SHIVAJI UNIVERSITY, KOLHAPUR

Pre Ph.D. Coursework for PHARMACY

PAPER-III

E-01 COSMETICS AND NUTRACEUTICALS

Unit I **(16 marks)**

Emerging Trends in Cosmetic Formulation: Overview of the cosmetic industry and formulation landscape, Impact of consumer preferences and market demands.

Cosmeceuticals and Advanced Skin Care, Hair Care and Scalp Health: Study of cosmeceutical ingredients and their mechanisms of action, Formulation and development of advanced skin care products, Hair care ingredients and formulation strategies, Diagnosis and treatment of hair and scalp disorders, Emerging trends and innovations in hair care products.

Unit II **(16 marks)**

Personalized Cosmetics: Customization and personalization trends in cosmetic formulation, Technologies for skin analysis and product customization, Personalized skincare and color cosmetics formulations.

Clean Beauty and Ingredient Transparency: Understanding the concept of clean beauty and ingredient safety, Trends in clean beauty formulations and marketing strategies, Regulatory considerations and labeling requirements.

Innovations in Cosmetic Formulation: Green and sustainable formulation practices, Natural and organic cosmetics, Advances in delivery systems and novel ingredient technologies, Formulation approaches for natural and plant-based cosmetics, Sustainable packaging and waste reduction initiatives.

Unit III **(16 marks)**

Biotechnology and Cosmetic Innovation: Biotechnological advancements in cosmetic ingredient development, Fermentation and bioconversion processes for sustainable ingredients, Bioactive compounds and their applications in cosmetic formulations.

Digital Technologies in Cosmetic Formulation: Applications of digital technologies in formulation development, Use of artificial intelligence and machine learning in formulation optimization, Digital tools for ingredient analysis and formulation customization.

Safety and Regulatory Aspects of Cosmetics: Regulatory guidelines and requirements for cosmetic products, Safety assessment of cosmetic ingredients and finished products, Toxicology testing and risk assessment in cosmetics, Ethical considerations in cosmetic testing and animal alternatives, Compliance with global regulations and standards.

Unit IV **(16 marks)**

Nutraceutical Science and Product Development: Introduction to Nutraceuticals and dietary supplements, Bioactive compounds and their roles in health and wellness, Development of nutraceutical products and dosage forms, Innovative technologies and formulation approaches, Nanotechnology in Nutraceuticals.

Evaluation of Nutraceutical Efficacy: Evidence-based medicine and systematic reviews, Meta-analysis and critical appraisal of research studies,Assessing the strength of evidence and clinical relevance.

Nutraceuticals and the Future of Medical Science: Development of designer foods for specific chronic diseases like diabetes, obesity, cardiovascular diseases, AIDS, Cancer, Nutraceuticals and cognitive health, Dietary fibers of microbial and plant origin.

Unit V **(16 marks)**

Integration of Nutraceuticals into Healthcare Practice: Collaboration between healthcare professionals and nutraceutical experts, Nutraceuticals in primary care and specialty settings, Patient education and counseling on nutraceutical use,Nutraceuticals and personalized nutrition, Functional foods and sports nutrition.

Safety Assessment and Regulatory Considerations: Toxicology and safety evaluation of Nutraceutical ingredients, Risk assessment and regulatory compliance,Quality control and product standardization, Claims substantiation and advertising regulations.

Clinical Trials in Nutraceutical Research: Design and methodology of clinical trials, Biomarkers and surrogate endpoints, Data analysis and interpretation.

References:

1. Cosmeceuticals: Science, Practice, and Clinical Perspectives" edited by Patricia K. Farris and Zoe Diana Draelos.
2. Personalized Cosmetics: Foundations, Emerging Knowledge and Applications" edited by Marie Loden and Howard I. Maibach.
3. Cosmetic Product Development: A Comprehensive Guide" edited by Desmond Goddard and Martin M. Rieger.
4. Handbook of Cosmetic Science and Technology" edited by André O. Barel, Marc Paye, and Howard I. Maibach.
5. Cosmetic Biotechnology: Methods and Protocols" edited by Renata J. C. Engler and Gisela Maria Dellamora-Ortiz.
6. Digital Approaches to Cosmetic Science: Practical Applications and Emerging Trends" edited by Janet Cooper and Johann W. Wiechers.
7. Cosmetics and Toiletries: Development, Production, and Use" edited by J. Vincent J. McBride.
8. Handbook of Nutraceuticals and Functional Foods" edited by Robert E. C. Wildman and Gianfranco C. Pacchioni.
9. Nutraceuticals and Functional Foods in Human Health and Disease Prevention" edited by Debasis Bagchi, Sreejayan Nair, and Chandan K. Sen.
10. Nutraceuticals in Health and Disease Prevention" edited by Klaus Kramer, Peter P. Hoppe, and Lynne M. Ausman.

PAPER-III

E-02 : NATURAL PRODUCT DRUG DEVELOPMENT

Unit-1. **[15 MKS]**

Significance in classification of medicinal plants, Phytochemical classification of plants, relationship between phytochemistry and taxonomy.

Different approaches for the discovery of new drugs from natural sources. Plant selection criteria along with the issue related to biodiversity and IPR. Detailed phytochemical investigation of plant material.

Unit-2. **[15 MKS]**

Novel herbal formulations and its evaluation: Phytosomes, Liposomes, Niosomes, Nanosphere, Microspheres, Proniosomes, Cubosomes,Plantibodies (immunoglobins) from plants,etc.

Unit-3. **[20 MKS]**

Quality control of herbal drugs/formulations- Overview of various Pharmacopeial monographs, general monographs on quality and other issue related publications. Conventional methods, Modern techniques (Role of genetic markers, RAPD, DNA fingerprinting technique etc). Quality control and use of excipients in herbal medicines and stability studies of herbal medicinal products.Determination of contaminants(microbial Load, aflatoxins, pesticide residues and heavy metals)

Unit-4. **[15 MKS]**

Phytochemical Reference Standards (PRS), Source and preparation of PRS, Fingerprint techniques, Analytical method development for the markers and validation assays.

Unit-5. **[15 MKS]**

Herbal Drug Regulatory affairs. Role and importance of national and international regulatory bodies in assessment of quality of herbal drugs and formulations including AYUSH Department.

References-

1. FDA Regulatory Affairs by Donglas J Pisano & David Mantus.

2. FDA Guidelines.

3. Yoganasimhan, S.N., Medicinal Plants of India, 1 st Edition, Interlive Publishing Pvt. Ltd.

4. Medicinal and Aromatic Plant abstracts (MAPA) CSIR, New Delhi.

5. Evans, W.C., Trease and Evans Pharmacognosy, W.B. Saunder& co., London.

6. Wallis, T.E., Text Book of Pharmacognosy.

7. Indian Herbal Pharmacopoeia.

8. Indian Pharmacopoeia.

9. Novel Drug Delivery Systems for Phytoconstituents Edited by Madhu Gupta, CRC

10. Kalia, A.N., Textbook of Industrial Pharmacognosy.

11. Mohammad Ali, Pharmacognosy and Phytochemistry.

12. Bruneton Jean, Pharmacognosy and Phytochemistry of Medicinal Plants.

13. Kaufmann, Natural Products from Plants, CRC Press, New York.

14. PhytotherapyA quick reference to herbal medicine, F Capasso, TS Gaginella, G Gradolini, AA Izzo, Springer Berlin, Heidelberg.

15.https://ayushnext.ayush.gov.in/detail/writeUps/ayurvedic-formulary-of-india-and-ayurvedic-drug- industry.

16. http://archiv.ayurveda.hu/doc/Protocol_For_Testing.pdf

17.https://apps.who.int/iris/bitstream/handle/10665/43510/?sequence=1

18. Natural Products: Drug Discovery and Therapeutic Medicine by L Zhang, A L Demain

PAPER-III

E-03 PHARMACEUTICAL TECHNOLOGY DEVELOPMENTS

Unit I **(10 marks)**

Preformulation Studies: Goals of preformulation, preformulation parameters, pre-formulation testing criteria, regulatory requirements, testing systems, solid-state characterization, drug excipient compatibility, transport across biological membranes.

Unit II **(10 marks)**

Polymers and Excipients: Polymer classification, physiochemical properties with respect to their pharmaceutical applications, biodegradable and non-biodegradable polymers, application of polymers in controlled release of drugs, transport of small molecules in polymers, ionic polymers as drug carriers, polymer drug interactions.

Unit III **(30 marks)**

Solid State Pharmaceutics: Introduction and importance of solid state characterization in drug development and formulation.

Crystallography and Crystal Structures- Crystal structures and packing arrangements, Crystal defects and their influence on drug properties.

Polymorphism and Amorphism- Polymorph screening and characterization techniques, Thermodynamic and kinetic aspects of polymorph stability, Impact of polymorphism and amorphism on drug formulation and bioavailability.

Solid-State Characterization Techniques: X-ray diffraction (XRD) analysis, Differential scanning calorimetry (DSC), Fourier-transform infrared spectroscopy (FTIR), Solid-state nuclear magnetic resonance (NMR), Microscopy techniques (optical microscopy, electron microscopy).

Particle Size and Surface Area Analysis: Particle size determination techniques (Laser diffraction, sedimentation, microscopy), Specific surface area measurement (BET analysis).

Solid-State Stability: Factors influencing solid-state stability (temperature, humidity, light). Degradation pathways and mechanisms, Methods for evaluating solid-state stability.

Mechanical Properties of Solids: Hardness, toughness, and brittleness, Compression and compaction properties, Powder flow and handling characteristics.

Solid-State Formulation and Processing: Techniques for solid dosage form preparation (granulation, compaction, coating), Influence of solid-state properties on formulation design and processing.

Solid-State Compatibility and Drug- Excipient Interactions: Compatibility studies and evaluation of drug-excipient interactions. Impact of drug-excipient interactions on solid dosage form stability and performance.

Emerging Topics in Solid State Pharmaceutics: Pharmaceutical cocrystals and their significance. Amorphous solid dispersions and their formulation strategies. Solid-state characterization of nanoscale drug delivery systems.

Unit IV **(15 marks)**

Regulatory Considerations and Intellectual Property: Regulatory guidelines and requirements for new formulation development. Intellectual property protection strategies for innovative formulations. Case studies highlighting regulatory challenges and successful commercialization of new formulations.

Unit V **(15 marks)**

Ethical and Safety Considerations: Ethical considerations in formulation development, including patient safety and informed consent. Evaluation of safety and toxicological aspects of new formulations. Risk-benefit assessment and post-marketing surveillance of new formulations.

Future Perspectives and Emerging Technologies: Exploration of emerging technologies and their potential impact on formulation development. Discussion of future trends and challenges in the field. Opportunities for innovation and collaboration in new formulation development.

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References:

1. Pharmaceutical Preformulation and Formulation: The Science and Practice of Dosage Form Design" by Mark Gibson.

2. Pharmaceutical Excipients: Properties, Functionality, and Applications in Research and Industry" edited by Linda A. Felton.
3. Solid State Characterization of Pharmaceuticals" edited by Bruno C. Hancock and Gary L. Amidon.
4. Pharmaceutical Solids: Characterization and Drug Delivery" edited by Harry G. Brittain.
5. Polymorphism in Pharmaceutical Solids" edited by Harry G. Brittain.
6. Solid State Properties of Pharmaceutical Materials" edited by Jens T. Carstensen and Christopher L. Forster.
7. Pharmaceutical Regulatory Affairs: Basics, Challenges, and Strategies" by Stephen C. Denyer, Norman A. Hodges, and Anthony J. Rawlins.

PAPER-III

E-04 PHARMACEUTCAL PRODUCT DEVELOPMENT

Unit I: **(16 marks)**

Recent Trends in Formulation Development: Importance of formulation development in the pharmaceutical industry, recent advancements and emerging trends in formulation approaches. Impact of new formulation strategies on drug delivery, bioavailability and therapeutic outcomes.

Unit II **(16 marks)**

Novel Drug Delivery Systems (NDDS): Overview of various NDDS such as liposomes, nanoparticles, micelles and dendrimers. Formulation strategies and manufacturing methods for NDDS. Application of NDDS for targeted drug delivery, sustained release and enhanced bioavailability. Case studies highlighting the successful implementation of NDDS in specific therapeutic areas.

Target oriented drug delivery systems: Rationale for targeted drug delivery, biological processes and events involved in drug targeting, pharmacokinetics and pharmacodynamic considerations. Stability protocols of pharmaceutical dosage forms as per ICH guidelines and cGMP.

Unit III **(16 marks)**

Advanced Dosage Forms: Formulation and development of novel dosage forms, including oral films, implantable devices, nanosuspensions and inhaled formulations. Novel approaches for modified-release and controlled-release dosage forms. Advantages, challenges and potential outcomes associated with advanced dosage forms.

Biopharmaceutical Considerations: Formulation strategies to improve drug solubility, permeability and stability, Use of solubilization techniques, amorphous solid dispersions and cyclodextrin complexes. Application of biopharmaceutical tools and predictive models for formulation optimization.

Bioequivalence Studies: Basic pharmacokinetic concepts, *in vitro* and *in vivo* methods in establishment of bioequivalence

Unit IV **(16 marks)**

Personalized Medicine and Precision Formulation: Personalized medicine and its impact on formulation development. Formulation considerations for customized therapies and patient-specific dosing. Integration of biomarkers, genomics and pharmacogenomics in formulation design.

Unit V **(16 marks)**

Quality-by-Design (QbD) in Formulation Development: Introduction to QbD principles and their application in formulation development. Design of experiments (DoE) and statistical tools for formulation optimization. Risk assessment and control strategies for formulation outcomes and product quality.

References:

1. Novel Drug Delivery Systems: Fundamentals, Developmental Concepts, Biomedical Assessments" by Yie W. Chien
2. Controlled Drug Delivery: Fundamentals and Applications" edited by Joseph R. Robinson and Vincent H. Lee.
3. Nanotechnology-Based Approaches for Targeting and Delivery of Drugs and Genes" edited by Vijay Mishra and Rahul Dev Jayant.
4. Pharmaceutical Quality by Design: Principles and Applications" edited by Walkiria S. Schlindwein and José C. Menezes.
5. J.I. Wells, Pharmaceutical Preformulation: The Physicochemical Properties of Drug Substances, Ellis Horwood, Chiechester (UK).
6. M. Gibaldi and D. Perrier, Pharmacokinetics, J. Swarbrick, ed., Marcel Dekker, N.Y.
7. Theory and Practice of Industrial Pharmacy By Lachmann and Libermann. Third edition, Varghese Publishing House.
8. Modern Pharmaceutics; By Gillbert and S. Banker.

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Paper-III

E-05 DESIGN AND DEVELOPMENT OF BIOACTIVES

UNIT-I **[15 MKS]**

Principles of molecular modeling, docking and QSAR: Quantum chemistry and Molecular force fields and Energy landscapes. wave function of drug molecules. Hamiltonian of Drugs. Absolute and relative energies of drug conformers. Rigid docking, flexible docking, manual docking, induced fit docking. Steric and electronic effects in QSAR: Hammett equation, lipophilicity effects. Hansch equation. Common minimum feature identification and Pharmacophore mapping techniques.

UNIT-II **[15 MKS]**

Principles of synthetic planning: Logic-centered molecular synthesis; Dislocation, synthetic tree, synthons, synthetic equivalents, logical imposition of boundary conditions, direct associated approach; Structure-functionality relationships, functionality and unsaturation levels; Polar reactivity analysis; Control elements, consonant and dissonant circuits; Protocol for synthetic design. Synthons used for formation of co-crystals.

UNIT-III **[20 MKS]**

Basic Chemical laboratory skill sets: Skills involved in synthetic work w.r.t. glasswares, hazardous chemicals and safety rules. Principles of chemical purifications and analysis of purity.

Process chemistry: Heterogeneous catalysis, homogeneous catalysis, Transition-metal and Organo-catalysis in organic synthesis: Metal-catalyzed reactions, asymmetric organocatalysis, phase transfer catalysis, benefits and challenges of applying phase transfer catalysis in pharmaceutical industry.

Emerging trends in process chemistry: Use of Domino, Cascade, and Tandem reactions, multi-component reactions, development of efficient one-pot process with examples, lithium-halogen exchange reactions in process chemistry

UNIT-IV **[15 MKS]**

Green Synthesis: Principles of green chemistry, examples of greener route to chemical reactions, designing robust reaction conditions, reaction media for green chemistry, organic reactions in water, sustainable development of a process.

Principle, Significance and applications in organic synthesis of organic reactions and heterocycles synthesis the following- Microwave, sonochemistry and enzymes. its applications in various

Industrial enzymes in drug development: Penicillin amidase, lipase, oxidoreductase,nitrilase, protease etc.; use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs/drug intermediates, future directions.

UNIT-V **[15 MKS]**

Basic principle involved in extraction technology of phytoconstituents including secondary metabolite and recent advances in extraction methodology e.g. Supercrtical Fluid extraction technology.

Dereplication techniques for common secondary metabolites present in herbal/medicinal plant extracts with suitable examples

Recommended books:

1. Molecular Modelling, byA. R. Leach
2. Organic Chemistry of Drug Design and DrugAction, by R.B. Silverman
3. Practical applications of computer aided drug design, by P.S. Charifson
4. Molecular modeling in Drug Design, by C. Cohen
5. Chemical applications of Molecular modeling, by J. Goodman
6. Pharmacophore perception, by O.F. Guner
7. Process Chemistry in the Pharmaceutical Industry by Kumar Gadamasetti, Marcel Dekker Inc.
8. Practical Process Research & Development by Neil G. Anderson, Academic Press

9. Principles of Process Research and Chemical Development in the Pharmaceutical Industry by O.Repic, John Wiley & Sons, Inc
10. Pharmaceutical Process Chemistry for Synthesis by Peter J. Harrington
11. Computational drug designA Guide for Computational andMedicinal Chemists by David C.Young,John Wiley & Sons.
12. Natural Products: Drug Discovery and Therapeutic Medicine by L Zhang, A L Demain
13. Phytochemical Methods A guide to Modern Technique of Plant Analysis by J.B. Harborne
14. K.I.Ramachandran,GDeepaandKrishnanNamboori.P.K.ComputationalChemistryandMolecular Modeling Principles and Applications 2008 [1] ISBN 978-3-540-77302-3 Springer-VerlagGmbH.
15. N.Mukhargi and Singh, Principal of Organic reactions
16. MedicinalandAromaticPlantabstracts(MAPA)CSIR,NewDelhi.
17. Evans,W.C.,Treaseand EvansPharmacognosy,W.B. Saunder&co.,London.
18. Wallis,T.E.,Text Book of Pharmacognosy.
19. IndianHerbalPharmacopoeia.
20. Kalia,A.N., Textbook ofIndustrial Pharmacognosy.
21. BrunetonJean,Pharmacognosyand PhytochemistryofMedicinalPlants.
22. Kaufmann, Natural Products fromPlants,CRC Press, New York.
23. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure by Michael B.Smith, and Jerry March
24. Designing Organic Syntheses by Stuart Warren
25. Organic Synthesis: the Disconnection Approach by Stuart Warren
26. Crystal Engineering: A textbook, Edited by G. R. Desiraju, J. J.Vittal and A. Ramanan
27. Advanced Organic Chemistry: Reactions and Synthesis, Part A & B: Structure & Mechanism

by Francis A. Carey; Richard J. Sundberg

28. Molecular Biotechnology by Principles and Applications of Recombinant DNA by
29. Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten, ASM Press
30. Principles of Fermentation Technology by P F Stanbury, A. Whitaker, S. J. Hall.
31. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press
32. Pharmaceutical Biotechnology by Concepts and Applications by Gary Walsh, John Wiley & Sons

PAPER-III

E-06 : TRENDS IN PHARMACOLOGY AND TOXICOLOGY

Unit 1. Toxicological Screening of drugs- **20 marks**

Acute, subacute, chronic - Oral, Inhalation, and Dermal as per OECD guidelines.

Unit 2. Scope and relevance of preclinical and clinical trials. **10 marks**

Adverse drug reactions (ADRs).

Role of pharmacovigilance in ADR monitoring.

Unit 3. Techniques to Evaluate drugs belonging to following categories: **20 marks**

- Anticancer activity (In vitro and In vivo)
- Antiviral activity (In vitro and In vivo)
- Anti-tubercular activity (In vitro and In vivo)
- Evaluation of Antioxidants (In vitro)
- Antimicrobial evaluation methods

Unit 4. Mechanism of action of drugs used in treatment of following diseases **15 marks**

- Tuberculosis
- Malaria.
- Cancer
- Diabetes
- Viral diseases

Unit-5. Introduction to pharmacogenomics, recent advances and applications of **15 marks**

Transgenic and Knockout animals.

Gene therapy: Concept of Gene therapy and its recent development in the treatment of various hereditary diseases.

Techniques for the study of Molecular Pharmacology:, ELISA, Western Blotting, PCR, etc.

References:

1. Goodman and Gilman‘s The Pharmacological basis of therapeutics, McGraw-Hill Education / Medical

2. David E Golan, Principles of Pharmacology. The Pathophysiologic basis of drug therapy.Wolters Kluwer Publisher.2004.
3. B.G. Katzung Basic and Clinical Pharmacology , Mc Graw Hill. 15th edition, 2020.
4. H.P. Rang and M.M. Dale Pharmacology, Elsevier, 9th edition, 2019.
5. Gibaldi and Prescott, Hand book of Clinical Pharmacokinetics, ADIS Health Science Press (January 1, 1983)
6. E T.Herfindal and Gourley, Text book of Therapeutics, drug and disease management, Lippincott Williams and Wilkins; 2007
7. OECD test guidelines (https://www.oecd.org/chemicalsafety/testing/oecdguidelinesforthetestingofchemicals.htm)
8. Karen E, Stine, Thomas M Brown, Principles of Toxicology, Boca raton, CRC press 2015.
9. Robert H. Gates, Infectious disease secrets, Hanley & Belfus;2003.
10. Dr. U. Satyanarayan and Dr U Chakrapani , Biotechnology ,2005
11. B. D. Singh - Biotechnology Expanding Horizons, Kalyani Publishers,2020
12. K. D. Tripathi, Essentials of Medical Pharmacology, Jaypee Publishers, 2008.

PAPER-III

E-07 : PHARMACOLOGICAL SCREENING METHODS

Unit-1. General Principles of Screening, Correlations between various animal models and human situations, Specific use of reference drugs and interpretation of screening results. Human equivalent dose calculations, animal equivalent dose calculation. **20 marks**

Unit- 2. Drug Toxicity, Safety Evaluation of new drugs. Regulations for Laboratory animal care and ethical requirements including OECD guidelines. **15 marks**

Unit 3. Techniques to evaluate drugs belonging to following categories: **20 marks**

a. Analgesics, Anti-inflammatory and Anti-Pyreticagents.

b. Antiulcer, Anti-diabetics, Hepato-protective, Nephroprotective and Anti-obesity activity.

c. Effects on behaviour and muscle coordination, Anti-epileptics drugs, Anti-Parkinsonism agents anddrugs used in Alzheimer disease.

Unit-4. Correlation between in-vitro and in-vivo screening; Special emphasis on **10 marks**

High throughput screening, transgenic animal model for drug screening, Cell based assay, radio ligand binding assay (adrenoreceptors, ion channels, 5 HT, dopamine, muscarinic, histamine).

Unit.5. Alternatives to animal experimentation: **15 marks**

a. Animal cell lines and their uses.
b. Enzymatic assays
c. In- silico methods
d. Patch clamp technique

References:

1. NodineSiegler, Animal and Clinical Pharmacological Techniques in Drug Evaluation. Journal of medical education, 1964.
2. Turner Robert A, Screening Methods in Pharmacology Vol.-I and II, Academic Press, London, 1971.
3. Goldstein, Principles of Drug Action: The Basis of Pharmacology, John Wiley and Sons, NewYork.1974.

4. James Crossland, John Jacob Lewis, Pharmacology, Churchill Livingstone, Edinburgh, 1970.
5. Goodman and Gilman: Pharmacological Basis of Therapeutics, Pregamon Press, New York.1941.
6. BacqZM,Fundamentals of Biochemical Pharmacology.1971.
7. Lawrence DR and Bacharach AL, Evaluation of Drug Activities: Pharmacometrics, AcademyPress, London.1964.
8. Ghosh MN, Fundamentals of Experimental Pharmacology, Scientific Book Agency, Calcutta.2008.
9. Kulkarni SK, Handbook of Experimental Pharmacology, VallabhPrakashan, Delhi.
10. Seth UK, Dadkar NK, and Kamat UG: Selected Topics in Experimental Pharmacology, Kothari Book Depot, Bombay.
11. Vogel HG, Drug Discovery and Evaluation, Springer, Germany.2008.
12. LaFollette H, Shanks N: *Brute Science: Dilemmas of animal experimentation*. London andNew York: Routledge; 1996.
13. Hau J: Animal Models. In *Handbook of Laboratory Animal Science Animal Models*. *VolumeII*. 2nd edition.
14. Overmier JB, Carroll ME: Basic Issues in the Use of Animals in Health Research. In *Animal Research and Human Health*. Edited by Carroll ME, Overmier JB. American Psychological Association; 2001:5.
15. http://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidance s/ucm078932.pdf.
16. Shanks N, Greek R, Nobis N, Greek J: Animals and Medicine: Do Animal ExperimentsPredict Human Response?
17. Houdebine LM: Transgenic animal models in biomedical research.
18. Methods MolBiol 2007, 360:163-202.
19. http://www.fda.gov/downloads/Drugs/Guidance Compliance Regulatory Information /Guidances/ucm078932.pdf.

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Paper-III

E-08 BIOMOLECULES AND DRUG DEVELOPMENT RESEARCH

Unit I **[15 mks]**

Amino acids, peptide bond and protein structure: End group determination of peptides, sequencing of peptides using various chemical and analytical techniques with case studies like LHRHand TRH peptides.

Peptidomimetics; Protein-ligand interactions; Multiple binding modes.

Structure of lipoproteins and glycoproteins in relation to their function.

Unit II **[15 mks]**

Structure of lipids, polysaccharides and carbohydrates: Relation-ship between their structure, physico-chemical properties and their biological functions.

Detailed structure of nucleic acids and protein-nucleic acid interactions: Nucleic acid and small molecule interactions; DNA damage and repair.

Unit III **[15 mks]**

Structure and function of biomolecules pertaining to different thearapeutic areas: Cancertubuline-role in cell proliferation, various binding sites, the chemistry and biology of tubuline inhibitors; farnesyltransferase- X-ray structure, ras protein and its role; Inflammation-COX-1 and COX-2 theirstructures and physiological role; Hyperlipidimia-HMG-CoA its structure and role in cholesterol manipulation.

Unit IV **[20 mks]**

Enzymology: Source of enzymes; production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions etc.

Immobilized enzyme technology: Different techniques of immobilization of enzymes and whole cells; Advantages and disadvantages of immobilization; Kinetics of immobilized enzymes, multi step immobilized enzyme systems; Applications of immobilized enzyme technology.

Unit V **[15 mks]**

Biological crystallography: Crystallisation data collection, refinement, identification of active

site, phase determination heavy atom derivatives, electron density maps. Differences in the small molecule and biomolecule crystallography.

Thermodynamical methods: Differential Scanning Calorimetry (DSC) and Thermogravimetric analysis (TA) of biomolecules, Isothermal Titration Calorimetry (ITC).Various thermodynamics based instrumental methods for estimation of structural features of biomolecules.

Recommended books:

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David Freifelder

3. Introduction to Biophysical methods in Protein and Neucleic Acid research, by J.A. Glasel

4. Monosaccharides. Their Chemistry and Their Roles in Natural Products

5. Essentials of Glycobiology by Varki

6. Carbohydrates by Osborn

7. Modern Methods in Carbohydrate Synthesis by Khan and O'Neill

8. Organic Synthesis with Carbohydrates by Boons and Hale

9. Enzymes in Synthetic Organic Chemistry by Wong and Whitesides

10. Methods in Modern Biophysics by B. Nolting

11. Introduction to Biophysical Methods in Protein and Neucleic Acid Research by J.A. Glasel.

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PAPER-III

E-09 BIO-ORGANIC CHEMISTRY AND BIOTECHNOLOGY

UNIT-I **[10 MKS]**

Importance of marine natural product chemistry in drug development: Chemistryand biology of marine natural products, marine chemical ecology, marine biomedicinalsand marine toxins from bacteria, microalgae, rhodophyta, chlorophyta, porifera, ascidians,corals, nudibranchs, biosynthesis of marine natural products.

UNIT-II **[15MKS]**

Carbohydrates: Mono, di, oligo- and polysaccharides, separation & isolation, purification, structure determination, linkage stereochemistry, biological activity.

Glycoproteins, lipoproteins and glycopeptidolipids; structure and biological activity, isolation, purification, degradation, structure determination.

Pharmacophore Perception: Unity in diversity; common minimum feature identification.Pharmacophore mapping techniques, methods of conformational search used in pharmacophoremapping. Comparison between the popular pharmacophore methods like Catalyst/HipHop, DiscoTech, & GASP with practical examples.

UNIT-III **[25 MKS]**

Enzymology: Source of enzymes; Production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and producttolerance, effects of metal ions etc.

Enzyme in organic solvents and ionic liquids: Various organic solvents and ionic liquidsused in Biocatalysis; Potential in organic solvents and ionic solvents.

Immobilized enzyme technology: Different techniques of immobilization of enzymes andwhole cells; Advantages and disadvantages of immobilization; Kinetics of immobilizedenzymes, design and operation of immobilized enzymes reactors; Calculations ofdiffusional resistances and Thiele's modulus, multistep immobilized enzyme systems;Application and future of immobilized enzyme technology.

Enzyme biosensors: Applications of enzymes in analysis; Design of enzyme electrodesand case studies on their application as biosensors in industry; healthcare and environment.

UNIT-IV **[15 MKS]**

De novo Bioactive Design: Active sites, allosteric sites, subpockets. Receptor/enzyme cavity size prediction.Predicting the functional components of cavities, designing drugs fitting into cavity. Trypanothioneinhibitor Design using De novo design strategies.

Molecular Dynamics: Trajectories – structural, energy, interaction. Dynamics of drugs, dynamics ofbiomolecules, dynamics of drug-receptor complexes. Molecular dynamics in estimation of free energyfrom dynamical methods. Entropy and van der Waals vs. electrostatic component. Residuewiseinteraction energy estimation using MD simulations. Human vs. PfDHFR interaction energy differencewith P218.

UNIT-V **[15 MKS]**

Tissue culture techniques: Micro-propagation of medicinal and aromatic plants, secondary metabolism in tissue culture, germplasm storage, methods of cell immobiliza-tion, Brassinosteroids as plant growth regulators.

Biotechnology of propagation and production of antibiotic and non-antibiotic drugs from lower plants.

Recommended books:

1. Chemistry of Natural Products by S. V. Bhat, B. A. Nagasampagi, M. Sivakumar
2. Medicinal Natural Products: A Biosynthetic Approach by Paul M. Dewick
3. Organic Chemistry Vol. 1: The Fundamental Principles by I. L. Finar
4. Lehninger's Principles of Biochemistry by Albert L. Lehninger, David Lee Nelson, Michael M. Cox
5. Biochemistry by Donald Voet, Judith G. Voet
6. Enzyme and Microbial Technology by J.Rehm and G.Reed
7. Biotol Series (This series has many books pertaining to all fields of Biotechnology students have to select the books as per the topics if interest)
8. Molecular Modelling, by A. R. Leach
9. Organic Chemistry of Drug Design and DrugAction, by R.B. Silverman
10. Practical applications of computer aided drug design, by P.S. Charifson
11. Introduction to Plant Tissue Culture by M. K. Razdan

PAPER-III

E-10 : COMPUTATIONAL MEDICINAL CHEMISTRY RESEARCH

UNIT-I **[15 MKS]**

Molecular modeling and Bioactive conformation: Wave function of drug molecules. Hamiltonian of Drugs. Absolute and relative energies of drug conformers. Energy minimization, comparison between global minimum conformation and bioactive conformation. Manual and automated conformational search methods, their advantages and disadvantages. Implicit and explicit solvent effects on the structures of drugs. Conformational interconversion, transition-state determination and their role in designing rigid analogs. Computer methodologies behind molecular modeling including artificial intelligence methods.

UNIT-II **[20 MKS]**

Molecular Docking: Rigid docking, flexible docking, manual docking, induced fit docking. Algorithms formolecular docking. Advantages and disadvantages of Glid, GOLD, Autodock and Dock software, withsuccessful examples.

Virtual Screening : Protocol development in virtual screening. Qualitative versus quantitative approaches- advantages and disadvantages. Random screening, Non-random screening, drug metabolism studies, clinical observations, rational approaches to lead discovery.

Pharmacophore Perception: Unity in diversity; common minimum feature identification.Pharmacophore mapping techniques, methods of conformational search used in pharmacophore mapping. Comparison between the popular pharmacophore methods like Catalyst/HipHop, DiscoTech, & GASP with practical examples.

UNIT-III **[15 MKS]**

QSAR: Steric and electronic effects: Hammett equation, lipophilicity effects. Hanschequation. Experimental and theoretical approaches for the determination of physico-chemical parameters, descriptors from Graph theory. Regression analysis, extrapolation versus interpolation, linearity versus nonlinearity. Descriptor calculation. The importance of biological data in the correct form;2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.

UNIT-IV **[15 MKS]**

De novo Bioactive Design : Active sites, allosteric sites, subpockets. receptor/enzyme cavity size prediction. Predicting the functional components of cavities, designing drugs fitting into cavity. Trypanothione inhibitor Design using De novo design strategies.

Molecular Dynamics : Trajectories – structural, energy, interaction. Dynamics of drugs, dynamics of biomolecules, dynamics of drug-receptor complexes. Molecular dynamics in estimation of free energy from dynamical methods. Entropy and van der Waals vs. electrostatic component. Residue wise interaction energy estimation using MD simulations. Human vs. PfDHFR interaction energy difference with P218.

UNIT-V **[15 MKS]**

Case studies : Anti-malarial agent design using CADD methods (PfDHFR), Anti-diabetic agent design(GSK3), anti-cancer agent design (TopoisomeraseII), Anti-leishmanial agent design (TR inhibitors).

Recommended books:

1. Molecular Modelling, byA. R. Leach

2. Organic Chemistry of Drug Design and DrugAction, by R.B. Silverman

3. Practical applications of computer aided drug design, by P.S. Charifson

4. Molecular modeling in Drug Design, by C. Cohen

5. Chemical applications of Molecular modeling, by J. Goodman

6. Pharmacophore perception, by O.F. Guner