**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 softwareôs 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 SRUCTURE

| Semeste | 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 Credi | No. of Paper | Credits (L+T/P | Total Credits | No. of Papers | Credi | |
| 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 C | | | 80 | | | 8 | | | 4 | | 4 | 96 |

**Semester-II**

| Paper Code | Title of the paper | Credits | Int. Ass. | Uni. Exam. | Marks |
|---|---|---|---|---|---|
| CCTP-5 | PC-201: Pharmacology and Drug Design | 4 | 30 | 70 | 100 |
| CCTP-6 | PC-202: Pharmacognosy | 4 | 30 | 70 | 100 |
| CCTP-7 | PC-203: Chemistry of Natural Products and Biomolecules | 4 | 30 | 70 | 100 |
| CCTP-8 | PC-204: Project and Seminar Presentation | 4 | - | - | 100 |
| CCPP-3<br>CCPP-4 | PC-205A: Inorganic Chemistry Practical<br>PC-205B: Organic Chemistry Practical | 8 | Continuous Evaluation | - | 200 |
| Value Added (Non Credited) (Inter Department) | *CH-205A: Science and Technology of Cosmetics<br>Or<br>*CH-205B: Bioethanol as Biofuel | - | - | - | - |
| | Total | 24 | | | 600 |

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

***Value Addition Courses (both Credited and Non Credited)**

The offered courses shall be announced by the Head, Chemistry Department in the beginning of session every year-

| | | | |
|---|---|---|---|
| Green Chemistry | Boron Chemistry and application to Cancer Treatment | Analgesics and Antipyretics | Narcotics and drug abuse |
| Bioethanol as Biofuels | Carbon dating | Science and Technology of Cosmetics | Pesticides and Insect repellents |
| Separation Techniques | CFCs and the Environment | Chemistry of Paints | Computational Chemistry |
| Nanochemistry | Chemistry of Explosives | Chemistry of Diamonds | Medicinal Application of Iodine & Radium |
| Drugs from Indian Medicinal Plants | Developments in Organic Synthesis | Water Chemistry | Lubricants |
| | | Chemical Dyes | Essential Oils and Perfumes |
| Chemistry of Alcohols | | | |

**M.Sc. Pharmaceutical Chemistry Semester II Syllabus**
**Paper Code CCTP-5: Pharmacology and Drug Design (PC-201)**
**Credits 4 MM 100 (70+30) Hours 60**

**Course Outcome:**

CO-1. It makes the student aware of absorption, distribution metabolism, excretion of drugs, mechanism of drug structure and the adverse response of drug.

CO-2. The chapters of drug therapy explain the various parameters involved in making the drug reach the site of action. Various methods involved in increasing the solubility of drug (Prodrug concept).

CO-3. The chapter on drug action on CNS explains various category of anaesthetic, hypertensive, sedatives, hypnotics and their mode of action. Synthesis of various drugs of this category also explained.

CO-4. The antipyretic chapter gives accounts of various drugs involved in controlling fever and their mode of action.

**Unit I**

General principles of pharmacology: Pharmacokinetic principles: absorption, distribution, metabolism and excretion of drugs. Dose of drugs and routes of administration.
Pharmacodynamic principles: dose response relationships, mechanism of drug action, unusual and adverse responses of drugs, structurally specific and nonspecific drugs. Fergusonôs principle.
Drug interactions-synergism, antagonism, drug addiction and drug dependence, drug tolerance, drug hypersensitivity.

**Unit II**

General Principles of Drug Therapy. Relationship between chemical structure, lipid solubility and biological activity of drugs. Stereochemistry and biological activity.
Drug action-receptor theories. Drug metabolismï different pathways.
Drug design: various factors of drug design, rational drug design. Methods of lead discovery: optimisation of the lead, natural and synthetic sources of lead compounds.
Bioisosterism. Prodrug and soft drug concept. Drug synthesis.
Combinatorial synthesis (basic concepts). Retrosynthetic analysis of benzocaine, saccharin, salbutamol and benzodiazepines.

**Unit III**

Drugs acting on CNS
General anaesthetics. Inhalation anaesthetics - ether, enflurane, halothane, nitrous oxide, cyclopropane. Intravenous anaesthetics - thiopentone sodium, ketamine.
Hypnotics, sedatives and anxiolytic agents: -benzodiazepines, buspirone and meprobamate.
Anticonvulsants: convulsions, types of epilepsy, barbiturates-hydantoins, oxazolidinediones, succinimides.
Analeptics: xanthines, amphetamines, nikethamide and ethamivan.
Antiparkinsonôs agents: dopamine agonists, dopamine releasing agents and synthetic anticholinergics. Drugs for Alzheimerôs disease: cholinergic agonists and acetylcholine esterase inhibitors.

**Unit IV**

Synthesis of the following drugs - Enflurane, Ketamine,Etomidate, Phenobarbital, Diazepam, Chlordiazepoxide, Meprobamate, Buspirone, Ethinamide, Nikethamide, Ethamivan, Trimethadione,Ethosuximide, Denzimol, Topiramate, Mephenesin, Levodopa, Besiperidine and Tacrine.

Narcotic analgesics - morphine and its analogues, phenyl (ethyl) piperidines, diphenyl heptanones.

**Unit V**

Antipyretics and NSAIDs: Basic idea of COX I & II inhibitors, salicylatesaspirin, p-aminophenol derivatives-paracetamol, phenacetin, pyrazolidinedionesphenyl butazone, oxyphenbutazone, anthranilicacid derivatives-mefanamic acid, flufenamic acid, indoleacetic acid derivatives-indomethacin, arylacetic/propionic acid derivatives (ibuprofen, ketoprofen, flubiprofen and diclofenac), oxicams (piroxicam and tenoxicam).
Synthesis of the following drugs-levorphanol, pethidine, methadone, phenyl butazone, flufenamic acid, diclofenac, piroxicam, allopurinol and celicoxib.

**Recommended Books-**


1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson Education.
2. Medicinal Chemistry, AshutoshKar, 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 II Syllabus**
**Paper Code CCTP-6: Pharmacognosy (PC-202)**

**Credits 4** **MM 100 (70+30)** **Hours 60**

**Course Outcome:**

CO-1. It makes the students aware of various types of active compounds isolated from different plants and the biological importance of these active principles.
CO-2. The students are also made aware of fixed and essential oils isolated from natural sources and their importance.
CO-3. The students get insight about various pharmacopoeia, its importance in studying various parameters of drugs.
CO-4. The students are also made aware of various pharmaceutical legislature in India patents, etc.
CO-5. Students are made aware of various inorganic compounds used as drugs, their methods of preparation and properties.
CO-6. In addition heavy metal toxicity in environmental and in living organism is also explained.
CO-7. The use of various radioisotopes of metals and their use as diagnostic agents in the identification of various diseases.

**Unit I**

Pharmacognosy
Pharmacognosy of the official drugs frequently used in pharmacy: their sources and constituents. Eg:- senna, belladona, digitalis, stramonium, vasaka, cinnamon, cinchona, ergot, cannabis, ipecacuanha, rauwolfia, liquorice, ginger, cloves, pyrethrum, santonica, nutmeg, nuxvomica, cardamom, umbelliferous fruits like Cumin, Fennel, Caraway, Opium, Aloes, Asafoetida, Vinca rosea, Brammi ( two varieties).
Fixed oils and essential oil used in pharmacy-their sources. Extraction, constituents, composition analysis of fixed oils. Elementary study of adulteration of fixed oils.

**Unit II**

Fixed Oils: Castor oil, Olive oil, Shark liver oil.
Essential Oils: Eucalyptus oil, Turpentine oil.
A brief study of the substances used as pharmaceutical necessities ï Starches, Gum Acacia, Gum Tragacanth, Agar Agar, Gelatin, Talc, Kaolin. Bentonite.

**Unit III**

Metallic compounds used in pharmaceutical chemistry: Calcium lactate, calcium gluconate, iron gluconate, iron fumerate, ferric ammonium citrate, ferrous sulphate, aluminium hydroxide gel, calamin, zinc oxide, zinc stearate, magnesium stearate, talc, yellow mercuric oxide, trivalent and pentavalent antomonials, selenium sulfide, lithium salts, gold, platinum and bismuth compounds. Metal toxicity - cadmium, lead, copper and mercury.

**UNIT IV**

Pharmaceutical Legislation in India. Legal aspects of trade in drugs. The drug Act and Drug rules. The Pharmacy Act. The dangerous Drug Act and Rules. The Drugs and Cosmetic Act and rules
Introduction to Pharmacopeia B.P, I.P. and general standard analysis,
Intellectual Property Rights (IPR), Patents, Trademarks, Copy rights, Patent Actsrelevant sections (basic ideas only)

**Unit V**

Diagnostic Agents and Tests
Radiopaques - organo iodo compounds. Compounds used in function tests, dyes, radio isotopes, RIA, ELISA. Dyes used in pharmacy: fluorescein, mercurochrome, acridine dyes. Colouring agents: official colours, colour code. Liver and gastric function tests and kidney function tests.

**Recommended Books:**


1. Pharmacognosy by Kokate, C.K A and Purohit, A.P
2. Pharmacognosy and Pharmacobiotechnology by Ashutosh Kar
3. Text book of Pharmacognosy by T.E.Wallis
4. Gokhale, S. B., Kokate, C. K. and Purohit, A. P. 2003. Pharmacognosy, Nirali Prakashan Publishers, Pune, India.
5. Singh, V. K., Govil, J. N. and Singh, G. 2002. Recent progress in Medicinal Plants: Vol 1 Ethnomedicine and Pharmacognosy. SCI Tech Publishing, LLV, USA.
6. NIIR Board of Consultants & Engineers, 2004. Drugs & Pharmaceutical: Technology and Hand book, Asia Pacific Business Press Inc. Delhi, India.


**M.Sc. Pharmaceutical Chemistry Semester II Syllabus**
**Paper Code CCTP-7: Chemistry of Natural Products and Biomolecules (PC-203)**
**Credits 4 MM 100 (70+30) Hours 60**

**Course Outcome:**

CO-1. The course content would help students to learn about various category of steroid, classification, nomenclature and various types present in the human body an there function.
CO-2. The student would also learn about various reaction involved in steroid chemistry and also their structure elucidation. The chapter also makes the student aware of synthesis of various steroid hormones.

CO-3. The alkaloid chapter would make the student aware of various categories of alkaloid, their importance and their structure elucidation. Students will also learn about steps involved in synthesis of few alkaloids.
CO-4. The chapter of vitamins gives insight in to the importance, structure and their synthesis.
CO-5. The chapter on natural colouring species gives emphasis on the anti-oxidant activity these compounds and their uses. Synthesis of these compounds was also emphasized.

**Unit I**

Steroids: classification and nomenclature of steroids. Reactions, structure elucidation, stereochemistry and biosynthesis of cholesterol. Structure and semi synthesis of steroid hormones-testosterone, estrogen and progesterone. Biosynthesis of steroids.

**Unit II**

Alkaloids: General methods of structure elucidation of alkaloids. Structure elucidation and synthesis of papaverine, quinine and morphine. Stereoselctive synthesis of reserpine. Biosynthesis of alkaloids.

**Unit III**

Vitamines: classification, structure and synthesis of vitamins A, C, B1 and B2.

**Unit IV**

Antibiotics: structure determination of pencillins and cephalosphorins, synthesis of pencillins and chloramphenicol. A brief study of macrolide antibiotics, aminoglycoside antibiotics, polyene antibiotics, fluoroquinolones.

**Unit V**

Natural colouring species: anthocyanins and carotenoids, structure and synthesis of cyanin, flavone, quercetine and ɓ-carotene.

**Recommended Books:**


1. Chemistry of Natural Products, Sujata V. Bhat, B.A. Nagasampagi, MeenakshiSivakumar, Springer.
2. The Chemistry of Natural Products, R.H. Thomson, Springer.
3. Bioactive Natural Products: Chemistry and Biology, GoutamBrahmachari, Wiley india Pvt. Ltd.
4. Organic Chemistry Vol. II, I.L. Finar, Pearson Education India.
5. 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.
6. 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 II Syllabus**
**Paper Code CCTP-8: Project and Seminar Presentation (PC-204)**
**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 II Syllabus**
**Paper Code CCPP-3, CCPP-4: Practical (PC-205A, PC-205B)**
**Credits 8 (4+4) MM: 200 (100+100)**

**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 chromatographaphic 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.

**PC-205A: INORGANIC CHEMISTRY**
Synthesis of
(a) $Ni(DMG)_2$
(b) $Hg[Co(CSN)_4]$
(c) Cis- and trans-$[Cu(gly)_2]$
(d) $[Ni(PPh_3)_2Cl_2]$
(e) $[Ni(PPh_3)(SCN)_2]$
(f) $[Al(acac)_3]$

General methods of separation and purification of organic compounds such as:
1. Solvent extraction
2. Fractional crystallization
3. TLC and Paper Chromatography
4. Column Chromatography

**PC-205B: ORGANIC CHEMISTRY**
Two steps synthesis involving-
Acetylation
Oxidation
Grignard reaction
Aldol condensation
Sandmeyer reaction
Acetoacetic ester Condensation
Cannizaro reaction

Friedel Craft reaction
Aromatic Electrophilic Substitution

**Recommended Books:**


1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.
3. Sethi, Arun., Systematic Lab Experiments in Organic Chemistry, New Age International Publisher.
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
5. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).


## M.Sc. Pharmaceutical Chemistry Semester II Syllabus
## Value Added (Non Credited)
## Science and Technology of Cosmetics (CH-205A)
## Hours 50

**Course outcomes:**

CO-1. This course allows students to understand and learn about the chemistry of cosmetics.
CO-2. More specifically, this course aims to introduce the scientific aspects such as chemical, physical and biological functions of different ingredients present in the cosmetics.
CO-3. This course also gives information about the formulation and technology of cosmetics

### Unit I

Basic concept of Cosmetics. Classification of cosmetic products for skin, hair and oral care. Forms of cosmetics and their suitable examples: Solutions, creams, lotions, ointment, paste, gels, sticks, tablets, capsules, powders and aerosols.

### Unit II

Cosmetic Ingredients and Classifications: Water, Surfactants, Foaming agents, Emulsifiers, and Solubilizers, rheological additives, Antioxidants, Antimicrobial and Chelating agents used as preservatives.

### Unit III

Perfume: Classification of perfumes, Perfume ingredients
Colour Cosmetics: Building block and formulation of Lipsticks, mascara, and nail polish
Hair conditioner: Building blocks and formulation of Hair conditioners, hair oils, hair dye
Herbal cosmetics

### Unit IV

Use of nanotechnology in cosmetics, suspensions, creaming, cracking and phase inversion
Micrometrics: Methods of determining particle size, optical microscopy, sieving, sedimentation measurements
Powders: porosity, densities, bulkiness and flow properties.

### Unit V

Rheology of Cosmetics: Newtonian systems, law of flow, kinematic viscosity, effect of temperature on viscosity,
non-Newtonian systems ï Plastic, pseudoplastic and dilant system, thixotropy determination of viscosity,

**Recommended Books:**


1. Harryôs Cosmeticology ï Wilkinson, Moore, seventh edition, George Godwin.
2. Cosmetics ï Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
3. Drugs and Cosmetic act/rules by govt. of India Publication
4. Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard
5. Maibach, Marianne Mahieu Informa Healthcare USA, Inc.


## M.Sc. Pharmaceutical Chemistry Semester II Syllabus
## Value Added (Non Credited)
## Bioethanol as Biofuels (CH-205B)
## Hours 50

**Course outcomes:**

CO-1. This course allows students to understand and learn about the chemistry of bioethanol as biofuels.

CO-2. More specifically, this course aims to introduce the scientific aspects such as chemical, physical and biological transformation of carbohydrate into bioethanol, a renewable source of energy.

CO-3. This course also gives information about the formulation and technology used for production of bioethanol.

### Unit I

Biomass as energy resources - Classification and estimation of biomass - Source and characteristics of biofuels ï Biodiesel ï Bioethanol ï Biogas - Waste to energy conversions.

### Unit II

Renewable and non-renewable source of energy, bioethanol, bioethanol as oxygenated fuel,

### Unit III

Advantages of domestic production of bioethanol, conversion of carbohydrate to bioethanol using pretreatment, dilute and concentrated acid hydrolysis, enzyme hydrolysis and fermentation.

### Unit IV

Structure, function, configuration & conformation, reactions of glucose and its important derivatives; disaccharides (lactose, maltose and sucrose)

### Unit V

Polysaccharides ï structural polysaccharide (cellulose, lignocelluloses, chitin); storage polysaccharides (starch and glycogen).

**Recommended Books:**


1. Biological Functions of Carbohydrates (Tertiary Level Biology S), D.J. Candy
2. Essentials of Carbohydrate Chemistry, John F. Robyt
3. Bioethanol: Science and Technology of fuel alcohol, Graeme M. Walker