Course Title with Credit Load
Ph.D. in Bioinformatics

Course Code	Course Title	Credits (L+P)
	Major: 12 credits	
	(5 credits of core plus 7 credits of optional)	
BI 601	Genome wide association study*	2+1
BI 602	#Computational analysis of Non-coding RNAs	1+1
BI 603	#Big data analytics	1+1
BI 604	#Systems Biology	3+0
BI 605	#Comparative and functional genomics*	1+1
BI 606	Phylogenetics	2+1
BI 607	#R and high dimensional genome data	1+1
BI 608	Pharmacogenomics & IPR	3+1
BI 609	Biological data integration and quality control	1+1
BI 610	Quantum theory and applications in bioinformatics	1+1
	Any other from 500 series	
	Minor (6 credits) – Any one/two of the following disciplines	
	Molecular Biology and Biotechnology	
	Biochemistry	
	Genetics and Plant Breeding	
	Microbiology	
	Supporting (5 credits) Any from the following disciplines	
	Statistics	
	Mathematics	
	Computer Science	
	Common Courses	
BI	Seminar I	0+1
BI	Seminar II	0+1
BI 600	Research	0+75
	Total	**100**

Course Contents
Ph.D. in Bioinformatics

I. Course Title : Genome Wide Association Study

II. Course Code : BI 601

III. Credit Hours : 2+1

IV. Aim of the course

To introduce the concepts, principles, various designs and techniques of genome wide association study.

V. Theory

Unit I (12 Lectures)

Definition, Allelic spectra of common diseases, Allele frequencies for susceptibility loci, Risks associated with disease-susceptibility variants, Applications of linkage-disequilibrium metrics, SNP map, Genome resequencing for full coverage in genome-wide association studies, Transmission Disequilibrium Test, common variant hypothesis, rare allele hypothesis, Genome-wide graph theory algorithms

Unit II (12 Lectures)

Case-Control design, Trio design, Cohort design, Cross-sectional designs for GWAS Selection of Study Participants, Environmental confounders in GWAS, Confounding by population stratification, Genotyping and Quality Control in GWA Studies, Analysis of association between SNP and traits.

Unit III (8 Lectures)

Uses of GWAS: gene-gene interaction, detection of candidate haplotypes, association between SNPs and gene expression.

VI. Practicals (16 Lectures)

Allelic spectra of common diseases, Allele frequencies for susceptibility loci, linkage-disequilibrium metrics, SNP map, Genome resequencing for full coverage in GWAS; Case-Control design, Trio design, Cohort design, Cross-sectional designs for GWAS Selection; Genotyping and Quality Control in GWA Studies; Analysis of association between SNP and traits.

VII. Suggested Reading

- Qin H. 2008. *Statistical Approaches for Genome-wide Association Study and Microarray Analysis.*
- Yang C. 2011. *SNP Data Analysis in Genome-wide Association Studies.*
- Kraft JS. 2010. *Genome-wide Association Study of Persistent Developmental Stuttering.*

I. Course Title : Computational analysis of Non-coding RNAs

II. Course Code : BI 602

III. Credit Hours : 1+1

IV. Aim of the course

To introduce non-coding RNAs, its role and regulation in model organisms and

tools and methods for *in silico* analyses

V. Theory

Unit I (8 Lectures)

Course overview; RNA molecules: biogenesis, types, structure and functions. Introduction to ncRNAs: types of ncRNAs, small ncRNAs, long ncRNAs, function of ncRNAs, Role of ncRNAs in plants and animals

Unit II (6 Lectures)

Small ncRNA: Introduction, miRNAs, siRNAs, hiRNAs, piRNAs, shRNAs; Post-transcriptional processing of microRNA; microRNA: target pairing and RISC function; miRNA target genomics; Functions and roles of miRNAs in growth & development of plants and animals. Stress responsive miRNAs, oncomiRs & tumour suppresser miRNAs.

Unit III (6 Lectures)

lncRNAs: biogenesis, classifications, structure and function of lncRNAs. Endogenous target mimic lncRNAs, triplet associated lncRNAs (miRNA, mRNA, lncRNAs); Circular RNAs: structure and functions. Role of circular RNA in cancer, growth and development.

Unit IV (6 Lectures)

Splicing and splice variants; Alternative splicing; Alternative splicing regulation; Nonsense mediated RNA decay; RNA editing.

Unit-V (6 Lectures)

Coding and non-coding sequences; TEs; lincRNAs and lncRNAs; Bacterial RNAs; riboswitches; Introduction to CRISPRs.

VI. Practicals (16 Lectures)

Exploration of databases and tools for identification and characterization of ncRNAs (miRNA, lncRNAs, circular RNAs); Prediction and characterization of ncRNAs from RNA-seq profiles; Structure prediction and validation of ncRNAs; Generation of new ncRNA resources and submission to genomic databases.

VII. Suggested Reading

- Ernesto Picardi Eds. 2015. *RNA bioinformatics*. Springer
- Ruzyo, G. J., and Walter, L., (Eds.) 2014. *RNA sequence, structure and function: computational and bioinformatic methods* –Springer
- Krebs, J. E., Lewin, B., Goldstein, E. S., Kilpatrick, S. T., 2014. *Lewin's Genes XI*- Jones & Bartlett Publishers
- MRS Rao. (ed.). 2017. *Long non-coding RNA biology*, springer
- Darnell J. 2011. *RNA: Life's indispensable molecule* – CSH press
- Krishnarao A. 2008. *MicroRNA-from basic science to disease biology*-Cambridge univ press

I. Course Title : Big Data Analytics

II. Course Code : BI 603

III. Credit Hours : 1+1

IV. Aim of the course

To introduce concepts of Big Data, Handling of unstructured genomic data using Big data analytics based tools.

V. Theory

Unit I (5 Lectures)

Big Data- Concepts, characteristics and relevance; MapReduce – Algorithm and application. Programming Models for Big Data.

Unit II (3 Lectures)

Hadoop framework, Hadoop Distributed File System (HDFS), YARN.

Unit III (5 Lectures)

Big Data SQL: – Hive Data Definition Language, Hive Data Manipulation Language, Hive Analytics: RegexSerDe, Views.

Unit IV (3 Lectures)

Apache Spark: Spark SQL, Spark DataFrame; PIG

VI. Practicals (16 Lectures)

Hadoop environment setup, HDFS, Spark SQL, Hadoop MapReduce, YARN, Hive, PIG.

VII. Suggested Reading

- Zikopoulos, P. C., Eaton, C., DeRoos, D., Deutsch, T., and Lapis, G. 2012. *Understanding big data: Analytics for enterprise class hadoop and streaming data* (p. 176). New York: Mcgraw-hill.
- Gandomi, A., and Haider, M. 2015. *Beyond the hype: Big data concepts, methods, and analytics. International Journal of Information Management, 35*(2), 137-144.
- Akerkar R. (Ed.). 2013. *Big data computing*. CRC Press.
- Prajapati, V. 2013. *Big data analytics with R and Hadoop*. Packt Publishing Ltd.

I. Course Title : Systems Biology

II. Course Code : BI 604

III. Credit Hours : 3+0

IV. Aim of the course

This course provides emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions, and evolutionary dynamics.

V. Theory

Unit I (16 Lectures)

Basic concepts in networks and chemical reactions; Input function of a gene, Michaelis-Menten kinetics, and cooperativity; Autoregulation, feedback and bistability; Introduction to synthetic biology and stability analysis in the toggle switch; Oscillatory genetic networks, Graph properties of transcription networks, Feed-forward loop network motif.

Unit-II (8 Lectures)

Introduction to stochastic gene expression, Causes and consequences of stochastic gene expression, Stochastic modeling—The master equation, Fokker-Planck Equation, and the Gillespie algorithm

Unit III (12 Lectures)

Introduction to microbial evolution experiments, and optimal gene circuit design, Evolution in finite populations, genetic drift, and the theory of neutral molecular

evolution; Clonal interference and the distribution of beneficial mutations, Fitness landscapes and sequence spaces.

Unit IV (12 Lectures)

Evolutionary games; Survival in fluctuating environments, Parasites, the evolution of virulence and sex; Interspecies interactions, the Lotka-Volterra model, and predator-prey oscillations; Ecosystem stability, critical transitions, and the maintenance of biodiversity; Dynamics of populations in space, The neutral theory of ecology.

VI. Suggested Reading

- Alon, Uri. 2006. *An Introduction to Systems Biology: Design Principles of Biological Circuits.* Chapman & Hall / CRC. ISBN: 9781584886426.
- Nowak, M. A. 2006. *Evolutionary Dynamics: Exploring the Equations of Life.* Belknap Press, ISBN: 9780674023383.
- Bruce A. 2009. *Essential Cell Biology.* Garland Science, ISBN: 9780815341291.
- Strogatz, Steven H. 2014. *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering.* Westview Press, ISBN: 9780813349107.
- L. AlberghinaH.V.westerhoff, 2005. *Systems Biology: Definitions and perspectives* Springer.
- A.Kriete, R.Eils,. 2014. *Computational systems biology* Second edition, Academic Press
- E.KlippR.Herwig, A.Kowlad, C.Wierling and H.Lehrach 2005. *Systems Biology in practice: Concepts, Implementation and applications*, WileyInterScience.
- Pengcheng Fu, Panke S. 2009. *Systems Biology and Synthetic Biology* Wiley InterScience.
- Rigoutsos I. and G. Stephanopoulos G. 2007. *Systems Biology* Vol.1: Genomics Oxford University Press Inc., USA.
- Choi S. 2007. *Introduction to Systems Biology.* Humana press Inc, New Jercy, USA.
- A.Kriete, R. Eils 2014. *Computational Systems Biology* (Second edition) Academic Press.

I. Course Title : Comparative and Functional Genomics

II. Course Code : BI 605

III. Credit Hours : 1+1

IV. Theory

Unit 1 (8 Lectures)

Functional elements, Chromosomes and transposons, Organellar Genomes, Symbiosis, Horizontal gene transfer, Gene duplication, Ploidy, Gene fates, Pan and core genomes, Recombination, Transposons, Gene clustering, SNPs and HapMaps, GWAS. Comparative methods for detection of species / organism relationships, Domain evolution, Study of co-evolution: Plant-insect interactions. Host-parasite interactions, viral evolution.

Unit II (8 Lectures)

Pre-and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics, Genome editing approaches and their applications; gene expression analyses and applications. RNAi. DNA chips and their use in transcriptome analysis, qPCR, SAGE, MPSS. Connecting Traits to Genes, and Genes to Functions; protein-protein interaction, and protein networks.

V. Practicals (16 Lectures)

Getting started on the HPC, Regular expressions, Unix and basic sequence statistics Databases, Genome browsers, Blast & HMMER, Short sequence alignments,

Distance trees, Maximum likelihood trees, Whole Genome Alignments, DotPlots, CoGeWebTool, AntiSMASHWebTool

VI. Suggested Reading

- Brown TA. 2006. *Genomes. 3rd edition. Garland Science*, New York.
- Sankoff D and Nadeau JH. 2000. *Comparative Genomics: Empirical and Analytical Approaches to Gene Order Dynamics, Map Alignment and the Evolution of Gene Families.* Netherlands, Kluwer Academic Publisher
- Jonathan Pevsner. 2009. *Bioinformatics and Functional Genomics.* Wiley Blackwell
- Wilkins MR, Williams KL, Appel RD, Hochstrasser DF. (Eds) 1997. *Proteome Research: New Frontiers in Functional Genomics.* Springer Verlag Berlin Heidelberg
- Gupta PK and Varshney RK. 2009. *Cereal genomics.*
- Grotewold E. 2006. *Plant Functional Genomics. Methods in Molecular Biology* Vol 236.
- Azuaje F and Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics.* John Wiley & Sons, US
- Primrose S.B and Twyman R. 2003. *Principles of Genome Analysis and Genomics.* Third Edition.
- Baxevanis. A. D. and Ouellette. B. F. F. (Eds). 2001. *Bioinformatics: A Practical guide to the analysis of genes and proteins.* Wiley Interscience. New York. 470p.
- Hunt and Livesey. 2000. *Functional Genomics: A Practical Approach.* Oxford University Press.
- Jollès P and Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis.* Birkhäuser.
- Branden. C and J. Troze. 1999. *Introduction to Protein Structure.* Second Edition.
- Brown TA. 2002. *Genomes* IInd Edition. Oxford Wiley Press (ISBN-10: 0-471-25046-5)
- Yun Bi Xu. 2009. *Molecular Plant Breeding.* CABI (ISBN: 978 1 84593 392)

I. Course Title : Phylogenetics

II. Course Code : BI 606

III. Credit Hours : 2+1

IV. Aim of the course

To find out the evolutionary relationship among various species by using different phylogenetic techniques and algorithms.

V. Theory

Unit I (14 Lectures)

Phylogenetic trees and their comparison: Definition and description, various types of trees; Consensus (strict, semi-strict, Adams, majority rule, Nelson); Data partitioning and combination Tree to tree distances, similarity; Phylogenetic analysis algorithms: Maximum Parsimony, Distance based: UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining.

Unit II (18 Lectures)

Probabilistic models of evolution, Maximum likelihood algorithm; Approaches for tree reconstruction: Character optimization; delayed and accelerated transformation, Reliability of trees, Bootstrap, jackknife, decay, randomization tests; Applications of phylogeny analyses: Comparison of Phylogenetic Trees obtained using DNA seq. vs. protein seq. vs. Full genomes. Need for addition of other properties towards total phylogenetic analysis, Comparative methods for detection of species/ organism relationships, Gene duplication, Horizontal transfer, Domain evolution, Study of co-evolution: Plant-insect interactions. Host-parasite interactions, viral evolution.

VI. Practicals (16 Lectures)

Different software for phylogenetic tree construction and evolution of tree such as EMBOSS, MrBayes, PAUP, PHYLIP, PAML, TREE puzzle, Dandogram, cladogram analysis.

VII. Suggested Reading

- Hall, B. G. 2001. *Phylogenetic Tress Made Easy: A How to Manual for Molecular Biologists.* SinauerAss.,USA.
- Nei, M. and Kumar, S. 2000. *Molecular Evolution and Phylogenetics.* Oxford University Press.
- Sankoff, D. & Nadeau JH. 2000. *Comparative Genomics: Empirical and Analytical Approaches to Gene Order Dynamics, Map Alignment and the Evolution of Gene Families.* Netherlands, Kluwer Academic Publisher
- Gustavo Caetano. 2010. *Evolutionary Genomics and Systems Biology.* Wiley-blackwell.
- Mount.D.W.2001. *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor Laboratory Press. New York. 564 pp.
- Nei M and Kumar S. 2000. *Molecular Evolution and Phylogenetics* Oxford University Press.
- Engels J.M.M, RamanathaRao.V, Brown.A.H.D and Jackson.M.T, 2002. *Managing Plant Genetic Diversity*, CABI Publishers, CAB International UK 489pp.

I. Course Title : R and High Dimensional Genome Data

II. Course Code : BI 607

III. Credit Hours : 1+1

IV. Aim of the course

This course mainly aims at teaching R and its packages, programming to the students and make them acquainted with the use of R for data analysis, in general, and genomic data analysis, in particular.

V. Theory

Unit I (8 Lectures)

R programming language: Introduction and basics, R data types- Arithmetic and Logical Operators. R Matrix- Create, Print, add Column, Slice; R Data Frame- Create, Append, Select, Subset, Sort; List in R- Create, Select; R Functions; If, Else, Else If statements in R; For loop and While Loop in R; Data Importing and Exporting; Correlation, Anova, T test , Simple and Linear Regression, Scatter Plot, Bar Chart and Histogram in R; Memory management;

Unit II (8 Lectures)

Applications of R: Univariate and Multivariate phenotypic data analysis; Linear Models – fixed effects model, random effects model, mixed effects model for genetic parameter estimation; GGE Biplot and AMMI for Stability analysis; Gene Expression analysis – Microarray and RNA-Seq data; Genome Wide Association Study (GWAS), Genomic Selection (GS), Sequence analysis; Genome Assembly and Annotation; Machine Learning – ANN, SVM, Random Forest, Deep Learning.

VI. Practicals (16 Lectures)

Matrix Operations In R; R Data Frame, Functions in R, Correlation in R, Simple and Linear Regression in R. ANOVA in R, Other applications of R for crop and animal improvement.

VII. Suggested Reading

- Ihaka R and Gentleman R. 1996. *R: a language for data analysis and graphics. Journal of computational and graphical statistics*, 5(3), 299-314.
- Gentleman R. 2008. *R programming for bioinformatics*. Chapman and Hall/CRC.

I. Course Title : Pharmacogenomics and IPR

II. Course Code : BI 608

III. Credit Hours : 3+1

IV. Theory

Unit I (8 Lectures)

Introduction to Drugs: Sources of drug- plant, animal, microbes, minerals. Drug name – chemical name, brand name or trade name, general name or common name. Drug classification – Chemotherapeutic agents, Pharmacodynamic agents, Miscellaneous agents. Routes of administration – Oral route and Parental route. Drug Absorption, Distribution, Metabolism and Excretion (ADME).

Unit II (8 Lectures)

Drug Response to Genetic Variations: SNP as markers in Pharmacogenomics-Turning SNPs into Useful Markers of Drug Response. Mechanism of drug action – receptor, agonist, ion channel. Inheritance and drug response - Pharmacogenetics of drug metabolism – Phase I metabolism, Phase II metabolism. Pharmacogenomics of Drug Transporters- Organic Anion and Cation Transporter Family, Peptide Transporter Family, Multidrug Resistance-Associated Proteins.

Unit III (6 Lectures)

Case Studies in Pharmacogenomics: Pharmacogenomics of Chemotherapeutic Agents in Cancer Treatment, Pharmacogenomics of Neurodegenerative Diseases: Examples and Perspectives, Pharmacogenomics of Alcoholism, Ethnicity and Pharmacogenomics. Ayugenomics. Pharmacogenomics and pharmaceutical Industries.

Unit IV (8 Lectures)

Basics of Toxicogenomics: Definition, genetic polymorphisms, Comparative toxicogenomics database (CTD) – Chemical gene interaction, chemical – disease association, gene – disease association. Specific applications of toxicogenomics – xenobiotics – insecticide - exposure assessment, hazard screening, variability of susceptibility, mechanistic information, cross-species extrapolation, dose-response relationship, development exposures, mixture.

Unit V (6 Lectures)

Databases for Toxicogenomics: Sample collection and data uniformity. Sharing and distributing data. Building toxicogenomic databases. ToxicogenomicDataRepositories – Standardization, availability, transparency. Data repositories - Stanford Microarray Database, CaBIG, DrugMatrix database, Tox-Express.

Unit VI (12 Lectures)

WTO and TRIPS Agreement: World Trade Organization (WTO)-Globalization-Trade Related Intellectual Property Rights (TRIPs) -General Obligations–substantive requirement of the TRIPS agreement in the WTO –International Union for the Protection of New Varieties of Plants (UPOV)- Multilateral treaties on patent

Forms of IPR and Role of Institutions: Different forms of IPR-Patents, Copyrights, GIs, Trademarks, Industrial Designs and Layouts, Trade secrets – Types of IPR forms-Utility, Design and plant patents, Generic and descriptive trademarks Role of Indian Patent Office (IPO), National Association of Creators, Owners and Users of Intellectual Property (NIPO), Geographical Indications (GI) registry-Multilateral organizations- World Intellectual Property Organization (WIPO), European Patent Office (EPO), US Patent and Trademark Office (USPTO),

Biotechnology and IP Rights: Biotech market in India- Biotech: SWOT – Bioinformatics in India – patent claims in biotechnology – patentable and non-patentable biotech inventions- patenting microorganisms and GMOs - Utility patents for genetic materials-patenting of biotech research tools - Types of bioinformatics patents -Infringement laws at National and International level- Acquisition / licensing of bio-tech patents and trade secrets.

IP Issues in Biotech Research and Development: Research and Development in Biotechnology - Biotechnology and seed policy- Role of Multi-national and Domestic Seed Firms- Moral issues in Patenting Biotechnological inventions- Bio-safety and Bioethics- International bio-safety protocols-cartegena protocols.

IP in Indian Agriculture: Sui-generis system and Status of plant varieties protection in India- Protection of plant genetic resources- protection of Bio-diversity in India- Protection of GIs.

V. Practicals (16 Lectures)

Literature resources: selection and study on a disease, Identification of receptor and ligand involved, search on the drugs at practice, mechanism of their action, toxicity issues-using search engines, Databases on Toxicogenomics- KEGG, chemical databases- Chemfinder, ADME databases, Identification of pharmacophores using databases- retrieving their properties, structure in Smiles notation using Pubchem/ drug bank. Conversion of SMILES, SYBYL, MOL files to PDB format- CORINA, conversion of coordinate file to topology formats- prodrg server, Small molecule generation, evaluation and optimization using Chemsketch, Comparative gene expression analysis on normal and diseased condition, A study on ADME properties- ADME database, calculation of ADME properties- Lipinski rule – Molinspiration tool, High throughput assay to determine a drug toxic effect- ADMEtox, Structural analysis of Protein and Pharmacophores; structural alignment, structural properties- Rasmol/SPDBV, Study of instruments used in experimental Pharmacology, smoking and fixing a kymograph - Handling of laboratory animals - Techniques of drug administrations in animals - Influence of route of administration of drugs on drug response.

VI. Suggested Reading

- Qing Yan. 2006. *Pharmacogenomics in Drug Discovery and Development*. Humana press.
- Licinio, J., and Wong, M.L. 2002. *Pharmacogenomics: The Search for Individualized Therapies*. Wiley-VCH,Verlag GmbH.
- Burcznski, M. E. 2003. *An Introduction to Toxicogenomics*. CRC press.
- Catania MG. 2005. *An A-Z Guide to Pharmacogenomics*, AACC Press.
- Kille P. 2008. *Comparative Toxicogenomics*. Christer Hogstrand. Elsevier Science
- Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
- Anonymous. 2004. *State of Indian Farmer*. Vol. V. Technology, Ministry of Agriculture, Government of India.

- Rothschild M and Scott N. (Ed.). 2003. *Generation and IPR Issues*. Academic Foundation.
- B.L.Wadera. 1996. *Patents, Trade Marks, Copy Right Designs & Geographical Indications*. Universal Law Publishing Co.Pvt.Ltd.
- Narayana PS. 2004. *Intellectual Property Law in India*. K.C.Gogia ,M/S Gogia Law Publication.
- Ganguli P. 2008. *Intellectual Property Rights: Unleashing Knowledge Economy*, McGraw Hill, New Delhi
- Santaniello V, Evenson RE, Zilberman D, Carlson GA. 2000. *Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issues in Biotechnology*, CABI Publishing, Wallingford, UK

I. Course Title : Biological Data Integration and Quality Control

II. Course Code : BI 609

III. Credit Hours : 1+1

IV. Aim of the course

To familiarize the techniques of data sources, data curation and integration of data sources

Unit I (5 Lectures)

Curation of genomics, genetic, proteomics, High-throughput screening, array, qPCR data sets; Quality management of data: tools and techniques.

Unit II (6 Lectures)

Biological data sources, Data granularity, Schema modelling, architecture, query design, extraction, transformation and loading, Long term data management, storage and security.

Unit III (5 Lectures)

Bio-chip information system, visualization and reporting, Risk factors for data quality management.

V. Practicals (16 Lectures)

Understanding the data sources, Data granularity, Data modeling and architecture, development of database, Storage, Security, Visualization and reporting.

VI. Suggested Reading

- Kozak, K. 2010. Large Scale Data Handling in Biology. 2010. Ventus Publishing ApS. ISBN 978-87-7681-555-4.
- Harold, E. and Means W.S. 2004. *XML in a Nutshell*, Third Ed. O'Reilly, Sebastopol, CA
- Witten, I.H. and Frank E. 2005. *Data Mining: Practical Machine Learning Tools and Techniques* WEKA, 2nd Ed. San Francisco, Morgan Kaufmann
- Lodish, H. *et al.* 2000. *Molecular Cell Biology*. New York: Freeman & Co.
- Kaneko K. 2006. *Life: An Introduction to Complex Systems Biology*. Springer.

I. Course Title : Quantum Theory and Applications in Biology

II. Course Code : BI 610

III. Credit Hours : 1+1

IV. Aim of the course

This course introduces the concepts of quantum theory with application in molecular biology

V. Theory

Unit I (5 Lectures)

Classical mechanics, Newton, Lagrange and Hamilton's equations, Schrodinger's equation and its complete solution for S.H.O, central force and angular momentum

Unit II (6 Lectures)

Atomic orbital models, the wave equation, molecular orbitals, the LCAO method, the overlap method, coulomb and resonance integrals, the hydrogen molecule, charge distributions, approximate methods

Unit III (5 Lectures)

Absorbance of frequency-specific radiation (photosynthesis), Conversion of chemical energy into motion, Magneto reception in animals, DNA mutation and Brownian motors in many cellular processes

VI. Practicals (16 Lectures)

Classical mechanics, Central force and angular momentum; Atomic orbital model, Wave equation, Resonance integers. DNA mutation and Brownian motors in many cellular processes.

VII. Suggested Reading

- Heisenberg W. 1949. *The Physical Principles of the Quantum T1heory.*
- Bohm D. 1951. *Quantum Theory.*
- Ghatakm AK and Lokanathan S. 2004. *Quantum Mechanics: Theory and Applications.*
- Bittner ER. 2009. *Quantum Dynamics: Applications in Biological and Materials Systems.*
- Blinder SM. 2004. *Introduction to Quantum Mechanics: In Chemistry, Materials Science, and Biology.*