

BHARATHIAR UNIVERSITY, COIMBATORE - 641 046.

PG DIPLOMA IN CHEMINFORMATICS

(with effect from 2010-11 onwards)

SEMESTER	SUBJECT AND PAPER	MARKS
I	Paper I : Basics of Cheminformatics	100
I	Paper II: Computer programming for Cheminformatics	100
I	Paper III : Cheminformatics Database Design and their Management	100
I	Paper IV : Pharmaceutical Chemistry	100
II	Paper V : Structure based drug design	100
II	Practical I : Computer programming	100
II	Practical II : Computer Aided Drug Design	100
II	Project & Viva-voce	100
	Total	800

*Practical I & II examinations will be conducted in the Second Semester

PAPER-I BASICS OF CHEMINFORMATICS

UNIT I:

Graph theory and molecular numerology; Logic, sets and functions; Algorithms, integers and matrices; Mathematical reasoning, induction and recursion; Counting; graphs, trees and sets, basic probability and statistics; Markov processes

UNIT II:

Basic Stereochemistry, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures. Introduction to drug action, pro drug design and applications

UNIT III:

History of scientific information communication-chemical literature-chemical information-chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources

UNIT IV:

Introduction; Experimental sources of biological data; Publicly available databases; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualisation of sequence data; Visualization of structures using Rasmol or SPDB Viewer or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics.

UNIT V:

Introduction to drugs, structure-based drug design. QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and *De Novo* Drug Design Virtual screening/docking of ligands. Protein structure, Drug action & enzymes. Drug action & receptors. Prediction of Binding Modes, Protein-Ligand binding free energies, Fragment-Based Drug Design, ADMET prediction.

REFERENCES:

1. "Mathematical Methods for Physicists" Arfken, Academic Press 1985
2. Schaum's Outline of Probability and Statistics, Murray R Spiegel, John J. Schiller, R. Alu Srinivasan
3. Stereochemistry, by David G. Morris, Eddie Abel
4. Introduction to Protein Structure: Second Edition, Carl Branden, John Tooze
5. Combinatorial Chemistry and Molecular Diversity in Drug Discovery, Eric M. Gordon, James F. Kerwin
6. Computer-Aided Drug Design: Methods and Applications, T.J. Perun C.L. Propst
7. Chemical Information Sources (Mcgraw-Hill Series in Advanced Chemistry), Gary Wiggins
8. Introduction to Bioinformatics, Teresa K. Attwood, David Parry-Smith
9. Molecular Modeling: Basic Principles and Applications, 3rd Edition, Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers
10. Trends in Bioinformatics. By Dr. P. Shanmughavel. 2006 Pointer publishers, Jaipur, India.
11. Principles of Bioinformatics. By Dr. P. Shanmughavel. 2005 Pointer publishers, Jaipur, India.

PAPER II COMPUTER PROGRAMMING FOR CHEMINFORMATICS

UNIT I:

Operating systems – Human interface, Algorithms-genetic algorithms- neural networks- Artificial intelligence, Grid & high-performance computing, Software, Open source. Document mark up languages: HTML, XHTML, XML: Key terminology, Characters and escaping, Well-formedness and error-handling, Schemas and validation Related specifications, Use on the Internet, Programming interfaces, Chemical Markup Language

UNIT II:

Basics of C & C++ : Basic Syntax - Variables, Constants and Built-in Types - Operators and Basic Expressions - Flow Control and Statement Blocks - Functions and Arguments - Modules and Scope – Arrays - Character Strings – Pointers - Defining New Types - Classes and Objects – Casts – Preprocessor The Programming Process - Writing Source Code.

UNIT III:

JAVA Programming -Introduction to Java - JavaScript for Cheminformatics: Basic Syntax - Variables, Constants and Built-in Types - Operators and Basic Expressions - Flow Control and Statement Blocks - Functions and Arguments - Modules and Scope – Arrays - Character Strings – Pointers - Defining New Types - Classes and Objects – Casts – Preprocessor

UNIT IV:

Programming in PERL and PYTHON : PERL: Introduction, Basic operators and control structures, Scalars, Lists, Hashes, File Manipulation, Pattern Matching and Regular Expressions, Subroutines, Text and string Processing Python Programming: Overview-Data structures-control flow-modules-basic I/O, Exception Handling, Regular expressions, File manipulation, classes, standard library.

UNIT V:

Computer networking: Introduction Network classification: Connection method- Scale-Functional relationship (network architecture)-Network topology Types of networks: Personal area network-Local area network-Campus area network- Metropolitan area network-Wide area network- Global area network- Virtual private network Internetwork: Intranet- Extranet-Internet Basic hardware components: Network interface cards, Repeaters, Hubs, Bridges, Switches, Routers

REFERENCES:

1. The C Programming Language, B.W.Kernighan and D.M. Ritchie 2nd Edition. Prentice Hall of India.
2. Programming Perl – Larry Wall, Tom Christiansen & John Orwant 3ed 2000- O’ Reilly
3. Programming Python – Mark Lutz – 2nd Ed., O’ Reilly
4. E. Balagurusamy - “Programming in C++ ” - Tata Mc. Graw Hill Edition
5. Byron Gottfried, - “Programming with C” (Schaum's Outline Series) - Tata
6. McGrawHill Publishing Company - 1998.
7. Object oriented programming with c++ -Robert Laffore -Waite series.
8. Programming Perl - Tom Christiansen, Larry. Wall Orielly Publications

PAPER –III CHEMINFORMATICS DATABASE DESIGN AND THEIR MANAGEMENT

UNIT I:

Database Concepts: Relational Databases-Object Databases-Basic SQL- Data types- Operators. E-R Model and Normalization - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables; Security, Backup and Recovery: Creating users- Encrypting traffic- Backup of the database- Recovery

Unit II:

Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Multimedia Databases - Basic Concepts and Applications; Indexing and Hashing; Text Databases; Introduction to Distributed Database Processing, Data Security. Interfacing programs with databases; Data interoperability using XML.

UNIT III:

Database Design: Introduction to Schema Refinement- Functional Dependencies-Normal Forms- First, Second, Third, Boyce code, Fourth and Fifth Normal forms- Multivalued Dependencies.

UNIT IV:

Introduction-chemical databases- types- chemical database design - Bio Catalysis Database. The MOS Database, reaction databases, The Failed Reaction Database. Protecting groups database- solid-phase synthesis database- Sequence Databases, Spectra. Databases, (Bio) Activity/Prop. Databases, Toxicology Databases.

UNIT V:

Data mining methods, Sub structural analysis, Discriminant Analysis, Neural networks, Decision Trees; Software for Chemical Data Mining. Data Mining and human genome. Combinatorial Chemistry Technologies and Libraries. Chemistry Libraries: Design of Focused, Diverse and Thematic Libraries. Biological Libraries, Bio planning, Peptide Display Libraries design and construction.

REFERENCES:

1. Database Systems Concepts ,Abraham Silberschatz, Henry F. Korth, S. Sudarshan
2. Database Management Systems, Raghu Ramakrishnan, Johannes Gehrke
3. Data Mining Techniques,Michael Berry & Gordon Linoff
4. Practicals in Bioinformatics By Dr. P. Shanmughavel and Gulshan Wadhwa, 2010 Pointer publishers, Jaipur, India.

PAPER IV - PHARMACEUTICAL CHEMISTRY

UNIT I:

Molecular basis of drug action: Receptor: Drug Receptor Interaction: Basic ligand concept, agonist, antagonist, partial agonist, inverse agonist, Drug receptor concepts with special reference to Opioid, Histaminergic, Adrenergic and GABA nergic receptors. Enzyme Inhibition – Enzyme, enzyme Kinetics, enzyme Inhibitors - reversible, irreversible, enzyme Inhibitors as drugs - HIV - Protease / Reverse Transcriptase, Integrase and Cytochrome P-450 Inhibitors. Drug binding to nucleic acid - Antimalarial, anti-cancer, antiviral.

UNIT II:

Definition of terms - disconnection, synthon, functional group interconversion (FGI), Basic rules in Disconnection, Use of synthon approach in synthesis of compounds: Trimethoprim, erfenadine, Ibuprofen, Propanolol, Fentanyl, Ciprofloxacin, Cimetidine, Piroxicam, osiglitazone, Diclofenac, Captopryl, Nifedipine, Losartan.

UNIT III:

Introduction, combinatorial approaches, chemical Peptide and small molecule libraries, applications, methodology, combinatorial organic synthesis, assays and screening of combinatorial libraries, introduction to High Throughputs Screening (HTS).

UNIT IV:

Nanochemistry-Physical chemistry related to nanoparticles such as colloids and clusters. Exploitation of self-assembly and self-organization to design functional structures in 1D, 2D or 3D structures. Nanomaterials: (Nanoparticles, nanoclusters, quantum dots synthesis): Top-down techniques: photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies, Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Pattern replication techniques: soft lithography, nano imprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques.

UNIT V:

Microwave synthesis- fundamentals of microwave synthesis- Microwaves Are Energy- Microwaves Can Interact with Matter- Two Principal Mechanisms for Interaction with Matter- Microwave Heating Differs from Conventional Means: Conventional Heating Methods- Microwave Heating - The Microwave Effect with examples - Single-Mode and Multimode Microwave Cavities

REFERENCES:

1. A Primer of Drug Action, Dr. Robert M. Julien M.D.
2. Designing organic syntheses, a programmed introduction to synthon approach, Stuart warren
3. Combinatorial Chemistry: Synthesis, Analysis, Screening, Günther Jung
4. Nanochemistry, G.B. Sergeev
5. Microwave Synthesis, B. L. Hayes

PAPER-V STRUCTURE BASED DRUG DESIGN

UNIT I:

Drug discovery-Strategies and historical developments - Introduction –conventional strategies to drug discovery-molecular mimetic- first and second generation rational approach-Rational drug design-assessment of drug activity.

UNIT II:

Introduction, Molecular Dynamics using simple models. Dynamics with continuous potentials. Constant temperature and constant dynamics. Conformation searching, Systematic search. Applications to protein folding.

UNIT III:

Developing and using QSAR- QSAR-validation methods-3D QSAR approach-QSAR descriptors, 3D QSAR-Introduction-Pharmacophore identification-binding site modeling of unknown receptor-receptor mapping-structural alignment and superposition-molecular field analysis (MFA).

UNIT IV:

3D pharmacophore, De novo Ligand design-introduction-approaches to de novo drug design problem-some current methods for de novo design.3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, prediction of binding energy of ligand-receptor complex-Free energies and salvation-electrostatic and non-electrostatic contribution.

UNIT V:

Molecular docking: Introduction Docking approaches: Shape complementarily- Simulation Mechanics of docking - Search algorithm-Scoring function-Applications.

REFERENCES:

1. The organic chemistry of drug design and drug action, Richard B. Silverman
2. Drug design: cutting edge approaches, Darren R. Flower
3. Molecular Modeling: Basic Principles and Applications, 3rd Edition, Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers
4. Molecular Modelling: Principles and Applications, Andrew R. Leach
5. Trends in Bioinformatics. By Dr. P. Shanmughavel. 2006 Pointer publishers, Jaipur, India.
6. Principles of Bioinformatics. By Dr. P. Shanmughavel. 2005 Pointer publishers, Jaipur, India.

PRACTICAL I - Computer programming

C++, JAVA, Perl, Python, Visual Basic, ORACLE

PRACTICAL II – Computer Aided Drug Design

- 1. Chemical databases** – ChemBank - ChemBioFinder – CSChemoffice - ZINC
- 2. Small Molecule Building** – Chems sketch, ISIS Draw
- 3. Molecular Modeling** – Modeller, Swisspdb
- 4. Molecular dynamics** - GROMACS- NAMD-VEGA ZZ
- 5. Structural chemistry** - NWChem –GAMESS
- 6. Docking** - Auto dock, DOCK -VEGA- FlexX

References:

Practicals in Bioinformatics By Dr. P. Shanmughavel and Gulshan Wadhwa, 2010 Pointer publishers, Jaipur, India.