



**UNIVERSITY OF RAJASTHAN
JAIPUR**

SYLLABUS

**M.A./M.Sc. PHARMACEUTICAL
CHEMISTRY**

(ANNUAL SCHEME)

M.A./M.Sc. (Previous) Examination 2020

M.A./M.Sc. (Final) Examination 2021

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University of Rajasthan
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Syllabus : M.Sc. Pharmaceutical Chemistry

M.Sc. PHARMACEUTICAL CHEMISTRY

(Two Year Course)

Paper, Course No., Course, Duration of Exam., Max. Marks & Min. Marks

M.Sc. I YEAR (PREVIOUS)

| Paper | Course No. | Course | Duration Hours | Max. Marks | Min. Marks |
|-----------|------------|--|----------------|------------|------------|
| Paper-I | PHC-1 | Instrumental Techniques for Chemical Analysis | 3 | 100 | 36 |
| Paper-II | PHC-2 | Basics of Computers | 3 | 50 | 18 |
| Paper-III | PHC-3 | Bio-inorganic/Biophysical /Bio-organic Chemistry | 3 | 100 | 36 |
| Paper-IV | PHC-4 | Organic Chemistry | 3 | 100 | 36 |
| Paper-V | PHC-5 | Pharmaceuticals-I and Toxicology | 3 | 100 | 36 |
| Paper-VI | PHC-6(A) | Mathematics for Chemists* | 3 | 50 | 18 |
| | | or | | | |
| | PHC-6(B) | Biology for Chemists** | | | |
| Practical | | | 14hrs | 200 | 72 |

* For students without Mathematics in B.Sc.

Total Marks : 700

** For Students without Biology in B.Sc.

M.Sc. II YEAR (FINAL)

| Paper | Course No. | Course | Duration Hours | Max. Marks | Min. Marks |
|------------|------------|--|----------------|------------|------------|
| Paper-VII | PHC-7 | Pharmaceutical Biotechnology | 3 | 100 | 36 |
| Paper-VIII | PHC-8 | Pharmaceuticals-II | 3 | 100 | 36 |
| Paper-IX | PHC-9 | Pharmaceutical Chemistry-I | 3 | 100 | 36 |
| Paper-X | PHC-10 | Pharmaceutical Chemistry-II | 3 | 100 | 36 |
| Paper-XI | PHC-11 | Chemical Engineering | 3 | 50 | 18 |
| Paper-XII | PHC-12 | Pharmaceutical Technology and Management | 3 | 50 | 18 |
| Practical | | | 14hrs | 200 | 72 |

Total Marks : 700

Grand Total (M.Sc. Previous & Final) : 1400

practicals the terminal examination will be held at the end of

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first year and second year respectively. The external assessment at the end of first year and second year will be of 14 hours duration spread over 2 days. The total marks allotted to practical is 200 each.

In theory each course has been subdivided into 5 units. There will be ten questions-two from each unit. The students are to attempt any five questions selecting at least one question from each unit.

- The number of papers and the maximum marks for each paper/practical shall be shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in the theory part as well as in practical part (wherever prescribed) of a subject/paper separately.
- A candidate for a pass at each of the Previous and the Final Examinations shall be required to obtain (i) atleast 36% marks in the aggregate of all the papers prescribed for the examination and (ii) atleast 36% marks in Practical(s) wherever prescribed at the examination, provided that if a candidate fails to secure atleast 25% marks in each individual paper at the examination and also in the dissertation/report/field work, wherever prescribed, he shall be deemed to have failed at the examination notwithstanding his having obtained the minimum percentage of marks required in the aggregate for the examination. No division will be awarded at the previous examination. Division shall be awarded at the end of the Final Examination on the combined marks obtained at the Previous and the Final Examination taken together, as noted below:
First Division 60% } of the aggregate marks taken
Second Division 48% } together of the Previous and the Final Examinations.

All the rest will be declared to have passed the examination.

- If a candidate clears any papers(s)/practical(s)/dissertation prescribed at the Previous and/or Final Examinations after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz. 25% (36% in the case of practical) shall be taken into account in respect of such paper(s)/practical(s)/dissertation are cleared after the expiry of the aforesaid period of three years; provided

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that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate.

- That Thesis/Dissertation/Survey Report/Field work shall be type written and submitted in triplicate so as to reach the office of the Registrar atleast 3 weeks before the commencement of the theory examinations. Only such candidates shall be permitted to offer Dissertation/Field Work/Survey Report/Thesis (if provided in the scheme of examination) in lieu of a paper as have secured atleast 55% marks in the aggregate of all the papers prescribed for the previous examination in the case of annual scheme irrespective of the number of papers in which a candidate actually appeared at the examination.
- In case of any clarifications or ambiguity the rules for university M.Sc. Chemistry annual scheme will be followed.

M.Sc. PHARMACEUTICAL CHEMISTRY

(2 Years Programme, Annual Scheme)

M.Sc. I Year (Previous)

PHC-I : Instrumental Techniques for Chemical Analysis

Time : 3 hours

Max Marks : 100

Unit-I

Ultraviolet-visible Spectroscopy: Introduction, energy of electronic excitations, absorption laws, chromophores and auxochromes, solvent effects on UV absorption, conjugated dienes, the Woodward Fieser rules for dienes, enones, UV spectra of polyenes, polynes, benzenoids, polynuclear aromatic hydrocarbons and heterocycles.

IR Spectroscopy : Introduction, force constants, stretching and bending modes, and their energy, absorption by various functional groups, finger print region, overtones, combination tones, Fermi resonance, factors influencing vibration frequencies, variation in the carbonyl frequencies, introduction to FTIR spectroscopy.

Unit-II

Nuclear Magnetic Resonance Spectroscopy: Introduction, equivalent and non-equivalent protons, chemical shifts, factors affecting chemical shifts, spin-spin coupling, splitting patterns (AX, AB, AMX, ABX), spin decoupling, deuterium labelling, chemical exchange, coupling constants (geminal, vicinal, long range), NOE, shift reagents

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¹³C NMR Spectroscopy: Introduction, ¹³C chemical shifts, off resonance spectra, ¹³C-¹H and ¹³C-¹³C coupling, introduction to FTNMR spectroscopy, interpretation of ¹³C spectra of simple molecules.

Unit-III

Mass Spectrometry: Electron impact line diagram of mass spectrometer, molecular ion peak, base peak, metastable ion, doubly charged ion, nitrogen rule, isotopic abundance and calculation of molecular formula, isotopic profile of halogen compounds, fragmentation patterns, simple cleavage, retro-Diels Alder cleavage, hydrogen transfer, rearrangement like scrambling, ortho effect, McLafferty rearrangement. Fragmentation pattern of simple aliphatic and aromatic compounds. Elementary idea of chemical ionization and negative ion mass spectrometry.

Unit-IV

ORD, CD, Octant rule, Cotton effect and their application in determination of stereo-structures, α -axial haloketone rule.

Spectrophotometry: Fundamental concepts, instrumentation for absorption measurement, applications of absorption spectroscopy to qualitative and quantitative analysis.

X-Ray Crystallography : Fundamental concepts, unit cells and Bravais lattices, Miller Indices, diffraction of X-rays by crystalline solids.

Unit-V

Simple structural problems based on UV, IR, ¹H NMR, ¹³C NMR and MS spectrometry.

Books Recommended

1. Spectroscopic Methods in Organic Chemistry, Williams and Fleming.
2. Organic Spectroscopy-An Introduction, Dyke, Floyd, Sainsbury and Thiobalt.
3. Spectroscopic Identification of Organic Compounds, Silverstein, Bassler and Morrill.
4. Organic Spectroscopy, William Kemp.
5. Stereochemistry of Carbon Compounds, N. Dasipuri.

PHC-2 : Basics of Computers

Max. Marks: 50

Unit-I

Time : 3 hours

Introduction to Computers: Characteristics, history, generation, classification, hardware, software, programming languages, computer architecture and I/O devices, secondary storage devices, networking, computer applications.

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Unit-II

Computer Organisation: Basics of primary memory and CPU, overview of number system; decimal, binary, octal and hexadecimal, representing real values, integer, and real arithmetic.

Unit-III

Introduction to MS-Office: MS-word, MS-excel, MS-Power Point, MS-access.

Unit-IV

Algorithm development: Problem analysis, flow chart, data flow diagram, fields, Vectors and files, searching, sorting and merging. Basic concepts of simulation.

Unit-V

Computer Programming in FORTRAN/BASIC : (The language features are listed here with reference to FORTRAN. The instructor may choose another language such as BASIC or C and the features may be replaced appropriately). Elements of the computer language. Constants and variables. Operations and symbols. Expressions. Arithmetic assignment statement. Input and output. Format statement. Termination statements. Branching statements such as IF or GO TO statement. LOGICAL variables. Double precision variables. Subscript variable and DIMENSION. DO statement. FUNCTION and SUBROUTINE. COMMON and DATA statements

Books Recommended :

1. Timothy J. O' Leary and Linda I. O'Leary: Computing Essentials. McGraw Hill Higher Education.
2. Peter Norton's Introduction to Computers, Third Edition, McGraw Hill.
3. R.K. Taxali: PC Software for Windows, Tata McGraw Hill.
4. Courter: Mastering Office 2000, Prentice Hall of India.
5. Ramon A. Mata-Toledo and Pauline K. Cushman: Introduction to Computer Science, McGraw Hill International Edition.
6. Mohapatra P.K.J., Mandal P., Bora M.C.: Introduction to System Dynamics Modelling, Universities Press (Indian) Ltd. 1994.

PHC-3. Bioinorganic, Bio-organic and Biophysical Chemistry

Max. Marks 100

Time : 3 hrs.

Unit-I

- (1) Role of bulk and trace metal ions in biological systems. Micronutrients, active transport of Na, K, Mg and Ca ions across the biological membranes, elements of bioenergetics with special reference to elements of high energy phosphate bond.

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- (II) Chlorophylls and their role in photosynthesis.
- (III) Haemoglobin & Myoglobin
- (IV) Iron storage and transport, Copper proteins
- (V) Metalloenzymes: General discussion of enzymes, functions of metal ions, inhibition (explanation based on coordination chemistry). Vitamin B₁₂ & B₁₂ coenzymes.
- (VI) Nitrogen fixation, its mechanism, nitrogenase, dinitrogen complexes as models for nitrogen fixation.
- (VII) Role of metals & non-metals in metabolism, metal & non-metals deficiency, toxicity, use of coordination compounds in medicine.

Unit-II Molecular Orbital Theory

Molecular Orbital Treatment of structure of hydrogen molecule and hydrogen molecule ion. Molecular orbitals of homo and hetero-nuclear diatomic molecules, correlation diagrams, self consistent field equation and molecular orbital energies. MO theory of polyatomic molecules of the type AX₂, AX₃, AX₄, AX₅, AX₆.

Details of Crystal Field Theory for weak and strong field complexes, comparison of VBT and CFT theories, Measurements of 10 Dq and factors affecting it. Thermodynamic aspects of crystal fields. Jahn - Teller effect, Complexes, of non cubic symmetry.

Unit-III

Brief review of laws of thermodynamics, concept of enthalpy, free energy, entropy, fugacity and activity, partial molar properties, chemical potential and their determination, thermodynamic function of mixing of free energy and mixing of entropy respectively. Formulation of equilibrium law, equilibrium constant and its variation with pressure and temperature, reaction isotherms and reaction isochores. Osmosis, osmotic pressure, thermodynamics of osmosis and the Donnan equilibrium.

The activities of ions in solution, the mean activity coefficient, Debye Huckel limiting law for calculating mean activity coefficients, significance of ionic strength in reactions.

The stability of colloids and the formation of micelles and critical micelle concentration, electrokinetic potential and electrical double layer in the stability of colloids, micellar catalysis and inhibition in simple first and second order reactions. Stability of biomolecules in solution, denaturation, methods of stabilization, lipid membrane confirmation and bioprocess applications, Corrosion, the type of corrosion, the rate of corrosion, inhibition of corrosion, passivity, corrosion control pourbiac diagram.

Unit-IV

Recaptulation of differential rate laws, rate constants and reaction order, integrated rate laws and their characteristics reaction approaching equilibrium, reversible, parallel and consecutive first order reactions, microscopic reversibility and detailed balance, mechanism of photochemical chain (H₂+Br₂) and oscillating reactions (B.Z. reaction)

Viscosity of a liquid, diffusion, Ficks law of diffusion, mobility of an ion, encounter pairs, diffusion controlled reactions in liquid, relaxation time for one step reaction, primary kinetic salt effect, diffusion and Brownian motion, kinetics of hydration of CO₂.

Unit-V

The growth and structure of surfaces, the extent of adsorption, physisorption and chemisorption, adsorption isotherms : Freundlich, Langmuir, BET isotherm and Temptkin isotherm thermodynamics of adsorption.

Rate of surface processes, catalytic activity at the surface, adsorption and catalysis, mechanism of surface reactions, catalyst support, catalyst preparation, kinetic parameter of heterogeneous catalytic reaction. Rates in homogeneous catalyst and acid base catalysis. Pharmaceutical applications of surface phenomenon. enzymes, purification, characteristics of enzymes, kinetics of enzyme catalysis and inhibition only for 1:1 enzyme-substrate system.

Books Recommended:

1. Physical Chemistry by P.W. Atkins, ELBS, Oxford University, 3rd Ed., 1986.
2. Thermodynamics for Chemists, S. Glasstone, Van Nostrand Co. I Princeton, N.J. 1946.
3. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Publications, New Delhi, 1996.
4. Chemical Kinetics, K.J. Laidler, Tata McGraw Hill, 1965.
5. Surface Chemistry, Adamson.
6. Physical Chemistry, Alberty.
7. Physical Chemistry, A. Martin, B.I. Waverly Pvt. Ltd. New Delhi, 1994.
8. Physical Chemistry, K.L. Kapoor, Vol I, II, III & IV.
9. Physical Chemistry, Puri, Sharma & Pathania.
10. Theory and Practice of Industrial Pharmacy, L. Lachman, H.A. Lieberman, J.L. Kanig, III Ed. Varghese Publishing House, Bombay, 1987.

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11. Bio-Inorganic chemistry by R.W. Hay, John Wiley & Sons
12. Inorganic Chemistry of Biological Processes by M.N. Hughes, John Wiley & Sons.
13. Bio-inorganic chemistry-An introduction, Vol. I & II by Eihrom Ochia, Allyn Bacon Inc.
14. Inorganic Chemistry, J.E. Huheey, Harper Row
15. Inorganic Biochemistry, Vol I & II by G.L. Eichrom, Elsevier.

PHC-4 : Organic Chemistry

Max. Marks : 100

Time : 3 hours

Unit-I

Concept of Aromaticity: Huckel's rule and its limitations, Benzenoid and non-benzenoid compounds, cyclopentadienyl anion, tropylium cation, sydnones, azulenes, annulenes, heteroannulenes, kekulene, catenanes, fullerenes (C₆₀), non-aromaticity versus antiaromaticity, homoaromaticity.

Methods of Determining Mechanisms: Mechanisms of esterification and hydrolysis reactions. Applications of Hammett and Taft equations with respect to structure and reactivity.

Structure, formation and proofs of participation in chemical reactions of the following:

1. Non-classical carbonium ions, neighbouring group participation
2. Carbenes
3. Nitrenes
4. Benzyne

Unit-II

Stereochemistry & Conformational Analysis: Concepts of chirality, recognition of symmetry elements and chiral structures, R-S nomenclature, Diastereoisomerism in acyclic Systems, optical activity without asymmetric carbon atom (allenes, spiranes and biphenyls).

Geometrical isomerism of olefins and oximes, E-Z nomenclature, Beckmann Transformation, analysis of simple cyclic (chair and boat) cyclohexanes and acyclic systems. Effects of conformation on reactivity in acyclic compounds and cyclohexanes. Interconversion of Fischer, Newman and Sawhorse projections.

Unit-III

Reagents in Organic Synthesis: N-Bromosuccinimide, SeO₂, Gilman's reagent, lithium diisopropylamide (LDA), Osmium tetroxide, dicyclohexylcarbodiimide, 1,3-dithiane (reactivity Umpolung), phase-transfer catalysis, Wilkinson's catalyst, Raney nickel, lead-tetraacetate, periodic acid, peracids, diazomethane, ozone.

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Unit-IV

Synthetic applications, mechanisms and stereochemistry (wherever applicable) of the following organic reactions and molecular rearrangements: Wolff-Kishner, Clemmensen, Birch, Meerwein-Ponndorf-Verley (MPV) reductions, Oppenauer oxidation, Baeyer-Villiger oxidation, Michael addition, Dieckmann, Stobbe condensation, Mannich, Reformatsky, Wittig, Chichibabin, Gatterman, Stork-enamine, Ulmann, Gabriel synthesis of primary amines, Arndt-Eistert synthesis, Aldol, Perkin, Hofmann, Lossen, Curtius, Schmidt, Beckmann, Fries, Favorskii, Wolf, Pinacol-pinacolone, Sharpless asymmetric epoxidation, Barton, Wagner-Meerwein rearrangement.

Unit-V

Pericyclic Reactions: Woodward-Hoffmann rules for conservation of orbital symmetry in concerted reactions, analysis of electrocyclic, cycloaddition (Diels-Alder reaction and Ene reaction) and sigmatropic reactions using:

1. Symmetry correlation diagrams.
 2. HOMO-LUMO interactions
 3. Huckel-Mobius concept.
- Sigmatropic rearrangement (Cope, Claisen).

Books Recommended:

1. Advanced Organic Chemistry, Jerry March John Wiley & Sons.
2. A Guide-book to Mechanism in Organic Chemistry, Peter Sykes, Orient Longman Limited.
3. Organic Chemistry, Volumes—1,2, I.L. Finar, ELBS, Publications.
4. Organic Chemistry, Solomons and Fryhle, John Wiley & Sons, Inc.
5. Advanced organic chemistry, Jerry March, John Wiley & Sons.
6. Advanced Organic Chemistry, Part-A and B, Carey and Sundberg, Plenum Press, New York.
7. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International Publishers Ltd., Wiley Eastern Limited.
8. Stereochemistry of Carbon Compounds, E.L. Eliel, Tata McGraw Hill.

PHC-5: Pharmaceuticals-I & Toxicology
(The Pharmacological basis of Therapeutics)

Max. Marks : 100

UNIT-I

Time : 3 hours

Pharmacokinetics : Introduction, defining drug absorption, disposition and elimination using pharmacokinetics, important pharmacokinetic parameters used in defining drug disposition and in therapeutics, use of pharmacokinetics in drug development process.

Pharmacodynamics : Introduction, enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug receptors,

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receptors, receptors for physiological regulatory molecules, regulation of receptors, classification of receptors and drug effect, action of drugs not mediated by receptors, quantization of drug-receptor interactions and elicited response.

UNIT-II

Drug metabolism : Definitions and concepts, types of metabolic reactions effecting xenobiotics, specificities and selectivities in xenobiotic metabolism, biological factors effecting drug metabolism, biotransformations, metabolic reactions, conjugate reactions, significance of drug metabolism in medicinal chemistry.

Principles of toxicology and treatment of poisoning : Introduction, doseresponse relationship, risk, spectrum of undesired effects, descriptive toxicity tests in animals, LD-50, incidence of acute poisoning, prevention of further absorption of poison; enhanced elimination of poison, antagonism or chemical inactivation of an absorbed poison.

Principles of therapeutics : Therapy as science, individualization of drug therapy, drug regulation and development, therapeutic jungle, sources of drug information.

UNIT-III

Drugs affecting cholinergic mechanism : Introduction, aspects of cholinergic system, cholinergic drugs, anticholinesterase agents, antidote for AChP inhibitors, memory and Alzheimers disease, cholinergic blocking agents, neuromuscular blocking agents.

Drugs affecting adrenergic mechanism : Adrenergic concepts and synthesis, catabolism, catecholaminergic receptors, indirect sympathomimetics α -receptors.

UNIT-IV

Steroids and therapeutically related compounds: Primary therapeutic classes, structural variation for modifying pharmacokinetic properties, sex hormones, estrogens and progestins, antiestrogens, androgens and anabolic agents, antiandrogens, chemical contraceptive agents. Other methods of chemical contraception, LH-RH agonists and antagonists, adrenal cortex hormones, cardiac steroids, other activities of steroids.

Unit-V

Definition and types of toxicology. Basic principles of toxicology. Carcinogenicity, mutagenicity, teratogenicity, acute, sub-acute and chronic toxicity. Pre-clinical evaluation of drugs. Drugs and pregnancy. Drug addiction and drug habit/dependence drug abuse, physical dependence, psychological dependence.

Detailed toxicity (mild/moderate/severe toxicology wherever applicable) and treatment of drugs such as salicylates, paracetamol, opium, quinine, ethyl alcohol, nicotine, digitalis, barbiturates, etc.

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Toxic chemicals in the environment, impact of toxic chemicals on enzymes. Biochemical effects of arsenic, lead, mercury, cadmium, aluminium, antimony, carbon monoxide, sulphur dioxide, pesticides and carcinogens.

Books Recommended:

1. Introduction to Medicinal Chemistry, Alex Gringauz, Wiley-VCH.
2. Wilson and Gisvolds Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed., Robert F. Dorge.
3. Burgers Medicinal Chemistry and Drug Discovery Vol I-V Ed. Monfred e. Wolff. John Wiley.
4. Goodman and Gilman's, Pharmacological Basis of Therapeutics, McGraw-Hill.

PHC-6(A): Mathematics for Chemists (For Bio Stds.)

Max.Marks:50

Time : 3 hours

Unit-I

Algebra and Elementary Concepts of Functions: Various functions, coordinate systems, Equation of first degree. Determinants. equations of second degree, Imaginaries, Functions of a complex variable general cubic, Binomial Theorem, Arithmetic and Geometric series.

Unit-II

Calculus-Differentiation: First principle, definition, Maxima, Minima, Partial Differentiation, Method of Lagrangian Multipliers. Differentiation of an Indefinite Integral, Differentiation of Functions of a complex variable. Ordinary Differential Equations. Concept of Boundary Values.

Unit-III

Techniques of Integration: Definite integral as area under a curve, Partial Fraction Integrals, Integration by substitution, line integrals, Integral Transforms such as Fourier Transform and Laplace Transform.

Unit-IV

Matrices, Vectors and Tensors: Types of operation with Matrices, Matrix notation, Matrices as operators, transrotation. Addition, Multiplication and Differentiation of Vectors, Gradient, Divergence, Curl and Laplacian, Orthogonal coordinate systems, Cartesian Tensors.

Unit-V

Permutation and Probability.

Permutations and combinations, probability and probability theorems, average, variance, root mean square deviation. examples from the kinetic theory of gases. etc., fitting (including least squares fit etc.) with a general polynomial fit.

OR

PHC-6 (B) Biology for Chemists (For Maths Stds.)

Max.Marks:50

Time : 3 hours

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Unit-I

1. Characteristics of Life, classification of plants and animals.
2. The cell. The cell as unit of life. The structure of cell; cell wall, nucleus, cytoplasm, plastids, mitochondria, golgi complex, ribosomes, lysosomes, centrosomes: Non-Living cell contents-carbohydrates, proteins and amino compounds, Fats and Oils. Secretory products in enzymes, chlorophyll, anthocyanins, vitamins. Waste products, tannins, essential oils, resins, gums, mineral salts, alkaloids.

Unit-II

1. Cell division-Mitosis, meiosis, amitosis.
2. The tissues-simple and complex tissues, classification & functions.
3. Structure of Roots, Stem and leaves, Transverse and longitudinal sections of monocots and dicots.
4. Bacteria and viruses-Structure, growth and importance.

Unit-III

1. Elementary idea about algae, fungi, bryophyta, pteridophyta, angiosperm, gymnosperm, hydrophytes and xerophytes.
2. Physiology of plants and animals-respiration, photo-synthesis, nutrition and growth.

Unit-IV

1. RNA and DNA (structure and role), Mendel's laws of heredity.

Unit-V

1. An elementary idea of evolution.
2. An elementary idea of ecology in relation to environment.

M.Sc. (Prev.)

Pharmaceutical Chemistry Practical

Max. Marks 200

Time : 14 hrs. (Spread in 2 days)

1. Analytical/Instrumental Techniques
One experiment based on any of the following :
(a) pH metry
(b) Potentiometric titrations
(c) Conductometric titrations
(d) Flame photometry
(e) Polarimetry
(f) Colourimetry 20
2. Separation and identification of components of binary mixture using chemical methods. 40
3. Organic Chemistry : Purification of organic compounds involving fractional distillation, fractional crystallization, steam distillation, sublimation, extraction. 20
4. Preparation of Organic compounds of medicinal interest

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- involving two steps. 40
5. One of the following experiments:
(a) Estimation of phenol and aniline by KBr/KBrO₃ method
(b) Estimation of amino group, unsaturation, reducing and non-reducing sugars.
(c) Estimation of a drug in the mixture using simple titration
(d) Colourimetric determination of the following:
Carbohydrates, ascorbic acid, proteins, cholesterol and urea. 30
 6. Viva-voce 30
 7. Laboratory Record 20

M.Sc. II YEAR (FINAL)

PHC-7 : Pharmaceutical Biotechnology

Max. Marks : 100

Time : 3 hours

Unit-I

Immunology : Basic immunology; Innate-Acquired immunity. Antibody structure; immune response against bacterial, viral and parasite infections. Vaccines (BCG, small pox, typhoid, cholera, polio-preparation and standardization, principles of multivalent subunit vaccines (ISCOMS, SMMA complexes etc), Synthetic peptide vaccines, recombinant antigen vaccines, vector vaccine, fertility vaccines, malaria vaccine, leprosy vaccine and transgenic plant vaccines.

Unit-II

Molecular Biology : DNA, RNA, Recombinant DNA methods, vectors, restriction enzymes, cloning, screening expression of cloned genes, isolation and implication of genes, genetic recombination, gene transfer mechanism.

Unit-III

Enzymes : Classification, and nomenclature, mode and mechanism of enzyme action, Pharmaceutical applications of enzymes. Bacteria enzymes, industrial enzymes and production of enzymes

Immobilized Enzymes - Methods of immobilization, types of matrices, application and advantages of immobilized enzymes, enzymes sensors and electrodes.

Fermentation technology : Fermentation for products of antibiotics, lab scale fermentation, scale up, downstream processing enzyme reactors.

Unit-IV

Coenzymes : Classification, structure and function of nicotinamide adenine dinucleotide (NAD and NADP), riboflavin nucleotides (FMN and FAD), lipoic acid, cytochrome, pyridoxyl phosphate, conjugates.

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Unit-V

Carbohydrates and metabolism : Configuration and chemical transformations of carbohydrates, absolute configuration of carbohydrates, general concepts, energetics and control in metabolic pathways. Glycolysis and citric acid cycle, phospho- and glycolipids.

Books Recommended

1. Biochemistry by L. Stryer, CBS Publishers and Distributors, Recent edition.
2. Biochemistry by D. Voet and J.G. Voet John Wiley and Sons, 1995.
3. Pharmaceutical Biotechnology-Vyas and Dixit
4. Industrial Microbiology- L.E. Casida
5. D.G. Jordan, Chemical Process Development-Pt. I.
6. M.S. Peters & K.D. Timmerhans, Plant Design and Economics for Chemical Engineers.
7. Grogging, P.H. (ed.) Unit Processes in Organic Syntheses, McGraw-Hill.
8. Shreve, R.N., Chemical Process Industries McGraw-Hill.
9. Coulson & Richardson, Chemical Engineering.

PHC-8 : PHARMACEUTICALS-II

Max. Marks : 100

Time : 3 hours

Unit-I

Antineoplastic agents : Introduction, causative factors, cancer chemotherapy, special problems, drug resistance, drug discovery strategies, cell cycle, alkylating agents, antimetabolites, carcinolytic antibiotics, mitotic inhibitors, hormonal agents, miscellaneous carcinolytics.

Analgesics and anti-inflammatory agents : Introduction, classification of pain, classification of analgesics, mild analgesics, prostaglandins, nonsteroidal anti-inflammatory agents, opium and strong analgesics, the opiate receptor, endogenous receptors, ligands, multiple opiate receptors.

Unit-II

Antimicrobial drugs : The antibiotics, cell wall synthesis inhibitors, cell wall biosynthesis, the β -lactam ring - the enchanting structure and other bicyclic β -lactams, monolactams, β -lactamase enzymes, β -lactamase inhibitors, antibiotics inhibiting protein synthesis. Local antiinfective agents, the 4-quinolones, nonbenzenoid nitro compounds, parasitic diseases, drugs used in the chemotherapy of protozoal infections- malaria, leishmaniasis, amoebiasis, giardiasis, trichomoniasis, antifungal agents, antiviral agents, urinary tract antiinfectives, antitubercular agents, antileprosy agents, anthelmintics, sulphonamides, trimethoprim, sulphamethoxazole.

Unit-III

Drugs and Cardiovascular diseases : Introduction, cardiovascular diseases, the drugs - inhibitors of peripheral sympathetic function, central intervention of cardiovascular output, direct acting arteriolar dilators, ACE inhibitors, diuretics, cardiotoxic agents, anti-arrhythmic agents, antianginal drugs- the coronary vasodilators, miscellaneous drugs, anticoagulants, anti thrombotics, thrombolytics, cyclooxygenase inhibitors, prostacyclins, plasminogen activators, hypo lipidemic, hypocholesterolemic drugs, drugs and diabetes, sickle cell disease, anemia, thyroid functions and drugs affecting them

Psychoactive drugs - the chemotherapy of mind : Introduction, historical overview, neurotransmitters, CNS depressants, general anesthetics, hypnotics and sedatives, anti-anxiety agents, benzodiazepines, buspirone, anti-epilepsy drugs, neurochemistry of mental disease, anti-psychotic drugs- the neuroleptics, the butyrophenones, serendipity and drug development, anti-depressants, fluorinated psychoactive drugs, stereochemical aspects of psychotropic drugs.

Histamine antagonists: Histamine antagonists, inhibition of mediator release, peptic ulcer disease, proton pump inhibitors (H^+ , K^+ -ATPase), prostaglandins.

Unit-IV

Structure, stereochemistry, nomenclature and therapeutic uses of Vitamins : Fat soluble vitamins (A, D, E and K), water soluble vitamins (folic acid, B_1 , B_2 , B_3 , B_7 and C).

General and local anaesthetics : Ethers, halogenated hydrocarbons (halothane), cyclopropane, nitrous oxide, intravenous anaesthetics (barbiturates), local anaesthetics; cocaine and synthetic compounds, esters, benzoic acid derivatives, amides, miscellaneous anaesthetics.

Unit-V

Hormones and Related Drugs : Steroids, sex hormones and related compounds estrogen, androgen, progestational agents, contraceptives, adrenal cortex hormones, thyroid hormones and anti-thyroid drugs, pancreatic hormones, hypothalamus hormones.

Disinfectants and Antiseptics : Phenol and homologs (chlorocresol, chloroxylenol, hexachlorophene, amylmetacresol, thymol), hydroxybenzoic acid, hydroxyquinolones, quaternary ammonium compounds, halogen derivatives, chloramine, dibromopropanidine, Isethionate, chlorohexidine HCl.

Dyes (crystal violet, brilliant green), thiomersol, alcohol

Books Recommended :

1. Introduction to Medicinal chemistry, Alex Gringauz, Wiley-VCH
2. Wilson and Gisvolds, Text Book of Organic Medicinal and

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Pharmaceutical Chemistry, Ed, Robert F. Derge.

- Burgers Medicinal Chemistry and Drug Discovery, Vol I-V Ed, Montfred E. Wolff John Wiley.
- Goodman and Gilman's, Pharmacological Basis of Therapeutics, McGraw-Hill.

PHC-9 : Pharmaceutical Chemistry-I

Max. Marks : 100

Time : 3 hours

Unit-I

From Discovery to Market : The development of pharmaceuticals :

Introduction, historical development, classification and nomenclature of drugs, evolution of drug development, cost of drug development, the drug development process, chemistry, preclinical studies, transition from practical to clinical, planning the drug development process, clinical research, the conduct of clinical trials, regulatory review during the conduct of clinical trials.

Drug Design : Development of new drugs : Introduction, procedure followed in drug design, the search for lead compounds, molecular modification of lead compounds, prodrugs and soft drugs, prodrug : Introduction, prodrug formation of compounds containing various chemical groups, multiple prodrug formation, soft drugs: design of soft drugs.

Unit-II

Structure-Activity Relationship (SAR) : Factors effecting bioactivity, resonance, inductive effect, isosterism, bioisosterism, spatial considerations, biological properties of simple functional groups, theories of drug activity, occupancy theory, rate theory, induced-fit theory, quantitative structure-activity relationship (QSAR) : History and development of QSAR, drug receptor interactions, the additivity of group contributions, physico-chemical parameters, lipophilicity parameters, lipophilicity contribution and calculation of partition coefficients, polarisability, electronic parameter, ionization constants, steric parameters, chelation parameters, surface activity parameter, redox potential, indicator-variables, quantitative models, Hansch analysis, Free-Wilson analysis, their application, relationship between Hansch and Free-Wilson analysis (the mixed approach), non-linear relationship, introduction to other QSAR approaches.

Unit-III

Design of enzyme inhibitors, 9-alkylpurines, 9-mercaptapurines and allopurines, active-site directed irreversible enzyme inhibition, suicide enzyme inactivators. Introduction to molecular modeling using computers, uses of molecular modeling manual use, further computer programming, X-ray crystallography.

Syllabus : M.Sc. Pharmaceutical Chemistry

Structure-based drug design: Process of structure based drug design, deactivation of certain drugs necessary for T cells functioning, determination of the active site with special reference to chymotrypsin design of inhibitors.

Antibiotics : Synthesis and therapeutic uses of penicillin G, penicillin V, ampicillin, amoxycillin, cefazolin, cefaclor, cefotaxime, griseofulvin, chloramphenicol, adriamycin, mitomycin C.

Unit-IV

Isolation, synthesis, stereochemistry (structure elucidation excluded) and therapeutic importance of :

Anticancer drugs : Catharanthus alkaloids (vinorelbine), taxol and its analogs podophyllotoxin (etoposide, teniposide), camptothecin, maytansine.

Antimalarials : Cinchona alkaloids (quinine), artemisinin.

CNS drugs : Opium alkaloids (morphine and its congener), cannabinoids reserpine.

Cardiovascular drugs: cardiac glycosides (digoxin), dicoumarol, warfarin, ajmalicine, rescinnamine, vincamine, guggul lipid.

Unit-V

Anaesthetic - Cocoa alkaloids (cocaine); antiarrhythmic - quinine; antiamebic emetine; anti-inflammatory-glycyrrhetic acid; antidiarrhoeal-berberine; laxative-sennosides, psyllium mucilage; antiasthma drugs- ephedrine; antifertility - gossypol

Prostaglandins : General study, nomenclature, biological activity, biosynthesis, structure of PG E2 and synthesis of key intermediates.

Books Recommended :

- Natural Products Chemistry, A Mechanistic and Biosynthetic Approach to Secondary Metabolism, K.B.G. Torssell, John Wiley & Sons Ltd.
- Natural Products, their chemistry and biological significance, Mann, Davidson, Hobbs, Banthorpe and Harborne, Longman.
- An Introduction to Drug Design by S.S. Pandeya and J.R. Dimmock, New Age International (P) Ltd. publishers.
- Burgers Medicinal Chemistry and Drug Discovery, Vol I (Ch 9 and 14); Ed. M.E. Wolff, John Wiley.
- Introduction to Medicinal Chemistry, Alen-Gringauz, Wiley-VCH
- The Organic Chemistry of Drug Synthesis by D. Lednicer and L.A. Mitscher, Vol. I-V, John Wiley.

PHC-10 : Pharmaceutical Chemistry-II

Max. Marks : 100

Time : 3 hours

Unit-I

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Antineoplastic agents : Mechlorethamine, cyclophosphamide, melphalan, chlorambucil, busulfan, uracil mustard, fluorouracil, 6-mercaptopurine, methotrexate.

Analgesics and Antipyretics : Pethidine, dextropropoxyphen, acetaminophen, phenacetin, aspirin, antipyrine, aminopyrine, phenyl butazone, oxyphenbutazone.

Antiinflammatory agents : Indomethacin, ibuprofen, diclofenac, naproxen.

Antimalarials : Chloroquine, amaroquine, primaquine, proguanil, trimethoprim, mepracine.

Unit-II

Anthelmintic : Quinacrine, niridazole, thiabendazole, mebendazole.

Antibacterials : Sulphonamides, sulphanilamide, sulphacetamide, salazopyrine, sulphacetamide sodium, silver sulphadiazine, furazolidone, nilidixic acid, ciprofloxacin, norfloxacin.

Antileprosy agents : Dapsone, MDT (dapsone, clofazimine and rifampicin).

Antitubercular agents : Aminosalicyclic acid, isoniazid, ethambutol, thiambutosine, Ethionamide.

Unit-III

Antifungal agents : Benzoic acid, salicylic acid, econazole.

Anticholinergic agents : Dicyclomine, cyclopentolate, nefopam.

Antihistaminic agents : Chlorpheniramine, cemetidine, ranitidine, diphenhydramine, mepyramine, promethazine, chlorcyclizine.

Antidiabetic agents : Tolbutamide, glipizide, chlorpropamide, recent developments in diabetic therapy.

Diuretics : Theophylline, triametrene, amiloride, chlorothiazide, frusemide, bumetanide.

Unit-IV

Psychoactive drugs :

Sedatives and Hypnotics : Barbiturates, nitrazepam, thiopental sodium, glutethimide, nitrazepam.

Anticonvulsants : Phenytoin, primidone, paramethadione.

Antianxiety agents : Meprobamate, diazepam, chlorazepam, alprazolam, buspirone.

Unit-V

Antipsychotics : Chlorpromazine, fluphenazine, prochlorperazine.

Antifertility agents : Norethynodrel, norgestrel, mestranol, 17 α - ethynyl estradiol, tamoxifen, centochroman.

Anti AIDS : AZT

Cardiovascular agents :

(i) **Antiarrhythmic-** Procainamide, Disopyramide.

Syllabus : M.Sc. Pharmaceutical Chemistry

(ii) **Antihypertensive-** Guanithidine, methyl dopa, clonidine, atenolol.

Books Recommended :

1. An Introduction to Drug Design by S.S. Pandeya and J.R. Dimmock, New Age International (P) Ltd., Publishers.
2. Burgers Medicinal Chemistry and Drug Discovery, Vol.1 (Ch 9 and 14), Ed M.E. Wolff, John Wiley.
3. Introduction to Medicinal Chemistry, Alen- Gringauz, Wiley - VCH
4. D. Lednicer and L.A. Mitscher, The Organic Chemistry of Drug Synthesis, Vol. 1 to V, John- Wiley.

PHC-11 : Chemical Engineering

Max. Marks : 50

Time : 3 hours

Unit-I

Fluid flow : Manometers, decanters, pipe fitting and valves. Bernoulli equation, pumps, reciprocating pumps, rotatory pumps, centrifugal pumps (theory excluded), fans, blowers and compressors, vacuum pumps, venturimeters, orifice meters.

Heat Transfer : Modes of heat transfer, heat exchange.

Mass Transfer : Principles of stage processes, **Drying :** A brief description of the basic principles and applications of the following dryers: tray dryers, flash dryers, rotary dryers, thin film dryers, drum dryers, and spray dryers.

Unit-II

Distillation : Vapour-liquid equilibrium, partial vaporisation, partial condensation, partial pressure, (Dalton's, Rault's & Henry's laws), relative volatility. Types of distillations, fractional distillation of binary mixtures, fractionating columns, calculations of number of plates for Lewis-Sorrel and Mc Cabe Thiel method, efficiency of number of distillation, azeotropic distillation, extractive distillation, steam distillation

Unit-III

Filtration : Introduction, classification of filters, filter process, chamber process, plate and frame processes, shell and leaf filters, rotary drum filter, filter aids and auxiliaries. Filtration theory, constant pressure filtration, constant rate filtration, washing of filter cakes, centrifuges, batch top driven centrifuge, batch under driven centrifuge, disk type centrifuge.

Crystallization : Principles of crystal growth, super saturation, nucleation, rate of crystallization, fractional crystallization, crystal growth, types of crystallization.

Unit-IV

Chemical Process Development : Process design development, technical evaluation of new project, plant location, plant layout, plant

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operation and control, materials handling.

Unit-V

Unit Processes Industrially feasible C-C bond formation and cleavage, reactions, oxidations, reductions, sulphonation, nitration, halogenation and their applications to manufacture of known drugs.

Books Recommended :

1. W.D. McCabe, J.C. Smith & P. Harriott, Unit Operations of Chemical Engineering, V Ed. McGraw-Hill.
2. K.R. Westreterp, W.P.M. Swaaij, AACM, Beanackers, Chemical Reactor Design and Operation.
3. W.L. Badger and J.T. Benchar, Introduction to Chemical Engineering, McGraw Hill.
4. Max Peters, Elementary Chemical Engineering.

PHC-12 : Pharmaceutical Technology and Management

Max. Marks : 50

Time : 3 hours

Unit-I

Introduction to different pharmaceutical dosage forms and various modes of administration.

Preformulation considerations: Analytical methods for characterisation of drugs, determination of pKa value, pH, solubility profile, and effect of temperature, solution and solid state stability.

Processing of Tablets : Types of tablets, granulation - manufacture of granules, their basic characteristics and properties with reference to different types of substances. Various additives included in formulation of tablets. Compression of tablets, compressing machines and their tooling, processing problems and their remedy, standardisation and evaluation of tablets as per official standards.

Unit-II

Coating of Tablets : Principles and equipment, taste masking, sugar coating, tensile strength of films, evaluation of coated tablets, defects of films.

Processing of capsules : Hard gelatin capsules, materials and production. Filling equipment, hand filling, semi-automatic and automatic filling operations, formulation, finishing and evaluation. Soft gelatin capsules, manufacturing process, nature of capsule shell and contents, physical stability, packing and evaluation.

Microencapsulation : Its importance and applications in pharmaceutical formulations, techniques and equipment for microencapsulation.

Unit-III

Quality assurance : GMP, cGMP, GLP, GCP, TQM, ISO-9000, process validation, Pharmacopoeia (IP, USP, BP) and assay, regulatory

Syllabus: M.Sc. Pharmaceutical Chemistry

protocols, guidelines, Indian FDA regulations as compared to those of USA and EEC.

Unit-IV

Patent law, intellectual property right (IPR), GATT, WTO.

Cost estimation : Factors effecting investment and production costs, cost factors in capital investment, manufacturing cost, preparation and appraisal of project report, domestic and international funding, return on investment, tax planning.

Unit-V

Statistical analysis : Introductory concepts and definitions, design of experiments and collect on of data, estimation, statistical inference, data transformation.

Books Recommended :

1. Cooper and Gunns Dispensing for Pharmaceutical Students, Ed. S.J. Carter, CBS publishers & distributors.
2. Cooper and Gunns, Tutorial Pharmacy.
3. L.Lachman, Theory and Practice of Industrial Pharmacy, Lea & Fabiger.
4. Bentley and Drivers, A Text book of Pharmaceutical Chemistry, Oxford Press.
5. I.S.O. Reports.
6. Indian Pharmacopoeia Govt. of India, Ministry of Health and Family Welfare.
7. British Pharmacopoeia.
8. Indian Patent Act.
9. P.P. Sharma, GMP, Vallabh Prakashan.
10. A. Osol, Remingtons Pharmaceutical Science. Mack Publishing Company.

M.Sc. (FINAL)

Pharmaceutical Chemistry Practical

Max. Marks : 200

Time : 14 hrs.

(Spread over 2 days)

1. Preparation of organic compound of medicinal interest involving 2 to 3 steps.
2. Techniques of purification : Vacuum distillation, column chromatography, sublimation, separation and identification of the components of a tablet using preparative TLC.
3. Separation and identification of components of ternary organic mixture using chemical methods and spectral data
4. Preparation and evaluation of the following :

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Emulsion, simple syrup, aqueous iodine, strong iodine, calamine lotion, boroglycerine, tannic acid/glycerine, phenol glycerine, peppermint water, rose water, non-staining iodine ointment cum methyl salicylate, formulation of ointment, stability studies of tablets, capsules, syrups.

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|-----|--|----|
| 5. | Perform one of the following experiments : | 20 |
| 1) | Quantitative applications of IR spectroscopy. | |
| 2) | Identification of isomers using proton NMR. | |
| 3) | Determination of specific rotation of ibuprofen and determination of percentage in the unknown sample. | |
| 4) | Volumetric determination of ibuprofen in the given tablet. | |
| 5) | Spectrophotometric determination of aspirin content in the soluble aspirin tablet. | |
| 6) | Spectrophotometric determination of paracetamol in the tablet. | |
| 7) | Extraction and spectrophotometric determination of oxyphenylbutazone | |
| 8) | Analysis of ampicillin trihydrate. | |
| 9) | Determination of Vitamin B1 in given tablet. | |
| 10) | Determination of Vitamin B2 in given tablet. | |
| 11) | Determination of ephedrine hydrochloride in given syrup. | |
| 12) | Determination of tetracycline in the given capsule. | |
| 13) | Determination of phenobarbitone in the given cough syrup. | |
| 14) | Extraction of cholesterol from gall stones and its analysis. | |
| 15) | To perform I.P. monograph of tablet. | |
| 16) | To perform I.P. monograph of hard gelatine capsule. | |
| 17) | Evaluation of injections. | |
| 18) | Determination of chloramphenicol in given capsule. | 40 |
| 6. | Viva-voce | 30 |
| 7. | Laboratory Record | 20 |

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