

Department of Biotechnology

Paper II Recent advances in Biotechnology

In the era of multidisciplinary approach revolution in biotechnology that began nearly 50 years ago has had an enormous impact. As biotechnology pertains to the study of living systems at the molecular level, especially DNA, RNA and PROTEIN, and provides a background appropriate for further work in the rapidly expanding areas, basic techniques in biotechnology are much needed by the students of Botany, Zoology, Microbiology, Fisheries, Veterinary, Pharmacology, Physiology, Medicine, Genetics, Agriculture and allied subjects. This course “Recent Advances in Biotechnology” will focus on selected aspects of biotechnology that provide a comprehensive overview of the key concepts in molecular biology, principles for understanding the structure and functional relationships of molecular biology techniques to facilitate and sharpen skills on biotechnology techniques.

Course will give emphasis on recent molecular biology techniques including several examples of molecular applications in field of Genomics, Cell biology, Agriculture, Microbiology, Diagnostics, Pharmacology etc.

The overall course is divided into following topics covering following techniques

- **Hybridization techniques** : Southern, Western, Northern and Dot Blots etc
- **Gene expression studies** : Real-Time-PCR, Micro arrays & Gene chips
- **Sequencing** : DNA and Protein sequencing
- **Immunological techniques**: Radial Immuno diffusion test, ELISA, RIA, Surface Plasmon Resonance etc.
- **Molecular Marker** : RFLP, AFLP, SCARs, SNPs, EST-SSR etc
- **Spectroscopic methods**: UV/Vis, fluorescence spectrometry
- **Electrophoretic techniques**: Vertical, Horizontal, 2-Dimensional, Denaturing gradient gel electrophoresis, Thermal gradient gel electrophoresis etc
- **Variants of PCR and Amplification of gene**: Semi-Quantitative RT PCR, Nested PCR, Multiplex PCR, DOP-PCR etc.
- **Bioinformatics** : Data Mining GENBANK, Blasting Sequence, Primer designing etc

Suggested readings:

- a. Genomes 3 by *T. A. Brown*
- b. Practical Biochemistry by *Wilson and Walker*

- c. Principles of Gene Manipulation and Genomics by *Primrose and Twymann*

Botany

Paper II- Recent advances in Botany

Max. Marks: 100

PAPER- II: Ph.D. Course (Botany)

1. Microbes and Mycorrhiza and their significance.
2. Biodiversity assessment and conservation: Distribution pattern, endemism, resource utilization and conservation.
3. Modern trend in taxonomy with special reference to Biosystematics.
4. Ecosystems: Diversity and Management with special reference to the Himalaya.
5. Genetic engineering and its implications: Gene isolation, enzymatic synthesis of gene, transgenic crops, PCR (Polymerase Chain Reaction).
6. Biotechnology: Scope and importance of biotechnology, tissue culture techniques in biotechnology, biotechnology in medicine and agriculture.

Suggested Readings:

1. Mitra, Sandhya (1996). Genetic Engineering. Mc – Millian India Co. Ltd., New Delhi.
2. Gupta, P.K. (2001). Elements of Biotechnology. Rastogi Publications, Meerut., Pp: 1-13.
3. Odum, E.P. (2000). Fundamentals of Ecology. Thomson Asia Pvt. Ltd., Singapore.
4. Ricklefs, Robert, E. and Gary L. Miller (2009). Ecology (IVth edition). W.H. Freeman and Company, New York.
5. Chawala, H.S. (2006). Introduction to Plant Biotechnology. Oxford and IBH Pub. Co., New Delhi.
6. Naik, V.N. (2001). Taxonomy of Angiosperms. Tata MC Graw- Hill Pub. Co. Ltd., New Delhi.
7. Christian Leveque and Jean-Claude Moun oluv.- Biodiversity, John Wiley & Sons, Ltd.
8. Smith, S.E. & D.J. Read – Mycorrhizal Symbiosis. Academic Press.
9. Mahendra Raj & Ajit Verma – Diversity and Biotechnology of Actomycorrhiza.

Chemistry

(Paper II : Recent Advances in Chemistry)

Max Marks: 100

1. GREEN CHEMISTRY

Basic Principles of Green Chemistry. Designing a Green Synthesis: Choice of starting materials, choice of reagents, choice of catalysts, choice of solvents. Green reagents: Green catalysts: Phase transfer catalysis for green synthesis. Organic synthesis in solid phase.

Versatile ionic liquids as green solvents. Some examples of synthesis involving basic principles of green chemistry of industrial importance.

2. NANOCHEMISTRY

Introduction, classification of nanoparticles, synthesis, characterization, properties and application of nanomaterials.

3. ADVANCED MATERIALS CHEMISTRY

Structure of solids, symmetry concepts, crystal structure. Preparative methods and characterization of inorganic solids. Crystal defects and non-stoichiometry. Interpretation of phase diagrams, phase transitions. Basics of magnetic, thermal, electrical, optical and mechanical properties of solids.

4. APPLICATION OF SILICATE-BASED INORGANIC SOLIDS

Silicates, Clays, Nano clays, Zeolite and Zeolitic Materials. Importance of Zeolite and Zeolitic Materials: As adsorbents and molecular sieves, As heterogeneous reusable catalysts in petrochemical industry, As filler in fire retardant materials, In nuclear industry, In agricultural industries

5. SPECTROSCOPY AND ITS APPLICATIONS

N M R Techniques in the identification and characterization of organic compounds, Inorganic complexes and Polymers.

6. INTRODUCTORY QUANTUM CHEMISTRY

Postulates of Quantum Mechanics. Operators. Chemical bonding: Born-Oppenheimer approximation. Variational treatment of hydrogen molecule ion. Valence bond and MO (LCAO) treatment of hydrogen molecule.

7. ADVANCED CHEMICAL KINETICS

Experimental methods for fast reactions. Temperature jump, pressure jump stopped flow and flash photolysis pulse technique as applied to reaction rates of short lived species. Shock tube kinetics. NMR studies in rate processes. Enzyme kinetics of complicated systems, theory of diffusion controlled reactions.

8. ANALYTICAL TECHNIQUES FOR MATERIAL CHARACTERIZATION

Diffraction Methods: X-Ray Diffraction, Neutron Diffraction, Electron Diffraction. Thermal Methods: TGA, DTA, DSC, Thermometric Titration. Adsorption/ Desorption Techniques: BET and EGME methods of determination of external and total surface area.

Suggested Readings :

1. Anastas, P. T. and Warner, J. C., Green Chemistry: Theory and Practice, New York, Oxford University Press.
2. Anatas, P. T. and Williamson, T. C., Green Chemistry: Frontiers in Benign Chemical Synthesis, New York, Oxford University Press.
3. Anatas, P. T. and Williamson, T. C., Green Chemistry: Designing Chemistry for Environment, Washington D. C., American Chemical Society.
4. Ahluwalia, V. K. and Kidwai, M., New Trends in Green Chemistry, Kluwer Academic Publishers.

5. Ahluwalia, V. K., Green Chemistry: Environmentally Benign Reactions, University of Delhi, India.
6. Clark, James and Macquarrie, Duncan, Handbook of Green Chemistry and Technology, Blackwell Publishing.
7. Geoffrey, A. Ozin and Andre C. Arsenault, Nano Chemistry: A Chemical Approach to Nano Materials, R S C Publishing
8. Sergeev, G. B., Nano Chemistry, Elsevier Ltd.
9. Cademartiri, Ludovico, Geoffrey, A. Ozin and Lehn, Marie Jean, Cocept of Nano Chemistry.
10. Weber, U. and Thicle, H., N M R Spectroscopy: Modern Spectral Analysis, Wiley, New York.
11. Rahman, Atta-Ur and Chaudhary, Moh. Iqubal, Solving Problems with N M R Spectroscopy, Academic press.
12. Simpson, Jeffrey H., Organic Structure Determination using 2 D N M R Spectroscopy: A Problem based approach, Elsevier, Academic Press
13. Croasmun, William R. and Carlson, R. M., Two Dimensional N M R Spectroscopy: Application for Chemists and Bio Chemists, John Wiley and sons.
14. Akitt, J. W. and Mann, B. E., N M R and Chemistry: An introduction to modern N M R Spectroscopy, Stanley Thomas Publishers.
15. West, Anthony R., Solid State Chemistry and its Applications, John Wiley and Sons.
16. Smart, Lesley and Moore Elaine, Solid State Chemistry An Introduction, Viva Books Private Limited. www.Nelsonthrones.com.
17. Pauling, L. and Wilson, E. B., Introduction to Quantum Mechanics, McGraw Hills.
18. Chandra, A. K., Introductory Quantum Mechanics, Tata McGraw Hills.
19. Willard, H. H., Merritte, L. L. Jr., Dean, J. A. and Settle, F. A. Jr., Instrumental Methods of Analysis, C B S Publishers and Distributers, New Delhi.
20. Laidler, K. J., Chemical Kinetics, Tata McGraw Hills.
21. Kalidas, C., Chemical Kinetic Methods, New age international publishers.

Forestry

Paper II- Recent advances in forestry

Max. Marks: 100

- Recent advances in the forestry: an introduction
- Various disciplines of forestry
- Forests and impact of climate change
- Research methods and sampling techniques for various disciplines of Forestry like Forest Ecology, Soil Sciences, Social Forestry, Agroforestry, Plantation Forestry, Watershed Management, Seed Science and Technology, Regeneration and Natural Resource Management (NRM).
- Forestry and its relation to industries, use of GIS and Remote Sensing and Computer application in forestry.

- Basic Statistics used in forestry, measures of central tendency, dispersion, correlation, regression and analysis of variation and use of various software in data analysis.
- Important instruments used in forestry research.

GEOLOGY

Ph. D Syllabus

Paper -2

Recent advances in the subject concerned

Recent developments in Himalayan geology - origin, sedimentation, magnetism and metamorphism.

Modern concept in global tectonics. Contemporary developments in Indian stratigraphy and palaeontology.

Recent mineral discoveries, genesis and occurrence in India. Environmental status of Indian subcontinent.

Role of geologist in climate change studies. Application of Computer softwares in Geology

Suggested Readings

1. The Making of India Geodynamic Evolution by K.S. Valdiya
2. Geology, Environment and Society by K.S. Valdiya
3. The Dynamic Earth by A.M. Patwardhan
4. Plate Tectonics and Crustal Evolution by Kent C. Condie
5. Fundamentals of Geology by A.B. Roy
6. A handbook of Minerals, Crystals, Rocks and Ores by P.K. Alexander
7. Economic Geology by Umeshwar Prasad
8. Precambrian Geology of India by S.M. Nakvi and Rogers
9. Precambrian of South India by S.M. Nakvi
10. Rockware ® Web page

Physics

Paper II- Recent advances in Physics

Max. Marks: 100

- **Mathematical Methods:** Complex variables, Cauchy-Ricmann condition, analytic functions, Cauchy's theorem, Legendre Bessel Hermite differential eg. Fourier integral and Fourier ransforms.

- **Classical Mechanics:** D' Alembert's principle and Lagrange's equations, Hamilton's principle, the principle of least action, Canonical transformations.
- **Non Relativistic Quantum Mechanics:** Schrodinger equation and its applications, Theory of angular momentum, Quantum Theory of Scattering, S-matrix Theory.
- **Statistical Physics:** Foundation of Statistical mechanics, Elements of ensemble theory- a system in Microcanonical, Canonical, and Grand Canonical ensembles, Partition functions applications of ensemble theory Maxwell-Boltzman, Bose-Einstein, Fermi-Dirac distributions.
- **Atomic and Molecular Physics:** Electronic spectra, Radiative transitions, Applications of Laser in spectroscopy, Basic idea of two photon processes and frequency up conversion.
- **Nuclear and particle Physics:** Nuclear forces, Nuclear Models, Beta decay Fermi theory, parity violation, Symmetry and conservation laws, Special Unitary Symmetries and Quark model.
- **Electrodynamics and Plasma Physics:** Maxwell's equations in four dimensions, Gauge transformations, Lorentz transformations, Elementary concept of Plasma and Magneto-Hydrodynamics.
- **Relativistic Quantum Mechanics:** Relativistic Quantum Mechanics, Basics concepts of Quantum Field Theory.
- **Electronics:** Linear integrated circuits, Operational amplifier and its applications.
- **Condensed Matter Physics:** Debye theory of solids, Bloch theorem, K.P. Model, distinction between Metal, insulator and semiconductor, Superconductivity, BCS theory of Superconductor.

Suggested Reading:

1. Introduction to Mathematical Physics by Charlie Harper
2. Classical Mechanics by H. Goldstein
3. Advanced Quantum Mechanics by B.S.Rajput
4. Introduction to solid state physics by C.S.Kittel
5. Atomic Spectroscopy by White
6. Introduction to Molecular Spectroscopy by G.M.Barrow
7. Quantum Theory by Davydov
8. Quantum Mechanics Vol.I & II by Messiah
9. Introduction to digital computer design by V.Rajaraman

10. Introduction to solid state physics by C.S.Kittle
11. Statistical physics/Mechanics by K.Huang
12. Introduction to High Energy physics by D.H.Perkins
13. Nuclear Physics by R.R.Roy and B.P.Nigam

Statistics

Paper II- Recent advances in Statistics

Max. Marks: 100

- I. **Sampling Theory –**
Small area estimation: concept of small area estimation, its importance and methods of small area estimation.
Controlled selection: definition, purpose and importance of controlled selection, different techniques of controlled selection. One dimensional and two dimensional controlled selection.
- II. **Composite Hypothesis Testing:** composite hypothesis, methods of testing composite hypothesis.
- III. **Analysis of Survey Data –**
Regression Analysis: simple linear regression, multiple linear regression, polynomial regression models, multicollinearity.
Categorical analysis: definition and analysis of categorical data.
- IV. **Bootstrapping/Jack Knifing:** Theory and application of jackknife and bootstrap
- V. **Fractional Factorial Designs:** construction and properties of fractionally replicated designs
- VI. **Bayesian Estimation Procedures for reliability and sequential estimation:** Bayesian estimation procedures, concept of reliability and sequential estimation, Bayesian estimation procedures for reliability and sequential estimation.
- VII. **Estimation through Simulation techniques/ Programming with R-software:** Review of simulation methods, implementation of simulation methods for various probability methods. Programming with R-software.
- VIII. **Markovian Processes:** Discrete and Continuous Markov Chain, Monte Carlo, Gibbs' sampling.

Suggested Readings:

1. Averill ML, Kelton D. 2005. Simulation, Modeling and Analysis. Tata McGraw Hill.
2. Ross SM 1997. Simulation. John Wiley.

3. Cochran WG, Cox GM. 1957. Experimental Designs. John Wiley & Sons.
4. Montgomery DC, Peck EA & Vining GG. 2003. Introduction to Linear Regression Analysis. 3rd Ed. John Wiley.
5. Rao CR. 1973. Linear Statistical Inference and its Applications. 2nd Ed. John Wiley.
6. Sukhatme PV, Sukhatme BV, Sukhatme S & Asok C. 1984. Sampling Theory of Surveys with Applications. Iowa State University Press and Indian Society of Agricultural Statistics, New Delhi.
7. Lehmann EL. 1986. Testing Statistical Hypotheses. John Wiley.
8. Sinha Sk 1998. Bayesian Estimation. New Age International.
9. Sinha SK. 1986. Reliability and Life Testing. Wiley Eastern Ltd.

Zoology

Paper II- Recent advances in Zoology

Max. Marks: 100

- **Biodiversity:** levels of biodiversity, value of biodiversity, regional, national and global status of biodiversity, threats to biodiversity, conservation and management of biodiversity, biodiversity act and related international conventions, bio-geographical classification of India.
- Environmental stresses and their management, global warming, atmospheric ozone, Biodegradation and bioremediation of chemicals.
- **Chemistry of gene:** structure of nucleic acids (A,B,C,&Z DNAs RL model of Sasisepharan, super coiling, genetic & Non-genetic RNA, DNA replication, DNA repair (excision repair, mismatch repair and SOS repair) and genetic diseases in humans. restriction enzymes in cloning, techniques used in recombinant DNA technology and its application, DNA fingerprinting.
- **Social behavior of animals:** costs and benefits of group-living, types of social acts, individual adjustments of group-living, parental care and socio-functional organization in apes & monkeys.
- **Special features of selected micro-organisms:** animal viruses, plant viruses, bacteriophages, rickettsiae, mycobacterium, mycoplasma, actinomycetes, fungi and slime-moulds.
- A brief knowledge of environmental endocrinology.

- **Cells in culture:** requirements for cell culture, aseptic technique, primary culture, organotypic cultures.
- **Pesticides:** brief history, pesticide industries and markets. Dose-response relationship, insecticide, carcinogenic, teratogenic effects.

INFORMATION TECHNOLOGY

Paper -II

RECENT ADVANCES IN INFORMATION TECHNOLOGY

Natural language processing

Unit 1: Introduction and Overview: what is Natural Language Processing, demonstrations of NLP, Ambiguity and uncertainty in language, The Turing test, Course outline and logistics.

Unit 2: Regular Expressions: Chomsky hierarchy, regular languages, and their limitations. Finite-state automata, Practical regular expressions for finding and counting language phenomena.

Unit3: Context Free Grammars: CFG definition, use and limitations, Chomsky Normal Form, Top-down parsing, bottom-up parsing, and there problems with each.

Unit4: Non – probabilistic Parsing and Probability: Efficient CFG parsing with CYK, another dynamic programming algorithm, Designing a little grammar, and parsing with it on some test data, introduction to probability theory the backbone of modern natural language processing.

Computer Algebra System

Unit1: Introduction and Overview: what is Computer Algebra System, Mathematics used in CAS, uses and application of CAS, Symbolic manipulations, disadvantages of CAS.

Unit2: Expression in CAS: The expressions manipulated by the CAS, polynomials in multiple variables, standard functions of expressions (sine, exponential, etc), various special functions, arbitrary functions of expressions; optimization; derivatives, integrals, simplifications, sums, and products of expressions.

Unit3: Data Structures: Introduction, Polynomials in one variable – Coefficients, Polynomials in one variable - Recursive definition, The Syntax Tree, Data Structure Implementation.

Unit4: Simplification in CAS: General Issues in Simplification, The Steps of Simplification, Transforming Negatives, Transforming Negatives, Leveling Operators, Simplifying Rational Expressions.

Information Retrieval

Unit1: Introduction and Overview: Information retrieval history, Information retrieval resources, and Boolean retrieval.

Unit2: Probabilistic information retrieval, Language models for information retrieval, Relevance feedback & query expansion.

Unit3: Language models for information retrieval, Text classification, Performance measures in information retrieval,

Unit4: Types of model in Information retrieval, first dimension and second dimension model, properties of the model in IR.

Suggested Reading:

1. Foundations of Natural Language Processing by Christopher D. Manning and Hinrich Schiitze (Stanford University and Xerox Palo Alto Research Center).
2. G. Gazdar and C. Mellish, *Natural Language Processing*, Addison Wesley.
3. *Readings in Natural Language Processing*, ed by B. Grosz, K. Sparck Jones and B. Webber, Morgan Kaufmann.
4. Learning in Computer Algebra System (CAS) Environment by, Cuoco, A., Fey, J. T., Kieren, C., McMullin, L., & Zbiek, R. M.
5. Mathematical Activities with Computer Algebra System, a resource book Etchells T, Hunter M, Monaghan J, Pozzi S, Rothery A.
6. The State of Computer Algebra System in Mathematics Education by Berry, J., Kronfellner, M., Kutzler, B., Monaghan, J.
7. Brief Introduction in Information Retrieval (IR), by Suresh K. Basandhara.
8. Text-Based Intelligent System: Current Research and Practice in Information Extraction and retrieval by Paul S. Jacobs.
9. Natural Language and the Computer Part 5 in Information Retrieval by Paul L. Garvin.

MATHEMATICS

Recent Advances in the Subject

Paper –II

Fuzzy set and Fuzzy logic: From classical crisp sets to fuzzy sets, operations on fuzzy sets, Introduction to fuzzy arithmetic, fuzzy relations, fuzzy logic, fuzzy relation equations,

uncertainty-based information, applications of fuzzy sets in decision making and physical sciences.

Chaos and bifurcation: Iteration of functions, phase portraits, periodic points and stable sets, differentiability and hyperbolicity, chaos in perspective, Routes to chaos, Chaos (definitions and examples), characteristics of chaos, bifurcation (definitions and examples).

Optimization Techniques: Unconstrained optimization techniques, constrained optimization techniques and solutions of constrained nonlinear optimization problems, Decision Theory, Introduction to Game theory, Heuristics based optimization Techniques.

Suggested Reading:

1. Discrete Dynamical systems by R.A.Holmgren
2. Chaos theory tamed by Garnett P. Williams , A Joseph Henry
3. Chaotic Dynamical systems by R.L.Devaney
4. Bifurcation and chaos in complex systems by Jian-Qiao Sun and Albert Luo
5. Operations Research by H.A. Taha
6. Optimization Techniques by Chander Mohan and Kusum Deep
7. Engineering Optimization by S.S.Rao
8. Fuzzy sets and fuzzy logic by Klir and Boyuan
9. Fuzzy sets, uncertainty and Information by Klir and Folger
10. Fuzzy sets and logics by Zimmerman.