Syllabus and Course Scheme
Academic year 2017-18

M.Sc.- Bioinformatics

Exam.-2018

UNIVERSITY OF KOTA
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UNIVERSITY OF KOTA, KOTA

M.Sc. Bioinformatics Exam.-2018

In view of increasing demand and requirement of trained manpower in the area of Bioinformatics, it is proposed to institute M.Sc. Bioinformatics course. This will be of two year duration.

Eligibility: Bachelors degree in science (special and general with biochemistry, Biology, Botany, Zoology, Chemistry, Electronics, Microbiology, Physics, Statistics), Agriculture, Computer science, Engineering, Medicine, Pharmacy, Technology and Veterinary science with at least 50% marks (45% for candidates belonging to reserved category SC/ST/OBC).

Intake: 40 students

Selection: Entrance Examination

Scheme of Examination and Courses of Study

1. The number of papers and maximum marks for each paper/practical are shown in the syllabus. It will be necessary for candidates to pass in the theory part as well as in the practical part (wherever prescribed) separately.
2. A candidate for a pass at each of the Previous and Final Examinations shall be required to obtain (i) at least 36% marks in the aggregate of all the papers prescribed for the examination and (ii) at least 36% marks in practical(s)/wherever prescribed at the examination, provided that if a candidate fails to secure at least 25% marks in each individual paper at the examination and also in the Test/Dissertation/Survey Report/Field works, wherever prescribed, he shall be deemed to have failed at the examination not withstanding 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 examinations taken together, as noted below:

First division	60%	on the aggregate mark taken.
Second division	48%	together in the Previous & Final Examinations.

3. If a candidate clears any paper(s) prescribed at the Previous and/or Final Examination 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) are cleared after the expiry of the aforesaid period of three years; provided that in case where a candidate require 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.
4. A total of eight theory papers (3 hours duration each) are prescribed (4 in previous and 4 in final). A combined Practical Examination (10 hrs duration, in two days) shall be conducted each year. Paper setter shall be asked to set total 9 questions for each theory paper (which have been divided into three sections) or 10 questions for each theory paper (which have no sections) out of which the examinee shall be asked to attempt any five questions. The list of papers is as below:
5. A candidate failing at M.Sc. Previous Examination may be provisionally admitted to the M.Sc. Final Class, provided that he passes in at least 50% papers as per Provisions of 0.235 (i).

6. A candidate may be allowed grace marks in only one theory papers upto the extent of 1% of the total marks prescribed for that examination.

Teaching and Examination scheme for M.Sc. Previous Bioinformatics

Course No	Course Name	Lecture hrs/week	Exams hrs	Max Marks
BIM01*	Basic Biology	3	3	100
BIM01*	Basic Mathematics	3	3	100
BIM02	Biochemistry and Enzyme Technology	3	3	100
BIM03	Bioinformatics	3	3	100
BIM04	Cell Biology, Genetics and Information flow processing	3	3	100
	Combined Practical			
	1. Experimental	12	12	120
	2. Project work and Record			50
	3. Viva –voice			30
		TOTAL		**600**

*Students from mathematics stream will take basic biology, while those from the biology stream will take basic mathematics.

Teaching and Examination scheme for M.Sc. Final Bioinformatics

Course No	Course Name	Lecture hrs/week	Exams hrs	Max Marks
BIM05	Computer Programming in object oriented languages	3	3	100
BIM06	Biological data banks, Data mining and data security, and database management	3	3	100
BIM07	Biostatistics & Computer Application	3	3	100
BIM08	Bio programming	3	3	100
	Combined Practical			
	1. Experimental	12	12	120
	2. Project work and Record			50
	3. Viva –voice			30
		TOTAL		**600**

M.Sc. Previous Bioinformatics Exam.- 2018

Paper I - Basic Biology

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries marks.

Section A

Origin of life: Prebiological chemical evolution, proteinoids, proto cells.

Systematics: Species concept, Kingdom to species, The five Kingdoms, Classical, phenetic and cladistic approaches.

Bacteria: Structure of Bacterial Cell, Bacterial types, transformation, transfaction, transduction, and conjugation; nutrition; phylogeny.

Viruses: Biology of viruses; bacteriophages, Plant and animal viruses; Replication of viral genome; HIV.

Section B

Protists: Endosymbiont theory of eukaryotic origin; Protozoans, algae, slime and water molds.

Fungal world: Feeding, reproduction, diversity and relationships.

Plant Diversity: Broad classification and inter-relationships of non vascular and vascular plants; tissue organization; reproductive patterns; transport mechanisms, growth, photosynthesis; hormones

Section C

Animal life: Major animal phyla, characteristics and interrelationships; tissues, organs, and organ systems; principles of nutrition, digestion, Thermoregulation, osmo-regulation and excretion, muscle contraction, neural reflexes, circulation, respiration and endocrines.

OR

Paper I - Basic Mathematics

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark

Section A

Sequence and series, finite and infinite series, arithmetical and geometrical progressions, determination of nth term and sum to n terms, arithmetic and geometric means between two numbers, sum of n terms, arithmetic geometric progression, sum of an infinite G.P., permutation and combination- simple problems under restrictions, binomial theorem for positive integral index and for any index (without proof), application of binomial theorem in summation of infinite series. Logarithms: definitions and law regarding product, quotient, power and change of base, application of exponential theorem and log series in summation of infinite series.

Matrices-definition, order of a matrix, types of matrices, transpose of a matrix, symmetry and skew symmetry matrices, algebra of matrices, scalar multiplication, addition and subtraction of matrices,

matrix multiplication, commutative, associative, and distributive laws for matrix addition and multiplication, inverse of matrix, determinant of a matrix, properties of determinants (without proof), evaluation of determinants upto third order, partial fractions (simple problems).

Section B

Co-ordinate geometry: 2D and 3D co-ordinate geometry, equation of line, circle, ellipse, parabola, hyperbola, sphere and cone. Rectangular co-ordinates, quadrants, distance between two points, the section formula, area of triangle, locus of a point, equation to the locus, graph of a linear function, equations to straight lines-parallel to axis, the slope form, the intercept form, normal form, general linear form, point slope form, two points form, points of intersection of two straight lines, angle between two lines, relation between slopes of two lines which are (i) parallel (ii) perpendicular line through the point of intersection of two given lines, concurrency of lines, co linearity of points.

Non linear functions- quadratic function, general quadratic equation, conic section, curves represented by general quadratic equation, standard equations and graphs of circles, parabola, ellipse, hyperbola and rectangular hyperbola.

Section C

Trigonometric functions: sin, cos, tan, cot, series expansion of these functions and other related functions.

Differential calculus: Functions, limit of function, evaluation of limits of functions, derivative of a function, derivative of X^n, sin X, cos X, e^x, log e^x
by ab-initio method, differentiation of algebric, circular, exponential and logarithmic functions, differentiation of inverse trigonometrical functions of sum, difference, product and quotient of two functions, derivatives of second order .

Integral calculus: Integration as inverse operation of differentiation, indefinite integrals, integration of simple functions, integration by substitution, integration by parts, definite integral properties of definite integral (without proof).

Paper II- Biochemistry & Enzyme Technology

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**
Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark

Section A

Biochemical evolution: Chemogeny, Biogeny and evolution of chromosome, organization and genetic regulatory mechanisms. Time factor in evolution. Evolution of enzyme systems.
Amino acid and peptides: Structure, function, methods of characterization. Separation techniques based on their structure and properties. Biosynthesis.
Carbohydrates: Mono and Polysaccarides, classification, structure, function, separation and characterization techniques. Biosynthesis.
Lipids: classification, structure, function, separation and characterization techniques.
Nucleic acid: Nucleic acids and Polynucleotides, classification, structure, function, separation and characterization techniques.

Section B

Vitamins, micro and macro-nutrients: Classification, structure, function, separation and characterization techniques.

Catabolism and generation of chemical energy.

Metabolic strategies: General principles of intermediary metabolism. Regulation of pathways, strategies for pathway analysis.

Metabolism of fatty acids: Fatty acid degradation. Biosynthesis of saturated fatty acids, regulation of fatty acid metabolism.

Glycolysis, Gluconeogenesis and Pentose Phosphate Pathway.

Glycolysis, and Gluconeogenesis. Regulation of glycolysis & gluconeogenesis.

The Pentose Phosphate Pathway.

Tricarboxylic acid cycle: Steps in TCA cycle, Aspects of TCA cycle reaction, ATP stoichiometry of TCA cycle, Thermodynamics of TCA cycle, Amphibolic nature of TCA cycle. Oxidation of other substrates by TCA cycle, Regulation of TCA cycle activity.

Section C

Enzymes: classification, nomenclature and general properties of enzyme. Their isolation, purification and large scale production.

Mechanism of enzyme action and regulation: action and regulatory sites. Chemical modification, general mechanistic principles, feedback inhibition. Isozymes, enzyme activation, Zymogens, multi-enzymes complexes and multifunctional enzymes.

Steady state kinetics: methods of estimation of rate of enzyme catalysed reaction with special reference to Michaelis-Menton kinetics.

Effects of substrate, temperature, pH and inhibitors on enzyme activity.

Paper III - Bioinformatics

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark

Section A

Bioinformatics an overview: Definition of bioinformatics, history of bioinformatics, kind of data used in bioinformatics. Three level of bioinformatics analysis of single genome, analysis of complete genomes, analysis of genes and genomes. Sub division of bioinformatics. Aims and scope of bioinformatics. Potential of bioinformatics. Application of bioinformatics.

Bioinformatics and pharmaceutical industry. Drug design based on bioinformatics tools. Concept of drugs discovery, genomic drugs, post genomic drugs. Bioinformatics industry challenges.

Introduction to logic and number system: Boolean logics, addition, subtraction, multiplication, and division using binary, octal, hexadecimal system. Fundamental of set theory.

Section B

Genomics: Genome evolution and sequencing. Genome assembly and identification. Genome annotation, comparison and analysis. Homologous sequences FASTA and BLAST versions.

Proteomics: Basic concepts of proteomics and analytical look. Technique of microarray . microarray design, analysis of data, application, 2D gel electrophoresis, mass spectroscopy. Peptide sequencing.

Metabolomies: Metabolic pathways. Drug target identification.

Biological databases: nucleic acids, proteins, published text.

Section C

Bioinformatics business: Commercialization of bioinformatics. Current market study. Future prospects of bioinformatics business.

Internet and Intranet: how communication works on the internet, cables, modems, content providers vs internet service providers, e-mail, file transfer protocols, world wide web, web surfing, browsers, search engines, common problems, Bioinformatics resources in the NET.

Career in bioinformatics: career outlook. Graduate employment opportunities. Geographical considerations, career outlook in India. Future of bioinformatics professionals, skills needed to pursue a career in bioinformatics.

Paper IV-Cell Biology, Genetics and Information flow processing

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark

Section A

Prokaryotics and eukaryotics cells; membrane and cellular compartmentation; an overview of organelles (mitochondria, chloroplast, endoplasmic reticulum, golgi, lysosomes and peroxisomes, nucleus and nucleolus) and organelle genetic systems.

Cell membranes: structure, transport, channels, carriers, receptors, endocytosis, membrane potencial

Cell motility and shape: Cyto skeleton elements, cilia and flagella; motor proteins.

Cell-cell interaction and signal transduction; intercellular junctions, signaling by hormones and neurotransmitters; receptors, G-proteins, protein kinesis and second messengers.

Protein traffic in cells: Proteins sorting and signal sequences; protein translocation in endoplasmic reticulum and vesicular transport to Golgi, lysosomes, and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes.

Cell cycle and its regulation; events during mitosis and meiosis.

Section B

Genetics: Objectives, terminologies, methods, mendelian principle of inheritance, Sex linked inheritance

Concept of linkage, linkage maps and recombination mutations-molecular, gene/point and chromosomal. Phenotype and genotype relationships, role of environment, from gene to phenotype, gene interactions. Study of quantitative traits. Genetics of populations, genetics and evolution, genetics of diseases, cancer.

Section C

Prokaryotic gene expression, operons-positive and negative regulation, sigma factors. Initiation, elongation and termination of transcription template and enzyme properties.

Eukaryotic RNA polymerase I, II, and III transcribed genes, promoter and regulatory sequence, transcription factors, Techniques-foot printing, Reporter genes.

Organization of globin, immunoglobin, HLA, rRNA, and sRNA genes.

Processing of RNA and proteins-transport and stability.

Stress and hormones regulated gene expression.

Organization of human genome, RFLP, fingerprinting, RAPDs, Microarrays, ESTs.

M.Sc Final Bioinformatics Exam.- 2018

Paper V- Computer Programming and Object Oriented Languages

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark

Section A

Fundamental of computing, introduction to operating system: WINDOWS, NT, UNIX/LINUX operating systems.

Comparative advantages of security (hacking/cracking), installation, portability and programming of these operating systems.

Computer viruses.

Elements of programming in 'C'-Pointers, pointers to the functions, macro and programming in 'C', graphs, Data structures-Linked list; Stack; Queue; Binary Trees, Threaded binary tree, File Handling in 'C'; exception handling in 'C'.

Section B

An introduction to JAVA programming. Object oriented programming in java. Java basics, working with objects. Arrays, conditionals and loops.

Creating classes and applications in java, java applets basic; graphics, fonts and colour. Simple animation, images and sound. Managing simple events and interactivity. Creating user interfaces with AWT.

Windows, networking and other titbits, modifiers, Access control and class design. Packages, Interfaces, Exceptions, multithreading, streams as I/O using native methods and libraries. Java programming tools. Working with data structures and java image filters.

Section C

Introduction to application development using Visual Basic, working with code and forms, variables, procedures and controlling program executor standard controls.

Data access using data control.

Connecting to oracle database using Visual Basic.

Structured Query Language (SQL): Constraints, types of SQL commands, data correlation, introduction to index, types of index.

Paper VI - Biological Databanks, Data Mining, Data Security and Database Management

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark.

Section A

Data warehousing, data capture, data analysis. Introduction to nucleic acid and protein sequence databanks; Gene bank, EMBL, nucleotide sequence databanks, AIDS virus sequence databanks, rDNA databanks. Protein sequence databanks: NBRF-PIR, SWISSPROT, signal peptide databanks. Database similarity alignment –NEEDLEMAN and Wunsch, Smith Waterman algorithms. Multiple sequence alignment-CLUSTAL, PRAS, Patterns, motifs and profiles: Prosite, blocks, Prints –S, Pfam etc. Primer design.

Data security: Science and study of methods of protecting data, discretionary and mandatory access controls, secure database design, data integrity, secure architecture, secure transaction processing, information flow protocols, interference controls and anding. Security models for rational and object oriented database. Security of databases in a distributed environment. Statistical database security. Prerequistes: INFS 762 and INFS 614.

Section B

Database system concepts and architecture. Data models and scheme and instances, Database independence, database language, interface and structure.

Data modelling using entity relationship model: ER model concept, notation for diagrams, mapping constraints, keys. Concept of super key, candidate keys, primary key, Generalization, Aggregation, Reducing ER diagrams to tables.

Relational data model and language: Concepts, integrity constraints, keys, domain constraints, referential integrity, assertions, triggers, foreign key, relational algebra and calculus.

Example database design: Functional dependencies, normal forms, first, second and third functional personal normal forms, BCNF, multivalued dependencies, fourth and fifth normal forms, Steps in database design.

Section C

Query processing and optimization. Transaction processing concepts, concurrency control techniques, Locking technique. Time stamping and concurrency control. Recovery.

Distributed database system. Fragments of relation. Optimization transmission cost by semi joins. Distributed concurrency control. The optimistic approach. Management of deadlocks and crashes. Advanced topics in databases like temporal database, spatial database, data mining, data warehousing and its applications.

Paper VII- Biostatistics and Computer applications

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark.

Section A

Collection, organization and representation of data: Collection of data. Primary and secondary data. Sampling and sampling design-Census method, sample method, random and non-random sampling. Size of sample. Tabulation and graphics representation. Measure of central tendency and dispersion: Mean, Median, and Mode.

Measure of dispersion: Range, Standard deviation, Lorenz curve.

Skewness and Kurtosis: Objective and measures of skewness. Karl person's coefficient of skewness. Bowley's coefficient of skewness. Kelley's measure of skewness. Kurtosis.

Correlation analysis: Types of correlation-partial and negative correlation, linear and non-linear correlation, methods of studying correlation-scatter diagram, Graphic method, Karl pearson's coefficient of correlation. Correlation of grouped data, Rank correlation, Cocurrent deviation method, Partial and multiple correlation.

Regression analysis: Regression line, Regression equations- of X on Y and Y on X. Regression in a bivariate grouped frequency distribution. Multiple regression.

Section B

Probability theory: Types of probability-Mathematical, posterior and axiomatic probability. Theorems of probability-Addition and Multiple theorem.

Theoretical distribution: Bionomial, Poission and Normal distribution.

Sampling and test of significance: Steps in tests of hypothesis. Sampling distribution. Standard error. Test of significance for attributes. Test for number of success and proportion of success. Test of significance for variables. (large samples)-tests of differences between means of two samples and between two standard deviations. Tests of significances for variables (small samples)-students t-distribution to test the difference between means of two samples, and test the significance of an observed correlation coefficient. Variance ratio test (or F-test).

Chi-square tests and goodness of fit: Characteristics of x^2 test, use of X-test, Yates correlation.

Analysis of variance: One way and two way classification. Multivariate analysis.

Section C

Introduction to Macro and Micro computers, Attachments and peripherals. Hardware and Software. Application of computers in statistical data processing.

Software packages for statistical analysis: SAS, MINITAB, BMDP, SPSS, S-Plus, MATLAB. Academic and research software-XGobi, XLisp-Stat, ExplorN, MANET.

Pitfalls of data analysis by employing statistics: Problem with statistics, Source of bias, Problem with interpretation.

Paper VIII - Bioprogramming

Min. Pass Marks: 36 **Duration: 3 Hours** **Max. Marks: 100**

Note: Attempt any five questions, taking atleast one question from each section. Each question carries mark.

Section A

Biological database: Codd rules, data normalization. Biological database importance and functioning. Types of biological databases, Micro biological databases, Primary sequence databases, Databases of carbohydrates, RNA, Genome, virological, organism.

Sequence database: Nucleotide sequence database, Protein sequence database, The EMBL nucleotide sequence databases, Structure databases.

Bioperl: General introduction to Bioperl documentation, Bioperl classes.

Sequences: The Bioperl sequence to class, Format converter, Sequence classes, building mechanism summary.

Section B

Feature and location classes: Codd feature, Codd reading, extracting CDS, tag system, location, graphical view of features. Sequence analysis tools.

Alignment IO, simple alignment, Codd reading protol 12 dna.

Analysis: Blast, running blast, parsing blast, biotools, BPlite family passers, position specific iterative blast, b12 sequence, bast 2 sequences, blast internal class structure.

Section C

Genscane.

Perl reminders, UML. Perl reminders to use bioperl modules, references, file handle and streams, exceptions, Getopt: Std, classes, BEGIN block.

Perl reminders for a further advanced understanding of bioperl modules, modules, compiler instructions, tie.

Solutions: Sequences, alignments, analysis, and databases.