



L. M. College of Pharmacy
(An Autonomous Institution)

Syllabus for
Doctor of Pharmacy (Pharm. D)
(w.e.f. Academic Year 2024-25)



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Programme Outcomes (POs)

A student completing this program will possess the following graduate attributes:

PO1: Pharmacy Knowledge: Possess knowledge and comprehension of the core and basic knowledge associated with the profession of pharmacy, including biomedical sciences; pharmaceutical sciences; behavioral, social, and administrative pharmacy 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 decisions 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 fulfilment of practice, professional and societal responsibilities. Assume participatory roles as responsible citizens or leadership roles when appropriate to facilitate improvement in health and wellbeing.

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: Honour 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.



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

PO9: 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-assess and use feedback effectively from others to identify learning needs and to satisfy these needs on an ongoing basis



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Teaching and Examination Scheme for Pharm. D Program (Academic Year: 2024 - 25)

Teaching and Examination Scheme for Pharm D Year-I

Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Human Anatomy and Physiology	PD24101TP	3	1	3	11	70	30	30	70	200
2	Medicinal Biochemistry	PD24102TP	3	1	3	11	70	30	30	70	200
3	Pharmaceutical Organic Chemistry	PD24103TP	3	1	3	11	70	30	30	70	200
4	Pharmaceutical Inorganic Chemistry	PD24104TP	2	1	3	9	70	30	30	70	200
5	Pharmaceutics	PD24105TP	2	1	3	9	70	30	30	70	200
6	Biology*	PD24106TP	3	1	3	11	70	30	30	70	200
7	Remedial Mathematics [#]	PD24107T	3	1	0	8	70	30	0	0	100
	Total		13 ^{\$} / 16 [#]	5 ^{\$} / 6 [#]	15 ^{\$#} / 18 [*]	59 ^{\$#} / 62 [*]	350 ^{\$} / 420 [#]	150 ^{\$} / 180 [#]	150 ^{\$#} / 180 [*]	350 ^{\$#} / 420 [*]	1000 ^{\$} /1100 [#] / 1200 [*]
*: Elective for students of XII A group, #: Elective for students of XII B group; Students from AB ^{\$} group would be exempted from both the electives. L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)											



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Teaching and Examination Scheme for Pharm D Year-II											
Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Pathophysiology	PD24201T	3	1	0	8	70	30	0	0	100
2	Pharmacology-I	PD24202T	3	1	0	8	70	30	0	0	100
3	Pharmacotherapeutics-I	PD24203TP	3	1	3	11	70	30	30	70	200
4	Community Pharmacy	PD24204T	2	1	0	6	70	30	0	0	100
5	Pharmaceutical Microbiology	PD24205TP	3	1	3	11	70	30	30	70	200
6	Pharmacognosy & Phytopharmaceuticals	PD24206TP	3	1	3	11	70	30	30	70	200
Total			17	6	9	55	420	180	90	210	900
L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)											

Teaching and Examination Scheme for Pharm D Year-III											
Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Pharmacology-II	PD24301TP	3	1	3	11	70	30	30	70	200
2	Pharmacotherapeutics-II	PD24302TP	3	1	3	11	70	30	30	70	200
3	Medicinal Chemistry	PD24303TP	3	1	3	11	70	30	30	70	200
4	Pharmaceutical Analysis	PD24304TP	3	1	3	11	70	30	30	70	200
5	Pharmaceutical Formulations	PD24305TP	2	1	3	9	70	30	30	70	200
6	Pharmaceutical Jurisprudence	PD24306T	2	0	0	4	70	30	0	0	100
Total			16	5	15	57	420	180	150	350	1100
L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)											



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Teaching and Examination Scheme for Pharm D Year -IV											
Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Pharmacotherapeutics-III	PD24401TP	3	1	3	11	70	30	30	70	200
2	Clinical Pharmacy	PD24402TP	3	1	3	11	70	30	30	70	200
3	Clinical Toxicology	PD24403T	2	1	0	6	70	30	0	0	100
4	Hospital Pharmacy	PD24404TP	2	1	3	9	70	30	30	70	200
5	Biopharmaceutics & Pharmacokinetics	PD24405TP	3	1	3	11	70	30	30	70	200
6	Biostatistics & Research Methodology	PD24406T	2	1	0	6	70	30	0	0	100
Total			15	6	12	54	420	180	120	280	1000

L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)

Teaching and Examination Scheme for Pharm D Year -V											
Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Clinical Research	PD24501T	3	1	0	8	70	30	0	0	100
2	Pharmacoepidemiology and Pharmacoeconomics	PD24502T	3	1	0	8	70	30	0	0	100
3	Clinical Pharmacokinetics & Pharmacotherapeutic Drug Monitoring	PD24503T	2	1	0	6	70	30	0	0	100
4	Clerkship	PD24504T	0	1	0	2	0	0	30	70	100
5	Project work (Six Months)	PD24505P	0	0	20	10	0	0	30	70	100
Total			8	4	20	34	210	90	60	140	500

L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)

Teaching and Examination Scheme for Pharm D Year -VI											
Sr. No.	Course Name	Course Code	L	T	P	C	E	M	I	V	Total
1	Internship	PD24601P	0	0	0	0	0	0	0	0	0

L= Lectures, P = Practical, T = Tutorial, C = Credit, E = External (T), M = Internal (T), I = Internal (P), V = External (P)



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Detailed Syllabi for each course



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Pharm D, Year I

Course Name:	Human Anatomy and Physiology	Credits:	8
Course Code:	PD24101TP	Credits:	3
Learning Hours (Theory):	120 (Lectures: 3; Tutorial: 1 per week)		
Learning Hours (Practical):	3 hours/ week		

Scope: This course is designed to impart a fundamental knowledge on the structure and functions of the human body. It also helps in understanding both homeostasis mechanisms and homeostatic imbalances of various body systems. Since a medicament, which is produced by pharmacist, is used to correct the deviations in human body, it enhances the understanding of how the drugs act on the various body systems in correcting the disease state of the organs.

Objectives: On learning the course, a student will be able to:

1. describe the structure (gross and histology) and functions of various organs of the human body;
2. describe the various homeostatic mechanisms and their imbalances of various systems;
3. identify the various tissues and organs of the different systems of the human body;
4. perform the hematological tests and also record blood pressure, heart rate, pulse and Respiratory volumes;
5. appreciate coordinated working pattern of different organs of each system; and
6. appreciate the interlinked mechanisms in the maintenance of normal functioning (homeostasis) of human body

Sr No	Course Contents	Total Hrs
1	Scope of anatomy and physiology , basic terminologies used in this subject (Description of the body as such planes and terminologies)	4
2	Structure of cell —its components and their functions.	5
3	Elementary tissues of the human body: Epithelial, Connective, Muscular and Nervous tissues –their sub-types and characteristics	4
4	a) Osseous system - structure, composition and functions of the Skeleton. (done in practical classes-6hrs) b) Classification of joints, Types of movements of joints and disorders of joints (Definitions only)	4
5	Haemopoetic System a) Composition and functions of blood b) Haemopoiesis and disorders of blood components (definition of disorder) c) Blood groups d) Clotting factors and mechanism e) Platelets and disorders of coagulation	6
6	Lymph a) Lymph and lymphatic system, composition, formation and circulation. b) Spleen: structure and functions, Disorders	3



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	c) Disorders of lymphatic system (definition only)	
7	Cardiovascular system a) Anatomy and functions of heart b) Blood vessels and circulation (Pulmonary, coronary and systemic circulation) c) Electrocardiogram (ECG) d) Cardiac cycle and heart sounds e) Blood pressure – its maintenance and regulation f) Definition of the following disorders Hypertension, Hypotension, Arteriosclerosis, Atherosclerosis, Angina, Myocardial infarction, Congestive heart failure, Cardiac arrhythmias	7
8	Respiratory system a) Anatomy of respiratory organs and functions b) Mechanism / physiology of respiration and regulation of respiration c) Transport of respiratory gases d) Respiratory volumes and capacities, and Definition of: Hypoxia, Asphyxia, Dybarism, Oxygen therapy and resuscitation.	6
9	Digestive system a) Anatomy and physiology of GIT b) Anatomy and functions of accessory glands of GIT c) Digestion and absorption d) Disorders of GIT (definitions only)	6
10	Nervous system a) Definition and classification of nervous system b) Anatomy, physiology and functional areas of cerebrum c) Anatomy and physiology of cerebellum d) Anatomy and physiology of mid brain e) Thalamus, hypothalamus and Basal Ganglia f) Spinal card: Structure & reflexes – mono-poly-planter g) Cranial nerves – names and functions h) ANS – Anatomy & functions of sympathetic & parasympathetic N.S.	9
11	Urinary system a) Anatomy and physiology of urinary system b) Formation of urine c) Renin Angiotensin system – Juxtglomerular apparatus - acid base balance d) Clearance tests and micturition	6
12	Endocrine system a) Pituitary gland b) Adrenal gland c) Thyroid and Parathyroid glands d) Pancreas and gonads	7



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13	Reproductive system a) Male and female reproductive system b) Their hormones – Physiology of menstruation c) Spermatogenesis & Oogenesis d) Sex determination (genetic basis) e) Pregnancy and maintenance and parturition f) Contraceptive devices	8
14	Sense organs a) Eye b) Ear c) Skin d) Tongue & Nose	6
15	Skeletal muscles a) Histology b) Physiology of Muscle contraction c) Physiological properties of skeletal muscle and their disorders (definitions)	5
16	Sports physiology a) Muscles in exercise, Effect of athletic training on muscles and muscle performance, b) Respiration in exercise, CVS in exercise, Body heat in exercise, Body fluids and salts in exercise, c) Drugs and athletics	4

Practical

Suggested list of experiments

- 1 Study of tissues of human body
(a) Epithelial tissue (b) Muscular tissue
- 2 Study of tissues of human body
(a) Connective tissue (b) Nervous tissue
- 3 Study of appliances used in hematological experiments.
- 4 Determination of W.B.C. count of blood.
- 5 Determination of R.B.C. count of blood.
- 6 Determination of differential count of blood.
- 7 Determination of
(a) Erythrocyte Sedimentation Rate. (b) Hemoglobin content of Blood. (c) Bleeding time & Clotting time
- 8 Determination of (a) Blood Pressure (b) Blood group
- 9 Study of various systems with the help of charts, models & specimens
(a) Skeleton system part I-axial skeleton (b) Skeleton system part II- appendicular skeleton (c) Cardiovascular system (d) Respiratory system (e) Digestive system (f) Urinary system (g) Nervous system (h) Special senses (i) Reproductive system
- 10 Study of different family planning appliances.
- 11 To perform pregnancy diagnosis test.
- 12 Study of appliances used in experimental physiology.
- 13 To record simple muscle curve using gastrocnemius sciatic nerve preparation.
- 14 To record simple summation curve using gastrocnemius sciatic nerve preparation
- 15 To record simple effect of temperature using gastrocnemius sciatic nerve preparation.



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- 16 To record simple effect of load & after load using gastrocnemius sciatic nerve preparation.
- 17 To record simple fatigue curve using gastrocnemius sciatic nerve preparation

Recommended Text Books:

1. Sembulingam, K., & Sembulingam, P. (2012). Essentials of medical physiology. JP Medical Ltd.
2. Patton, K. T., Bell, F. B., Thompson, T., & Williamson, P. L. (2022). Anatomy & Physiology with Brief Atlas of the Human Body and Quick Guide to the Language of Science and Medicine-E-Book: Anatomy & Physiology with Brief Atlas of the Human Body and Quick Guide to the Language of Science and Medicine-E-Book. Elsevier Health Sciences.
3. Tandon, O. P., and Tripathi, Y. (2011). Best & Taylor's Physiological Basis of Medical Practice, 13/e with the Point Access Scratch Code. Wolters Kluwer India Pvt Ltd.
4. Jackson, J. E. H. (2006). Textbook of Medical Physiology, Arthur C. Guyton & John E. Hall by Elsevier Inc. Elsevier Inc.
5. Tortora, G. J., & Derrickson, B. H. (2012). Principles of Anatomy and Physiology, 2012. Hoboken: John Wiley & Sons.
6. Singh, I. (2011). Textbook of human histology.
7. Ghai, C. L. (2012). A textbook of practical physiology. JP Medical Ltd.

Recommended Reference Books:

1. John, N. A. (2018). *CC Chatterjee's Human Physiology*. CBS Publishers & Distributors Private Limited.
2. Barrett, K. E., Barman, S. M., Yuan, J., & Brooks, H. L. (2019). Ganong's review of medical physiology. Mcgraw Hill Professional.

Important URL:

'Meet the heart and double lung transplant recipient turned triathlete champion' by SBS provides an article and video about a Brisbane woman who has received a heart and double lung transplant: www.sbs.com.au/topics/life/health/article/2016/10/07/meet-heart-and-double-lungtransplant-recipient-turned-triathlete-champion



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Pharm D, Year I

Course Name:	Medicinal Biochemistry		
Course Code:	PD24102TP		
Learning Hours (Theory):	120 (Lectures: 3; Tutorial: 1 per week)	Credits:	8
Learning Hours (Practical):	3 hours/ week	Credits:	3

Scope: Applied biochemistry deals with complete understanding of the molecular level of the chemical process associated with living cells. Clinical chemistry deals with the study of chemical aspects of human life in health and illness and the application of chemical laboratory methods to diagnosis, control of treatment, and prevention of diseases.

Objectives: The objective of the present course is providing biochemical facts and the principles to the students of pharmacy. Upon completion of the subject student shall be able to –

- Understand the catalytic activity of enzymes and importance of iso enzymes in diagnosis of diseases.
- Know the metabolic process of biomolecules in health and illness (metabolic disorders).
- Understand the genetic organization of mammalian genome; protein synthesis; replication; mutation and repair mechanism.
- Know the biochemical principles of organ function tests of kidney, liver and endocrine gland.
- Do the qualitative analysis and determination of biomolecules in the body fluids.

Sr. No.	Course Contents	Total Hrs
1	Introduction to biochemistry: Cell and its biochemical organization, transport process across the cell membranes. Energy rich compounds; ATP, Cyclic AMP and their biological significance.	5
2	Enzymes: Definition; Nomenclature; IUB classification; Factor affecting enzyme activity; Enzyme action; enzyme inhibition. Isoenzymes and their therapeutic and diagnostic applications; Coenzymes and their biochemical role and deficiency diseases.	7
3	Carbohydrate metabolism: Glycolysis, Citric acid cycle (TCA cycle), HMP shunt, Glycogenolysis, gluconeogenesis, glycogenesis. Metabolic disorders of carbohydrate metabolism (diabetes mellitus and glycogen storage diseases); Glucose, Galactose tolerance test and their significance; hormonal regulation of carbohydrate metabolism.	16
4	Lipid metabolism: -oxidation); Ketogenesis and ketolysis; biosynthesis of fatty acids, lipids; metabolism of cholesterol; Hormonal regulation of lipid metabolism. Defective metabolism of lipids (Atherosclerosis, fatty liver, hypercholesterolemia)	12



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5	Biological oxidation: Coenzyme system involved in biological oxidation. Electron transport chain (its mechanism in energy capture; regulation and inhibition); Uncouplers of ETC; Oxidative phosphorylation;	7
6	Protein and amino acid metabolism: protein turn over; nitrogen balance; Catabolism of Amino acids (Transamination, deamination & decarboxylation). Urea cycle and its metabolic disorders; production of bile pigments; hyperbilirubinemia, porphyria, jaundice. Metabolic disorder of Amino acids.	12
7	Nucleic acid metabolism: Metabolism of purine and pyrimidine nucleotides; Protein synthesis; Genetic code; inhibition of protein synthesis; mutation and repair mechanism; DNA replication (semiconservative /onion peel models) and DNA repair mechanism.	10
8	Introduction to clinical chemistry: Cell; composition; malfunction; Roll of the clinical chemistry laboratory.	2
9	The kidney function tests: Role of kidney; Laboratory tests for normal function includes- a) Urine analysis (macroscopic and physical examination, quantitative and semiquantitative tests.) b) Test for NPN constituents. (Creatinine /urea clearance, determination of blood and urine creatinine, urea and uric acid) c) Urine concentration test d) Urinary tract calculi. (stones)	5
10	Liver function tests: Physiological role of liver, metabolic, storage, excretory, protective, circulatory functions and function in blood coagulation. a) Test for hepatic dysfunction-Bile pigments metabolism. b) Test for hepatic function test- Serum bilirubin, urine bilirubin, and urine urobilinogen. c) Dye tests of excretory function. d) Tests based upon abnormalities of serum proteins. Selected enzyme tests.	5
11	Lipid profile tests: Lipoproteins, composition, functions. Determination of serum lipids, total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides.	3
12	Immunochemical techniques for determination of hormone levels and protein levels in serum for endocrine diseases and infectious diseases. Radio Immuno Assay (RIA) and Enzyme Linked Immuno Sorbent Assay (ELISA)	3
13	Electrolytes: Body water, compartments, water balance, and electrolyte distribution. Determination of sodium, calcium potassium, chlorides, bicarbonates in the body fluids.	3



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Practical

Suggested list of experiments

- 1 Qualitative analysis of normal constituents of urine.*
- 2 Qualitative analysis of abnormal constituents of urine.*
- 3 Quantitative estimation of urine sugar by Benedict's reagent method.**
- 4 Quantitative estimation of urine chlorides by Volhard's method.**
- 5 Quantitative estimation of urine creatinine by Jaffe's method.**
- 6 Quantitative estimation of urine calcium by precipitation method.**
- 7 Quantitative estimation of serum cholesterol by Libermann Burchard's method.**
- 8 Preparation of Folin Wu filtrate from blood.*
- 9 Quantitative estimation of blood creatinine.**
- 10 Quantitative estimation of blood sugar Folin-Wu tube method.**
- 11 Estimation of SGOT in serum.**
- 12 Estimation of SGPT in serum.**
- 13 Estimation of Urea in Serum.**
- 14 Estimation of Proteins in Serum.**
- 15 Determination of serum bilirubin**
- 16 Determination of Glucose by means of Glucoseoxidase.**
- 17 Enzymatic hydrolysis of Glycogen/Starch by Amylases.**
- 18 Study of factors affecting Enzyme activity. (pH & Temp.)**
- 19 Preparation of standard buffer solutions and its pH measurements (any two)*
- 20 Experiment on lipid profile tests**
- 21 Determination of sodium,calcium and potassium in serum.**

Recommended Text Books:

1. Murray, K., Rodwell, V., Bender, D., Botham, K. M., Weil, P. A., & Kennelly, P. J. (2009). Harper's illustrated biochemistry. 28. Citeseer, New York, United States.
2. Satyanarayana, U., & Chakrapani, U. (2020). Biochemistry, (Updated and Revised Edition)-E-Book. Elsevier India.
3. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2019). Textbook of biochemistry for medical students. Jaypee brothers Medical publishers.
4. Chawla, R. (2014). Practical clinical biochemistry: methods and interpretations. JP Medical Ltd.
5. Marshall, W. J., Lapsley, M., Day, A., & Shipman, K. (2020). Clinical chemistry. Elsevier Health Sciences.
6. David Plummer (2017). A Text book of practical biochemistry.. McGraw Hill Education

Recommended Reference books:

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.
2. Wilson, K., & Walker, J. (Eds.). (2000). Principles and techniques of practical biochemistry. Cambridge University Press.
3. Pattabiraman, T (2015). Laboratory Manual and Practical Biochemistry. All India Publishers &



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Distributors

Important URLs:

1. <https://www.britannica.com/science/cell-biology/Coupled-chemical-reactions>
2. <http://aulanni.lecture.ub.ac.id/files/2012/01/15616949-Lehninger-Principles-of-Biochemistry-1-copy.pdf>
3. <https://biochem.oregonstate.edu/undergraduate/educational-resources>



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Pharm D, Year I

Course Name:	Pharmaceutical Organic Chemistry		
Course Code:	PD24103TP		
Learning Hours (Theory):	120 (Lectures: 3; Tutorial: 1 per week)	Credits:	8
Learning Hours (Practical):	3 hours/ week	Credits:	3

Scope: This subject deals with general methods of preparation and reaction of organic compounds. Reactivity of organic compounds is also included here. The course emphasizes on mechanism and orientation of reactions.

Objectives: This course is designed to impart a very good knowledge about

- IUPAC/Common system of nomenclature of simple organic compounds belonging to different classes of organic compounds.
- Some important physical properties of organic compounds.
- Free radical/ nucleophilic [alkyl/ acyl/ aryl] /electrophilic substitution, free radical/ nucleophilic / electrophilic addition, elimination, oxidation and reduction reactions with mechanism, orientation of the reaction, order of reactivity, stability of compounds.
- Some named organic reactions with mechanisms; and e. Methods of preparation, test for purity, principle involved in the assay, important medicinal uses of some important organic compounds.

Sr. No.	Course Contents	Hours
1	Structures and Physical properties: a. Polarity of bonds, polarity of molecules, M.P, Inter molecular forces, B.P, Solubility, nonionic solutes and ionic solutes, protic and aprotic Solvents, ion pairs, b. Acids and bases, Lowry Bronsted and Lewi's theories c. Isomerism	9
2	Nomenclature of organic compound belonging to the following classes Alkanes, Alkenes, Dienes, Alkynes, Alcohols, Aldehydes, Ketones, Amides, Amines, Phenols, Alkyl Halides, Carboxylic Acid, Esters, Acid Chlorides and Cycloalkanes.	8
3	Free radicals chain reactions of alkane: Mechanism, relative reactivity and stability	6
4	Alicyclic compounds: Preparations of cycloalkanes, Bayer strain theory and orbital picture of angle strain.	3
5	Nucleophilic aliphatic substitution mechanism: Nucleophiles and leaving groups, kinetics of second and first order reaction, mechanism and kinetics of SN2 reactions. Stereochemistry and	7



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	steric hindrance, role of solvents, phase transfer catalysis, mechanism and kinetics of SN1 reactions, stereochemistry, carbocation and their stability, rearrangement of carbocation, role of solvents in SN1 reaction, Ion dipole bonds, SN2 versus SN1 solvolyses, nucleophilic assistance by the solvents.	
6	Dehydrohalogenation of alkyl halides: 1,2 elimination, kinetics, E2 and E1 mechanism, elimination via carbocation, evidence for E2 mechanism, absence of rearrangement isotope effect, absence hydrogen exchange, the element effect, orientation and reactivity, E2 versus E1, elimination versus substitution, dehydration of alcohol, ease of dehydration, acid catalysis, reversibility, orientation.	5
7	Electrophilic and free radicals' addition: Reactions at carbon-carbon, double bond, electrophile, hydrogenation, heat of hydrogenation and stability of alkenes, Markownikov rule, addition of hydrogen halides, addition of hydrogen bromides, peroxide effect, electrophilic addition, mechanism, rearrangement, absence of hydrogen exchange, orientation and reactivity, addition of halogen, mechanism, halohydrin formation, mechanism of free radicals addition, mechanism of peroxide initiated addition of hydrogen bromide, orientation of free addition, additions of carbene to alkene, cyclo addition reactions.	6
8	Carbon-carbon double bond as substituents: Free radical halogenations of alkenes, comparison of free radical substitution with free radical addition, free radical substitution in alkenes, orientation and reactivity, allylic rearrangements.	4
9	Theory of resonance: Allyl radical as a resonance hybrid, stability, orbital picture, resonance stabilization of allyl radicals, hyper conjugation, allyl cation as a resonance hybrid, nucleophilic substitution in allylic substrate, SN1 reactivity, allylic rearrangement, resonance stabilization of allyl cation, hyper conjugation, nucleophilic substitution in allylic substrate, SN2 nucleophilic substitution in vinylic substrate, vinylic cation, stability of conjugated dienes, resonance in alkenes, hyper conjugation, ease of formation of conjugated dienes, orientation of elimination, electrophilic addition to conjugated dienes, 1,4- addition, 1,2-versus 1,4-addition, rate versus equilibrium, orientation and reactivity of free radical addition to conjugated dienes.	6
10	Electrophilic aromatic substitution: Effect of substituent groups, determination of orientation, determination of relative reactivity, classification of substituent group, mechanism of nitration, sulphonation, halogenation, Friedel craft alkylation, Friedel craft acylation, reactivity and orientation, activating and deactivating O,P,M	6



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	directing groups, electron release via resonance, effect of halogen on electrophilic aromatic substitution in alkyl benzene, side chain halogenation of alkyl benzene, resonance stabilization of benzyl radical.	
11	Nucleophilic addition reaction: Mechanism, ionization of carboxylic acids, acidity constants, acidity of acids, structure of carboxylate ions, effect of substituent on acidity, nucleophilic acyl substitution reaction, conversion of acid to acid chloride, esters, amide and anhydride. Role of carboxyl group, comparison of alkyl nucleophilic substitution with acyl nucleophilic substitution.	5
12	Mechanism of aldol condensation, Claisen condensation, Cannizzaro reaction, crossed aldol condensation, crossed Cannizzaro reaction, benzoin condensation, Perkin condensation. Knoevenagel, Reformatsky reaction, Wittig reaction, Michael addition.	5
13	Hoffman rearrangement: Migration to electron deficient nitrogen, Sandmeyer's reaction, basicity of amines, diazotization and coupling, acidity of phenols, Williamson synthesis, Fries rearrangement, Kolbe reaction, Reimer Tieman's reactions.	5
14	Nucleophilic aromatic substitution: Bimolecular displacement mechanisms, orientation, comparison of aliphatic nucleophilic substitution with that of aromatic.	4
15	Oxidation reduction reaction.	5
16	Study of the following official compounds- Preparation, test for purity, assay and medicinal uses of Chlorbutol, Dimercaprol, Glycerol trinitrate, Urea, Ethylene diamine dihydrate, Vanillin, Paraldehyde, Ethylene chloride, Lactic acid, Tartaric acid, citric acid, salicylic acid, aspirin, methyl salicylate, ethyl benzoate, benzyl benzoate, dimethyl phthalate, sodium lauryl sulphate, saccharin sodium, mephensin.	6

Practical

Suggested list of experiments

- 1 Introduction to the various laboratory techniques through demonstration involving synthesis of the following compounds (at least 8 compounds to be synthesized):**
 1. Acetanilide / aspirin (Acetylation)
 2. Benzanilide / Phenyl benzoate (Benzoylation)
 3. P-bromo acetanilide / 2,4,6 – tribromo aniline (Bromination)
 4. Dibenzylidene acetone (Condensation)
 5. 1-Phenylazo-2-naphthol (Diazotization and coupling)
 6. Benzoic acid / salicylic acid (Hydrolysis of ester)



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7. M-dinitro benzene (Nitration)
 - 8, 9, 10 – Anthraquinone (Oxidation of anthracene) / preparation of benzoic acid from toluene or benzaldehyde
 9. M-phenylene diamine (Reduction of M-dinitrobenzene) / Aniline from nitrobenzene
 10. Benzophenone oxime
 11. Nitration of salicylic acid
 12. Preparation of picric acid
 13. Preparation of *o*-chlorobenzoic acid from *o*-chlorotoluene
Preparation of cyclohexanone from cyclohexanol
- 2 Identification of organic compounds belonging to the following classes by:**
Systematic qualitative organic analysis including preparation of derivatives Phenols, amides, carbohydrates, amines, carboxylic acids, aldehyde and ketones, Alcohols, esters, hydrocarbons, anilides, nitro compounds.
- 3 Introduction to the use of stereo models:** Methane, Ethane, Ethylene, Acetylene, Cis alkene, Trans alkene, inversion of configuration.

Recommended Text Books:

1. Mehta, B., & Mehta, M. Organic Chemistry. PHI Learning Private Limited.
2. Bahl, B. S., & Bahl, A. Textbook of Organic Chemistry. S. Chand Publisher
3. Mann, F. G., & Saunders, B. C. Practical Organic Chemistry. Pearson Publication
4. Vishnoi, N. K. Advanced Practical organic chemistry. Vikas Publication
5. Ahluwalia, V. K., & Chatwal, R. K. Organic Reaction and reaction mechanism.
6. Soni, P. L., Text Book of Organic Chemistry. S. Chand Publisher

Recommended Reference Books:

1. Morrison, R. T., Boyd, R. N., & Bhattacharjee, S. K. Organic Chemistry. Pearson Publication
2. Finar, I. L. Organic Chemistry (Volume-I & II). Pearson Publication
3. Furniss, B. S., Vogel's text book of Practical Organic Chemistry. Pearson Publication
4. Pavis, D., & Lampman, G., & Kriz G., Introduction to Organic Laboratory techniques by Pavia, Lampman and Kriz. Fort Worth Publisher.
5. Wade, L. G., Organic Chemistry. Pearson Publication
6. Favre, H. A., & Powell W. H., Nomenclature of Organic Chemistry. Royal Society of Chemistry

Important URLs:

1. https://www.google.co.in/books/edition/Organic_Chemistry/kQgu2j_ber0C?hl=en&gbpv=1&dq=organic+chemistry+book&printsec=frontcover
2. https://www.google.co.in/books/edition/Nomenclature_of_Organic_Chemistry/4USgAgAAQBAJ?hl=en&gbpv=1&dq=books+for+IUPAC+nomenclature&printsec=frontcover



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Pharm D, Year I

Course Name:	Pharmaceutical Inorganic Chemistry		
Course Code:	PD24104TP		
Learning Hours (Theory):	90 (Lectures: 2; Tutorial: 1 per week)	Credits:	6
Learning Hours (Practical):	3 hours/ week	Credits:	3

Scope: This course mainly deals with fundamentals of Analytical chemistry and also the study of inorganic pharmaceuticals regarding their monographs and also the course deals with basic knowledge of analysis of various pharmaceuticals.

Objectives: On learning the course, a student will be able to:

- Understand the principles and procedures of analysis of drugs and also regarding the application of inorganic pharmaceuticals.
- Know the analysis of the inorganic pharmaceuticals their applications.
- Appreciate the importance of inorganic pharmaceuticals in preventing and curing the disease.

Sr. No.	Course Contents	Hours
1	Errors: Errors in Analysis: Error, Accuracy and Precision, Types of Errors, Methods of expressing precision, Test for rejection of data, Significant figures, Rounding of figures, Confidence limits	2
2	Volumetric analysis (Titrimetric analysis)	
2.1	Acid-base titrations: Relative strength and its effect on titration, common ion effect, pH, Henderson-Hasselbach equation, buffers, neutralization curve, acid bas indicators, theory of indicators, back titrations, biphasic titrations, pharmacopoeial applications, hydrolysis of salts, ionic products of water and law of mass action.	7
2.2	Redox titrations: Theory of redox titrations, redox indicators, types of redox titrations, iodometry, cerrimetry, mercurymetry, diazotization nitrite titrations, 2,6- dichlorophenol-indophenol titrations, titration curve and calculations of potentials during course of titrations.	6
2.3	Nonaqueous titrations: Nonaqueous solvents, titrants and indicators. Differentiating and levelingsolvents.	3
2.4	Argentometric or precipitation titrations: Mohr's, Fajan's and Volhard's methods	3



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2.5	Complexometric titrations: Theory of the titrations, titrant, indicators and pharmacopoeial applications.	4
3	Gravimetric analysis: Stability, solubility products, types of precipitations, precipitation techniques, pharmacopoeial applications	3
4	Impurities in Pharmaceuticals: Sources of impurities, tests for purity and identity, limit tests for iron, arsenic, lead, heavy metals, chloride, sulphate.	4
5	Gases and Vapors: Oxygen, Anesthetics and Respiratory Stimulants	2
6	Acidifying agents: Dilute HCl	1
7	Antacids: Types, Ideal characteristics of an antacid, Aluminum compounds, Calcium compounds, Magnesium compounds, Sodium compounds, Combination of Antacids	2
8	Cathartics: Classification, Magnesium hydroxide, Magnesium sulphate, Sodium Phosphate, Dried Sodium Phosphate, Sodium Potassium tartarate, Potassium bitartarate, Mercurous chloride	2
9	Major intra and extra-cellular electrolytes: Physiological ions, electrolytes used for replacement therapy, acids-base balance and combination therapy.	4
10	Essential and trace elements: Transition elements and their compounds of pharmaceutical importance: Iron and haematinics, mineral supplements.	3
11	Antimicrobials	2
12	Pharmaceutical Aids used in pharmaceutical industry: Anti- oxidants, preservatives, Filter aids, Adsorbents, Diluents	3
13	Dental products: Dentifrices, Anti-caries agents.	2
14	Miscellaneous agents: Sclerosing agents, Expectorants, Emetics, poisons and Anti-dotes, Sedatives	4
15	Inorganic Radiopharmaceuticals: Nuclear radiopharmaceuticals, reactions, Nomenclature, Methods of obtaining their standards and units of activity, measurements of activity, clinical applications and dosage, hazards and precautions.	3



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Practical

Suggested list of experiments

- 1 Limit test (6 exercises)**
 - a. Limit test for chlorides b. Limit test for sulphates c. Limit test for iron d. Limit test for heavy metals e. Limit test for arsenic f. Modified limit tests for chlorides and sulphates
- 2 Assays (10 exercises)**
 - a. Ammonium chloride- Acid-base titration b. Ferrous sulphate- Cerimetry c. Copper sulphate-Iodometry d. Calcium gluconate- Complexometry e. Hydrogen peroxide – Permanganometry f. Sodium benzoate – Nonaqueous titration g. Sodium chloride – Modified volhard's method h. Assay of KI – KIO₃ titration i. Gravimetric estimation of barium as barium sulphate j. Sodium antimony gluconate or antimony potassium tartarate
- 3 Estimation of mixture (Any two exercises)**
 - a. Sodium hydroxide and sodium carbonate b. Boric acid and Borax c. Oxalic acid and sodium oxalate
- 4 Test for identity (Any three exercises)**
 - a. Sodium bicarbonate b. Barium sulphate c. Ferrous sulphate d. Potassium chloride
- 5 Test for purity (Any two exercises)**
 - a. Swelling power in Bentonite b. Acid neutralizing capacity in aluminum hydroxide gel c. Ammonium salts in potash alum d. Adsorption power heavy Kaolin e. Presence of Iodates in KI
- 6 Preparations (Any two exercises)**
 - a. Boric acids b. Potash alum c. Calcium lactate d. Magnesium sulphate

Recommended Text books

1. Chatwal, G. R. Pharmaceutical Chemistry-Inorganic. India: Himalaya Publishing House
2. Bentley and Driver. Textbook of Pharmaceutical Chemistry, Oxford University Press
3. Vogel, A. I., Bassett, J. Vogel's Textbook of Quantitative Inorganic Analysis: Including Elementary 4. Instrumental Analysis. United Kingdom: English Language Book Society
5. Beckett, A. H., Stenlake, J. B. Practical Pharmaceutical Chemistry: Part II Fourth Edition. United Kingdom: Bloomsbury Academic
6. Indian Pharmacopoeia, Indian Pharmacopoeia Commission (Latest edition)

Recommended Reference books

1. Schroff, M. L. Pharmaceutical chemistry. Calcutta: National Book Centre
2. Kasture, A. V., Pharmaceutical Inorganic Chemistry. (2008). India: Nirali Prakashan.
3. Bothara, K.G., Inorganic Pharmaceutical Chemistry. India: Nirali Prakashan.
4. Bhandari A. Pharmaceutical Chemistry I. India: CBS Publisher
5. Rao, P. G. Inorganic Pharmaceutical Chemistry. India: Vallabh Prakashan.



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Important URLs:

1. https://www.google.co.in/books/edition/Vogel_s_Textbook_of_Quantitative_Inorgan/eZQrAQAAMAAJ?hl=en&gbpv=0&bsq=Vogel,%20A.%20I.,%20Bassett,%20J.%20Vogel%27s%20Textbook%20of%20Quantitative%20Inorganic%20Analysis
2. https://www.google.co.in/books/edition/Pharmaceutical_Chemistry/dtMYzgEACAAJ?hl=en



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Pharm D, Year I

Course Name:	Pharmaceutics		
Course Code:	PD24105TP		
Learning Hours (Theory):	90 (Lectures: 3; Tutorial: 1 per week)	Credits:	6
Learning Hours (Practical):	3 hours/ week	Credits:	3

Scope: This course is designed to impart a fundamental knowledge on the art and science of formulating different dosage forms. It prepares the students for most basics of the applied field of pharmacy.

Objectives: On learning the course, a student will be able to:

- Know the formulation aspects of different dosage forms.
- Do different pharmaceutical calculation involved in formulation.
- Formulate different types of dosage forms.
- Appreciate the importance of good formulation for effectiveness.

Sr. No.	Course Contents	Hours
1	a. Introduction to dosage forms - classification and definitions b. Prescription: definition, parts and handling c. Posology: Definition, Factors affecting dose selection. Calculation of children and infant doses.	6
2	Historical back ground and development of profession of pharmacy and pharmaceutical industry in brief.	2
3	Development of Indian Pharmacopoeia and introduction to other Pharmacopoeias such as BP, USP, European Pharmacopoeia, Extra pharmacopoeia and Indian national formulary.	2
4	Weights and measures, Calculations involving percentage solutions, allegation, proof spirit, isotonic solutions etc.	5
5	Powders and Granules: Classification advantages and disadvantages, Preparation of simple, compound powders, Insufflations, Dusting powders, Eutectic and Explosive powders, Tooth powder and effervescent powders and granules.	8
6	Monophasic Dosage forms: Theoretical aspects of formulation including adjuvant like stabilizers, colorants, flavours with examples. Study of Monophasic liquids like gargles, mouth washes, Throatpaint, Ear drops, Nasal drops, Liniments and lotions, Enemas and collodions.	7
7	Biphasic dosage forms: Suspensions and emulsions, Definition, advantages and disadvantages, classification, test for the type of emulsion, formulation, stability and	6



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	evaluation.	
8	Suppositories and pessaries: Definition, advantages and disadvantages, types of bases, method of preparation, Displacement value and evaluation.	4
9	Galenicals: Definition, equipment for different extraction processes like infusion, Decoction, Maceration and Percolation, methods of preparation of spirits, tinctures and extracts.	5
10	Pharmaceutical calculations.	6
11	Surgical aids: Surgical dressings, absorbable gelatin sponge, sutures, ligatures and medicated bandages	3
12	Incompatibilities: Introduction, classification and methods to overcome the incompatibilities.	6

Practical

Suggested list of experiments

- 1 **Syrups**
 - a. Simple Syrup I.P b. Syrup of Ephedrine HCl NF c. Syrup Vasaka IP d. Syrup of ferrous Phosphate IP e. Orange Syrup
- 2 **Elixir**
 - a. Piperizine citrate elixir BP b. Cascara elixir BPC c. Paracetamol elixir BPC
- 3 **Linctus**
 - a. Simple Linctus BPC
 - b. Pediatric simple Linctus BPC
- 4 **Solutions**
 - a. Solution of cresol with soap IP b. Strong solution of ferric chloride BPC
 - c. Aqueous Iodine Solution IP d. Strong solution of Iodine IP e. Strong solution of ammonium acetate IP
- 5 **Liniments**
 - a. Liniment of turpentine IP*
 - b. Liniment of camphor IP
- 6 **Suspensions***
 - a. Calamine lotion b. Magnesium Hydroxide mixture BP
- 7 **Emulsions***
 - a. Cod liver oil emulsion
 - b. Liquid paraffin emulsion
- 8 **Powders**
- 9 **Suppositories**
- 10 **Incompatibilities**
 - a. Mixtures with Physical b. Chemical & Therapeutic incompatibilities



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Recommended Text Books:

1. Carter S.J., Cooper and Gunn's-Dispensing for Pharmaceutical Students, CBS publishers, New Delhi.
2. Carter S.J., Cooper and Gunn's. Tutorial Pharmacy, CBS Publications, New Delhi.
1. James Swarbrick & James C. Boylon, Encyclopedia of Pharmaceutical Technology, Marcel Dekker, INC, New York, 1994.
2. Relevant editions of IP, BP, BPC
3. R.M.Mehta, Pharmaceutics-I, Vallabh prakashan, Latest edition.
4. A. K. Seth, A Text book of pharmaceutics, Pee Vee publisher, Latest edition.

Recommended Reference Books:

1. Husa's Pharmaceutical Dispensing, Edited by Eric Martin, Sixth Edition, Mack Publishing Company, 1996.
2. Pharmaceutical Calculations, A.C. Ansel and M.J.Stoklosa, Lippincott Williams and Wilkins, 2006.
3. Pharmaceutical Calculations – Bradley, Gustafson and Stoklosa, Third Edition, Lea and
4. M. E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Division Of Longman Group UK Ltd, 2002.
5. H.C. Ansel et al., Pharmaceutical Dosage Form and Drug Delivery System, Lippincott Williams and Walkins, New Delhi.
6. Lachmann. Theory and Practice of Industrial Pharmacy, Lea & Febiger Publisher, The University of Michigan.
7. Alfonso R. Gennaro Remington. The Science and Practice of Pharmacy, Lippincott Williams, New Delhi.
8. E.A. Rawlins, Bentley's Text Book of Pharmaceutics, English Language Book Society, Elsevier Health Sciences, USA.

Important URLs:

1. <https://pharmatimes.com/>
2. <https://www.medscape.com/>



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Pharm D, Year I

Course Name:	Biology		
Course Code:	PD24106TP		
Learning Hours (Theory):	120 (Lectures: 3; Tutorial: 1 per week)	Credits:	8
Learning Hours (Practical):	3 hours/ week	Credits:	3

Scope: This is an introductory course in Biology, which gives detailed study of natural sources such as plant and animal origin. This subject has been introduced to the pharmacy course in order to make the student aware of various naturally occurring drugs and its history, sources, classification, distribution and the characters of the plants and animals. This subject gives basic foundation to Pharmacology.

Objectives: On learning the course, a student will be able to:

1. Know the history, modern concepts of biology and its relevance to pharmaceutical sciences
2. Know the classification and salient feature of five kingdoms of life
3. Knowledge about morphology of plant, flower, fruit and seed
4. Basic components of anatomy and physiology of plant along with study of microbes.
5. Learn about various tissue system and organ system in animals, Poisonous animals study, with special reference to human beings and detailed study of different system of Frog

Sr. No.	Course Contents	Total Hrs
Part A		
1	Introduction	2
2	General organization of plants and its inclusions	4
3	Plant tissues	4
4	Plant kingdom and its classification	4
5	Morphology of plants	5
6	Root, Stem, Leaf and Its modifications	8
7	Inflorescence and Pollination of flowers	6
8	Morphology of fruits and seeds	6
9	Plant physiology	4
10	Taxonomy of Leguminosae, Umbelliferae, Solanaceae, Lilliaceae, Zinziberaceae, Rubiaceae	8
11	Study of Fungi, Yeast, Penicillin and Bacteria	10
Part B		
1	Study of Animal cell	4
2	Study animal tissues	4
3	Detailed study of frog	6
4	Study of Pisces, Reptiles, Aves	8
5	General organization of mammals	4
6	Study of poisonous animals	3



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Practical

Suggested list of experiments

- 1 Introduction of biology experiments.
- 2 Study of cell wall constituents and cell inclusions.
- 3 Study of Stem modifications.
- 4 Study of Root modifications.
- 5 Study of Leaf modifications.
- 6 Identification of Fruits and seeds.
- 7 Preparation of Permanent slides.
- 8 T.S. of Senna, Cassia, Ephedra, Podophyllum.
- 9 Simple plant physiological experiments.
- 10 Identification of animals
- 11 Detailed study of Frog
- 12 Computer based tutorials

Recommended Text Books:

1. Text book of Biology by S. B. Gokhale
2. A Text book of Biology by Dr. Thulajappa and Dr. Seetaram.

Recommended Reference Books:

1. A Text book of Biology by B.V. Sreenivasa Naidu
2. A Text book of Biology by Naidu and Murthy
3. Botany for Degree students By A. C. Dutta.
4. Outlines of Zoology by M. Ekambaranatha ayyer and T. N. Ananthkrishnan.
5. A manual for pharmaceutical biology practical by S.B. Gokhale and C. K. Kokate
6. Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi.
7. Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson, Churchill Livingstone, New York
8. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co, Riverview, MI USA
9. Text book of Medical Physiology- Arthur C, Guyton and John. E. Hall. Miamisburg, OH, U.S.A.
10. Principles of Anatomy and Physiology by Tortora Grabowski. Palmetto, GA, U.S.A.
11. Textbook of Human Histology by Inderbir Singh, Jaypee brother's medical publishers, New Delhi
12. Textbook of Practical Physiology by C.L. Ghai, Jaypee brother's medical publishers, New Delhi
13. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother's medical publishers, New Delhi



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Pharm D, Year I

Course Name:	Remedial Mathematics*		
Course Code:	PD24107T		
Learning Hours (Theory):	120 (Lectures: 3; Tutorial: 1 per week)	Credits:	8
Learning Hours (Practical):	-	Credits:	0

Scope: This is an introductory course in mathematics. This subject deals with the introduction to matrices, determinants, trigonometry, analytical geometry, differential calculus, integral calculus, differential equations, laplace transform.

Objectives: On learning the course, a student will be able to:

- Know Trigonometry, Analytical geometry, Matrices, Determinant, Integration, Differential equation, Laplace transform and their applications.
- Solve the problems of different types by applying theory.
- Appreciate the important applications of mathematics in pharmacy.

Sr. No.	Course Contents	Hours
1	Algebra: Determinants, Matrices	10
2	Trigonometry: Sides and angles of a triangle, solution of triangles	12
3	Analytical Geometry: Points, Straight line, circle, parabola	12
4	Differential calculus: Limit of a function, Differential calculus, Differentiation of a sum, Product, Quotient Composite, Parametric, exponential, trigonometric and Logarithmic function. Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions of two variables	18
5	Integral Calculus: Definite integrals, integration by substitution and byparts, Properties of definite integrals	12
6	Differential equations: Definition, order, degree, variable separable, homogeneous, Linear, heterogeneous, linear, differential equation with constant coefficient, simultaneous linear equation of second order.	16
7	Laplace transform: Definition, Laplace transform of elementary functions, Properties of linearity and shifting	10

Recommended Text Books:

- Grewal B.S., (2014), Higher Engineering Mathematics, Khanna Publishers (40th ed.)
- Sharma R.D., (2021), Mathematics Class XII, Dhanpat Rai Publications. (2021 ed.)
- Sharma R.D., (2021), Mathematics Class XI, Dhanpat Rai Publications. (2021 ed.)



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4. Bais V. K., Bais, Kumar D., Goyal P., (2017), PV Remedial Mathematics, S Vikas and company.
5. Aggarwal R.S., Secondary School Mathematics for Class 12, (2020), Bharati Bhawan.

Recommended Reference Books:

1. Shanti Narayan, Mittal P. K., (2005), Differential Calculus, S. Chand and Company.
2. Panchaksharappa Gowda D.H. (2014), Pharmaceutical Mathematics with application to Pharmacy (1st ed.), BSP Books Pvt. Ltd.
3. Shanti Narayan, Mittal P. K., (2005), Integral Calculus, S. Chand and Company.
4. Kachot K. R., (2010), Remedial Mathematics for Pharmacy, Mahajan Publishing house (3rd ed.).
5. Vashistha A.R., Sharma S. K., Vashistha A.K., (2009), Differential Calculus, Krishna Prakashan media (P) ltd. (21st ed.).

Important URLs:

1. <https://www.desmos.com/calculator>
2. <https://www.mathway.com/Graph>
3. <https://www.symbolab.com/solver/laplace-transform-calculator>