

# BANASTHALI VIDYAPITH

## Bachelor of Pharmacy



### Curriculum Structure

First Semester Examination, December-2020  
Second Semester Examination, April/May-2021  
Third Semester Examination, December-2021  
Fourth Semester Examination, April/May-2022  
Fifth Semester Examination, December-2022  
Sixth Semester Examination, April/May-2023  
Seventh Semester Examination, December-2023  
Eighth Semester Examination, April/May-2024

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

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

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

New Delhi, the 25th October, 1983

**NOTIFICATION**

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

**NOTICE**

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.

<b>Sl. No.</b>	<b>Contents</b>	<b>Page No.</b>
1	Programme Educational Objectives	4
2	Programme Outcomes	5
3	Curriculum Structure	7
4	Evaluation Scheme and Grading System	14
5	Syllabus	16

## **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 these needs on an ongoing basis.

## Curriculum Structure

### Bachelor of Pharmacy

#### First Year

#### Semester - I

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English /सामान्य हिन्दी	2	0	0	2
	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/ MATH 110	Remedial Biology <sup>@</sup> / Remedial Mathematics	3	0	0	3
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
PHAR 108L	Remedial Biology Lab	0	0	2	1
<b>Semester Total:</b>		<b>23</b>	<b>0</b>	<b>18</b>	<b>32</b>

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

#### Semester - II

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी/General English	2	0	0	2
	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
<b>Semester Total:</b>		<b>23</b>	<b>0</b>	<b>16</b>	<b>31</b>

## 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
<b>Semester Total:</b>		<b>23</b>	<b>0</b>	<b>16</b>	<b>31</b>

### 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
<b>Semester Total:</b>		<b>23</b>	<b>0</b>	<b>16</b>	<b>31</b>

**Third Year****Semester - V**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
	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
<b>Semester Total:</b>		<b>24</b>	<b>0</b>	<b>12</b>	<b>30</b>

**Semester - VI**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
	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
<b>Semester Total:</b>		<b>25</b>	<b>0</b>	<b>12</b>	<b>31</b>

## 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
<b>Semester Total:</b>		<b>20</b>	<b>0</b>	<b>16</b>	<b>28</b>

## 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
<b>Semester Total:</b>		<b>20</b>	<b>0</b>	<b>16</b>	<b>28</b>

## 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
PHAR 426	Cell and Molecular Biology	4	0	0	4

PHAR	427	Pharmacological Screening Methods	4	0	0	4
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**List of Core Foundation Course**

<b>Course Code</b>		<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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**

<b>Course Code</b>		<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
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**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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

<b>Aesthetic Education I/II</b>	<b>Physical Education I/II</b>
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
<b>Practical Education I/II</b>	BVFF 213 Hockey
BVFF 301 Banasthali Sewa Dal	BVFF 214 Judo
BVFF 302 Extension Programs for Women Empowerment	BVFF 215 Kabaddi
BVFF 303 FM Radio	BVFF 216 Karate - Do
BVFF 304 Informal Education	BVFF 217 Kho-Kho
BVFF 305 National Service Scheme	BVFF 218 Net Ball
BVFF 306 National Cadet Corps	BVFF 219 Rope Mallakhamb
	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

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

## 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:

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

Where n is the number of courses (with letter grading) registered in the semester,  $CC_i$  are the course credits attached to the  $i^{\text{th}}$  course with letter grading and  $GP_i$  is the letter grade point obtained in the  $i^{\text{th}}$  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:

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

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**

## First Semester

### PHAR 102 Human Anatomy and Physiology-I

Max. Marks : 100  
(CA: 40 + ESA: 60)

L	T	P	C
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, hemopoiesis, 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*, 6<sup>th</sup> Ed., New Delhi: Jaypee Brothers' medical publisher.
2. Kathleen, J.W. (1992). *Anatomy and Physiology in Health and Illness*, 7<sup>th</sup> 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*, 11<sup>th</sup> Ed., Saunders.
5. Tortora, G.J., Grabowski S.R. (2000). *Principles of Anatomy and Physiology*, 9<sup>th</sup> Ed., New York: Wiley.
6. Singh, I. (2011). *Textbook of Human Histology*, 6<sup>th</sup>Ed., New Delhi: Jaypee brother's medical publishers.
7. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8<sup>th</sup>Ed., 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](http://www.opentextbc.ca)
2. [www.study.com](http://www.study.com)
3. [www.getbodysmart.com](http://www.getbodysmart.com)
4. [www.kenhub.com](http://www.kenhub.com)

## PHAR 104 Pharmaceutical Analysis-I

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
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*, 4<sup>th</sup>Ed., vol 1-2. London: Stahlone Press.
2. Mendham, (2019). *Vogel's AI- Text Book of Quantitative Inorganic analysis*, 6<sup>th</sup>Ed., Pearson.
3. Rao, P.G. (2006). *Inorganic Pharmaceutical Chemistry*, 3<sup>rd</sup>Ed., 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*, 3<sup>rd</sup>Ed., 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](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](https://www.who.int/medicines/publications/pharmacopoeia/Radgen_mono)

## PHAR 105 Pharmaceutical Inorganic Chemistry

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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, Sodium Bicarbonate\*, 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  $\alpha$ ,  $\beta$ ,  $\gamma$  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*, 4<sup>th</sup>Ed., vol 1-2. London: Stahlone Press.
2. Mendham, (2019). *Vogel's AI- Text Book of Quantitative Inorganic Analysis*, 6<sup>th</sup>Ed., Pearson.
3. Rao, P.G. (2006). *Inorganic Pharmaceutical Chemistry*, 3<sup>rd</sup>Ed., 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](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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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:**

History of profession of Pharmacy in India in relation to pharmacy education, industry and 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 calculations based 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 enhancement techniques

**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, chemical and 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 dosage forms

### Books recommended:

1. Allen, I.V., Popovich, J.N.G. Ansel, H.C. (2005). *Ansel's Pharmaceutical Dosage Form and Drug Delivery System*, 8<sup>th</sup>Ed., New Delhi: Lippincott Williams and Walkins.
2. Carter, S.J. (2008). *Cooper and Gunn's-Dispensing for Pharmaceutical Students*, 12<sup>th</sup>Ed., New Delhi: CBS publishers.
3. Aulton, M.E. (2002). *Pharmaceutics, The Science & Dosage Form Design*, 2<sup>nd</sup>Ed., 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*, 21<sup>st</sup>Ed., New Delhi: Lippincott Williams and willikins.
8. Carter, S.J. (2005). *Cooper and Gunn's-Dispensing for Pharmaceutical Students*, 12<sup>th</sup>Ed., 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*, 2<sup>nd</sup>Ed., 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.sbm.ac.ir/uploads/Remington\\_Essentials\\_of\\_Pharmaceutics\\_-\\_Felton,\\_Linda.pdf](https://health.sbm.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**

**(CA: 40 + ESA: 60)**

**L T P C**

**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, Protista, 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 & Dicotyledons.

#### **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*, 5<sup>th</sup> 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](http://www.opentextbc.ca)
2. [www.study.com](http://www.study.com)
3. [www.getbodysmart.com](http://www.getbodysmart.com)
4. [www.kenhub.com](http://www.kenhub.com)
5. [www.apchute.com](http://www.apchute.com)
6. [www.openstax.cnx.org](http://www.openstax.cnx.org)

**MATH 110 Remedial Mathematics**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**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),  $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = na^{n-1}$ ,  $\lim_{x \rightarrow \infty} \frac{1}{x} = 0$

### 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 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  $x^n$  w.r.t.  $x$ , where  $n$  is any rational number, Derivative of  $e^x$ , Derivative of  $\log_e x$ , Derivative of  $a^x$ , 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*, 36<sup>th</sup> Ed., Khanna Publisher.

**Suggested e-material:**

1. [www.openculture.com/free-math-textbooks](http://www.openculture.com/free-math-textbooks)
2. E-Books | [mathematics.library.cornell.edu](http://mathematics.library.cornell.edu)

## **PHAR 102L Human Anatomy and Physiology - I Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

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.

**Books Recommended:**

1. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8th Ed., New Delhi: Jaypee brother's medical publishers.
2. Srinageswari, K., Sharma, R. (2015). *Practical workbook of Human Physiology*, New Delhi: Jaypee brother's medical publishers.
3. Singh, I. (2011). *Textbook of Human Histology*, 6th Ed., New Delhi: Jaypee brother's medical publishers.

**PHAR 104L Pharmaceutical Analysis - I Lab****Max. Marks : 100****L T P C****(CA: 40 + ESA: 60)****0 0 4 2****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.

**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

#### **Books Recommended:**

1. Atherden, L.M. (2004). *Bentley and Driver's Textbook of Pharmaceutical Chemistry*, Oxford University Press.
2. Beckett, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*, 4thEd., vol 1-2. London: Stahlone Press.
3. Mendham, (2019). *Vogel,s AI- Text Book of Quantitative Inorganic analysis*, 6 thEd.,Pearson.
4. Indian Pharmacopoeia, (2014). Addendum 2016.

## **PHAR 105L Pharmaceutical Inorganic Chemistry Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **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.

### **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

### **Books Recommended:**

1. Siddiqui, A.A. (2013). *Practical Pharmaceutical Chemistry*, CBS Publishers.

2. Mendham, (2019). *Vogel,s AI- Text Book of Quantitative Inorganic analysis*, 6 thEd.,Pearson.
3. Chatwal, G.R. (2010). *Pharmaceutical Chemistry Inorganic*, Himalaya Publishing House.
4. Indian Pharmacopoeia, (2014). Addendum 2016.

### **PHAR 107L Pharmaceutics - I Lab**

**Max. Marks : 100**

**L T P C**

**(CA: 40 + ESA: 60)**

**0 0 4 2**

#### **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.

#### **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) Aluminium 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

**Books Recommended:**

1. *Pharmacopoeia of India*, The controller of Publications, Delhi.

2. Lachman L et. Al, *Theory and practice of Industrial Pharmacy*, Lea & Febiger, Philadelphia, USA.
3. Carter, SJ, *Cooper and Gunn's Tutorial Pharmacy*, CBS Publishers, Delhi.
4. Gaud & Gupta, *Practical Pharmaceutics*, CBS Publishers & distributors, New Delhi, India.

## PHAR 108L Remedial Biology Lab

**Max. Marks : 100**

**L T P C**

**(CA: 40 + ESA: 60)**

**0 0 2 1**

### Learning Outcomes:

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

- Evolutionary biology and behaviour.
  - Anatomy, physiology and regulation of various body system.
  - Plant physiology.
1. Introduction to experiments in biology
    - a) Study of Microscope
    - b) Section cutting techniques
    - c) Mounting and staining
    - d) Permanent slide preparation
  2. Study of cell and its inclusions
  3. Study of Stem, Root, Leaf, seed, fruit, flower and their modifications
  4. Detailed study of frog by using computer models
  5. Microscopic study and identification of tissues pertinent to Stem, Root Leaf, seed, fruit and flower
  6. Identification of bones
  7. Determination of blood group
  8. Determination of blood pressure
  9. Determination of tidal volume

### Books Recommended:

1. Kale S. R, Kale R. R. *Practical Human Anatomy and Physiology*, 7<sup>th</sup> Ed., New Delhi: Nirali Prakashan.
2. Gokhale S. B, Kokate C. K, Shriwastava S. P. *A Manual of Pharmaceutical biology practical*, 5<sup>th</sup> Ed., New Delhi: Nirali Prakashan.

3. Shafi M. J. H. Biology practical manual according to National core curriculum .Biology forum of Karnataka. 1<sup>st</sup> Ed., Karnataka: Cengage Learning.

## Second Semester

### CS 102 Computer Applications in Pharmacy

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 data 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**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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:**  $\beta$ -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 (Phenylketonuria, Albinism, alcaptonuria, 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*, 6<sup>th</sup> 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*, 28<sup>th</sup> 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*, 5<sup>th</sup> Ed., New York: John Wiley & Sons.
6. Gupta, R.C., Bhargavan, S. (2019). *Practical Biochemistry*, 5<sup>th</sup> Ed., New Delhi: Jaypee brother's medical publishers
7. Plummer, D.T. (1987). *An Introduction of Practical Biochemistry*, 3<sup>rd</sup> 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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 intestine and 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*, 6<sup>th</sup> Ed., New Delhi: Jaypee Brothers' medical publisher.
2. Kathleen, J.W. (1992). *Anatomy and Physiology in Health and Illness*, 7<sup>th</sup> 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*, 11<sup>th</sup> Ed., Saunders.
5. Tortora, G.J., Grabowski S.R. (2000). *Principles of Anatomy and Physiology*, 9<sup>th</sup> Ed., New York: Wiley.
6. Singh, I. (2011). *Textbook of Human Histology*, 6<sup>th</sup>Ed., New Delhi: Jaypee brother's medical publishers.
7. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8<sup>th</sup>Ed., 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. Chatterje, C.C. (2005). *Human Physiology*, vol 1-2. Kolkatta: Academic Publishers.

**Suggested e-material:**

1. [www.apchute.com](http://www.apchute.com)
2. [www.openstax.cnx.org](http://www.openstax.cnx.org)
3. [www.wesnorman.com](http://www.wesnorman.com)

**PHAR 106 Pharmaceutical Organic Chemistry – I**

<b>Max. Marks : 100</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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, Saytzeff's 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<sub>1</sub> and SN<sub>2</sub> reactions - kinetics, order of reactivity of alkyl halides, stereochemistry and rearrangement of carbocations. SN<sub>1</sub> versus SN<sub>2</sub> reactions, Factors affecting SN<sub>1</sub> and SN<sub>2</sub> 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*, 7<sup>th</sup>Ed., Pearson.
2. Finar, I.L. (2002). *Organic Chemistry*, Vol. 1, 6<sup>th</sup>Ed., 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**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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, gonorrhoea.

### 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*, 6<sup>th</sup> Ed., Jaypee Publications.
3. Laurence, B., Bruce, C., Bjorn, K. (2011). *Goodman Gilman's the Pharmacological Basis of Therapeutics*, 12<sup>th</sup> Ed., New York: McGraw-Hill.
4. Herbert, C., Taylor, Burke, N. (2011). *Best and Taylor's Physiological basis of medical practice*, 13<sup>th</sup> Ed., Wolters Kluwer India Pvt. Ltd.
5. Colledge, N.R., Walker, B.R., Stuart, H.R. (2010). *Davidson's Principles and Practice of Medicine*, 21<sup>st</sup> Ed., London: ELBS/Churchill Livingstone.

6. Guyton, A.J., Hall, E. (2010). *Textbook of Medical Physiology*, 12<sup>th</sup> Ed., WB Saunders Company.
7. Piro, J.D., Talbert, R.L., Yee, G., Wells, B., Michael, L., Posey, (2014). *Pharmacotherapy: A Pathophysiological Approach*, 9<sup>th</sup> 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*, 3<sup>rd</sup> Ed., London: Churchill Livingstone publication.

**Suggested e-material:**

1. [www.wesnorman.com](http://www.wesnorman.com)
2. [www.pharmacologyeducation.org](http://www.pharmacologyeducation.org)
3. [www.pharmacology2000.com](http://www.pharmacology2000.com)
4. [www.healthline.com](http://www.healthline.com)
5. [www.mayoclinic.org](http://www.mayoclinic.org)

## **CS 102L Computer Applications in Pharmacy Lab**

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

**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.
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 in the 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

**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.

**PHAR 101L Biochemistry Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**Learning Outcomes:**

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

- Qualitative analysis of carbohydrates.

- Identification tests for Proteins, lipids etc.
  - Diagnostic applications of enzymes.
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.

**Books Recommended:**

1. Gupta, R.C., Bhargavan, S.(2019). *Practical Biochemistry*, 5th Ed., New Delhi: Jaypee brother's medical publishers
2. Plummer, D.T. (1987). *An Introduction of Practical Biochemistry*, 3 rd Ed., McGraw-Hill.
3. Rajagopal, G., Ramakrishna, S.(1983). *Practical Biochemistry for Medical students*, Orient BlackSwan.

**PHAR 103L Human Anatomy and Physiology - II Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

Practical physiology is complimentary to the theoretical discussions in physiology. Practicals 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. 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.

**Books recommended:**

1. Ghai, C.L. (2013). *Textbook of Practical Physiology*, 8<sup>th</sup> Ed., New Delhi: Jaypee brother's medical publishers.
2. Srinageswari, K., Sharma, R. (2015). *Practical workbook of Human Physiology*, New Delhi: Jaypee brother's medical publishers.
3. Singh, I. (2011). *Textbook of Human Histology*, 6<sup>th</sup> Ed., New Delhi: Jaypee brother's medical publishers.

## PHAR 106L Pharmaceutical Organic Chemistry - I Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes:

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

- Systematic qualitative analysis of unknown 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.
- Molecular models to understand stereochemistry.

### 1. Systematic qualitative analysis of unknown organic compounds like

- Preliminary test: Color, odour, aliphatic/aromatic compounds, saturation and unsaturation, etc.
- Detection of elements like Nitrogen, Sulphur and Halogen by Lassaigne's test
- Solubility test
- Functional group test like Phenols, Amides/ Urea, Carbohydrates, Amines, Carboxylic acids, Aldehydes and Ketones, Alcohols, Esters, Aromatic and Halogenated Hydrocarbons, Nitro compounds and Anilides.
- Melting point/Boiling point of organic compounds
- Identification of the unknown compound from the literature using melting point/ boiling point.
- Preparation of the derivatives and confirmation of the unknown compound by melting point/ boiling point.
- Minimum 5 unknown organic compounds to be analysed systematically.

2. Preparation of suitable solid derivatives from organic compounds
3. Construction of molecular models

**Books Recommended:**

1. Agarwal, O.P. (2017). *Advanced Practical Organic Chemistry*, 3 rd Ed., Krishna,s Education Publishers.
2. 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.
3. Vishnoi, N.K. (2009). *Advanced Practical organic chemistry*. 3rd Ed., New Delhi: Vikas Publishing House.

## Third Semester

### PHAR 204 Pharmaceutical Microbiology

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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*, 7<sup>th</sup> Ed., London: Blackwell Scientific publications.
2. Reed, G (2004). *Prescott and Dunn Industrial Microbiology*. 4<sup>th</sup> Ed., Delhi: CBS Publishers & Distributors.
3. Pelczar, M.J., Chan, E.C.S, Kreig, N.R. (2002). *Microbiology*. 5<sup>th</sup> 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*. 9<sup>th</sup> Ed., WB Saunders Co.
7. Carter, S.J. (2005). *Cooper and Gunn's: Tutorial Pharmacy*. 12<sup>th</sup> Ed., New Delhi: CBS Publisher and Distributors.
8. Peppler, H.J., Perlman, D. (1979). *Microbial Technology*. 2<sup>nd</sup> Ed., Wisconsin: Elsevier.
9. I.P., B.P., U.S.P. - latest editions.
10. Ananthnarayan, R. (1990). *A Text Book of Microbiology*. 4<sup>th</sup> Ed., Hyderabad: Orient Longman Limited.
11. Edward, A.I. (1983). *Fundamentals of Microbiology*. 4<sup>th</sup> Ed., Addison Wesley Publishing Company.
12. Jain, N.K. (2005). *Pharmaceutical Microbiology*. 2<sup>nd</sup> Ed., Delhi: Vallabh Prakashan.
13. Bergey, D.H., Holt, J.G. (1994.) *Bergeys manual of systematic bacteriology*. 2<sup>nd</sup> Ed., Baltimore: Williams and Wilkins.

**Suggested e-material:**

1. <https://www.elsevier.com/books/pharmaceutical-microbiology/>
2. [moscmm.org/pdf/Anathanarayan%20microbio.pdf](http://moscmm.org/pdf/Anathanarayan%20microbio.pdf)

**PHAR 205 Pharmaceutical Organic Chemistry - II**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**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*. 6<sup>th</sup> Ed., New York: Prentice Hall.
2. Finar, I.L. (1963). *Organic Chemistry*. 4<sup>th</sup> Ed., London: Longman.
3. Bahl, A., Bahl, B.S. (2014). *Textbook of Organic Chemistry*. 5<sup>th</sup> Ed., New Delhi: S Chand and Company Ltd.
4. Soni, P.L., Chawla, H.M. (2012). *Textbook of Organic Chemistry*. 29<sup>th</sup> Ed., New Delhi: S Chand & Sons.
5. Mann, F.G., Saunders, B.C. (2009). *Practical Organic Chemistry*. 4<sup>th</sup> 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*. 5<sup>th</sup> Ed., London: Pearson.
7. Vishnoi, N.K. (2009). *Advanced Practical organic chemistry*. 3<sup>rd</sup> Ed., New Delhi: Vikas Publishing House.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. (1998). *Introduction to Organic Laboratory techniques*. 3<sup>rd</sup> 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**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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*. 6<sup>th</sup> Ed., New Delhi: CBS Publication.

**Suggested e-material:**

1. [gmpua.com/Process/ProcessEngineering](http://gmpua.com/Process/ProcessEngineering)

**PHAR 217 Physical Pharmaceutics - I****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****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*. 3<sup>rd</sup> Ed., Maryland: Lippincott Williams and Wilkins.
2. Parott, L.E., Sasaki, W. (1977). *Experimental Pharmaceutics*. 4<sup>th</sup> Ed., Minneapolis: Burgess Publishers.
3. Cater, S.J. (2005). *Tutorial Pharmacy*. 6<sup>th</sup> Ed., New Delhi: CBS publishers.
4. Stocklosam, M.J., Ansel, H.C. (1986). *Pharmaceutical Calculations*. 8<sup>th</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
5. Liberman, H.A., Lachman, C., Schwartz, J.B. (1990). *Pharmaceutical Dosage forms, Tablets*, 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.
6. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms. Disperse systems*, 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.
7. Ramasamy, C., Manavalan, R. (2015). *Physical Pharmaceutics*. 2<sup>nd</sup> Ed., Chennai: Vignesh Publisher.
8. Subramanyam, C.V.S., Settee, T.J. (2014). *Laboratory Manual of Physical Pharmaceutics*. 2<sup>nd</sup> Ed., New Delhi: Vallabh Publication.
9. Subramanyam, C.V.S. (2000). *Text book of Physical Pharmaceutics*. 2<sup>nd</sup> Ed., New Delhi: Vallabh publication.

10. Jain, G., Khar, R.K., Ahmad, F.J. (2012). *Theory and practice of Physical Pharmacy*. 1<sup>st</sup> 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/](http://www.elsevier.com/books/)
6. <https://accesspharmacy.mhmedical.com/book.aspx?bookid=513>

**PHAR 219 Pharmaceutical Physical Chemistry**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**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:** Freundlich 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.

### Books Recommended:

1. Bahl, B.S., Tuli, G.D., Bahl, A. (2009). *Essential of Physical Chemistry*. 1<sup>st</sup> Ed., New Delhi: S. Chand & Company Pvt Ltd.
2. Negi, A.S., Anand, S.C. (1985). *Textbook of Physical Chemistry*, 5<sup>th</sup> Ed., New Delhi: Wiley Eastern Ltd.
3. Glasstone, S., Lewis, D. (1993). *Elements of Physical Chemistry*, 2<sup>nd</sup> Ed., London: Macmillan Education.

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

**Suggested e-material:**

- <https://ocw.mit.edu/courses/chemistry/5-61-physical-chemistry>
- <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**

**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.
- 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.
  - Sterilization of glassware, preparation and sterilization of media.
  - Sub culturing of bacteria and fungus. Nutrient stabs and slants preparations.
  - Staining methods- Simple, Grams staining and acid fast staining (Demonstration with practical).
  - 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.

**Books Recommended:**

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

**PHAR 205L Pharmaceutical Organic Chemistry - II Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**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, principles/mechanisms, properties and applications of various organic compounds.
- 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-naphthol 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

### Books Recommended:

1. Mann, F.G., Saunders, B.C. (2009). *Practical Organic Chemistry*. 4th Ed., London: Pearson. 2009.
2. 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.
3. Vishnoi, N.K. (2009). *Advanced Practical organic chemistry*. 3rd Ed., New Delhi: Vikas Publishing House.
4. Pavia, D.L., Lampman, G.M., Kriz, G.S. (1998). *Introduction to Organic Laboratory techniques*. 3rd Ed.

## PHAR 213L Pharmaceutical Engineering Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### 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.
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 dryer and 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.

**Books Recommended:**

1. P.S. Sona, *A practical manual of pharmaceutical engineering*, publisher: Laxmi Publications
2. D.M. Sarkar, *Laboratory manual of pharmaceutical engineering*, Publisher: Nirali Prakashan

**PHAR 217L Physical Pharmaceutics - I Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**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.
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 CCl<sub>4</sub> 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

**Books Recommended:**

1. C.V.S Subramanyam, Laboratory Manual of Physical Pharmaceutics, Vallabh Prakashan.
2. S. K Dutta & K. K Sen, A Laboratory Manual of Physical Pharmaceutics, PharmaMed Press

## Fourth Semester

### PHAR 211 Medicinal Chemistry - I

<b>Max. Marks : 100</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

#### 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, methyl dopa, 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, labetalol, 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, isofluorophate, 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, benztrapine 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 barbiturates: Methohexital sodium\*, thiamylal sodium, thiopental sodium.

Dissociative anesthetics: Ketamine hydrochloride.\*

### **Narcotic and Non-Narcotic Analgesics:**

**Morphine and related drugs:** SAR of morphine analogues, morphine sulphate, codeine, meperidine hydrochloride, 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, zomepirac, 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

#### **Miscellaneous:**

**Amides & imides:** Glutethimide.

**Alcohol & their carbamate derivatives:** Meprobamate, ethchlorvynol.

**Aldehyde & their derivatives:** Triclofos sodium, paraldehyde.

#### **Antipsychotics**

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

**Ring analogues of phenothiazines:** 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*, 12<sup>th</sup> 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*, 7<sup>th</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7<sup>th</sup> Ed., New York: John Wiley and Sons.

- Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3<sup>rd</sup> Ed., Harwood academic publishers.
- Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences*, 21<sup>st</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
- Finar, I.L. (2002). *Organic Chemistry: Volume 2. Stereochemistry and the Chemistry Natural Products*. 5<sup>th</sup> Ed., London: Pearson.
- Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5<sup>th</sup> Ed., New York: John Wiley and Sons Ltd.
- Indian Pharmacopoeia*, (2014). Addendum 2016.
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. (2009). *Vogel's Tatchell: Text book of practical organic chemistry*, 5<sup>th</sup> Ed., London: Pearson.

#### Suggested e-material:

- [https://books.google.co.in/books/about/Foye\\_s\\_Principles\\_of\\_Medicinal\\_Chemistry.html?id=R0W1ErpsQpkC](https://books.google.co.in/books/about/Foye_s_Principles_of_Medicinal_Chemistry.html?id=R0W1ErpsQpkC)
- <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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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-hydroxyquinoline, 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 ( $\text{NaBH}_4$  and  $\text{LiAlH}_4$ ), 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*, 6<sup>th</sup> Ed., Pearson Education.
2. Bahl, B.S., Bahl, A. (2014). *A text book of organic chemistry*, 5<sup>th</sup> Ed., S. Chand and Company Ltd.
3. Bansal, R.K. (2017). *Heterocyclic Chemistry*, 5<sup>th</sup> Ed., New Age International Private Ltd.
4. Morrison, R.T., Boyd, R.M., Bhattacharjee, S.K. (2011) *Organic Chemistry*, 7<sup>th</sup> Ed., Pearson Publishers.
5. Gilchrist, T.L. (1997). *Heterocyclic Chemistry*, 3<sup>rd</sup> 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, leaf constants, 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*, 16<sup>th</sup> Ed., London: W.B. Saunders & Co.
2. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9<sup>th</sup> Ed., Philadelphia: Lea and Febiger.
3. Wallis, T.E., Churchill, A. (2005). *Text Book of Pharmacognosy*, 5<sup>th</sup> Ed., New Delhi: CBS Publishers.
4. Mohammad, A. (2012). *Pharmacognosy and Phytochemistry*, 2<sup>nd</sup> Ed., New Delhi: CBS Publishers and Distribution.
5. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37<sup>th</sup> Ed., Pune: Nirali Prakashan.
6. Choudhary, R.D. (1996). *Herbal drug industry*, 1<sup>st</sup> Ed., New Delhi: Eastern Publisher.

7. Ansari, S.H. (2007). *Essentials of Pharmacognosy*, 2<sup>nd</sup> Ed. New Delhi: Birla publications.
8. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18<sup>th</sup> Ed. Pune: Nirali Prakashan.
9. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12<sup>th</sup> Ed., PharmaMed Press.

**Suggested e-material:**

1. <http://nsdl.niscair.res.in>
2. [http://www.herbs4youth.eu/files/workbook\\_processingtransf.pdf](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](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](http://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](http://www.ayurveda.hu/api/API-Vol-1).

**PHAR 216 Pharmacology - I**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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*, 9<sup>th</sup> Ed., London: Churchill Livingstone Elsevier.
2. Katzung, B.G., Masters, S.B., Trevor, A.J. (2010). *Basic and clinical pharmacology*, 11<sup>th</sup> 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*, 13<sup>th</sup> 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*, 9<sup>th</sup> Ed., Philadelphia: Lippincott Williams &Wilkins.
5. Tripathi, K.D. (2018). *Essentials of Medical Pharmacology*, 8<sup>th</sup> Ed., New Delhi: Jaypee Brothers Medical Publishers Ltd.
6. Sharma, H. L., Sharma, K.K. (2012). *Principles of Pharmacology*, 2<sup>nd</sup> Ed., Ahmedabad: Paras Medical Publisher.
7. Craig, C.R., Sitzel, R.E. (2003). *Modern Pharmacology with clinical Applications*, 6<sup>th</sup> Ed., Philadelphia: Lippincott Williams &Wilkins.
8. Ghosh, M.N. (2012). *Fundamentals of Experimental Pharmacology*, 6<sup>th</sup> Ed., Kolkata: Hilton & Company.
9. Kulkarni, S.K. (2005). *Handbook of experimental pharmacology*. 3<sup>rd</sup> Ed., New Delhi: Vallabh Prakshan.

**Suggested e-material:**

1. [www.cvparmacology.com](http://www.cvparmacology.com)
2. [www.treatment4addiction.com](http://www.treatment4addiction.com)
3. [www.medicalnewtoday.com](http://www.medicalnewtoday.com)

4. [www.edvivas.com](http://www.edvivas.com)
5. [www.pharmafactz.com](http://www.pharmafactz.com)
6. [www.ausmed.com](http://www.ausmed.com)
7. [www.medicinenet.com](http://www.medicinenet.com)

## PHAR 220 Physical Pharmaceutics - II

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**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*, 3<sup>rd</sup> Ed., Maryland: Lippincott Williams and Wilkins.
2. Parott, L.E., Sasaki, W. (1977). *Experimental Pharmaceutics*, 4<sup>th</sup> Ed., Minneapolis: Burgess Publishers.
3. Cater, S.J. (2005). *Tutorial Pharmacy*, 6<sup>th</sup> Ed., India: CBS publishers.
4. Stocklosam, M.J., Ansel, H.C. (1986). *Pharmaceutical Calculations*, 8<sup>th</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.

5. Liberman, H.A., Lachman, C., Schwartz, J.B. (1990). *Pharmaceutical Dosage forms, Tablets*, 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.
6. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms. Disperse systems*. 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.
7. Ramasamy, C., Manavalan, R. (2015). *Physical Pharmaceutics*. 2<sup>nd</sup> 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/](http://www.elsevier.com/books/)

## PHAR 211L Medicinal Chemistry - I Lab

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

**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.
- Importance of Partition coefficient.

**I Preparation of drugs/ intermediates**

- 1,3-pyrazole
- 1,3-oxazole
- Benzimidazole
- Benzotriazole
- 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

### Books recommended:

1. Mann, F.G., Saunders, B.C. (2009). *Practical Organic Chemistry*. 4th Ed., London: Pearson. 2009.
2. 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.
3. Indian Pharmacopoeia, (2014). Addendum 2016.

## PHAR 215L Pharmacognosy and Phytochemistry - I Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes:

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

- 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.
1. Analysis of crude drugs by chemical tests: (i) Tragacanth (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 palisade 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

### Books Recommended:

1. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18<sup>th</sup> Ed. Pune: Nirali Prakashan.

2. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12<sup>th</sup> Ed., PharmaMed Press.
3. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37<sup>th</sup> Ed., Pune: Nirali Prakashan.

## **PHAR 216L Pharmacology - I Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### **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.
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

**Books Recommended:**

1. Ghosh, M.N. (2012). *Fundamentals of Experimental Pharmacology*, 6<sup>th</sup> Ed., Kolkata: Hilton & Company.
2. Kulkarni, S.K. (2005). *Handbook of experimental pharmacology*. 3<sup>rd</sup> Ed., New Delhi: Vallabh Prakshan.
3. Brunton, L.L., Knollmann, B., Dandan, R.H. (2017). *Goodman and Gilman's, The Pharmacological Basis of Therapeutics*, 13<sup>th</sup> 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*, 9<sup>th</sup> Ed., Philadelphia: Lippincott Williams &Wilkins.
5. Grover, J.K., (1990). *Experiments in Pharmacy & Pharmacology*, New Delhi: CBS Publishers.

## PHAR 218L Physical Pharmaceutics - II Lab

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

### Learning Outcomes:

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

- 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.
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

### Books Recommended:

1. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms.*

*Disperse systems*. 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.

2. Ramasamy, C., Manavalan, R. (2015). *Physical Pharmaceutics*. 2<sup>nd</sup> Ed., Chennai: Vignesh Publisher.
3. Cater, S.J. (2005). *Tutorial Pharmacy*, 6<sup>th</sup> Ed., India: CBS publishers.

## Fifth Semester

### PHAR 313 Industrial Pharmacy-I

**Max. Marks : 60**

**(CA: 20 + ESA: 40)**

**L T P C**

**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 stability studies.

**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*, 21<sup>st</sup> 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*, 9<sup>th</sup> edition, Palm Springs: Chemical Publishing Company.
7. Balsam, M.S., Sagarin, E., (2008) *Cosmetics: Science and Technology*, 2<sup>nd</sup> 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/](http://www.elsevier.com/books/)

## PHAR 403 Medicinal Chemistry-II

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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<sub>1</sub>-antagonists:** Diphenhydramine hydrochloride\*, Dimenhydrinate, Doxylamines succinate, Clemastine fumarate, Diphenylpyraline 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<sub>2</sub>-antagonists:** Cimetidine\*, Famotidine, Ranitidine.

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

**Anti-neoplastic agents:**

**Alkylating agents:** Meclorothamine\*, 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, Norgestrel, 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: Acarbose, 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, Dipiperodon, Dibucaine.\*

**Books recommended:**

1. Beale, J.M., Block, J., Wilson, G. (2010). *Organic medicinal and Pharmaceutical Chemistry*, 12<sup>th</sup> 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*, 7<sup>th</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7<sup>th</sup> Ed., New York: John Wiley and Sons.
4. Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3<sup>rd</sup> Ed., Australia: Harwood academic publishers.
5. Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences*, 21<sup>st</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
6. Buckley, G. (1988). *Martindale's extra pharmacopoeia*, 29<sup>th</sup> Ed., British journal of general practice.
7. Finar, I.L. (2002). *Organic Chemistry: Stereochemistry and the Chemistry Natural Products*, vol 2, 5<sup>th</sup> Ed., London: Pearson.
8. Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5<sup>th</sup> 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*, 5<sup>th</sup> Ed., London: Pearson.

**Suggested e-material:**

1. [https://books.google.co.in/books/about/Foye\\_s\\_Principles\\_of\\_Medicinal\\_Chemistry.html?id=R0W1ErpsQpkC](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**

**(CA: 40 + ESA: 60)**

**L T P C**

**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 autocoids 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 & Gilman The 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 & Pharmacotherapeutics*, Bombay: Popular Prakashan Pvt. Ltd.

**Suggested e-material:**

1. [www.cvpharmacology.com](http://www.cvpharmacology.com)
2. [www.treatment4addiction.com](http://www.treatment4addiction.com)
3. [www.medicalnewtoday.com](http://www.medicalnewtoday.com)
4. [www.edvivas.com](http://www.edvivas.com)
5. [www.pharmafactz.com](http://www.pharmafactz.com)
6. [www.ausmed.com](http://www.ausmed.com)

## PHAR 316 Pharmacognosy and Phytochemistry-II

<b>Max. Marks : 100</b>	<b>L T P C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>4 0 0 4</b>

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

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

**Suggested e-material:**

1. <http://nsdl.niscair.res.in>
2. [http://www.herbs4youth.eu/files/workbook\\_processingtransf.pdf](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](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](http://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](http://www.ayurveda.hu/api/API-Vol-1)

## PHAR 315 Pharmaceutical Jurisprudence

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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](http://www.imedpub.com/.../pharmaceutical-jurisprudence-journals-articles-ppts-list.php)
2. <https://cdsco.gov.in>

## PHAR 313L Industrial Pharmacy - I Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### 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.
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)

### Books Recommended:

1. Pharmacopoeia of India, The controller of Publications, Delhi.
2. Liberman, H.A., Lachman, C. (1990). *Pharmaceutical Dosage forms. Disperse systems*. 2<sup>nd</sup> Ed., New York: Marcel Dekkar Inc.
3. Cater, S.J. (2005). *Tutorial Pharmacy*, 6<sup>th</sup> Ed., India: CBS publishers.
4. Gaud & Gupta, Practical Pharmaceutics, CBS Publishers & distributors, New Delhi India.

## PHAR 317L Pharmacology-II Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### 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.
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

**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. Barar, F.S.K., (2013). *Text Book of Pharmacology*, New Delhi: S Chand.
4. Kulkarni, S.K., (2005). *Hand Book of Experimental Pharmacology* Delhi: Vallabh Prakashan.

## PHAR 316L Pharmacognosy and Phytochemistry-II Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**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.

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

**Books recommended:**

1. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12<sup>th</sup> Ed., PharmaMed Press.
2. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37<sup>th</sup> Ed., Pune: Nirali Prakashan.
3. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9<sup>th</sup> Ed., Philadelphia: Lea and Febiger.
4. Choudhary, R.D. (1996). *Herbal drug industry*, 1<sup>st</sup> Ed., New Delhi: Eastern Publisher.

## 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 through 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 -  $K$ ,  $t_{1/2}$ ,  $V_d$ ,  $AUC$ ,  $K_a$ ,  $Cl_T$  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. Pamarowski, 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****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:

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

**Suggested e-material:**

1. <http://nsdl.niscair.res.in>
2. [http://www.herbs4youth.eu/files/workbook\\_processingtransf.pdf](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](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](http://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](http://www.ayurveda.hu/api/API-Vol-1)

**PHAR 404 Medicinal Chemistry-III****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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.

**$\beta$ -Lactam antibiotics:** Penicillin, Cephalosporins,  $\beta$ -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, Artesunate, Artemether, Atovoquon

### Section-B

#### Anti-tubercular Agents

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

**Anti-tubercular antibiotics:** Rifampicin, Rifabutin, Cycloserine, Streptomycin, 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, Tioconazole, 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, Sulfamethoxazole\*, 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, Hammett's electronic parameter, Taft's 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*, 12<sup>th</sup> 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*, 7<sup>th</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
3. Abraham, D.J., Rotella, R.J. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development*, 7<sup>th</sup> Ed., New York: John Wiley and Sons.
4. Smith, J.H., Williams, H. (2010). *Introduction to principles of drug design*, 3<sup>rd</sup> Ed., Harwood Academic Publishers.
5. Remington, P.J., Beringer, P. (2006). *Remington's Pharmaceutical Sciences*, 21<sup>st</sup> Ed., Philadelphia: Lippincott Williams and Wilkins.
6. Buckley, G. (1988). *Martindale's extra pharmacopoeia*, 29<sup>th</sup> Ed., British journal of general practice.
7. Finar, I.L. (2002). *Organic Chemistry: Stereochemistry and the Chemistry Natural Products*, vol 2, 5<sup>th</sup> Ed., London: Pearson.
8. Lednicer, D. (1997). *The Organic Chemistry of Drug Synthesis*, 5<sup>th</sup> 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*, 5<sup>th</sup> Ed., London: Pearson.

**Suggested e-material:**

1. [https://books.google.co.in/books/about/Foye\\_s\\_Principles\\_of\\_Medicinal\\_Chemistry.html?id=R0W1ErpsQpkC](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](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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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, hemopoietic 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 fluoroquinolones, 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, organophosphorus 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*, 5<sup>th</sup>Ed., 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*, 3<sup>rd</sup>Ed., New York: Wiley-Blackwell Publishers.
7. Gad, C.S. (2015). *Animal Models in Toxicology*, 3<sup>rd</sup>Ed., 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*, 3<sup>rd</sup>Ed., New York: CRC Press.

**Suggested e-material:**

1. [www.cvpharmacology.com](http://www.cvpharmacology.com)
2. [www.treatment4addiction.com](http://www.treatment4addiction.com)
3. [www.medicalnewtoday.com](http://www.medicalnewtoday.com)
4. [www.edvivas.com](http://www.edvivas.com)
5. [www.pharmafactz.com](http://www.pharmafactz.com)
6. [www.ausmed.com](http://www.ausmed.com)

## **PHAR 314 Pharmaceutical Biotechnology**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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*, vol. 69, Verlag Chemie.
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](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](http://web.xidian.edu.cn/yqxia/files/20140227_103205.pdf)
3. <https://drive.google.com/file/d/0BxB7ZrIzz8L7STd4WEhneHIKcXc/view?usp=drivesdk>

## PHAR 319 Quality Assurance

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### 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 and documents, 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](http://www.ich.org)
2. <https://www.who.int>

## PHAR 312L Herbal Drug Technology Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

**Learning Outcomes:**

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

- Standardization of extract.
  - Analysis of herbal and crude drugs.
  - Chromatography helps in identification and quantification of mixture of chemical constituents present in the drugs.
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

**Books Recommended:**

1. Tyler, V.E., Brady, L.R., Robbers, J.E. (1988). *Pharmacognosy*, 9<sup>th</sup> Ed., Philadelphia: Lea and Febiger.
2. Wallis, T.E., Churchill, A. (1953). *Practical Pharmacognosy*, 6<sup>th</sup> Ed., India: CBS Publishers.
3. Purohit, A.P., Kokate, C.K., Gokhale, S.B. (2007). *Text book of Pharmacognosy*, 37<sup>th</sup> Ed., New Delhi: Nirali Prakashan.
4. Choudhary, R.D. (1996). *Herbal drug industry*, 1<sup>st</sup> Ed., New Delhi: Eastern Publisher.
5. Gokhale, S.B., Kokate, C.K. (2017). *Practical Pharmacognosy*, 18<sup>th</sup> Ed. New Delhi: Nirali Prakashan.
6. Lyengar, M.A., Nayak, S.G.K. (2017). *Anatomy of Crude Drugs*, 12<sup>th</sup> Ed., PharmaMed Press.
7. Lohar, D.R., *Protocol for testing of Ayuervedic, Siddha & Unani Medicines*, Pharmacopoeia laboratory for Indian Medicine, Department of Ayush, Government of India.
8. Harbone, J.B., (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*, 3<sup>rd</sup> Ed. London: Chapman & Hall Ltd.
9. Khandelwal, K.R., (2008). *Practical Pharmacognosy: Technique and Experiment*, New Delhi: Nirali Prakashan.
10. Sharma, P.P., (2014). *Cosmetics Formulation Manufacturing and Quality Control*, 5<sup>th</sup> Ed. Delhi: Vandana Publications.
11. Mithal, B.M., Saha, R.N., (2002). *A Hand Book of Cosmetic*, 1<sup>st</sup> Ed. Delhi: Vallabh Prakashan.

## PHAR 404L Medicinal Chemistry-III Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes:

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

- Structural activity relationship of different class of drugs.
- Synthesis of some important class of drugs by conventional or MW method.
- Mechanism pathways of different class of medicinal compounds.
- Chemistry of drugs with respect to their pharmacological activity
- Physicochemical properties of drugs.
- Knowledge of software's to draw chemical structures.

### 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)

**Books Recommended:**

1. Mann, F.G., Saunders, B.C. (2009). *Practical Organic Chemistry*. 4th Ed., London: Pearson.
2. 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.
3. Indian Pharmacopoeia, (2014). Addendum 2016.

**PHAR 318L Pharmacology - III Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**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, hemopoietic system, respiratory system, endocrine system, diuretics and autacoids.
1. Dose calculation in pharmacological experiments

2. Antiallergic activity by mast cell stabilization assay
3. Study of anti-ulcer activity of 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*

**Books Recommended:**

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

4. Grover, J.K., (1990). *Experiments in Pharmacy & Pharmacology*, New Delhi: CBS Publishers.
5. Barar, F.S.K., (2013). *Text Book of Pharmacology*, New Delhi: S Chand.

## Seventh Semester

### PHAR 416 Instrumental Methods of Analysis

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 of documentation 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 Pharmaceutical Chemistry*. 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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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*. 21<sup>st</sup> 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. 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](http://www.ich.org)
2. [www.cdSCO.in](http://www.cdSCO.in)
3. [www.who.int](http://www.who.int)

## PHAR 417 Novel Drug Delivery System

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 and formulation 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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 elegance 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, Chichester.
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*. 21<sup>st</sup> 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

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### **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 of documentation and express the observations with clarity.
  - Professional and safety responsibilities for working in the analysis laboratory.
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

**Books Recommended:**

1. Backeet, A.H., Stenlake, J.B. (1962). *Practical Pharmaceutical Chemistry*, vol. 1-2, London: The Atholone Press of the University of London.
2. Stahl, E. (1969). *Thin layer chromatography a laboratory handbook*. 2nd Ed., New York: Springer-Verlag Berlin Heidelberg.
3. Indian Pharmacopoeia (2018), Ministry of Health, Govt. of India.

### **PHAR 414L Dosage Form Design Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**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.

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

**Books recommended:**

1. Gibson M. (2001). *Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection To Commercial Dosage Form*. New York: CRC press.
2. Wells, J.I. (1990). *Pharmaceutical Prefomulation: The Physicochemical Properties of Drug Substances*. London: Ellis Horwood, Chichester.
3. Yalkowsky, S.H. (1981). *Techniques of Solubilization of Drugs*. New York: Marcel Dekker.
4. Banker, G.S. Rhode, C.T. (1979). *Modern Pharmaceutics*. New York: Marcel DekkarInc.
5. Troy, D.B. (2006). *Remington: The Science and Practice of Pharmacy*. 21<sup>st</sup> Ed., vol.1-2, Easton Pennsylvania: Mack Publishing Co.

## PHAR 422L Practice School

<b>Max. Marks : 100</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>4</b>

### 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

<b>Max. Marks : 100</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### 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 regression models

### 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.

**Books Recommended:**

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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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. Impact 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, national programme 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

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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, R<sub>f</sub> 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-gravimetric 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 Pharmaceutical Chemistry*, 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/](http://fist.ump.edu.my/index.php/en/)
2. <https://www.acs.org/content/dam/acsorg>

## PHAR 419 Pharmaceutical Regulatory Science

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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](http://www.fda.gov)
2. <https://www.ich.org/products/guidelines.html>

## **PHAR 424 Quality Control and Standardization of Herbals**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
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 Quality of 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: Quality Specifications, 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**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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/](http://www.who.int/vaccine_safety/en/)
6. [http://www.ipc.gov.in/PvPI/pv\\_home.html](http://www.ipc.gov.in/PvPI/pv_home.html)

**PHAR 413 Cosmetic Science****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****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 cosmeceuticals. Antiperspirants & 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-phenylene 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 benefits. 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 and techniques 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, packaging and 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 appropriate channel, conflict in channels, physical distribution management: Strategic importance, tasks in physical distribution 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, issues in 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; Rural Marketing; 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). 6<sup>th</sup> 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.

### **PHAR 426 Cell and Molecular Biology**

<b>Max. Marks : 100</b>	<b>L T P C</b>
<b>(CA: 40 + ESA: 60)</b>	<b>4 0 0 4</b>

#### **Learning outcomes:**

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

- Summarize cell and molecular biology history.
- Summarize cellular functioning and composition.
- Describe the chemical foundations of cell biology.
- Summarize the DNA properties of cell biology.
- Describe protein structure and function.
- Describe cellular membrane structure and function.
- Describe basic molecular genetic mechanisms.
- Summarize the Cell Cycle

#### **Section-A**

Cell and Molecular Biology: Definitions theory and basics and Applications. Cell and Molecular Biology: History and Summation, Properties of cells and cell membrane, Prokaryotic versus Eukaryotic, Cellular Reproduction, Chemical Foundations – an Introduction and Reactions (Types).

DNA and the Flow of Molecular Information, DNA Functioning, DNA and RNA, Types of RNA, Transcription and Translation.

### Section-B

Proteins: Defined **and** Amino Acids, Protein Structure<sup>173</sup>, Regularities in Protein Pathways, Cellular Processes, Positive Control and significance of Protein Synthesis,

Science of Genetics, Transgenics and Genomic Analysis, Cell Cycle analysis, Mitosis and Meiosis, Cellular Activities and Checkpoints.

### Section-C

Cell Signals: Introduction, Receptors for Cell Signals, Signaling Pathways: Overview, Misregulation of Signaling Pathways, Protein-Kinases: Functioning.

#### Books recommended:

1. Hugo, W. B., & Russell, A. D. (1998). *Pharmaceutical Microbiology*. Oxford London: Blackwell Science.
2. Prescott, S. C., & Dunn, C. G. (1949). *Industrial Microbiology*. Delhi: CBS Publishers & Distributors.
3. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2001). *Textbook of Microbiology*. New York: MC Graw-Hill publications.
4. Malcolm, H., Balliere, T., & Cox. (1964). *Pharmaceutical Microbiology*. London USA: The Williams & Wilkins Co.
5. Rose, A.H. (1961). *Industrial Microbiology*. London: Butterworths.
6. Probisher., Hinsdill *et al.* (1974). *Fundamentals of Microbiology*. Japan: Thomson Learning.
7. Cooper and Gunn's. (2008). *Tutorial Pharmacy*. Delhi: CBS Publisher and Distribution.
8. Pepler, H. J. (1967). *Microbial Technology*. New York: Reinhold.
9. Edward, A.I. (1993). *Fundamentals of Microbiology*. Addison-Wesley Educational Publishers Inc.
10. Jain, N.K. (2008). *Pharmaceutical Microbiology*. Delhi: Vallabh Prakashan.
11. Sneath, P. H., Mair, N. S., Sharpe, M. E., & Holt, J. G. (1986). *Bergey's Manual of Systematic Bacteriology*. Williams & Wilkins.
12. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.

13. Goldsby, R. A., Kindt, T., Osborne, B.A., Kuby, J. I. (2000). *Kuby Immunology*: W H Freeman & Co (Sd).

## PHAR 427 Pharmacological Screening Methods

**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:

- Appreciate the applications of various commonly used laboratory animals.
- Appreciate and demonstrate the various screening methods used in preclinical research.
- Appreciate and demonstrate the importance of biostatistics and research methodology.
- Design and execute a research hypothesis independently.

### **Section-A**

**Laboratory Animals:** Study of CPCSEA and OECD guidelines for maintenance, breeding and conduct of experiments on laboratory animals, Common lab animals: Description and applications of different species and strains of animals. Popular transgenic and mutant animals.

Techniques for collection of blood and common routes of drug administration in laboratory animals, Techniques of blood collection and euthanasia.

**Preclinical screening models:** Introduction, Dose selection, calculation and conversions, preparation of drug solution/suspensions, grouping of animals and importance of sham negative and positive control groups. Rationale for selection of animal species and sex for the study.

### **Section-B**

**Study of screening animal models for:** Diuretics, nootropics, anti-Parkinson's, antiasthmatics,

**Preclinical screening models:** for CNS activity- analgesic, antipyretic, anti-inflammatory, general anaesthetics, sedative and hypnotics, antipsychotic, antidepressant, antiepileptic, antiparkinsonism, Alzheimer's disease

**Preclinical screening models:** for ANS activity, sympathomimetics, sympatholytics, parasympathomimetics, parasympatholytics, skeletal muscle relaxants, drugs acting on eye, local anaesthetics

### Section-C

**Preclinical screening models:** for CVS activity- antihypertensives, diuretics, antiarrhythmic, antidyslipidemic, anti aggregatory, coagulants, and anticoagulants. Preclinical screening models for other important drugs like antiulcer, antidiabetic, anticancer and antiasthmatics.

**Research methodology and Bio-statistics:** Selection of research topic, review of literature, research hypothesis and study design. Pre-clinical data analysis and interpretation using Students't' test and One-way ANOVA. Graphical representation of data.

### Books Recommended:

1. Ghosh, M. (2008). *Fundamentals of Experimental Pharmacology*. India: Hilton and Company.
2. Kulkarni, S. K. (1987). *Hand Book of Experimental Pharmacology*. India: Vallabh Prakashan.
3. CPCSEA guidelines for laboratory animal facility.
4. Vogel, H. G., & Vogel, W. H. (Eds.). (2013). *Drug Discovery and Evaluation: Pharmacological Assays*. New York: Springer Science & Business Media.
5. Gupta, S. K. (2004). *Drug Screening Methods*. India: Jaypee Brothers.
6. Rao, P. S., & Richard, J. (2012). *Introduction to biostatistics and research methods*. PHI Learning Pvt. Ltd.

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