

**M.Sc. Pharmaceutical Chemistry**  
**University of Lucknow**

**Programme Outcomes**

- PO-1. Demonstrate, solve and an understanding of major concepts in all disciplines of Chemistry independently and in group as well as draw logical conclusions through Project and Seminar Presentation.
- PO-2. Encourage students to make critical thinking and the scientific knowledge gained would help them to design, carry out, record and analyze the results of Chemistry as well pharmaceutical experiments.
- PO-3. Equip students to face the employment challenges and instil confidence to turn into entrepreneur and also step into research career.
- PO-4. Generation of new scientific insights or to the innovation of new applications of chemical research
- PO-5. Present scientific and technical information resulting from laboratory as well as Industrial/pharmaceutical experimentation in both written and oral formats, would make them perfect.
- PO-6. Learns modern methods of chemical systems in a laboratory setting make them perfect for any scientific laboratory and industry.
- PO-7: The students will become well versed in the mechanisms and also with the mode of action of drugs.
- PO-8. The present course content will build confidence in students and the students will improve their competencies on par with their counterparts in premier institutions across the nation.

**Programme Specific Outcome**

- PSO-1 Students will be able to understand the basic concepts of bio-inorganic, bio-organic, physical chemistry, analytical chemistry, drug formulation, drug design and development, and green chemistry
- PSO-2. Students will develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.
- PSO-3. Students will be able to use and apply professional software relevant to chemistry.
- PSO-4. Students will be able to demonstrate knowledge to develop Pharmaceutically important molecules, new drug delivery systems etc.
- PSO-5. Students will demonstrate an ability to analyze and interpret data of analytical experiments in production, quality control & assurance of pharmaceutical synthesis and formulation.
- PSO-6. Students will be able to apply analytical tools for determination of organic molecules.
- PSO-7. Students will be able to generate validation protocol for all pharmaceutical operations starting from drug research to development to formulation.
- PSO-8. Learn Role of drugs to inhibit the particular enzymes and treatment of disease
- PSO-9. Learn Mode of action of different drugs.

## M.Sc. PHARMACEUTICAL CHEMISTRY

### PROGRAMME STRUCTURE

The Master of Science in Pharmaceutical Chemistry is a Two Year Full Time Course consisting of Four Semesters.

Semester I

Semester II

Semester III

Semester IV

### COURSE STRUCTURE

Semester	Core Course			Elective Course			Open elective Course			Value Added		Total Credits
	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits	
I	4	16+8	24	0	0+0	0	0	0+0	0	1	4	28
II	4	16+8	24	0	0+0	0	0	0+0	0	0	0	24
III	2	8+8	16	1	4+0	4	1	4+0	4	0	0	24
IV	1D	12+4	16	1	4+0	4	0	0+0	0	0	0	20
Total			80			8			4		4	96

**Semester-III**

Paper Code	Title of the paper	Credits	Int. Ass.	Uni. Exam.	Marks
CCTP-9	PC-301: Project and Seminar	4	-	-	100
CCTP-10	PC-302: Spectroscopic Methods in Pharmaceutical Chemistry	4	30	70	100
CCEP-1. Course Freeze Elective	PC-303A: Medicinal Chemistry-I /MOOC Or PC-303B: Medicinal Chemistry-II /MOOC	4	30	70	100
CCPP-5	PC-304A: Preparation of some specified Crude Plants extract and qualitative analysis (Chemical Methods & TLC) PC-304B: Isolation of Phytochemicals	8	Continuous Evaluation	-	200
COEP-1. Open Elective (Inter Department)	CH-306: Concept of Chemistry	4	30	70	100
	Total	24			600

CCTP (Core Course Theory Paper). CCPP (Core Course Practical Paper). CCEP (Core Course Elective Paper). COEP (Course Open Elective Paper).

**M.Sc. Pharmaceutical Chemistry Semester III Syllabus**  
**Paper Code CCTP-9: Project and Seminar Presentation (PC-301)**

**Credits 4**

**MM 100**

**Course Outcome:**

- CO-1. students should be able demonstrate ability to plan and strategize a scientific problem, and implement it within a reasonable time frame.
- CO-2. It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project.
- CO-3. In addition, students will be able to know the library search and handle the data in a meaningful way.
- CO-4. Also, students will be able to interpret the spectral data independently.
- CO-5. Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.

For project work and seminar presentation, the area of the work would be to be decided by the advisor/mentor based on syllabus. On completion of the project work, students have to submit the work in the form of seminar followed by oral presentation in the presence of faculty members.

**M.Sc. Pharmaceutical Chemistry Semester III Syllabus**

**Paper Code CCTP-9: Spectroscopic Methods in Pharmaceutical Chemistry (PC-302)**

**Credits 4**

**MM 100 (70+30)**

**Hours 60**

**Course Outcome:**

- CO-1. The chapter makes the student aware of various types of transitions and how they are affected by change of solvent polarity.
- CO-2. Woodward Fieser and Fieser Kuhn rules for the calculation of  $\lambda_{max}$  is also explained.
- CO-3. The IR chapter takes into account various types of fundamental vibration, combination bands, overtones and Fermi resonance. The effect of ring size, hydrogen bonding, types of substituents on the position of fundamental vibration was also explained.
- CO-4. The steps are taken to explain the position of fundamental vibration for each group and then students were made to solve different spectral problems of IR.

**Unit I**

Ultraviolet-Visible and Chiroptical Spectroscopy: Energy levels and selection rules, Woodward-Fieser and Fieser-Kuhn rules. Influence of substituent, ring size and strain on spectral characteristics. Solvent effect, Stereochemical effect, non-conjugated interactions. Chiroptical properties-ORD, CD, octant rule, axial haloketone rule, Cotton effect. Problems based on the above topics.

**Unit II**

Infrared Spectroscopy: Fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), influence of substituent, ring size, hydrogen bonding, vibrational coupling and field effect on frequency, determination of stereochemistry by IR technique. IR spectra of different groups. Problems on spectral interpretation with examples.

**Unit III**

Nuclear Magnetic Resonance Spectroscopy: Magnetic nuclei with special reference to  $^1\text{H}$  and  $^{13}\text{C}$  nuclei. Chemical shift and shielding/deshielding, factors affecting chemical shift, relaxation processes, chemical and magnetic non-equivalence, local diamagnetic shielding and magnetic anisotropy. Proton and  $^{13}\text{C}$  NMR scales. Spin-spin splitting: AX, AX<sub>2</sub>, AX<sub>3</sub>, A<sub>2</sub>X<sub>3</sub>, AB, ABC, AMX type coupling, first order and non-first order spectra, Pascal's triangle, coupling constant, mechanism of coupling, Karplus curve, quadrupole broadening and decoupling, diastereomeric protons, virtual coupling, long range coupling-epi, peri and bay effects.

**Unit IV**

NOE. NOE and cross polarization. Simplification non-first order spectra to first order spectra: shift reagents, spin decoupling and double resonance, off resonance decoupling. Chemical shifts and homonuclear/heteronuclear couplings. Basis of heteronuclear decoupling. 2D NMR and COSY, HOMOCOSY and HETERO-COSY Polarization transfer. Selective Population Inversion. DEPT, INEPT and RINEPT. Sensitivity enhancement and spectral editing, MRI. Problems on spectral interpretation with examples.

**Unit V**

Mass Spectrometry

Molecular ion: ion production methods (EI). Soft ionization methods: SIMS, FAB, CA, MALDI, PD, Field Desorption Electrospray Ionization. Fragmentation patterns-nitrogen and ring rules. McLafferty rearrangement and its applications. HRMS, MS-MS, LC-MS, GC-MS. Problems on spectral interpretation with examples.

X-ray

**Recommended Books:**

1. Spectrometric Identification of Organic Compounds, Silverstein and Bassler, Wiley.
2. Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press.)

3. Organic Spectroscopy, P.S. Kalsi, New Age International (P) Limited.
4. Spectroscopy of Organic Compounds, Pavia, Mery Finch Publication.
5. Organic Spectroscopy, I Fleming, McGraw-Hill Inc., US.
6. Advanced Organic Chemistry: Structure & Mechanisms, Ashutosh Kar, Medtech.

**M.Sc. Pharmaceutical Chemistry Semester III Syllabus**  
**Paper Code CCEP-1: Medicinal Chemistry-I (PC-303A)**

**Credits 4**

**MM 100 (70+30)**

**Hours 60**

**Course Outcome:**

After the completion of the course the student will acquire the knowledge of:

- CO-1. absorption, distribution, metabolism and excretion of drugs, clinical pharmaco-kinetics, therapeutic drugs monitoring.
- CO-2. cholinergic agonists, anticholinesterase agents, organophosphorus poisoning and its treatment.
- CO-3. adrenergic receptor blocking agents, Adrenergic neuron blocking drugs and ganglionic stimulants and blocking agents.
- CO-4. digitalis glycoside and other drugs effective in cardiac failure and drugs affecting coagulation, bleeding and thrombosis.
- CO-5. general consideration of chemotherapy, classifications, mode of actions, principles of selecting anti-infective agents.
- CO-6. use of some drugs in emergency (Myocardial infarction, hypertensive emergency, acute cardiac failure, anaphylaxis, cardiovascular collapse, pulmonary embolism etc.)

**Unit I**

Drugs acting on ANS

Adrenergic stimulants: Phenyl ethanolamine derivatives:adrenaline, isoprenaline, salbutamol,ephedrine, and phenylephrine. Imidazole derivatives:naphazoline, xylometazoline and oxymetazoline.

Adrenergic blockers: and adrenoceptor antagonists: phenoxybenzamine, phentolamine, tolazoline, DCI,

Cholinergic stimulants:nicotinic and muscarinic receptors, pilocarpine, bethanechol and carbachol.

Cholinergic blockers: tertiary and quaternary antimuscarinics,

antispasmodic drugs: dicyclomine, glycopyrrolate,

antiulcer drugs: pirenzepine, cycloplegic drugs-tropicamide, homatropine.

**Unit II**

Anticholinesterases:

Competitive inhibitors: physostigmine and neostigmine

Non competitive inhibitors: organophosphorus compounds, Nerve gases,

Cholinesterase regenerators:2 PAM.

Ganglion blocking agents: mecamlamine and trimethophan

Synthesis of the following drugs: salbutamol, naphazoline, tolazoline, propranolol, bretilium, carbachol, mecamlamine and gallamine.

**Unit III**

Drugs acting on CVS

Cardiotonic drugs: cardiac glycosides-their chemistry and stereochemistry, Digoxin and digitoxin.

Antiarrhythmic drugs: quinidine, disopyramide, phenytoin and procainamide

Calcium channel blockers: verapamil, Nifedipine and Neurone blockers-bretilium.  
Antihypertensive Drugs: peripheral antiadrenergics-prazosin and terazosin. Centrally acting drugs-reserpine, clonidine and methyl dopa. -blockers propranolol, atenolol and labetalol.  
ACE inhibitors-captopri. Angiotensin receptor blockers-losartan.  
Antianginal drugs: vasodilators-nitrites and nitrates,  
Anticoagulants: heparin, coumarin derivatives and indane dione derivatives.  
Antilipidemic agents: Statins-lovastatin, simvastatin, fluvastatin, Fibrates-clofibrate.  
Synthesis of the following drugs: procainamide, disopyramide, amlodipine, verapamil, captopril and fluvastatin.

#### Unit IV

##### Chemotherapy

Sulphonamides: sulphanilamide, N-substituted sulphanilamide derivatives, mechanism of action, sulphones-dapsone, dihydrofolate reductase inhibitor trimethoprim and cotrimoxazole.  
Antitubercular agents: first line drugs-isoniazid, rifampicin, pyrazinamide, ethambutol, and streptomycin. Second line drugs-ethionamide, paraaminosalicylic acid and fluoroquinolones.  
Antifungal agents: Azole derivatives-ketoconazole, terconazole, fluconazole and clotrimazole.  
Pyrimidine derivatives- 5 Flucytosine.

#### Unit V

Antiviral drugs: amantidine, interferon and ribavirin. Anti HIV agents zidovudine, and abacavir. Anti herpes simplex agents-brivudine, vidarabin and acyclovir. Anti-influeza agents-oseltamivir(tamiflu).  
Antiprotozoal agents: Amoebicides-metranidazole and tinidazole.  
Anthelmintics piperazines and benzimidazoles. .  
Synthesis of the following drugs: ampicillin, cephalexin, chloramphenicol, sulphamethoxazole, dapsone, trimethoprim, ethambutol, griseofulvin, clotrimazole, acyclovir, metranidazole, primaquine, mebendazole.

#### Recommended Books:

1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson Education.
2. Medicinal Chemistry, Ashutosh Kar, New Age International (P) Limited.
3. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press.
4. Textbook of Medicinal Chemistry, V. Alagarsamy, Elsevier Health Sciences.
5. The Practice of Medicinal Chemistry, Camille G. Wermuth, Elsevier Health Sciences.
6. Drug-like Properties: Concepts, Structure Design and Methods: From ADME to Toxicity Optimization, Edward H Kerns, Li Di, Elsevier Health Sciences.

#### M.Sc. Pharmaceutical Chemistry Semester III Syllabus Paper Code CCEP-1: Medicinal Chemistry-II (PC-303B)

Credits 4

MM 100 (70+30)

Hours 60

#### Course Outcome:

After the completion of the course the student will acquire the knowledge of:

- CO-1. understanding how antineoplastic drugs work and their therapeutic approaches.
- CO-2. synthesis of some cancer treating drugs and the proprietary names, mechanisms of action, therapeutic indications, and side effects of a wide array of psychopharmacological agents.
- CO-3. common Diuretics and their mechanism of action, synthesis of some sedative and hypnotic.
- CO-4. histamine and its biological role, Anti-diabetic medication and local anesthesia and the properties of local anesthetic agents.

CO-5. medicines used to suppress or relieve coughing i.e. Antitussives and synthesis of some related drugs.

### Unit I

Antineoplastic Drugs: Neoplasm-cause therapeutic approaches. Alkylating agents-nitrogen mustards, nitrosourea, aziridines and aryl sulphonates. Antimetabolites-folic acid. Antagonists-purine and pyrimidine antagonists. Antibiotics-anthracyclines, actinomycin D, bleomycin. Plant products-vinca alkaloids, taxol derivatives. Hormones and their antagonists-tamoxifen.

### Unit II

Synthesis of the following drugs: chlorambucil, carmustin, thiotepa, methotrexate, 5-fluoro uracil, procarbazine.

Psychopharmacological Agents

Antidepressants: MAO inhibitors-Isocarboxazide, tranylcypromine and phenelzine. Tricyclic compounds-imipramine, trimipramine, amitriptyline, doxepine, amoxapine

Antipsychotics: phenothiazine and thiothixene derivatives, butyrophenones: haloperidol, droperidol. Hallucinogens: triptamine derivatives-DMT, psilocybin, phenylalkylamines-mescaline, lysergic acid derivatives-LSD.

### Unit III

Synthesis of the following drugs: chlordiazepoxide, imipramine, chlorpromazine, tranylcypromine and haloperidol.

Diuretics: common diuretics and their mechanism of action-mercurial and nonmercurial diuretics, carbonic anhydrase inhibitors- acetazolamide and methazolamide, thiazide derivatives-hydrochlorothiazide, Loop diuretics-furosemide and ethacrynic acid, potassium sparing diuretics-amiloride, spironolactone.

### Unit IV

Antihistaminic drugs: histamine and its biological role, H1 antagonists: aminoalkyl ethers, diphenhydramine and doxylamine, ethylenediamine derivatives-pyrilamine, piperazine derivatives-cyclizine, miscellaneous compounds-cetirizine and cyproheptadine.

Hypoglycemic agents: type 1 and type 2 diabetes, insulin, sulphonyl ureas tolbutamide, acetohexamide and glibenclamide, biguanides-metformin, thiazolidinediones-rosiglitazone.

Local anaesthetics: clinical application of local anaesthesia, coca and cocaine, hexylcaine, para aminobenzoic acid derivative-benzocaine, procaine, tetracaine, chlorprocaine, anilides, lidocaine, etidocaine and prilocaine.

### Unit V

Antitussives: centrally acting antitussives-opium alkaloids and synthetic substitutes-codaine, noscapine, pholcodine, ethylmorphine, dextromethorphan, Non narcotic antitussives-diphenhydramine, expectorants-terpin hydrate, guaicol and bromhexine.

Synthesis of the following drugs: acetazolamide, chlorthiazide furosemide, ethacrynic acid, amiloride, diphenhydramine, pyrilamine, promethazine, omeprazole, tolbutamide, phenformin, benzocaine, procaine lidocaine, dextromethorphan.

### Recommended Books-

1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson Education.
2. Medicinal Chemistry, Ashutosh Kar, New Age International (P) Limited.
3. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press.
4. Textbook of Medicinal Chemistry, V. Alagarsamy, Elsevier Health Sciences.
5. The Practice of Medicinal Chemistry, Camille G. Wermuth, Elsevier Health Sciences.

6. Drug-like Properties: Concepts, Structure Design and Methods: From ADME to Toxicity Optimization, Edward H Kerns, Li Di, Elsevier Health Sciences.
7. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
8. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.

**M.Sc. Pharmaceutical Chemistry Semester III Syllabus**  
**Paper Code CCPP-5: Practical (PC-304A, PC-304B)**

**Credits: 8 (4+4)**

**MM: 200 (100+100)**

**Course Outcome:**

After the completion of the course the student will acquire the knowledge of:

- CO-1. Understand Thin Layer Chromatographic technique for separation of crude plant extracts and their detection.
- CO-2. The students will be well versed with Pharmacopoeia of India (I.P.) and British Pharmacopoeia.
- CO-3. Analysis of many drugs.
- CO-4. Isolation of various phytochemicals from their natural sources.

**PC-304A**

1. Preparation of some specified crude plant extracts and qualitative analysis (chemical or TLC) of crude plant extracts/ products to detect the presence of phytochemicals-alkaloids, carbohydrates, glycosides, tannins, flavanols and saponins.
2. Analysis of drugs as per Pharmacopoeia of India (I.P.) and British Pharmacopoeia (B.P.),

**PC-304B**

Isolation of phytochemicals from their natural sources.

Caffeine from Tea  
 Piperine from black pepper  
 Cucumin from turmeric  
 Citric acid from lemon  
 Lycopene from tomato  
 -Carotene from carrot  
 Trimyristin from nutmeg  
 Eugenol from cloves

**Recommended Books:**

1. Sethi, Arun., Systematic Lab Experiments in Organic Chemistry, New Age International Publisher.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Indian Pharmacopoeia (I.P.).
5. British Pharmacopoeia (B.P.).



**M.Sc. Pharmaceutical Chemistry Semester III Syllabus**  
**Inter Department Elective**  
**Paper Code-COEP-1: Concepts of Chemistry (CH-306)**  
**MM 100 (70+30)**

**Credits 4**

**Hours 60**

**Course Outcome:**

After the completion of the course the students will acquire the knowledge of:

- CO-1: Use of arrow notations in Organic reactions mechanism, different kinds of polymer and their importance, different techniques of polymerization, each quantum number represents and how to obtain quantum numbers for any electron in an atom and determine the number of protons, neutrons, electrons and nuclei in elements and compounds.
- CO-2: Periodic properties of all the elements, electronegativity and whether a bond is metallic, ionic, covalent or polar covalent.
- CO-3: Predict atomic structure, chemical bonding or molecular geometry based on accepted models
- CO-4: Electronic effects operates in covalent bonds, Types of Reactions and different types of Intermediates formed during the reactions
- CO-5: Appropriate method of solution for a variety of Mathematic problems, basic physical quantities and various gas Laws for observation of behaviour of gas and Kinetic molecular model.

**Unit I**

Types of arrows used in Organic Reaction Mechanism ó Curved arrow, half-headed and double headed arrows

Introduction of Polymers, natural and synthetic polymers, properties of polymers, Biomedical polymers and their importance

Quantum numbers. Zeeman effect. Pauli's exclusion principle. Aufbau principle. Effective nuclear charge, screening effect, Slater's rule- applications and limitations

**Unit II**

Classification of Elements and Periodicity of Properties, noble gases and s, p, d and f- block elements. Modern periodic table. Position of hydrogen in the periodic table. Horizontal, vertical and diagonal relationships in the periodic table. Scales of electronegativity- Pauling, Mulliken and Allred Rochow scale.

Ionic bond ó factors influencing the formation of ionic compounds ó ionization energy, electron affinity and lattice energy; inert pair effect, Fajan's rules. Covalent bond ó polarity of covalent bond.

**Unit III**

Valence bond theory (VBT) ó sigma and pi bonds, hybridization, valence shell electron pair repulsion (VSEPR) theory and geometries of molecules ó  $\text{BeCl}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{BF}_3$ ,  $\text{NH}_3$ ,  $\text{XeF}_4$ ,  $\text{BrF}_3$ ,  $\text{PCl}_5$ ,  $\text{SF}_6$  and  $\text{IF}_7$ .

Molecular orbital theory (MOT) ó bonding and antibonding orbitals, bond order, applications of MOT to  $\text{H}_2$ ,  $\text{He}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{O}_2^+$ ,  $\text{O}_2^-$ ,  $\text{HF}$  and  $\text{CO}$ . Comparison between VBT and MOT.

**Unit IV**

Resonance and Inductive effect

Reaction Intermediates ó Homolytic and Heterolytic bond breaking (carbonium ion, carbanion and free radical)

Types of Reactions ó Addition, Elimination, Substitution and Rearrangement Reactions.

## Unit V

Mathematical concepts:

Logarithm, anti-logarithm, functions, integrations and differentiation, partial differentiation, trigonometric functions, exponential functions, binary and decimal numbers.

Basics of physical chemistry:

Physical quantities- moles, mole fraction, normality, molality, molarity, formality, equivalent weight, molecular weight and their determination, SI units and derived units.

Kinetic molecular theory:

Ideal and non-ideal gases, laws of gases, the kinetic molecular model, expressions for the pressure of gas, molecular velocities and their relations, mean free path, collision diameter, collision number.

### Recommended Books:

1. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
2. Pradeep's Inorganic Chemistry, K. K. Bhasin, Pradeep Publication.
3. Chemistry for Degree Students, R. L. Madan, S. Chand Publishing.
4. Organic Chemistry, M. K. Jain, Shoban Lal & Co.
5. Pradeep's Organic Chemistry, S. N. Dhawan, Pradeep Publication.
6. Physical Chemistry, Puri Sharma & Pathania.
7. Pradeep Physical Chemistry, Khetrpal, Pradeep Publication.