Syllabus for Bio-Informatics (SCQP06)

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Unit 1: Mathematics and Statistical Foundation Calculus:
The concept of limit of a Functions, continuity, differentiability, successive differentiation, Liebnitz theorem, asymptotes, definite integrals, reduction formulae, order and degree of ordinary differential equations, linear differential equations with constant coefficient and Laplace transformations. Algebra: Mappings, groups, subgroups, matrices, elementary operations of matrices, inverse of matrices, application of matrices to system of linear equations, vector spaces, linear transformation and their matrix representations. Analysis Open set, closed set, limit, continuity, Taylor's theorem, Lagrange's mean theorem, Rolle's Theorem, sequences and series, convergence of series. Probability Distribution: Basics of Binomial, Poisson and Normal distributions and their application in biology. Random Variable; Discrete and Continuous Probability Distribution, Probability mass function, probability Density function, Mathematical Expectation. Geometry Plane, straight line, sphere, cone, cylinder, conicoids.

Unit 2: Role of Chemistry in Bioinformatics
Kinetic theory of gases, Atomic Structure, Periodic Properties, Chemical bonding, Distribution of electrons in organic compounds. Homegenous equilibria, chemical Kinetics, p and d block elements, Stereo Chemistry, Configurational Isomerism, Elements of symmetry, Chirality. Colligative properties, thermodynamics, Chemistry of elements of first transition series, Coordination Compouds, Organometallic Compounds, Alicyclic Compounds Esters cont aining active methylene group, Aromatic Compounds, Nuclear Chemistry, Zero group elements, Phase Rule and Electrochemistry

Unit 2: Biochemistry and Molecular Biology
Carbohydrates and lipids, their importance in cells. Proteins: Amino acids and peptides; primary, secondary, tertiary and quaternary structures; protein – protein interactions; sequence homology, functional and evolutionary relationships of proteins. Nucleic acids: Bases, nucleotides, RNA and DNA. Different Structural from of DNA, denaturation and renaturation of DNA, protein-nucleic acid interactions. Enzymes: Units of activity, coenzymes and metal cofactors, temperature and pH effects, MichaelisMenten kinetics, inhibitors and activators, active site and mechanism of enzyme action, isoenzymes, allosteric enzymes, regulation by covalent modification. Organization of metabolic systems: enzyme chains, multienzyme complexes and multifunctional enzymes, regulatory enzumes and feedback control of metabolic pathways, energy charge Carbohydrate metabolism: Glycolysis, gluconeogenesis, glycogenolysis, glycogenolysis and pentose phosphate pathway; hormonal control. TCA cycle and oxidative phosphorylation. B-oxidation and biosynthesis of fatty acids. Transamination and deamination of amino acids, ketogenic and glycogenic and glycogenic amino acids, urea cycle.Purine and pyrimidine biosynthesis.

Unit 3: Microbiology and Immunology Viruses:
Morphology, architecture, Nomenclature, Classification and symmetry, Structure of a typical plant (TMV), Animal (polio) and Bacterial (T4) Viruses; Bacteriophages (Lytic & lysogenic cycles) Role of microorganisms in biogeochemical cycles of Nitrogen and Carbon. Biological nitrogen fixation with special reference to Rhizobium. Industrial application of microorganisms: Organic acids, alcohol, food processing, milk products with special reference to Lactobacillus, antibiotics with reference to Streptomyces, biopesticides. Methods in Microbiology – staining, sterilization method culture media, pure culture methods, methods for population estimation, growth determination. Immunology: Immunity, Immune system in Human: Active and Passive Immunity, Antigens, Antibodies, Classes of Immunoglobulins, Antigen – Antibody reaction, B-cells and T-cells and their role in immunity to infection, Autoimmunity. Immunity to infectious agents; AIDS and other immunodeficiencies, Vaccines, Hybridoma Technology and Monoclonal antibodies, Gene Therapy.

Unit 4: Genetic Engineering, Gene Sequencing and RDT
DNA as genetic material, Structure and Biological importance of DNA; Types of RNA and their structure; Replication of DNA. Genetic code, Central Dogma, Transcription, Translation, RNA editing,

DNA repair. Introduction: Plasmids and bacteriophages: Cosmids, M13, Shuttle vectors and lambda of E. coli, Applications of genetic engineering in medicine, industry and agriculture. Enzymes for RDT: polymerase, restriction endonucleases, ligases, Introduction of r-DNA into living cells – Transformation and Transfection, Identification of recombinants.

Techniques in Genetic Engineering: PCR, Gene Sequencing – Maxam Gilbert method & Sanger method, Electrophoresis, Southern and northern blotting techniques. Transgenic plants and animals, Gene therapy, Intellectual Property Rights, Bioethics.

Unit 5: Biophysics

Energetics of a living body, sources of heat limits to temperature (qualitative treatment), heat dissipation to conservation, and laws of thermodynamics. Nature of chemical bonds, intra and intermolecular interaction in biological systems. Force field used in Molecular Dynamics Simulation. Absorption spectroscopy- Beer-Lambert's law, Colorimetry to Spectrophotometry (single and double beam spectrophotometer), primary biophysical events in photosynthesis. Spectroscopic techniques to find out molecular structure (quantitative techniques), general spectroscopy (UV, Visible, Fluorescence, Atomic absorption, IR to Raman spectra). Instrumental techniques: Concept of chromatography, electrophoresis; spectrophotometry, UV-VIS, IR, NMR', -and spectroscopy. Physical methods of imaging, intact biological structures (X-ray, CT-Scan, ECG, EEG, NMR), and radioactive pollution-GM counter Structure of proteins – primary, secondary, tertiary, and quaternary. X-ray crystallography Physical methods for determining size and shape of macromolecules – diffusion to sedimentation, reverse osmosis, ultracentrifugation, Ramachandran Plot Analysis.

Unit 6: Fundamentals of Information Technology and Computer Programming

An overview of resolution in computers and communication. Applications software (Word processing, spreadsheets, database, financial, communicating, etc.) Processors (micro clips, CPU., Main memory, representation of data & programs, microcomputer system unit, future processing power), Input and output, storage, Interactivity, Multimedia System Software, The use of online resources and the internet, Communications technology (hardware, channels & Networks), Software development (programming & languages). Introduction to programming in C++, C++ control structures (if, if/else, while, do/while, for, switch). Functions (definition and prototypes, storage classes, Scope rules, Recursion, inline functions, references and reference parametric, function overloading, function templates), Arrays (declaration, passing arrays to functions, sorting and searching arrays, multiple subscripted arrays. Pointers (declaration & initialization, pointer operators, calling functions by reference, pointer expression and pointer arithmetic, pointers & arrays, arrays of pointers, function pointers), Introduction to characters and string processing, classes(structures, class scope, access utility functions, constructors, destructors, use of data members and member functions). Color models: CMY, HSV, RGB, Visualization techniques. Graphics display devices, Raster and Random scan devices, color CRT monitors, LCD, and LED. Artificial Neural Networks, Genetic algorithm, Bayesian modeling, Monte Carlo Simulation Method, Markov Models and their application.

Perl basic: Variables, Perl operations, A Program to store DNA sequence, Concatenating DNA fragment, Transcription: DNA to RNA, Subroutines, scoping and subroutines, command-line arguments and arrays passing data to subroutines, modules, and libraries of subroutines, fixing bugs.

Unit 7: Basics of Bio-Informatics

What is Bioinformatics and its relation with molecular biology Examples of related tools, databases and software, Data generation; Generation of large-scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-ray diffraction, and microarray). Applications of Bioinformatics. Biological Database and its Types, Introduction to Data Types and Source. Population and sample, Classification, and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases, Protein databases (Primary, Composite, and Secondary).Specialized Genome databases: Structure databases Data storage and retrieval and Interoperability, Flat files, relational, object-oriented databases and controlled vocabularies. File Format, Introduction to Metadata and search; Indices, Boolean, Fuzzy,

Neighboring search.The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. Sequence Alignments and Visualization, Introduction to Sequences, alignments and Dynamic Programming, Local alignment and Global alignment (algorithm and example), Pairwise alignment and multiple sequence alignment. Methods for presenting large quantities of biological data: sequence viewers, 3D structure viewers, and Anatomical visualization. Gene Expression and Representation of patterns and relationship, General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS.Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.