W., Crueger, A., (2000). *Biotechnology-A Textbook of Industrial Microbiology*, Delhi: Panima Publishing Corporation.

Suggested e-material:

1. http://site.iugaza.edu.ps/tbashiti/files/2013/02/2.Pharmaceutical_Biotechnology_ConceptsApplications-Gary_Walsh.pdf
2. http://web.xidian.edu.cn/yqxia/files/20140227_103205.pdf
3. https://drive.google.com/file/d/0BxB7ZrIzz8L7STd4WEhneHlKcXc/view?usp=drivesdk

PHAR 319 Quality Assurance

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning outcomes

Upon completion of this course student will have an understanding of:

- The importance of quality in pharmaceutical products.
- Importance of Good practices such as GMP, GLP etc.
- Factors affecting the quality of pharmaceutical are explored.
- Regulatory aspects of pharmaceutical taught to the student.
- Process involved in manufacturing of pharmaceuticals different section/department and activity is learnt.

Section-A

Organization and personnel: Personnel responsibilities, training, hygiene and personal records.

Premises: Design, construction and plant layout, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination.

Equipments and raw materials: Equipment selection, purchase specifications, maintenance, purchase specifications and maintenance of stores for raw materials.

Section-B

Quality Control: Quality control test for containers, rubber closures and secondary packing materials.

Good Laboratory Practices: General Provisions, Organization and Personnel, Facilities, Equipment, Testing Facilities Operation, Test and Control Articles, Protocol for Conduct of a Nonclinical Laboratory Study, Records and Reports, Disqualification of Testing Facilities

Complaints: Complaints and evaluation of complaints, Handling of return good, recalling and waste disposal.

Section-C

Document maintenance in pharmaceutical industry: Batch Formula Record, Master Formula Record, SOP, Quality audit, Quality Review and Quality documentation, Reports anddocuments, distribution records.

Calibration and Validation: Introduction, definition and general principles of calibration, qualification and validation, importance and scope of validation, types of validation, validation master plan. Calibration of pH meter, Qualification of UV-Visible spectrophotometer, General principles of Analytical method Validation.

Warehousing: Good warehousing practice, materials management

Books Recommended:

1. Quality Assurance Guide (1996) by Organization of Pharmaceutical Procedures of India, 3rd revised Ed., Volume I & II.
2. Weinberg, S. (1995). Good Laboratory Practice Regulations. 2nd Ed., Vol. 69, New York: Marcel Dekker, Inc.
3. Quality Assurance of Pharmaceuticals- A compendium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
4. Sharma, P. P. (1991). How to Practice GMP's. Agra:Vandana Publications.
5. The International Pharmacopoeia (2005)– Vol I, II, III, IV & V - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Excipients and Dosage forms, 3rd Ed., WHO, Geneva.
6. Hirsch, A. F. (1989). Good Laboratory Practice Regulations. Vol 38, New York: Marcel Dekker Inc.
7. Deshpande, S. W., Gandhi, N. The Drugs and Cosmetics Act 1940 and Rules 1945. 8th Ed., Mumbai:Susmit Publishers.

8. Shah, D. H. (2000). QA Manual. 1st Ed., Business Horizons, Elsevier.

9. Willig, S. H., Stoker J. (1991). Good Manufacturing Practices for Pharmaceuticals A Plan For Total Quality Control. Vol. 52, 3rd Ed., New York: Marcel Dekker Inc.

Suggested e-material:

1. www.ich.org
2. https://www.who.int

PHAR 312L Herbal Drug Technology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. To perform preliminary phytochemical screening of crude drugs.
2. Determination of the alcohol content of Asava and Arista.
3. Evaluation of excipients of natural origin.
4. Incorporation of prepared and standardized extract in cosmetic formulations like creams, lotions and shampoos and their evaluation.
5. Incorporation of prepared and standardized extract in formulations like syrups, mixtures and tablets and their evaluation as per Pharmacopoeial requirements.
6. Monograph analysis of herbal drugs from recent Pharmacopoeias.
7. Determination of Aldehyde content
8. Determination of Phenol content
9. Determination of total alkaloids

PHAR 404L Medicinal Chemistry-III Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

I **Preparation of drugs and intermediates**

1. Sulphanilamide
2. 7-Hydroxy, 4-methyl coumarin
3. Chlorobutanol
4. Triphenyl imidazole
5. Tolbutamide
6. Hexamine

II **Assay of drugs**

1. Isonicotinic acid hydrazide
2. Chloroquine
3. Metronidazole
4. Dapsone
5. Chlorpheniramine maleate
6. Benzyl penicillin

III Preparation of medicinally important compounds or intermediates by Microwave irradiation technique

IV Drawing structures and reactions using chem draw®

V Determination of physicochemical properties such as logP, clogP, MR, Molecular weight, Hydrogen bond donors and acceptors for class of drugs course content using drug design software Drug likeliness screening (Lipinskies RO5)

PHAR 318L Pharmacology - III Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Dose calculation in pharmacological experiments
2. Antiallergic activity by mast cell stabilization assay
3. Studyof anti-ulcer activityof a drug using pylorus ligand (SHAY) rat model and NSAIDS induced ulcer model.
4. Study of effect of drugs on gastrointestinal motility
5. Effect of agonist and antagonists on guinea pig ileum
6. Estimation of serum biochemical parameters by using semi-autoanalyser
7. Effect of saline purgative on frog intestine
8. Insulin hypoglycemic effect in rabbit
9. Test for pyrogens (rabbit method)
10. Determination of acute oral toxicity (LD50) of a drug from a given data
11. Determination of acute skin irritation / corrosion of a test substance
12. Determination of acute eye irritation / corrosion of a test substance
13. Calculation of pharmacokinetic parameters from a given data
14. Biostatistics methods in experimental pharmacology (student's t test, ANOVA)
15. Biostatistics methods in experimental pharmacology (Chi square test, Wilcoxon Signed Rank test)

**Experiments are demonstrated by simulated experiments/videos*

Seventh Semester

PHAR 416 Instrumental Methods of Analysis

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Instrumentation techniques available.
- Aspects of separation for multi components of drugs and excipients using various instrumentation techniques.
- Accurate analysis and report the results in defined formats ofdocumentation and express the observations with clarity.
- professional and safety responsibilities for working in the analysis laboratory

Section-A

Ultraviolet-visible (UV-vis) spectroscopy: Electronic transitions, chromophores, auxochromes, spectral shifts, solvent effect on absorption spectra, Beer and Lambert's law, Derivation and deviations.

Instrumentation - Sources of radiation, wavelength selectors, sample cells, detectors (Photo tube, Photomultiplier tube, Photo voltaic cell, Silicon Photodiode) & calibration as per ICH and USFDA guidelines.

Applications - Spectrophotometric titrations, single component and multi component analysis.

Infra-red (IR) spectroscopy: Introduction, fundamental modes of vibrations in poly atomic molecules, sample handling, factors affecting vibrations. *Instrumentation* - Sources of radiation, wavelength selectors, detectors (Golay cell, bolometer, thermocouple, thermister, pyroelectric detector) & calibration as per ICH and USFDA guidelines.

Applications (Interpretation of data/ IR spectra of some simple compounds).

Section-B

Fluorimetry: Theory, concepts of singlet, doublet and triplet electronic states, internal and external conversions, factors affecting fluorescence, quenching, instrumentation, applications & calibration as per ICH and USFDA guidelines.

Flame photometry (AAS & AES): Principle, interferences, instrumentation, applications & calibration as per ICH and USFDA guidelines.

Nephelo-turbidometry: Principle, instrumentation and applications

Section-C

Nuclear magnetic resonance spectroscopy: Principle of proton-NMR, shielding & de-shielding of magnetic nuclei, chemical shift and its measurements, factors affecting chemical shift, spin-spin interaction (relaxation & coupling), coupling constant 'J', factors influencing coupling constant. Instrumentation and applications (Interpretation of data/ NMR spectra of some simple compounds).

Mass spectrometry: Introduction to mass spectra, principle, fragmentation, different types of peak (molecular ion, isotopic ion peak, fragmentation peak) and their importance. Instrumentation.ionization techniques (Electron impact, chemical, ionization, MALDI, FAB), analyzers (Time of flight and Quadrupole). Applications (Interpretation of data/mass spectra of some simple compounds).

Books Recommended:

1. Chatten, L.G. (1966). *A text book of PharmaceuticalChemistry.* vol. 1-2, New York: Marcel. Dekkar.

2. Backeet, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*, vol. 1-2, London: The Atholone Press of the University of London.

3. Willard, H.H., Merrit, L., Dean, J.A. (1966) *Instrumental methods of analysis*. New York: Van Nostrand Renhold.

4. Obonson, J.W.R. (1970). *Undergraduate Instrumental Analysis.* New York: Marcel Dekkar Inc.

5. Parikh, V.H. (1974). *Absorption Spectroscopy of Organic Molecules.* London: Addison-Wesley Publishing Co.

6. Indian Pharmacopoeia (2018), Ministry of Health, Govt. of India.

7. Backeet, A.H. Stenlake, J.B. (1988). *Practical Pharmaceutical Chemistry*, vol. 1-2. London: The Atholone Press.

Suggested e-material:

1. https://nptel.ac.in/downloads/103108100/
2. https://catalog.williams.edu

PHAR 415 Industrial Pharmacy-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Process of pilot plant and scale up of pharmaceutical dosage forms.
- Process of technology transfer from lab scale to commercial batch.
- Different Laws and Acts that regulate pharmaceutical industry Understand the approval process and regulatory requirements for drug products

Section-A

Pilot plant scale up techniques: General considerations - including significance of personnel requirements, space requirements, raw materials, Pilot plant scale up considerations for solids, liquid orals, semi solids and relevant documentation, SUPAC guidelines, Introduction to platform technology.

Technology development and transfer: WHO guidelines for Technology Transfer(TT): Terminology, Technology transfer protocol, Quality risk management, Transfer from R & D to production (Process, packaging and cleaning), Granularity of TT Process (API, excipients, finished products, packaging materials) Documentation, Premises and equipments, qualification and validation, quality control, analytical method transfer, Approved regulatory bodies and agencies, Commercialization - practical aspects and problems (case studies), TT agencies in India - APCTD, NRDC, TIFAC, BCIL, TBSE /SIDBI; TT related documentation - confidentiality agreement, licensing, MoUs, legal issues

Section-B

Regulatory affairs: Introduction, Historical overview of Regulatory Affairs, Regulatory authorities, Role of Regulatory affairs department, Responsibility of Regulatory Affairs Professionals

Regulatory requirements for drug approval: Drug Development Teams, Non-Clinical Drug Development, Pharmacology, Drug Metabolism and Toxicology, General considerations of Investigational New Drug (IND) Application, Investigator's Brochure (IB) and New Drug Application (NDA), Clinical research / BE studies, Clinical Research Protocols, Biostatistics in Pharmaceutical Product Development, Data Presentation for FDA Submissions, Management of Clinical Studies.

Section-C

Indian Regulatory Requirements: Central Drug Standard Control Organization (CDSCO) and State Licensing Authority: Organization, Responsibilities, Certificate of Pharmaceutical Product (COPP), Regulatory requirements and approval procedures for new Drugs.

Registration of Indian drug product in overseas market

Procedure for export of pharmaceutical products, Technical documentation, Drug Master Files (DMF), Common Technical Document (CTD), electronic Common Technical Document (eCTD), ASEAN Common Technical Document (ACTD) research.

Books Recommended:

1. Troy, D.B. (2006). *Remington: The Science and Practice of Pharmacy*. 21st Ed., vol.1-2, Easton Pennysylvannia: Mack Publishing Co.
2. Cooper, J.W. Gunn, G. (1986). *Tutorial Pharmacy*, London: Petman Books Ltd.
3. Lachman L. (1986). *Theory and Practice of Industrial Pharmacy*. Philadelphia: Lea & Febiger.
4. Ansel, HC. *Allen, L.V. (2014). Introduction to Pharmaceutical Dosage Forms*. Philadelphia: Wolters Kluwer.
5. Willing, Tuckerman and Hitching. *GMP for Pharmaceuticals*.
6. ISO reports.
7. Indian Patent act.
8. Castensen, J. T. (1990). *Drug Stability: Principles and Practices*. New York: Marcel Dekker.

Suggested e-material:

1. www.ich.org
2. www.cdsco.in
3. www.who.int

PHAR 417 Novel Drug Delivery System

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Various approaches for development of novel drug delivery systems.
- Criteria for selection of drugs and polymers for the development of Novel drug delivery systems, their formulation and evaluation

Section-A

Controlled drug delivery systems: Introduction, terminology/definitions and rationale, advantages, disadvantages, selection of drug candidates.Approaches to design controlled release formulations based on diffusion, dissolution and ion exchange principles. Physicochemical and biological properties of drugs relevant to controlled release formulations

Polymers: Introduction, classification, properties, advantages and application of polymers in formulation of controlled release drug delivery systems.

Microencapsulation: Definition, advantages and disadvantages, microspheres /microcapsules, microparticles, methods of microencapsulation, applications

Mucosal Drug Delivery system: Introduction, Principles of bioadhesion /mucoadhesion, concepts, advantages and disadvantages, transmucosal permeability andformulation considerations of buccal delivery systems

Section-B

Implantable Drug Delivery Systems: Introduction, advantages and disadvantages, concept of implants and osmotic pump.

Transdermal Drug Delivery Systems: Introduction, Permeation through skin, factors affecting permeation, permeation enhancers, basic components of TDDS, formulation approaches

Gastro-retentive drug delivery systems: Introduction, advantages, disadvantages, approaches for GRDDS – Floating, high density systems, inflatable and gastro-adhesive systems and their applications

Section-C

Nasopulmonary drug delivery system: Introduction to Nasal and Pulmonary routes of drug delivery, Formulation of Inhalers (dry powder and metered dose), nasal sprays, nebulizers

Targeted drug Delivery: Concepts and approaches advantages and disadvantages, introduction to liposomes, niosomes, nanoparticles, monoclonal antibodies and their applications

Ocular Drug Delivery Systems: Introduction, intra ocular barriers and methods to overcome -preliminary study, ocular formulations and ocuserts

Intrauterine Drug Delivery Systems: Introduction, advantages and disadvantages, development of intra uterine devices (IUDs) and applications.

Books recommended:

1. Chien, Y.W. (1992). *Novel Drug Delivery Systems*. New York: Marcel Dekker, Inc.
2. Robinson, J.R., Lee, V.H.L. (1992). *Controlled Drug Delivery Systems.* New York: Marcel Dekker, Inc.
3. Mathiowitz, E. (2002). *Encyclopedia of Controlled Delivery*. New York: Wiley Interscience Publication.
4. Jain, N.K. (1997). *Controlled and Novel Drug Delivery*, New Delhi: CBS Publishers & Distributors.
5. Vyas, S.P., Khar, R.K. (2002). *Controlled Drug Delivery-concepts and advances*, New Delhi: Vallabh Prakashan.

Suggested e-material:

1. Indian Journal of Pharmaceutical Sciences (IPA)
2. Indian Drugs (IDMA)
3. Journal of Controlled Release (Elsevier Sciences)
4. Drug Development and Industrial Pharmacy(Marcel & Decker)
5. International Journal of Pharmaceutics (Elsevier Sciences)

PHAR 414 Dosage Form Design

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Concept of pre-formulation; prodrug and their influence on formulation and stability of products.
- BCS Classification and solubilization in context to dosage form development.
- *in vitro* dissolution study of solids and interpretation of dissolution data.
- Bioavailability studies and *in vivo* methods of evaluation and their statistical treatment.

Section-A

Pre-formulation Studies: Introduction to pre-formulation, goals and objectives, study of physicochemical characteristics of drug substances.

Physical properties*:* Physical form (crystal & amorphous), particle size, shape, flow properties, solubility profile (pKa, pH, partition coefficient), polymorphism.

Chemical Properties*:* Hydrolysis, oxidation, reduction, racemisation, polymerization. Application of pre-formulation parameters in the development and stability of dosage forms.

BCS classification: Introduction, classification and its applications.

Section-B

Prodrugs: Introduction, types, application of prodrug in solving problems related to stability, bioavailability and elegancy of formulation.

Solubility and solubilization: Techniques of solubilization of drugs including surfactant systems, co-solvents, solid state manipulations, complexation and chemical modifications.

Section-C

Performance evaluation, in vitro: Dissolution: Introduction, dissolution studies for solid dosage forms, methods of interpretation of dissolution data: model dependent and model independent methods, dissolution profile comparison.

Performance evaluation, in vivo: bioavailability studies: Introduction, bioavailability testing protocol and procedures, methods of evaluation and statistical treatment.

Books recommended:

1. Wells, J.I. (1990). *Pharmaceutical Prefomulation: The Physicochemical Properties of Drug Substances*. London: Ellis Horwood, Chiechester.
2. Yalkowsky, S.H. (1981). *Techniques of Solubilization of Drugs*. New York: Marcel Dekker.
3. Lewis, G.A. (2007). *Optimization Methods. In Encyclopedia of Pharmaceutical Technology*. New York: Informa Healthcare.
4. Banker, G.S. Rhode, C.T. (1979). *Modern Pharmaceutics*. New York: Marcel DekkarInc.
5. Bean, H.S. Beckett, A.H., Careless, A.H. (1982). *Advances in pharmaceutical sciences*, vol.1-4, London: Academic Press.
6. Gibaldi, M. Perrier, D. (1982). *Pharmacokinetics.* New York: Marcel Dekkar Inc.
7. *Troy, D.B. (2006). Remington: The Science and Practice of Pharmacy.* 21st Ed., vol.1-2,Easton Pennsylvania: Mack Publishing Co.
8. Khar, R.K., Vyas, S.P., Ahmad, F.J., Jain, G.K. (2013). *Lachman/Liebermans: The Theory and Practice of Industrial Pharmacy.* New Delhi: CBS Publisher.
9. Gibaldi, M. (1991). *Biopharmaceutics and clinical Pharmacokinetics.*

Suggested e-material:

1. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
2. https://www.pdfdrive.com/pharmaceutical-books.html
3. http://202.74.245.22:8080/xmlui/handle/123456789/39/browse?type=subject
4. http://swepub.kb.se/

PHAR 421 Pharmacy Practice

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- The role of pharmacist in different areas of hospital and hospital pharmacy
- Production and handling of radiopharmaceuticals.
- Drug information services and data retrieval in healthcare

Section-A

Hospital and it's organization: Definition, Classification of hospital- Primary, Secondary and Tertiary hospitals, Classification based on clinical and non- clinical basis, Organization Structure of a Hospital, and Medical staffs involved in the hospital and their functions.

Hospital pharmacy and its organization: Definition, functions of hospital pharmacy, Organization structure, Location, Layout and staff requirements, and Responsibilities and functions of hospital pharmacists.

Adverse drug reaction: Classifications - Excessive pharmacological effects, secondary pharmacologicaleffects, idiosyncrasy, allergic drug reactions, genetically determined toxicity, toxicity following sudden withdrawal of drugs, Drug interaction- beneficial interactions, adverse interactions, and pharmacokinetic drug interactions, Methods for detecting drug interactions, spontaneous case reports and record linkage studies, and adverse drug reaction reporting and management.

Community Pharmacy: Organization and structure of retail and wholesale drug store, types and design, Legal requirements for establishment and maintenance of a drug store, Dispensing of proprietary products, maintenance of records of retail and wholesale drug store.

Drug distribution system in a hospital: Dispensing of drugs to inpatients, types of drug distribution systems, charging policy and labelling, Dispensing of drugs to ambulatory patients, and Dispensing of controlled drugs.

Section-B

Hospital formulary: Definition, contents of hospital formulary, Differentiation of hospital formulary and Drug list, preparation and revision, and addition and deletion of drug from hospital formulary.

Therapeutic drug monitoring: Need for Therapeutic Drug Monitoring, Factors to be considered during the Therapeutic Drug Monitoring, and Indian scenario for Therapeutic Drug Monitoring.

Medication adherence: Causes of medication non-adherence, pharmacist role in the medication adherence, and monitoring of patient medication adherence.

Patient medication history interview: Need for the patient medication historyinterview, medication interview forms.

Community pharmacy management: Financial, materials, staff, and infrastructure requirements.

Pharmacy and therapeutic committee: Organization, functions, Policies of the pharmacy and therapeutic committee in including drugs into formulary, inpatient and outpatient prescription, automatic stop order, and emergency drug list preparation.

Drug information services: Drug and Poison information centre, Sources of drug information, Computerised services, and storage and retrieval of information.

Patient counseling: Definition of patient counseling; steps involved in patient counseling, and Special cases that require the pharmacist

Section-C

Education and training program in the hospital: Role of pharmacist in the education and training program, Internal and external training program, Services to the nursing homes/clinics, Code of ethics for

community pharmacy, and Role of pharmacist in the interdepartmental communication and community health education.

Prescribed medication order and communication skills: Prescribed medication order- interpretation and legal requirements, and Communication skills- communication with prescribers and patients.

Budget preparation and implementation: Budget preparation and implementation

Clinical Pharmacy: Introduction to Clinical Pharmacy, Concept of clinical pharmacy, functions and responsibilities of clinical pharmacist, Drug therapy monitoring - medication chart review, clinical review, pharmacist intervention, Ward round participation, Medication history and Pharmaceutical care. Dosing pattern and drug therapy based on Pharmacokinetic & disease pattern.

Over the counter (OTC) sales: Introduction and sale of over the counter, and Rational use of common over the counter medications.

Drug store management and inventory control: Organisation of drug store, types of materials stocked and storage conditions, Purchase and inventory control: principles, purchase procedure, purchase order, procurement and stocking, Economic order quantity, Reorder quantity level, and Methods used for the analysis of the drug expenditure

Investigational use of drugs: Description, principles involved, classification, control, identification, role of hospital pharmacist, advisory committee.

Interpretation of Clinical Laboratory Tests: Blood chemistry, hematology, and urinalysis

Books Recommended:

1. Merchant, S.H., Quadry, J.S. (2001). *A textbook of hospital pharmacy*. Ahmadabad: B.S. Shah Prakakshan.

2. Parthasarathi, G., Nyfort-Hansen, K., Nahata, M.C. (2004). *A textbook of Clinical Pharmacy Practice- essential concepts and skills.* Chennai: Orient Longman Private Limited.

3. Hassan, W.E. (1986). *Hospital pharmacy*. Philadelphia: Lea & Febiger.

4. Bajaj, A. Tipins, H.P. (2008). *Hospital Pharmacy*. Nashik: Career Publications.

5. Lee, M. (2013). *Basic skills in interpreting laboratory data*, Bethesda: American Society of Health System Pharmacists Inc.

6. Parmar, N.S. (2008). *Health Education and Community Pharmacy, New Delhi*: CBS Publishers & Distributers.

Suggested e-material:

1. Therapeutic drug monitoring. ISSN: 0163-4356

2. Journal of pharmacy practice. ISSN : 0974-8326

3. American journal of health system pharmacy. ISSN: 1535-2900 (online)

4. http://202.74.245.22:8080/xmlui/bitstream/handle/123456789/418/Martin%20Stephens%20Hospital%20Pharmacy%20%202011.pdf?sequence=1

PHAR 416L Instrumental Methods of Analysis Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will know:

- Handling of Various instrumentation technique of analysis.

1. Determination of absorption maxima and effect of solvents on absorption maxima of organic compounds

2. Estimation of dextrose by colorimetry

3. Estimation of sulfanilamide by colorimetry

4. Simultaneous estimation of ibuprofen and paracetamol by UV spectroscopy
5. Assay of paracetamol by UV- Spectrophotometry
6. Estimation of quinine sulfate by fluorimetry
7. Study of quenching of fluorescence
8. Determination of sodium by flame photometry
9. Determination of potassium by flame photometry
10. Determination of chlorides and sulphates by nephelo turbidometry
11. Separation of amino acids by paper chromatography
12. Separation of sugars by thin layer chromatography
13. Separation of plant pigments by column chromatography
14. Demonstration experiment on HPLC
15. Demonstration experiment on Gas Chromatography

PHAR 414L Dosage Form Design Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes

Upon completion of this course student will know:

- Preformulation study of API for dosage form development
- Evaluation as performance indicator

1. Preformulation studies including determination of solubility, partition coefficient, flow property, melting point, particle size and size distribution of paracetamol/aspirin/or any other drug.
2. Preformulation studies including drug excipient compatibility studies, effect of stabilizers, preservatives etc. in dosage form design

3. Experiments demonstrating improvement in bioavailability through prodrug concept.
4. Stability evaluation of various dosage forms and their expiration dating
5. Dissolution testing and data evaluation for oral solid dosage forms
6. Evaluation of Pharmaceutical equivalence of some marketed products

PHAR 422L Practice School

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Patient based assessment skills.
- Therapeutic decision making skills.
- Interpretation of the laboratory results to aid in clinical diagnosis.
- Rationale pharmacotherapeutic alternatives.
- Individualization of therapeutic regimen.

The students will undertake hospital training during this course.

Eighth Semester

PHAR 412 Biostatistics and Research Methodology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Operation of M.S. Excel, SPSS, R and MINITAB, DoE (Design of Experiment)
- Various statistical techniques to solve statistical problems

Section-A

Introduction: Statistics, Biostatistics, Frequency distribution

Measures of central tendency: Mean, Median, Mode- Pharmaceutical examples

Measures of dispersion: Dispersion, Range, standard deviation, Pharmaceutical problems

Correlation: Definition, Karl Pearson's coefficient of correlation, Multiple correlation Pharmaceuticals examples

Regression: Curve fitting by the method of least squares, fitting the lines y= a + bx and x

= a + by, Multiple regression, standard error of regression– Pharmaceutical Examples

Probability: Definition of probability, Binomial distribution, Normal distribution, Poisson's distribution, properties - problems Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM) - Pharmaceutical examples

Parametric test: t-test (Sample, Pooled or Unpaired and Paired), ANOVA, (One way and Two way), Least Significance difference

Section-B

Non Parametric tests: Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal-Wallis test, Friedman Test

Introduction to Research: Need for research, Need for design of Experiments, Experiential Design Technique, plagiarism

Graphs: Histogram, Pie Chart, Cubic Graph, response surface plot, Counter Plot graph

Designing the methodology: Sample size determination and Power of a study, Report writing and presentation of data, Protocol, Cohorts studies, Observational studies, Experimental studies, Designing clinical trial, various phases.

Blocking and confounding system for Two-level factorials

Regression modeling: Hypothesis testing in Simple and Multiple regressionmodels

Section-C

Introduction to practical components of industrial and clinical trials problems: Statistical Analysis Using Excel, SPSS, MINITAB, design of experiments, R Online Statistical Software's to Industrial and Clinical trial approach

Design and Analysis of experiments:

Factorial Design: Definition, 2^2, 2^3 design. Advantage of factorial design

Response Surface methodology: Central composite design, Historical design, Optimization Techniques.

BooksRecommended:

1. Bolton, S. Bon, C. (2010). *Pharmaceutical statistics- Practical and clinical applications.* New York: Informa Health Care.

2. Gupta, S.C. (2018). *Fundamental of Statistics*. Mumbai: Himalaya Publishing House.

3. Pannerselvam, R. (2012). *Design and Analysis of Experiments*. Delhi:PHI Learning Private Limited,

4. Montgomery, D.C. (1997). *Design and Analysis of Experiments*. New York: Wiley.

Suggested e-material:

1. https://www.elsevier.com/.../research-methodology-and-biostatistics

2. https://www.eolss.net/sample-chapters/C02/E4-31-04-00.pdf

PHAR 425 Social and Preventive Pharmacy

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- High consciousness of current issues related to health and pharmaceutical problems within the country and worldwide.
- Critical way of thinking based on current healthcare development.
- Evaluate alternative ways of solving problems related to health and pharmaceutical issues.

Section-A

Concept of health and disease: Definition, concepts and evaluation of public health. Understanding the concept of prevention and control of disease, social cases of diseases and social problems of the sick.

Social and health education: Food in relation to nutrition and health, balanced diet, nutritional deficiencies, vitamin deficiencies, malnutrition and its prevention.

Sociology and health: socio cultural factors related to health and disease. Imapct of urbanization on health and disease.Poverty and health.

Section-B

Preventive medicine: General principles of prevention and control of diseases such as cholera, SARS, Ebola virus, influenza, acute respiratory infections, malaria, chicken guinea, dengue, lymphatic filariasis, pneumonia, hypertension, diabetes mellitus, cancer, drug-addiction-drug substance abuse.

National health programs, its objectives, functioning and outcome of the following: HIV and AIDS control programme, TB, integrated disease surveillance program (IDSP), National leprosy control programme, national mental health program, nationalprogramme for prevention and control of deafness, Universal immunization programme, National programme for control of blindness, Pulse polio programme.

Section-C

National health intervention programme for mother and child, National family welfare programme, National tobacco control programme, National Malaria Prevention Program, National programme for the health care for the elderly, Social health programme; role of WHO in Indian national program.

Community services in rural, urban and school health: Functions of PHC, Improvement in rural sanitation, national urban health mission, Health promotion and education in school.

Books Recommended:

1. Prabhakara, G.N. (2010). *Short Textbook of Preventive and Social Medicine*, New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.

2. Roy, R.N., Saha, I. (2013). *Mahajan and Gupta-Textbook of Preventive and Social Medicine*. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.

3. Jain, V. (2014). Review of Preventive and Social Medicine (Including Biostatistics. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.

4. Hiremath, L.D., Hiremath, D.A. (2012). *Essentials of Community Medicine—A Practical Approach*. New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.

5. Park, K. (2011). *Textbook of Preventive and Social Medicine*, Jabalpur: Banarsidas Bhanot Publishers.

6. Adepu, R. (2015). *Community Pharmacy Practice*, Hyderabad: BSP publishers.

Suggested e-material:

1. Research in Social and Administrative Pharmacy, Elsevier, Ireland

PHAR 423P Project Work

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**0**	**0**	**16**	**8**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Experiments, the research tools like literature review, presentation of data etc.

This course will govern the process of literature review and presentation, which is prescribed for any type of research work. The project work will be divided in four equal components

Advanced Instrumentation Techniques Project Lab

1. To perform experiment based on solid phase extraction and liquid-liquid extraction
2. To perform experiment based on various chromatography:
    a) Adsorption and partition column chromatography
    b) Thin layer chromatograph
    c) Paper chromatography
    d) Gel chromatography

e) Affinity chromatography

f) Gas chromatography /High performance liquid chromatography

3. To perform experiment based on electrophoresis.
4. To perform experiment based on thermal techniques.
5. To perform experiment based on XRD.
6. To perform experiment based on radioimmunoassay technique.

Cosmetic Science Project Lab

1. To prepare and evaluate cold cream.
2. To prepare and evaluate Vanishing cream.
3. Formulation & evaluation Suppositories.
4. To prepare and evaluate Shaving creams.
5. Development and evaluation of Shampoo.
6. Development and evaluation of Toothpaste.
7. Development and evaluation of Antidandruff Shampoo.
8. Formulation & evaluation of Clear gel.
9. To prepare and evaluate herbal creams.

Quality Control and Standardization of Herbals Project Lab

1. Determination of lycopodium spores in per mg lycopodium powder.
2. Determination of starch grains in per mg ginger powder by lycopodium spore method.
3. Determination of acid insoluble and water soluble ash value of given crude drug.
4. Determination of sugar content in Ayurvedic formulation.
5. Determination of total phenolic content of given extract.

6. Determination of total flavonoid content of given extract.
7. Determination of antioxidant activity of given alcoholic extract by DPPH method.
8. Quantification of flavonoids /steroids By HPTLC.
9. Quantification of flavonoids /steroids By HPLC.
10. Extraction of volatile oil and their chromatographic profile.
11. Standardization of marketed herbal formulation.

Social and Preventive Pharmacy Lab

1. Experiments based on different aspects of social and preventive pharmacy.
2. Experiments related to prescription analysis.

Evaluation of therapeutic dosage regimen.

Discipline Electives

PHAR 411 Advanced Instrumentation Techniques

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Advanced instruments used and its applications in drug analysis.
- Chromatographic separation and analysis of drugs
- Calibration of various analytical instruments
- Analysis of drugs using various analytical instruments.

Section-A

Extraction techniques: General principle and procedure involved in the solid phase extraction and liquid-liquid extraction

Chromatography: Introduction to chromatography

Adsorption and partition column chromatography-Methodology, advantages, disadvantages and applications.

Thin layer chromatography- Introduction, Principle, Methodology, Rf values, advantages, disadvantages and applications.

Paper chromatography-Introduction, methodology, development techniques, advantages, disadvantages and applications

Gel chromatography-Introduction, theory, instrumentation and applications

Affinity chromatography-Introduction, theory, instrumentation and applications.

Section-B

Chromatography:

Gas chromatography - Introduction, theory, instrumentation, derivatization, temperature programming, advantages, & disadvantages, applications and calibration of GC as per ICH &US FDA guidelines.

High performance liquid chromatography (HPLC)-Introduction, theory, instrumentation, advantages, applications and calibration of HPLC as per ICH &US FDA guidelines.

Ion exchange chromatography- Introduction, classification, ion exchange resins, properties, mechanism of ion exchange process, factors affecting ion exchange, methodology and applications

Hyphenated techniques: LC-MS/MS, GC-MS/MS, HPTLC-MS.

Electrophoresis: Introduction, factors affecting electrophoretic mobility, Techniques of paper, gel, capillary electrophoresis, applications.

Section-C

Thermal methods of analysis: Principle, instrumentation and applications of thermo-gravimeteric analysis (TGA), Differential thermal analysis (DTA), and differential scanning calorimetry (DSC).

X-ray diffraction methods: Origin of x-rays, basic aspects of crystals, x-ray crystallography, rotating crystal technique, single crystal diffraction, powder diffraction, structural elucidation and applications.

Radioimmunoassay: Importance, various components, principle, different methods, limitation and applications of radioimmunoassay

Books Recommended:

1. Chatten, L.G. (1966). *A text book of PharmaceuticalChemistry*,vol. 1-2, New York: Marcel. Dekkar.
2. Backeet, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*, vol. 1-2, London: Atholone Press of the University of London.
3. Willard, H.H., Merrit, L., Dean, J.A. (1966) *Instrumental methods of analysis*. New York: Van Nostrand Renhold.
4. Obonson, J.W.R. (1970). *Undergraduate Instrumental Analysis.* New York: Marcel Dekkar Inc.
5. Parikh, V.H. (1974). *Absorption Spectroscopy of Organic Molecules.* London: Addison-Wesley Publishing Co.
6. Indian Pharmacopoeia (2018), Ministry of Health, Govt. of India.

7. Backeet, A.H. Stenlake, J.B. (1988). *Practical Pharmaceutical Chemistry* Vol. I and II. London: The Atholone Press.

Suggested e-material:

1. fist.ump.edu.my/index.php/en/
2. https://www.acs.org/content/dam/acsorg

PHAR 419 Pharmaceutical Regulatory Science

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Process of drug discovery and development
- Regulatory authorities and agencies governing the manufacture and sale of pharmaceuticals
- Regulatory approval process and their registration in Indian and international markets

Section-A

New Drug Discovery and development Stages of drug discovery-Drug development process, pre-clinical studies, non-clinical activities, clinical studies, Innovator and generics, Concept of generics, Generic drug product development.

Regulatory Approval Process- Approval processes and timelines involved in Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA) in US. Changes to an approved NDA / ANDA.

Section-B

Regulatory authorities and agencies- Overview of regulatory authorities of United States, European Union, Australia, Japan, Canada (Organization structure and types of applications)

Registration of Indian drug product in overseas market-Procedure for export of pharmaceutical products, Technical documentation, Drug Master Files (DMF), Common Technical Document (CTD), electronic Common Technical 164 Document (eCTD), ASEAN Common Technical Document (ACTD) research.

Section-C

Clinical trials- Developing clinical trial protocols, Institutional Review Board / Independent Ethics committee - formation and working procedures, Informed consent process and procedures, GCP obligations of Investigators, sponsors & Monitors, Managing and Monitoring clinical trials, **Pharmacovigilance** - safety monitoring in clinical trials

Regulatory Concepts Basic terminologies, guidance, guidelines, regulations, laws and acts, Orange book, Federal Register, Code of Federal Regulatory, Purple book.

Books Recommended:

1. Itkar, S. Vyawahare, N.S. *Drug Regulatory Affairs*, Pune: Nirali Prakashan.
2. Berry, I.R., Martin, R.P. (2008). *The Pharmaceutical Regulatory Process*, Ed. Drugs and the Pharmaceutical Sciences, CRC press.
3. Richard, A. Guarino, M.D. (2004). *New Drug Approval Process: Accelerating Global Registrations.* CRC Press.
4. Weinberg, S. (2008). Guidebook for drug regulatory submissions. New York: John Wiley & Sons. Inc.
5. Pisano, D.J. Mantus, D. (2008). FDA Regulatory Affairs: a guide for prescription drugs, medical devices, and biologics. CRC Press.

Suggested e-material:

1. www.fda.gov
2. https://www.ich.org/products/guidelines.html

PHAR 424 Quality Control and Standardization of Herbals

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Detection of different type of adulteration present in the crude drug
- Evaluation of the quality and purity of the drugs by morphological, microscopical, chemical, physical and biological evaluation
- Stereochemistry of natural products
- Biogenetic pathways ongoing in the plants for the production of secondary metabolites

Section-A

Basic tests for drugs – Pharmaceutical substances, Medicinal plants materials and dosage forms. WHO guidelines for quality control of herbal drugs. Evaluation of commercial crude drugs intended for use

Quality assurance in herbal drug industry-cGMP, GAP, GMP and GLP in traditional system of medicine.WHO Guidelines on current good manufacturing Practices (cGMP) for Herbal Medicines.WHO Guidelines on GACP for Medicinal Plants.

Section-B

EU and ICH guidelines for quality control of herbal drugs- Research Guidelines for Evaluating the Safety and Efficacy of Herbal Medicines. **Stability testing of herbal medicines-** Application of various chromatographic techniques in standardization of herbal products.Preparation of documents for new drug application and export registration GMP requirements and Drugs & Cosmetics Act provisions.

Section-C

Regulatory requirements for herbal medicines-WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems Comparison of various Herbal Pharmacopoeias.Role of chemical and biological markers in standardization of herbal products.

Books Recommended:

1. Evans, W. (2009). *Trease and Evans' Pharmacognosy*. Saunders Ltd.
2. Kokate, C.K., Purohit, A.P., Gokhale, G.B. (2008). *Pharmacognosy*. New Delhi: Nirali Prakashan.
3. Rangari, V.D. (2006). *Text book of Pharmacognosy and Phytochemistry.* Nashik: Carrier Pub.
4. Aggrawal, S.S. (2002). *Herbal Drug Technology*. Universities Press.
5. EMEA. Guidelines on Qualityof Herbal Medicinal Products/Traditional Medicinal Products.
6. Mukherjee, P.W. (2002). *Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals.* New Delhi: Business Horizons Publishers.
7. Shinde, M.V., Dhalwal, K., Potdar, K., Mahadik, K. (2009). *Application of quality control principles to herbal drugs*. International Journal of Phytomedicine. 1p, 4-8.
8. WHO. Quality Control Methods for Medicinal Plant Materials, World Health Organization, Geneva, 1998.
9. WHO. Guidelines for the Appropriate Use of Herbal Medicines. WHO Regional Publications, Western Pacific Series No 3, WHO Regional office for the Western Pacific, Manila, 1998.
10. WHO. The International Pharmacopeia, Vol. 2: QualitySpecifications, 3rd edn. World Health Organization, Geneva, 1981.
11. WHO. Quality Control Methods for Medicinal Plant Materials. World Health Organization, Geneva, 1999.
12. WHO. WHO Global Atlas of Traditional, Complementary and Alternative Medicine. 2 vol. set. Vol. 1 contains text and Vol. 2, maps. World Health Organization, Geneva, 2005.

13. WHO. Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants. World Health Organization, Geneva, 2004.

Suggested e-material:

1. https://www.elsevier.com/books/quality-control-and...of-herbal.../
2. https://onlinelibrary.wiley.com.

PHAR 420 Pharmacovigilance

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- history and development of pharmacovigilance
- national and international scenario of pharmacovigilance
- detection of new adverse drug reactions and their assessment
- international standards for classification of diseases and drugs
- adverse drug reaction reporting systems and communication in pharmacovigilance
- ICH guidelines for ICSR, PSUR, expedited reporting, pharmacovigilance planning
- CIOMS requirements for ADR reporting

Section-A

Introduction to Pharmacovigilance - History and development of Pharmacovigilance.Importance of safety monitoring of Medicine.WHO international drug monitoring programme. Pharmacovigilance Program of India(PvPI).

Introduction to adverse drug reactions - Definitions and classification of ADRs .Detection and reporting.Methods in Causality assessment .Severity and seriousness assessment.Predictability and preventability assessment.Management of adverse drug reactions.

Basic terminologies used in pharmacovigilance Terminologies of adverse medication related events. Regulatory terminologies.

Drug and disease classification- Anatomical, therapeutic and chemical classification of drugs. International classification of diseases .Daily defined doses . International Nonproprietary Names for drugs.

Section-B

Drug dictionaries and coding in pharmacovigilance - WHO adverse reaction terminologies . MedDRA and Standardised MedDRA queries . WHO drug dictionary . Eudravigilance medicinal product dictionary

Information resources in pharmacovigilance - Basic drug information resources .Specialised resources for ADRs.

Establishing pharmacovigilance programme- Establishing in a hospital .Establishment & operation of drug safety department in industry .Contract Research Organisations (CROs).Establishing a national programme.

Vaccine safety surveillance - Vaccine Pharmacovigilance . Vaccination failure .Adverse events following immunization.

Pharmacovigilance methods - Passive surveillance.Spontaneous reports and case series. Stimulated reporting . Active surveillance – Sentinel sites, drug event monitoring and registries . Comparative observational studies – Cross sectional study, case control study and cohort study .Targeted clinical investigations.

Communication in pharmacovigilance - Effective communication in Pharmacovigilance . Communication in Drug Safety Crisis management .Communicating with Regulatory Agencies, Business Partners, Healthcare facilities & Media.

Section-C

Statistical methods for evaluating medication safety data - Safety data generation .Pre-clinicalphase .Clinical phase. Post approval phase.

ICH Guidelines for Pharmacovigilance -Organization and objectives of ICH . Expedited reporting . Individual case safety reports . Periodic safety update reports. Post approval expedited reporting . Pharmacovigilance planning . Good clinical practice in pharmacovigilance studies.

Pharmacogenomics of adverse drug reactions

Drug safety evaluation in special population - Paediatrics .Pregnancy and lactation .Geriatrics ,CIOMS. CIOMS Working Groups . CIOMS Form

CDSCO (India) and Pharmacovigilance - D&C Act and Schedule Y.Differences in Indian and global pharmacovigilance requirements.

Books Recommended:

1. Gupta, SK. (2011). *Textbook of Pharmacovigilance.* New Delhi: Jaypee Brothers, Medical Publishers.
2. Cobert, B. Biron, P. (2009). *Practical Drug Safety from A to Z*. Jones and Bartlett Publishers.
3. Andrews, E.B. Moore, N. (2014). *Mann's Pharmacovigilance*: New York: Wiley Publishers.
4. Talbot, J. Walle, P. (2003). *Stephens' Detection of New Adverse Drug Reactions*. New York: Wiley Publishers.
5. Waller P. Harrison-Woolrych, M. (2017). *An Introduction to Pharmacovigilance. New York:* Wiley Publishers.

Suggested e- learning:

1. http://www.whoumc.org/DynPage.aspx?id=105825&mn1=7347&mn2=7259&mn3=7297
2. http://www.ich.org/
3. http://www.cioms.ch/
4. http://cdsco.nic.in/
5. http://www.who.int/vaccine_safety/en/
6. http://www.ipc.gov.in/PvPI/pv_home.html

PHAR 413 Cosmetic Science

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Various key ingredients and basic science to develop cosmetics and cosmeceuticals
- Scientific knowledge to develop cosmetics and cosmeceuticals with desired safety, stability and efficacy with compliance to Indian Regulatory Authority.

Section-A

Classification of cosmetic and cosmeceutical products: Definition of cosmetics as per Indian and EU regulations, Evolution of Cosmeceuticals from cosmetics, cosmetics as quasi and OTC drugs **Cosmetic excipients:** Surfactants, rheology modifiers, humectants, emollients, preservatives.

Classification and application Skin: Basic structure and function of skin.

Hair: Basic structure of hair. Hair growth cycle.

Oral Cavity: Common problem associated with teeth and gums.

Principles of formulation and building blocks of skin care products: Face wash, Moisturizing cream, Cold Cream, Vanishing cream and their advantages and disadvantages. Application of these products in formulation of cosmecuticals.Antiperspants & deodorants- Actives & mechanism of action.

Section-B

Principles of formulation and building blocks of Hair care products: Conditioning shampoo, Hair conditioner, anti-dandruff shampoo. Hair oils. Chemistry and formulation of Para-phylene diamine based hair dye. Principles of formulation and building blocks of oral care products: Toothpaste for bleeding gums, sensitive teeth. Teeth whitening, Mouthwash.Sun protection, Classification of Sunscreens and SPF.

Role of herbs in cosmetics:

Skin Care: Aloe and turmeric Hair care: Henna and amla.

Oral care: Neem and clove

Analytical cosmetics: BIS specification and analytical methods for shampoo, skin-cream and toothpaste.

Section-C

Principles of Cosmetic Evaluation: Principles of sebumeter, corneometer. Measurement of TEWL, Skin Color, Hair tensile strength, Hair combing properties. Soaps, and syndet bars. Evolution and skin benfits. Oily and dry skin, causes leading to dry skin, skin moisturisation. Basic understanding of the terms Comedogenic, dermatitis.

Cosmetic problems associated with Hair and scalp: Dandruff, Hair fall causes

Cosmetic problems associated with skin: blemishes, wrinkles, acne, prickly heat and body odor.

Books Recommended:

1. Wilkinson, J.B. Moore, R.J. (1982). *Harry's Cosmeticology*. Chemical Publication.
2. Sharma, P.P. (2014). *Cosmetics – Formulations, Manufacturing and Quality Control*, Delhi: Vandana Publications Pvt. Ltd.
3. Nanda, S. Khar, R.K. (2010).*Cosmetic Technology*. Delhi: Birla Publications Pvt Ltd.

Suggested e-material

1. http://202.74.245.22:8080/xmlui/handle/123456789/39/browse?type=subject
2. https://pharmaclub.in/free-pharmacy-ebooks-pharmaceutics/
3. https://www.pdfdrive.com/pharmaceutical-books.html

PHAR 418 Pharmaceutical Marketing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning outcomes

Upon completion of this course student will have an understanding of:

- Marketing concepts andtechniques used in marketing
- Application of the marketing in the pharmaceutical industry.

Section-A

Marketing: Definition, general concepts, and scope of marketing; Distinction between marketing & selling; Marketing environment; Industry and competitive analysis; Analyzing consumer buying behavior; industrial buying behavior.

Pharmaceutical market: Quantitative and qualitative aspects; size and composition of the market; demographic descriptions and socio-psychological characteristics of the consumer; market segmentation& targeting.Consumer profile; Motivation and prescribing habits of the physician; patients' choice of physician and retail pharmacist.Analyzing the Market;Role of market research.

Section-B

Product decision: Meaning, Classification, product line and product mix decisions, product life cycle, product portfolio analysis; product positioning; New product decisions; Product branding, packagingand labeling decisions, Product management in pharmaceutical industry.

Promotion: Meaning and methods, determinants of promotional mix, promotional budget; An overview of personal selling, advertising, direct mail, journals, sampling, retailing, medical exhibition, public relations, online promotional techniques for OTC Products.

Pharmaceutical marketing channels: Designing channel, channel members, selecting the appropriatechannel, conflict in channels, physical distribution management: Strategic importance, tasks in physicaldistribution management.

Section-C

Professional sales representative (PSR): Duties of PSR, purpose of detailing, selection and training, supervising, norms for customer calls, motivating, evaluating, compensation and future prospects of the PSR.

Pricing: Meaning, importance, objectives, determinants of price; pricing methods and strategies, issuesin price management in pharmaceutical industry.An overview of DPCO (Drug Price Control Order) and NPPA (National Pharmaceutical Pricing Authority).

Emerging concepts in marketing: Vertical & Horizontal Marketing; RuralMarketing; Consumerism; Industrial Marketing; Global Marketing.

Books Recommended:

1. Kotler, P. Keller, K.L. (2011). *Marketing Management*, New Delhi: Prentice Hall of India.
2. Walker, O.C., Boyd, H.W. and Larreche, J.C. (2006). *Marketing Strategy- Planning and Implementation*, New Delhi: Tata MC GrawHill.
3. Grewal, D. Levy, M. *Marketing*. (2012). 6th Ed., New Delhi: Tata MC Graw Hill.
4. Kumar, A. Menakshi, N. (2011). *Marketing Management*, New Delhi: Vikas Publishing.
5. Saxena, R. (2009). *Marketing Management*. New Delhi: Tata MC Graw Hill.