UNIVERSITY OF LUCKNOW
MASTERS OF PHARMACEUTICAL CHEMISTRY PROGRAMME
REGULATION 2020

Applicability

These regulations shall apply to the Masters in Pharmaceutical Chemistry programme from the session 2020-21.

2. Minimum eligibility for admission

A three/four years Bachelor's degree or equivalent with chemistry as one of the subject in final year awarded by University or Institute established as per law and recognized as equivalent by university with minimum 45% marks for general and OBC (SC/ST 40%) or equivalent grade shall constitute the minimum requirement for admission to the Masters in Pharmaceutical Chemistry Programme

3. Programme Objectives

i. To enable the students to understand the basic concepts of bio-inorganic, bio-organic, physical chemistry, analytical chemistry, drug formulation, drug design and development.
ii. To develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.
iii. To be able to use and apply professional softwares relevant to chemistry.
iv. To equip the students with the knowledge to develop Pharmaceutically important molecules, new drug delivery systems etc.
v. To learn the application of analytical tools for determination of organic molecules and to generate validation protocol for all pharmaceutical operations starting from drug research to development to formulation.
vi. To learn the Mechanism of Action of various class of drugs.
vii. To learn the brief overview of the use of various drugs in treatment of various diseases.

4. 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.

5. Programme Specific Outcomes

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.

6. Course Structure

The course structure of the Masters in Pharmaceutical Chemistry programme shall be as under.

Course No.	Name of the Couse	Credit	Remark
	Semester I		
PHCHCC-101	Physical Chemistry	**04**	**Core Course**
PHCHCC-102	Organometallic & Nuclear Chemistry	**04**	**Core Course**
PHCHCC-103	Organic Chemistry	**04**	**Core Course**
PHCHCC-104A PHCHCC-104B	Inorganic Chemistry Practical Organic Chemistry Practical	**08**	**Core Course**
PHCHVC-101	Separation Techniques	**04**	Value Added (Credited)
	Semester Total	**24**	
	Semester II		
PHCHCC-201	Pharmacology and Drug Design	**04**	**Core Course**
PHCHCC-202	Pharmacognosy	**04**	**Core Course**
PHCHCC-203	Chemistry of Natural Products and Biomolecules	**04**	**Core Course**
PHCHCC-204	Project and Seminar Presentation	**04**	**Core Course**
PHCHCC-205A PHCHCC-205B	Inorganic Chemistry Practical Organic Chemistry Practical	**08**	**Core Course**
PHCHVNC-201	Science and Technology of Cosmetics	**00**	Value Added (Non Credited)
	Semester Total	**24**	
	Semester III		
PHCHCC-301	Project and Seminar	**04**	**Core Course/** MOOC
PHCHCC-302	Pharmaceutical Chemistry Practical	**04**	**Core Course**
PHCHEL-302	Spectroscopic Methods in Pharmaceutical Chemistry	**04**	**Elective Course**
PHCHEL-301A	Medicinal Chemistry-I	**04**	**Elective Course**
PHCHEL-301B	Medicinal Chemistry-II		
PHCHIN-301	Summer Training	**04**	Summer Training
PHCHIER-301	Concepts of Chemistry	**04**	Interdepartmental Course
	Semester Total	**24**	
	Semester IV		
PHCHCC-401	Advance Organic Chemistry Practical	**04**	**Core Course**
PHCHEL-401	Biochemistry and Bacteriology	**04**	**Elective Course**
PHCHEL-401A	Chemistry of Analgesics and Antipyretics	**04**	**Elective Course**
PHCHEL-401B	Bioethanol as Biofuel		
PHCHMT-401	Dissertation and Master Thesis	**08**	**Master Thesis**
PHCHIRA-401	Analytical Chemistry	**04**	Intradepartmental

Course No.	Name of the Couse	Credit	Remark
			Course
	Semester Total	**24**	
	GRAND TOTAL	**96**	

PHCH - Subject; PHCHCC - Core Course; PHCHVC – Value added (credited); PHCHVNC – Value added (non-credited); PHCHEL – Elective; PHCHIER – Interdepartmental course; PHCHIRA – Intradepartmental course

7. Course Outlines

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

Sem	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	12+8	20	0	0+0	0	0	0+0	0	1	4	24
II	5	16+8	24	0	0+0	0	0	0+0	0	1	0	24
III	3	4+4+4	12	2	4+4	8	1	4+0	4	0	0	24
IV	2	4+8	12	3	4+4+4	12	0	0+0	0	0	0	24
Total Credits			68			20			4		4	96

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Semester-IV

Paper Code	Title of the paper	Credits	Int. Ass.	Uni. Exam.	Marks
PHCHCC-401	Advance Organic Chemistry Practical	**4**			
PHCHEL-401	Biochemistry and Bacteriology	**4**			
PHCHEL-401A **PHCHEL-401B**	Chemistry of Analgesics and Antipyretics Or Bioethanol as Biofuel	**4**			
PHCHMT-401	Dissertation and Master Thesis	**8**			
PHCHIRA-401 Intra-Departmental	Analytical Chemistry	**4**			
	Total	24			

PHCH - Subject; PHCHCC - Core Course; PHCHVC – Value added (credited); PHCHVNC – Value added (non-credited); PHCHEL – Elective; PHCHIER – Interdepartmental course; PHCHIRA – Intradepartmental course

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Core Course
Paper Code PHCHCC-401: Advanced Organic Chemistry Practical

Credits: 04

Course Objective:

The practicals have been designed in a way to enhance studentsô knowledge with respect to three-step synthesis of drug intermediates, their purification, use of different types of chromatographic techniques and characterization of organic molecules by spectroscopic methods.

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, ^{1}H & ^{13}C-NMR and Mass Spectroscopy.

Three steps synthesis of drugs and drug intermediates incorporating various name reactions.
Identification of organic compounds by using their spectral data (UV, IR, ^{1}H & ^{13}C-NMR and Mass Spectroscopy)

Recommended Books:

1. Vogel, A.I. A Textbook of Qualititative organic Analysis.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

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. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Elective Course
Paper Code PHCHCEL-401: Biochemistry and Bacteriology
Credits 4 **Hours 60**

Course Objective:
Students opting for this course will learn about the different mechanisms in living cells, about concepts of bioenergetics, genomics and DNA structure.

Course Outcome:
After the completion of the course the student will acquire the knowledge of-
CO-1. cell cycle, cell division and cell death mechanisms, the discovery of DNA as genetic material.
CO-2. exposure with the nature of various biomolecules present in living cells and also the amino acid and nucleotide sequences of proteins and DNA respectively.
CO-3. basic concepts of bioenergetics, mechanisms of oxidative phosphorylation and photophosphorylation., carbohydrate metabolism, blood sugar, diabetes.
CO-4. importance of lipids as storage molecules and as structural component of biomembranes.
CO-5. composition of blood cells, urine and acid base balance, the concepts of genomics, proteomics, metabolomics and their importance in human health.

Unit I
Amino acids, Proteins and Nucleic Acids: Cells-classification and cell division. Ramachandran plot and secondary structure of proteins. Tertiary structure and structural motifs-protein folding and domain structure of proteins. Quaternary structure of proteins. Purification and characterization of proteins. Functions of proteins. Chemical synthesis of proteins-protecting groups, solid phase peptide synthesis. DNA and RNA. Double helical structure of DNA. Replication of DNA. RNAclassification of RNA. Genetic code. Nucleic acids as carriers of genetic information. Protein biosynthesis.

Unit II
Enzymes and Hormones: Nomenclature and classification of enzymes. Mechanism of enzyme action.Substrate specificity of enzymes. Enzyme inhibition. Isoenzymes. Allosteric enzymes. Enzyme synthesis. Enzymes and digestion of food. Clinical uses of enzymes. Immobilization of enzymes. Clinical tests for sugar and cholesterol. ELIZA.
Functions and modes of actions of hormones. Pituitary, thyroid, parathyroid, pancreatic, adrenal and adrenocortical hormones. Male and female sex hormones.Antihormones.

Unit III
Biological Oxidation and Metabolism:ATP and ADP. Oxidative phosphorylation. Cytochromes. Food as a source of energy. Calorific value of food. Basal metabolism.Respiratory quotient. Carbohydrate metabolism: Glycogenesis and Glycolysis.

Blood sugar level. Cori cycle. The role of insulin. The citric acid cycle. Genetic and metabolic disorders. Diabetes mellitus (type 1 and type 2).

Unit IV

Lipid metabolism. Lipaemia. Oxidation of fatty acids. Ketogenesis and ketosis. Biosynthesis of fatty acids. Essential fatty acids.
Prostaglandins-nomenclature, structure and biosynthesis.
Metabolism of amino acids and proteins. Oxidative deamination and trans amination reactions. Urea formation-ornithine cycle. Inborn errors of metabolism.

Unit V

Blood Composition and Acid Base Balance: Blood groups-Rh factor. Blood transfusion. Composition of blood cells.Chemistry of haemoglobin. Anaemias. Plasma proteins. Blood clotting- factors and mechanism. Coagulants.
Regulation of acid base balance. Acidosis and alkalosis. Renal functionformation and composition of urine.
DNA fingerprinting technique. Elementary principles of Recombinant DNA technology, gene therapy, cloning and bioinformatics.

Recommended Books:

1. D.L. Nelsen, M.M. Cox, Lehninger Principles of Biochemistry, 5 th Edn., W.H. Freeman, 2008.
2. J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemistry, 5th Edn., W.H. Freeman, 2002.
3. A.J. Salle, Fundamental Principles of Bacteriology, Tata McGraw Hill, 1984.
4. Schaums Outline of Human Anatomy and Physiology, Third Edition (Schaums Outline Series)
5. Plants Physiology ï Lincoln Taiz and Eduardo Zeiger
6. Cell Biology ï 2010 ï Dr. C.B.Powar
7. Lehninger Principles of Biochemistry ï David L. Nelson and Michael M. Cox

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Elective Course
Paper Code PHCHEL-401A: Chemistry of Analgesics and Antipyretic

Credits 4 **Hours 60**

Course Objective:

To provide students coming in the first year of Masters program to learn about the recent development in the area of antipyretics and analgesics and also about the structure activity relationship which play pivotal role in drug development.

Course Outcome:

After completing the course, students shall be able to learn:

CO-1. the structural activity relationship of different class of drugs.
CO-2. the synthesis of drug molecules using the reactions of synthetic organic chemistry.
CO-3. well acquainted with the synthesis of some important class of drugs.
CO-4. the mechanism pathways of certain class of medicinal compounds and their modes of action with receptors.
CO-5. the chemistry of drugs with respect to their pharmacological activity.

Unit I

Introduction, classification, mode of action, structural activity relationship of narcotic analgesics and applications of the following:

1. Derivatives of morphin
2. Morphinan
3. phenylpiperidine
4. benzazocine
5. diphenyl propylamine and isosters.

Unit II

Introduction, classification, mode of action, structural activity relationship of narcotic antagonists and applications of the following:

1. n-allyl-nor morphine
2. Levellorphan
3. Naloxone

Unit III

Synthesis of the following narcotic analgesics and antagonists:

1. Phenylpiperidine
2. Benzazocine
3. Diphenyl propylamine
4. n-allyl-nor morphine
4. Levellorphan
5. Naloxone

Unit IV

Introduction, classification, mode of action, structural activity realationship of antipyretic analgesics and applications of the following:

1. Paracetamol
2. Asprin
3. Indomethacin
4. Diclophenac sodium
5. Ibuprofen
6. Piroxicam

Unit V

Synthesis of the following antipyretics:

1. Paracetamol
2. Asprin
3. Indomethacin
4. diclophenac sodium
5. ibuprofen
6. piroxicam

Recommended Books:

1. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed., Lippincott Williams & Wilkins, 2012.
2. Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013.
3. D. Sriram, P. Yogeeswari, Medicinal Chemistry, Pearson Education India, 2009.
4. Ashutosh Kar, Medicinal Chemistry, 4th Edition, New Age Publication.

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Elective Paper
Paper Code PHCHEL-401B: Bioethanol as Biofuels

Credits 04 **Hours 60**

Course Objective:
To provide students coming in the first year of Masters program knowledge about the transformation of carbohydrate products into alcohol which can form the basis of the development of bioethanol.

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

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Master Thesis
Paper Code PHCHMT-401: Dissertation and Master Thesis

Credits 08

Course Objective:

In the last semester of Masters, the main objective is the exposure of students towards project/dissertation is to elevate their understanding into the practical and experimental aspects of some targeted areas of chemistry. This course will develop their analytical ability and will provide them an apt exposure to work in any research group and will motivate them to execute research in the area of their interest in pharmaceutical sciences.

Course Outcome:

CO-1. To learn the procedure of identifying, approaching, applying and getting approval of internship from pharmaceutical companies.
CO-2. To witness the entire work area of the pharmaceuticals.
CO-3. To understand the nature of job.
CO-4. To identify the RD procedures and technical skills involved.
CO-5. To understand the complete mechanism of the reactions involved in the manufacturing areas at different sectors.
CO-6. To correlate the manufacturing procedures with simple laboratory synthesis.
CO-7. To learn the environment aspects, pollution, their control involved in the manufacturing unit.
CO-8. To prepare a final evaluation report and presentation for the internship carried out for 90 to 100 days.

3-4 Months training in any Pharmaceutical or Scientific laboratory. After the completion of training project report will be submitted, followed by its evaluation by presentation & viva-voce examination.

M.Sc. Pharmaceutical Chemistry Semester IV Syllabus
Intradepartmental Course
Paper Code PHCHIRA-401: Analytical Chemistry

Credits 04 **Hours 60**

Course Objective:

The main objective of the course is to give a better understanding of chemical method of analysis, types of titration. It also aims to provide knowledge about instrumentation required for various separation techniques.

Course Outcome:

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

CO-1. gain general basixs, principles and application of chemistry, assess and interpret the different properties of chemical method of analysis.
CO-2. types of titration, titration curve, the concentration of an acid or base that has been titrated to equivalence and different types of indicators.
CO-3. fundamental thermodynamics behind various separation methods like solvent extraction and select the operating conditions for various separation techniques.
CO-4. different types of chromatographic techniques and their operating principles also the instrumentation required for various separation techniques.

Unit I

Titrimetric and Gravimetric Methods of Analysis: General principles: Solvents in analytical chemistry, acid base equilibria, concentration systems, stoichiometic calculation, Quantitative analysis via functional group, spot tests. Bio-Assay: Quantitative assay of drugs by biological methods.Optical rotation, refractive index, atomic absorption, kinematic,Viscosity, pharmacokinetics.

Unit II

Acid-base titration, titration curves, acid base indicators, applications of acid-base titration, complexometric titration, metal-ion indicators, precipitation titration, Mohrôs titration, Volhardôs titration, adsorption indicators, Fajanôs titration, titration curves in oxidation-reduction titration, redox indicators, applications of redox titrations.

Unit III

Separation Techniques ï I: (A) Solvent Extraction: Fundamental treatment, theoretical principle, classification, and factors favouring extraction,extraction equillibria, applications. Liquid ï liquid extraction, use of oxime. Ultra centrifugation, dithiazone - in extraction.
(B) Solid phase extraction and solid phase micro extraction, applications.
(C) Ion- Exchange: Theories, use of synthetic ion exchange in separation, chelating ion exchange resins, liquid ion exchangers, experimental technique.

Unit IV

Separation Techniques ï II:An introduction to chromatographic methods, paper, thin layer and column chromatography, theory of chromatography, classification of chromatographic techniques, retention time, relationship between retention time and partition coefficient, the rate of solute migration,
differential migration rates, band broadening & column efficiency, kinetic variables affecting band broadening (No mathematical derivation), Electrophoresis and capillary electrophoresis.

Unit V

GC, LC and HPLC:Instrumentation of GC, LC and HPLC, applications in qualitative and quantitative analysis, comparison of GC and HPLC,Ion chromatography, pyrolytic gas chromatography, size exclusion chromatography, super critical fluid chromatography, affinity chromatography. Column matrices. Detectors. Affinity and chiral columns.

Recommended Books:

1. Introduction to instrumental analysis by R. D. Braun, MC. Graw Hill- International edition.
2. Analytical spectroscopy by Kamalesh Bansal- First edition.
3. Instrumental methods of chemical analysis by Willard, Dean and Merittee- Sixth edition.
4. Analytical chemistry principles by John H. Kenedey- Second edition, Saunders college publishing.
5. Spectroscopic identification of organic compounds Fifth Ed., Silvestrine, Bassler, Morrill, John Wiley and sons.
6. Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley ï VCH 7) Vogelôs Textbook of quantitative Chemical Analysis, sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
7. Instrumental methods of analysis. Willard Merrit, Dean and Settle, , 6th Edition, CBS Publisher, 1986.