Outline for the Syllabus for M.Phil. in Interdisciplinary Basic Sciences

(32 credits=800 marks)

Semester I (16 credits = 400 marks)

1. Research Methodology (4 credits=100 marks) (MIBS 101)

Marks and credit distribution for the Paper Research Methodology: (**3 credits,75 marks**= theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks**= practical/tutorial classes, final and internal exam.)

2. Fundamentals of Computing (4 credits=100 marks) (MIBS 102)

Marks and credit distribution for the Paper Fundamentals of Computing:(**3 credits, 75 marks** = theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks** = practical/tutorial classes, final and internal exam.)

3. Experimental Techniques-I (4 credits=100 marks) (MIBS 103)

Marks and credit distribution for the Paper Experimental Techniques-I:(**3 credits, 75 marks** = theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks** = practical/tutorial classes, final and internal exam.)

4. Bibliography I (4 credits=100 marks) (MIBS 104)

Semester II (16 credits = 400 marks)

1. Data Analysis Techniques (4 credits=100marks) (MIBS 201)

Marks and credit distribution for the Paper Data Analysis Techniques:(**3 credits, 75 marks** = theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks** = practical/tutorial classes, final and internal exam.)

2. Bioinformatics (4 credits=100 marks) (MIBS 202)

Marks and credit distribution for the Paper Bioinformatics:(**3 credits, 75 marks** = theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks** = practical/tutorial classes, final and internal exam.)

3. Experimental Techniques-II (4 credits=100 marks) (MIBS 203)

Marks and credit distribution for the Paper Experimental Techniques-II:(**3 credits, 75 marks** = theory classes and final exam (55 marks) and Internal assessment (20 marks); and **1 credit, 25 marks** = practical/tutorial classes, final and internal exam.)

4. Bibliography II (4 credits=100 marks) (MIBS 204)

Semester III& IV

Dissertation Work

(MIBS101) Research Methodology (3 Credits=75 Marks)

Unit 1: Numerical Techniques and Computer Application

Approximations and round off errors, Truncation errors and Taylor Series, C programs/M codes of iteration, bisection and Newton Raphson method to determine the solution of polynomial and/ or transcendental equations. Solutions of simultaneous algebraic equations by Gauss Elimination and Gauss-Siedel iteration methods and its Program in C language and MATLAB.RungeKutta (IV Ordered) Method to determine the Numerical solution of System of ODEs and its program in C language or MATLAB.

Unit 2: Quantitative Methods and Computer Application

Classification, tabulation and frequency distribution of the data, graphical representation by histogram. Polygon, Ogive curve and pie diagram. Central tendency and deviation of data (Mean, Median, Mode, Mean deviation and Standard deviation) Above representation and method drawing by R or MATLAB or Microsoft Office Excel Worksheet.

Unit 3: Scientific Ethics and Research Design

Research Design and Ethics, Animal ethics in experimental Research, Committee for the Purpose of Control and Supervision on Experiments on Animals (CPCSEA) guidelines for laboratory animal facility, Animal models in research, Institutional Animal Ethics Committee (IAEC), Form for permission for animal experiment, Human ethics in clinical Research: ICMR guideline for research in human participants, Institutional ethics committee (IER), subject information sheet and consent, Drug trials and their different phases.

Unit 4: IPR

Introduction to IPR; Overview & Importance; Patents ;their definition; granting; infringement;searching& filing; Copyrights ; their definition; granting; infringement;searching& filing, distinction between related and copy rights; Trademarks, role in commerce ,importance , protection, registration; domain names; Industrial Designs; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications, international protection; Plagiarism and Research Ethics.

Recommended Books:

1. C. R. Kothari, Research Methodology (Methods and Techniques). New Age International Publisher.
2. P. N. Arora and P. K. Malhan, Biostatistics. Himalaya Publishing House.
3. SemourLipschutz and Marc Lars Lipson, Theory and Problems of Discrete Mathematics. Tata McGraw-Hill Publishing Company Limited. (Schaum's Series)

4. K. H. Rosen, Discrete Mathematics and Its application. Tata McGraw-Hill Publishing Company Limited.
5. Curtis F. Gerald, Patrich O. Wheatley, Applied Numerical Analysis. Addison–Wesley (6^{th}, Edition) 2001.
6. E. Balagurusamy, C Programming, Tata McGraw Hills Publishing House.

(MIBS102) Fundamentals of Computing (3 Credits=100 Marks)

Unit I: Concepts in Computing

Computer system: components, Characteristics & capabilities; classification; computer storage and memory, preliminary concept of software, hardware, Software evolution, Computer Languages: High-level and Low-level Languages, Language translators: Assemblers, Compilers, Interpreter and Editor; Concepts of flowcharting, algorithm development, pseudo codes etc. Basic concepts of programming languages: Programming domains, Operating Systems: Linux operating systems

Unit II: C Programming: Part I

Program Compilation, Running of a Program; Header file concept Basic elements: Variables and Constants, Rules for naming the Variables/Identifiers; Basic data types of C, int, char, float, double; Storage classes; Operators and Expressions: Assignment Operator, Arithmetic Operator and Arithmetic exp., Relational Operator and Relational exp., Logical Operator, Expression Evaluation (Precedence of Operators); statements, simple I/O statements. Control structures, if, if else, switch-case, for, while, do-while, break, continue.

Unit III: C Programming: Part II

One and two dimensional arrays, declaration, initialization and processing; Strings: String handling functions; Pointers: The & and * Operators, pointer declaration, assignment and arithmetic, visualizing pointers, array & pointer relationship, dynamic memory allocation, pointer to arrays, array of pointers. Functions: Library, User defined functions, declaration, definition & scope, recursion, call by value, call by reference. File handling: text and binary files,

Unit IV: Databases and Data Mining Techniques

Evolution of database systems, DBMS concepts and architecture, classification of database management systems, Database Models**,**Data modeling using ER models, Relational data model, Database languages; Data Mining: Basic Concept of Knowledge Discovery and Data Mining, Exploration of Data Mining tools for Biodata analysis, Pattern Mining. Association Analysis, Classification methods, Cluster Analysis methods, Computational Modeling of Biological Networks, Applications of Data Mining to Bioinformatics

Reference books:

1. Introduction to Information Technology – ITL Education Solutions Limited, Pearson Education
2. Introduction to Computers - Peter Norton, TMH

3. Deitel and Deitel: How to Program C, Addison Wesley, Pearson Education Asia, Seventh Edition
4. Bryon Gottfried, Programming with C, McGraw Hill International.
5. Korth H and Silberschataz A, Database System Concepts, McGraw Hill.
6. RamezElmasri, ShamkantNavathe "Fundamentals of Database Systems" Addison Wesley, Pearson Education Asia, Sixth Edition
7. Jason T.L. Wang, Mohammed J. Zaki, "Data Mining in Bioinformatics", Springer International Edition

(MIBS103) Experimental Techniques-I (3 Credits=75 Marks)

Unit-I: Spectroscopic Techniques

Absorption spectroscopy (UV-Vis), Fourier transform-infra-red (FT-IR) spectroscopy, Fluorescence, Phosphorescence, Raman and micro Raman spectroscopy, dynamic light scattering spectroscopy, Circular dichroism, mass spectroscopy and MALDI, NMR (theory and applications), cyclic voltametery, impedance spectroscopy and its applications, X-Ray photoelectron spectroscopy. X-ray energy dispersion analysis, Microwave spectroscopy, X-Ray differaction.

Unit-II: Microscopic Techniques

Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), scanning tunneling microscopy, atomic force microscopy as versatile tools for fabrication - characterization and nanomanipulation of biomolecules, SNOM, Phase contrast, focal and Con-focal microscope, fluorescence microscopy, confocal microscopy, SNOM microscopy, magnetic resonance imaging (MRI) etc.

Unit-III: Biophysical techniques

Surface tension and surface free energy, Dynamic surface tension, Contact angle: Young's Equation, Contact angle hysteresis, Refractive index for solute-solvent interactions, Lorentz-Lorentz equation for *polarizability*, Electrophoresis, Electroosmosis, Calorimetry: Differential Scanning calorimetry, Isothermal titration calorimetry, TGA.

Unit-IV: Biochemical Techniques

Methods of disruption of cells, Estimation of proteins by various methods, SDS-PAGE and 2D electrophores, Chromatography: ion-exchange: cation exchange, anion exchange, gel filtration, affinity, HPLC, reverse phase HPLC, FPLC, VLC. Concentration of proteins: lyophilization, ultra filtration: column-based concentration of proteins, dialysis, thin layer and coloumn chromatography.

Recommended Books:

[1] C. N. Banwell, *Fundamentals of molecular spectroscopy*, 4th ed. London ; New York: McGraw-Hill, 1994.
[2] P. W. Hawkes and J. C. H. Spence, Eds., *Science of microscopy*. New York: Springer, 2007.

(MIBS201) Data Analysis Techniques (3 Credits=75 Marks)

Unit 1: Descriptive Statistics and Distribution

Measures of location and spread; symmetry of data (moments, skewness and kurtosis).Probability, law of probability, conditional probability, Baye's Rule and Screening Tests; ROC curves, Prevalence and Incidents.Random variable, probability distribution, binomial, poission and normal distributions.

Unit2: Hypothesis Testing

Hypothesis, z-test, t-test, **One-sample hypothesis**: hypothesis concerning the mean, confidence limit for population mean, sample size and estimation of population mean, hypothesis limit for the population variance, hypothesis concerning the variance. **Two-sample hypothesis**: difference between two mean, testing for difference between two variance. **Pair-sample hypothesis**: mean comparison of pair sample. Multiple hypotheses: mean comparison more than two groups (ANOVA).

Unit 3: Non-parametric methods and Category data analysis

Nonparametric statistics, The Sign Test, Wilcoxon Signed-Rank Test, The Wilcoxon Ranks-Sum Test, two sample test for binomial properties, Fisher's Exact Test, McNemar's Test, $R \times C$ Contingency tables, chi-square goodness of fit test, Data Transformation, clustering analysis.

Unit 4: Regression and Correlation methods

Fitting regression line- method of least squares, inference about parameters from regression lines, interval estimation for linear regression, assessing the goodness for fit of linear regression lines, correlation coefficient, inference of correlation coefficient, and multiple regressions, partial and multiple correlation and rank correlation.

Recommended Books:

[1] B. Rosner, *Fundamentals of biostatistics*. Boston: Brooks/Cole, Cengage Learning, 2011.
[2] J. H. Zar, *Biostatistical analysis*, 4th ed. Upper Saddle River, N.J: Prentice Hall, 1999.
[3] P. N. Arora, P. K. Malhan, *Biostatistics*, Himalaya Publishing House, 2006.
[4] S. C. Gupta, V. K. Kapoor, *Fundamental of mathematical statistics,* Sultan chand and Sons New Delhi.
[5] V. K. Rohatgi, A. K. Md. Ehsanes Saleh, *An introduction to probability and statistics*, 2nd ed., John Wiley and Sons (Asia) Pte. Ltd.

(MIBS202) Bioinformatics (3 Credits=75 Marks)

Unit I: Bioinformatics Basics

Bioinformatics concepts, Need for Bioinformatics Technologies, Human Genome Project, Sequence and structure file formats, Information Resources and Analysis Tools, Nature of biological data, Overview of available Bioinformatics resources on the web: NCBI/EBI/EXPASY etc,Open access bibliographic resources: PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore. Applications and Emerging areas in Bioinformatics

Unit II: Bioinformatics Resources and Sequence Analysis

Biological Databases:Nucleic acid sequence databases:GenBank, EMBL, DDBJ, Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, UniParc; Repositories for high throughput genomic sequences: EST, STS GSS; Structure Database: PDB, NDB, PubChem, Database search engines and Data Retrieval from Databases;Sequence Analysis: Pair-wise and multiple sequence alignment. Similarity searches in DatabasesBLAST, FASTA, PSI-BLAST, CLUSTAL W and CLUSTAL X

Unit III: Protein Structure and Prediction

Introduction to Structural biology, Anatomy of Protein structure, Significance of Structural Biology, concepts of homology modeling, Secondary structure prediction methods: Protein prediction methods, Threading, Ab initio structure prediction; Structure validation, Visualization and representation of molecular structure, protein structure comparisons and analysis.

Unit IV: Drug Design and Discovery

Drug Discovery Process: Role of Bioinformatics in drug design, Target identification and validation, lead optimization and validation, Structure-based drug design and ligand based drug design, modeling of target-small molecule interactions, Molecular docking-Rigid docking, flexible docking and partially rigid and partially flexible docking, manual docking Protein ligand docking, Protein- Protein docking. De-novo ligand design methods, High throughput screening; Virtual screening; QSAR and ADMET properties.

Recommended Books:

1. Discovering Genomics, Proteomics and Bioinformatics (2nd Edition) by A. Malcolm Campbell and Laurie J. Heyer. Published by ColdSpringHarbor Laboratory Press and Benjamin Cummings.
2. Baxevanis A.D., Davison D.B., Page R. D. M. &Petsko G.A. Current Protocols in Bioinformatics. New York, John Wiley & Sons Inc., 2004. ISBN: 0555015254.
3. Baxevanis Andreas D. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition. Publisher: New York, John Wiley & Sons, Inc. 2002, ISBN: 9814126756.
4. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.
5. Sternberg Michael J. E. Protein Structure Prediction: A Practical Approach. Publisher: USA, OxfordUniversity Press. 1997. ISBN: 0199634953.

(MIBS203) Experimental Techniques-II (3 Credits=75 Marks)

Unit I: Tools and Techniques in Molecular Biology Part I:
Enzymes used in recombinant DNA technology: DNA and RNA polymerases, ligases, methylases, endonucleases and exonucleases. DNAases and RNAases. Principle of restriction digestion, Star activities, Development of DNA based marker, Restriction Fragment Length Polymorphism (RFLP), DNA fingerprinting, Genotyping, Mutation analysis.

Unit II: Tools and Techniques in Molecular Biology Part II:
DNA isolation from different sources; Nucleic acid separation techniques: Agarose gel electrophoresis of DNA. Radio labeling of DNA, Nick translation, Kinase reaction, random primer labeling, Blottings: Southern and Northern blotting techniques. Nucleic acid amplification protocols; DNA sequencing.

Unit III: Tools and Techniques in Molecular Biology Part III:
Sterilization and disinfection. Radioimmunoassay (RIA) and Enzyme Linked Immunosorbant Assay (ELISA). Western blotting techniques, Immunohistochemistry, Fluorescence in situ hybridization (FISH), Gene localization, Germ line genetics, Somatic cell genetics approaches, Formation of heterokaryones.

Unit IV: Tools and Techniques in Molecular Biology Part IV:
Basic principle of cloning, Vectors: Basic requirements for a suitable cloning vector. Recombinant DNA.Competent cell preparation and transformation protocols.Cloning and selection transformants and recombinants.Characterization of recombinant clone.

Recommended Books:

1) Brown TA; Gene Cloning and DNA analysis: An Introduction (Fifth Edition); Blackwell Publishing.
2) Primrose SB &Tyman RM, 2006. Principles of gene manipulation and genomics. Seventh Edition. Blackwell Publishing.
3) Sambrook and Russell; Molecular Cloning A Laboratory Manual; Third edition; Cold Spring Laboratory Press International Edition, Cold Spring, New York, USA.