

Chemistry Department, University of Lucknow, Lucknow
M.Sc.(Pharmaceutical Chemistry) UNDER CBCS (with effect from 2015 onwards)
Theory and Practical papers in each semester

M.Sc. (Pharmaceutical Chemistry) Semester-I

Paper	Title of the paper	Hrs	Credit	Int. Ass.	Uni. Exam.	Marks
Paper-I	PH1CO1: Physical Chemistry	52	4	30	70	100
Paper-II	PH1CO2: Organometallic and Nuclear Chemistry	52	4	30	70	100
Paper-III	PH1CO3: Organic Chemistry	52	4	30	70	100
Paper-IV (Elective)	Physical-Inorganic Chemistry	40	3	30	70	100
Paper-V	PH1PO1 and PH1PO2: Laboratory courses	104	8	-	200	200

M.Sc. (Pharmaceutical Chemistry) Semester-II

Paper	Title of the paper	Hrs	Credit	Int. Ass.	Uni. Exam.	Marks
Paper-I	PH2CO4: Pharmacology and drug design	52	4	30	70	100
Paper-II	PH2CO5: Pharmacognosy	52	4	30	70	100
Paper-III	PH2CO6: Chemistry of Natural Products and Biomolecule	52	4	30	70	100
Paper-IV (Elective)	Principles of Organic Chemistry	40	3	30	70	100
Paper-V	PH2PO3 and PH2PO4: Laboratory courses	104	8	-	200	200

M.Sc. (Pharmaceutical Chemistry) Semester-III

Paper	Title of the paper	Hrs	Credit	Int. Ass.	Uni. Exam.	Marks
Paper-I	PH3CO7: Spectroscopic Methods in Pharmaceutical Chemistry	52	4	30	70	100
Paper-II	PH3CO8: Medicinal Chemistry I	52	4	30	70	100
Paper-III	PH3CO9: Medicinal ChemistryII	52	4	30	70	100
Paper-IV (Elective)	Organic Chemistry	40	3	30	70	100
Paper-V	PH3PO5 and PH3PO6: Laboratory courses	104	8	-	200	200

M.Sc. (Pharmaceutical Chemistry) Semester-IV

Paper	Title of the paper	Hrs	Credit	Int. Ass.	Uni. Exam.	Marks
Paper-I	PH4CO10: Biochemistry and Bacteriology	52	4	30	70	100
Paper-II	PH4CO11: Analytical Chemistry	52	4	30	70	100
Paper-III	PH4CO12: Pharmaceutical Training	3 to 4 months	4	-	100	100
Paper-IV (Elective)	Green Chemistry	40	3	30	70	100
Paper-V	PH4PO7 and PH4PO8: Laboratory courses	104	8	-	200	200

M.Sc. Pharmaceutical Chemistry
University of Lucknow

Programme Outcomes

- PO-1. Learn, demonstrate, solve and understand the major concepts of domains of Pharmaceutical 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 assist the candidates to pursue their career in various disciplines of pharmaceutical industry. Also, the willing students can endeavour their career in research and development program by registering themselves in Ph.D. program in different Universities as well as the CSIR Labs of national importance. After proper exposure during internship candidates can impart their knowledge in developing themselves as entrepreneur to develop a start-up.

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's 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 Semester I

Paper I, PH1CO1: Physical Chemistry

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

- CO-1. To know and understand that how living organism acquires and transforms energy in order to perform biological work.
- CO-2. To understand how enzyme catalysis increases reaction rates without altering the the chemical equilibrium.
- CO-3. To become familiar with Langmuir theory, BET theory and their uses, Zeta potential Electrokinetic phenomenon, Donnan equilibrium, Primary and Secondary salt effects.
- CO-4. To know the latest techniques which are used in determining the fast reactions.

M.Sc. Pharmaceutical Chemistry Semester I

Paper II, PH1CO2: Inorganic Chemistry

(Organometallic and nuclear Chemistry)

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

In this semester students shall learn:

- CO-1. the reaction mechanism and vibrational properties associated with inorganic coordination complexes which now-a-days are gaining importance as
 - Homogenous catalysts
 - Electron transfer agents
 - Sensors to detect ions as well as molecules such as nitroaromatic compounds a noxious compound utilized as an ingredient in explosives
 - Sensitizers in new-generation solar cells
- CO-2. about the design of different highly reactive but potent organometallic compounds. This information can be a stepping stone to such students who are willing to excel themselves in industries in particular dealing with pharma sector.
- CO-3. To recognize the importance of inorganic molecules in supporting organic biological systems.
- CO-4. about how metal ions function as catalytic and structural centers in biological systems.
- CO-5. about the metal ion transport and storage within cells and how any malfunction can result in various diseases.
- CO-6. To gain insight into cutting edge developments that utilizes metal ions for medical purposes.
- CO-7. To develop an appreciation for the structure and function of metal ions in the biological systems and how chemists aim to mimic them.
- CO-8. to recognize the metal used for diagnosis and chemotherapy.

M.Sc. Pharmaceutical Chemistry Semester I

Paper III, PH1CO3: Organic Chemistry

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

- CO-1. To learn different applications of physical organic chemistry like Energy profiles, control on product formation, Hammond postulate, kinetic isotope effects, Linear free energy relationship, Hammett and Taft equation.
- CO-2. To gain the knowledge about synthetic and modern Synthetic Methods.
- CO-3. To learn the mechanism of oxidation and reduction and the reagents used in these reactions.
- CO-4. To learn about different types of reduction reactions.

- CO-5. To learn molecular orbital symmetry and possibility of thermal and photochemical pericyclic reactions.
- CO-6. To predict conformational analysis and its effect on organic reactivity, stereoselective and stereospecific synthesis.
- CO-7. To gain the knowledge and learn chiral drug synthesis.

M.Sc. Pharmaceutical Chemistry Semester I
PH1PO1 and PH1PO2- Laboratory courses

Credits 8 **MM: 200 (150+50)** **Hours 104 (80+24)**

Course Outcome:

- CO-1. After completion of degree, students will gain the theoretical as well as practical knowledge of handling chemicals.
- CO-2. Students will gain an understanding of:
- a. the distinction between qualitative and quantitative chemical analysis.
 - b. how to calculate a limiting reagent, yield, and percent yield.
- CO-3. students should be able to explain and perform the theoretical principles and important applications of classical analytical methods within titration (acid/base titrations, complexometric titration, redox titration) and various techniques of gravimetric and volumetric analysis.
- CO-4. students should be able to check the purity of organic molecules by the use of TLC and how to calculate their R_f values.
- CO-5. Also, students will be able to understand how to maintain a detailed scientific notebook.

Project and Seminar Presentation

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.

Elective paper I

M.Sc. Pharmaceutical Chemistry Semester I
Physical-Inorganic Chemistry

Credits 3 **MM = 100 (70+30)** **Hours 40**

Course Outcome:

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

- CO-1. Molecular symmetry and various symmetry operations of molecules.
- CO-2. Transition metal chemistry.
- CO-3. Concepts of Hybridization and V.B Theory of inorganic molecules and transition metal complexes.
- CO-4. Chemical statistical thermodynamics.

M.Sc. Pharmaceutical Chemistry Semester II

Paper I, PH2CO4

Pharmacology and Drug Design

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

CO-1. To learn and understand the biological response to drugs, their passage across membranes.

CO-2. To understand how drugs are absorbed, distributed, metabolized and excreted.

CO-3. To learn Dose of drugs and routes of administration.

CO-4. To understand basic classification of drugs and their mechanism of action.

CO-5. To understand the concept of Prodrug and soft drug.

CO-6. To learn and know about the structure and synthesis of various drugs e.g. General anaesthetics, Hypnotics, sedatives, Anticonvulsants, Antipyretics and NSAIDs and Centrally acting muscle relaxants.

CO-7. To understand drug designing and development, their SAR and QSAR.

CO-8. To understand mode of action of different drugs.

M.Sc. Pharmaceutical Chemistry Semester II

Paper II, PH2CO5

Pharmacognosy

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

CO-1. To understand Pharmacognosy of drugs and their use in pharmacy.

CO-2. To learn about Fixed oils and essential oils.

CO-3. To learn and understand the substances used as pharmaceutical necessities e.g. Starches, Gum Acacia, Gum Tragacanth, Agar Agar, Gelatin, Talc, Kaolin. Bentonite.

CO-4. To study metallic compounds used in pharmaceutical chemistry and their toxicity.

CO-5. To learn Pharmaceutical Legislation in India.

M.Sc. Pharmaceutical Chemistry Semester II

Paper III, PH2CO6

Chemistry of natural products and biomolecules

Credits 4

MM = 100 (70+30)

Hours 52

This course gives students the ability:

CO-1. To gain knowledge about the synthesis and structure elucidation of steroids.

CO-2. To learn about the basic classification and role of alkaloids and structure elucidation, stereochemistry and degradation of alkaloids.

CO-3. To learn about classification, role and importance of Vitamins.

CO-4. To learn about structure and synthesis Anthocyanins and carotenoids and their importance.

M.Sc. Pharmaceutical Chemistry Semester II

PH2PO3 and PH2PO4-Laboratory courses

Credits: 8

MM: 200 (150+50)

Hours 104 (80+24)

Course Outcome:

CO-1. Students will be able to demonstrate ability to plan and strategize a scientific problem, and implement it within a reasonable time frame.

CO-2. The students will become familiar about the inorganic coordination compounds and transition elements will also be able to prepare various inorganic complexes.

CO-3. Students will be able to understand methods for separation and purification of organic compounds and chromatographic techniques for their separation.

CO-4. Students will understand how to recrystallize the organic compounds.

- CO-5. Students will be able to perform two step organic preparations involving different organic reactions such as Acetylation, Oxidation, Grignard reaction, Aldol condensation, Sandmeyer reaction etc.

Project and Seminar Presentation

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.

Elective paper II

M.Sc. Pharmaceutical Chemistry Semester II

Principles of Organic Chemistry

Credits 3

MM = 100 (70+30)

Hours 40

Course Outcome:

After completion of the course, the students will acquire 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. Electronic effects operates in covalent bonds, Types of Reactions and different types of Intermediates formed during the reactions.
- CO-3. Mechanisms of all types of organic reaction involving different reaction intermediates.
- CO-4. Stereochemistry of organic compounds.

M.Sc. Pharmaceutical Chemistry Semester III

Paper I, PH3CO7

Spectroscopic Methods In Pharmaceutical Chemistry

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

- CO-1. To learn to apply various spectroscopic techniques.
- CO-2. To understand the instrumental techniques terms used in various spectroscopy and interpret spectra and how to determine the structure of organic molecules using NMR, ¹³C NMR, Mass, UV and IR spectroscopic techniques.
- CO-3. To learn an understanding of the theory and applications of the most methods of pharmaceutical analysis (NMR spectroscopy, mass spectrometry etc.)

M.Sc. Pharmaceutical Chemistry Semester III

Paper II, PH3CO8

Medicinal Chemistry I

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

- CO-1. To understand the basic classification of drugs.
- CO-2. To learn and know about the structure and synthesis of various drugs e.g. Antihypertensive β -blockers, diuretics, antianginal, anticoagulants and antilipidemic agents.
- CO-3. To understand mode of action of different drugs.

CO-4. To understand and apply knowledge about recent developments in medicinal chemistry.

M.Sc. Pharmaceutical Chemistry Semester III
Paper III, PH3CO9
Medicinal Chemistry II
MM = 100 (70+30)

Credits 4

Hours 52

Course Outcome:

This course gives students the ability:

- CO-1. To learn the synthesis of various drugs and understand their mode of action.
- CO-2. To understand and apply knowledge about recent developments in medicinal chemistry.
- CO-3. To understand the structure and SAR of various drugs e.g. Antineoplastic Agents , Cardiovascular, Local Antiinfectives, Psychoactive drugsetc.
- CO-4. To know the structure, SAR of antibiotics and their use.

M.Sc. Pharmaceutical Chemistry Semester III
PH3PO5 and PH3PO6 Laboratory courses

Credits: 8

MM: 200 (150+50)

Hours 104 (80+24)

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.

Project and Seminar Presentation

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.

Elective paper III

M.Sc. Pharmaceutical Chemistry Semester III
Organic Chemistry

Credits: 3

MM = 100 (70+30)

Hours 40

Course Outcome:

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

- CO-1. Generation, reactivity and named reactions involving carbanions.
- CO-2. Chemistry of carbocations and named reactions involving carbocations.
- CO-3. Radical generation and named reactions involving this intermediate.
- CO-4. Different reactions of carbonyl compounds.

M.Sc. Pharmaceutical Chemistry Semester IV

Paper I, PH3CO10

Biochemistry and Bacteriology

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

CO-1. To understand the structure of Amino acids and Proteins.

CO-2. To know about the classification and the Biological functions of proteins and peptide drugs.

CO-3. To understand the structure and functions the Purine and pyrimidine bases

CO-4. To know about the nucleosides, nucleotides.

CO-5. To know the classification of enzymes.

CO-6. To understand biological oxidation and metabolism.

CO-7. To know Lipid metabolism, Blood Composition and Acid Base Balance, Blood groups.

CO-8. To understand renal function and formation and composition of urine.

M.Sc. Pharmaceutical Chemistry Semester IV

Paper II, PH3CO11

Analytical Chemistry

Credits 4

MM = 100 (70+30)

Hours 52

Course Outcome:

This course gives students the ability:

CO-1. To learn titrimetric and gravimetric methods of analysis.

CO-2. To understand the principles of the most important liquid and gas chromatography.

CO-3. To develop skills in procedures and various instrumental methods applied in analysis tasks.

CO-3. To understand about the principle and methodology of Adsorption and partition chromatography, Column, Paper, Thin Layer Chromatography.

M.Sc. Pharmaceutical Chemistry Semester IV

Paper III, PH3CO12

Pharmaceutical Training

Credits 4

MM = 100

Course Outcome:

CO-1. To witness the entire work area of the pharmaceuticals.

CO-2. To understand the nature of job.

CO-3. To identify the RD procedures and technical skills involved.

CO-4. To understand the complete mechanism of the reactions involved in the manufacturing areas at different sectors.

CO-5. To correlate the manufacturing procedures with simple laboratory synthesis.

CO-6. To prepare a final evaluation report and presentation for the internship carried out for 90 to 100 days.

M.Sc. Pharmaceutical Chemistry Semester IV

PH4PO7 and PH4PO8 Laboratory courses

Credits: 8

MM: 200 (150+50)

Hours 104 (80+24)

Course Outcome:

After the completion of the course the student will be able to:

CO-1. perform three step preparation of drugs and drug intermediates.

CO-2. Purify the synthesized compounds by crystallization.

CO-3. Perform chromatographic technique to check completion of reaction.

CO-4. different types of chromatographic techniques and their operating principles also the instrumentation required for various separation techniques.

CO-5. to characterize organic molecules by physical and spectroscopic means including UV, IR, ^1H & ^{13}C -NMR and Mass Spectroscopy.

Project and Seminar Presentation

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. Also, students will be able to interpret the spectral data independently.
- CO-4. Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.

Elective paper IV

M.Sc. Pharmaceutical Chemistry Semester IV

Credits 3

MM = 100 (70+30)

Hours 40

Course Outcome:

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

- CO-1. The principles of green chemistry, green organic synthesis and use of green chemistry in pharmaceutical industry.
- CO-2. Photochemistry of carbonyl compounds and alkenes.
- CO-3. All types of thermal and photochemical pericyclic reactions.
- CO-4. Elimination reactions.