DAV UNIVERSITY, JALANDHAR

Syllabus of Courses for
Master of Science - Biochemistry (Honours)

(Program ID – 36)

Course Syllabus for Semesters 1-4

Course Syllabus Applicable to Admissions in 2015

Semester 1

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH501	Bioanalytical Techniques	4	1	0	4	**Core**
2.	BTY511	Molecular Biology	4	1	0	4	**Core**
3.	BTY513	Cell Biology	4	1	0	4	**Core**
4.	BCH524	Principles of Biochemistry	4	0	0	4	**Core**
5.	BCH503	Bioanalytical Techniques Laboratory	0	0	3	2	**Core**
6.	BTY512	Molecular Biology Laboratory	0	0	3	2	**Core**
7.	BTY514	Cell Biology Laboratory	0	0	3	2	**Core**
8.	BCH525	Principles of Biochemistry Laboratory	0	0	3	2	**Core**
		Total	**16**	**3**	**12**	**24**	

L: Lectures T: Tutorial P: Practical Cr: Credits

Semester 2

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BTY551	Recombinant DNA Technology	4	0	0	4	**Core**
2.	BCH525	Genetics and Genomics	4	0	0	4	**Core**
3.	BTY525	Biostatistics	4	0	0	4	**Core**
4.	BTY526	Biostatistics Laboratory	0	0	3	2	**Core**
5.	BCH526	Genetics and Genomics Laboratory	0	0	3	2	**Core**
6.	BTY555	Recombinant DNA Technology Laboratory	0	0	3	2	**Core**
7.		Departmental Elective I	4	0	0	4	**Departmental Elective**
8.		Open Elective I	4	0	0	4	**Open Elective I**
		Total	**20**	**0**	**9**	**26**	

L: Lectures T: Tutorial P: Practical

Departmental Electives: Choose from any theory course and the accompanyting laboratory course.

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH528	Biology of Cancer	4	0	0	4	**Departmental Elective**
2.	BCH627	Regulation of Gene Expression	4	0	0	4	**Departmental Elective**

Semester 3

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH521	Computational Techniques for Biologists	4	1	0	4	**Core**
2.	BCH601	Biochemical and Environmental Toxicology	4	0	0	4	**Core**
3.	BCH625	Concepts in Immunology	4	0	0	4	**Core**
4.	BCH622	Critical Review of Scientific Literature	2	0	0	2	**Core**
5.	BCH522	Computational Techniques for Biologists Laboratory	0	0	3	2	**Core**
6.	BCH609	Biochemical and Environmental Toxicology Laboratory	0	0	3	2	**Core**
7.	BCH626	Concepts in Immunology Laboratory	0	0	3	2	**Core**
8.	BCH614	Project – I	0	0	0	2	**Core**
8.		Departmental Elective II	4	0	0	4	**Departmental Elective**
		Total	**18**	**1**	**12**	**26**	

L: Lectures T: Tutorial P: Practical

Departmental Electives: Choose from any theory course and the accompanyting laboratory course.

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH629	Principles of Neurobiology	4	0	0	4	**Departmental Elective**
2.	BCH605	Plant Biochemistry	4	0	0	4	**Departmental Elective**

Semester 4

S.No.	Paper Code	Course Title	L	T	P	Cr	Course Type
1.	BCH615	Project - II	0	0	0	8	**Core**
2.	BCH521	Principles of Cell Signaling	4	0	0	4	**Core**
3.	BCH603	Clinical Biochemistry	3	0	0	3	**Core**
4.	BCH607	Nutritional Biochemistry	4	1	0	4	**Core**
5.	BCH604	Clinical Biochemistry Laboratory	0	0	2	1	**Core**
6.	BCH608	Nutritional Biochemistry Laboratory	0	0	3	2	**Core**
7.		Open Elective II	4	0	0	4	**Open Elective**
		Total	**15**	**1**	**5**	**26**	

L: Lectures T: Tutorial P: Practical

Course Title: Bioanalytical Techniques
Paper Code: BCH501

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The course introduces students all the major bioanalytical techniques relevant to students of biochemistry. It covers the theoretical aspects of various techniques, along with their instrumentation and applications.

Unit A (20 hours)

Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, Fluorescence Spectroscopy.

Chromatography – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit B (20 hours)

Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Mass Spectrometry – Principle of MS, ionization modes, equipment, MS of proteins/peptides, interface of MS with other methods – MS/MS, LC/MS, and GC/MS, peptide mapping, post-translation modification analysis of proteins, protein sequencing by MS.

Unit C (10 hours)

Electrophoretic techniques – Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis.

Immunochemical techniques – Making antibodies, Immunoassay formats, Immunomicroscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Fluorescent activated cell sorting (FACS), Cell and tissue staining techniques, Immunocapture, polymerase chain reaction (PCR) Immunoaffinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies

Unit D (10 hours)

Bioinformatics – Overview, Sequence databases – DNA, protein, genome, EST and SNP databases, BLAST programs, ClustalW, Tertiary protein structure databases, PDB, Rasmol, Pymol and Swiss-PDB viewer, Homology modeling.

Recommended books:

1. Physical Biochemistry – Principles and Applications – 2nd Edition – David Sheehan, Wiley-Blackwell (2009).

2. Analytical Biochemistry – 3rd Edition – David Holme and Hazel Peck, Pearson Education Ltd. (1998)

Course Title: Bioanalytical Techniques Laboratory

Paper Code: BCH503

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Titration of a weak acid using a pH meter, preparation of buffers

2. Verification of Beer-Lambert's law and determination of absorption coefficients

3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture

4. Thin layer chromatography of fatty acids

5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column

6. Electrophoresis

Course Title: Molecular Biology

Course Code: BTY511

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination. 12 hours

Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA. 12 hours

Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post- translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. 10 hours

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Cell signaling: signal transduction pathways and their regulation. 10 hours

Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. 8 hours

Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression. Molecular mechanism of nitrogen fixation. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. 8 hours

Recommended Books:

1. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.

2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. *Lewin's GENES XI*. 11th Edition. Jones & Bartlett Learning. 2012. Print.

3. Sambrook, J., Fritsch, E.F. and Maniatis, T.*Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.

4. Watson, J.D. *Molecular Biology of the Gene.* 7th Edition. Benjamin Cummings. 2013. Print.

Course Title: Molecular Biology-LAB

Course Code: BTY512

L	T	P	Credits	Marks
0	0	3	2	50

1. Isolation of genomic DNA from bacteria.
2. Isolation of genomic DNA from plant.
3. Isolation of total RNA from tissue.
4. Demonstration of DNA protein interaction.
5. Quantitation of nucleic acids and proteins.
6. Gel electrophoresis: Nucleic acid - Protein

Course Title: Cell Biology

Course Code: BTY513

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The object of the present course is to develop basic knowledge in cell biology to understand the structure and function of the cellular and sub cellular components of cells and tissues with the help of recent techniques. The course will help students to get an understanding of cell function at the molecular level including the fundamentals of biology. They will become aware of the complexity and harmony of the cell.

1. History of cell biology: Development of cell theory Diversity of cell size and shape: General organization and diversity of prokaryotic and eukaryotic cells. Origin of cells: Assembly of macromolecules (proteins and nucleic acid), mechanism of assembly, evolutionary steps in the origin of cells (Chemical evolution). **9 hours**
2. Microscopic techniques for study of cells: Bright field, Fluorescence, Phase contrast, DIC, dark field, Polarization, Confocal. Electron Microscopy: TEM, SEM, AFM, STEM, Preparation of samples for EM. Applications of Light Microscopy and EM in cell biology. **6 hours**
3. Sub cellular fractionation: Fractionation and marker enzymes and functional integrity, FACS, separation techniques for membrane proteins. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility). **6 hours**

4. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. **5 hours**
5. Cell Trafficking : Targeting proteins to endoplasmic reticulum, signal recognition parcticle, signal recognition particle receptor, protein folding and processing in ER protein export from ER; Protein sorting and export from Golgi Apparatus; SNARE hypothesis; Protein import into Mitochondria, mitochondrial genome; Import and sorting of chloroplast protein. Cellular energy transactions: Role of mitochondria and chloroplasts. **8 hours**
6. Cell division and Cell cycle & its regulation: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Molecular events and model systems; the role of the cyclins and cyclin-dependent kinases, cell cycle checkpoints, methods for synchronizing the cell cycle in cell populations. **3 hours**
7. Cellular responses to environmental signals in plants and animals: Mechanism of signal transduction. Cell signaling - Modes of cell signaling, steroid hormone

receptors, plant hormones, G-protein coupled receptors; regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing, c- AMP pathway of signal transduction ; c GMP, phospholipids and calcium ions, Ras, Raf , MAP kinase pathway , JAK –STAT pathway , Apoptosis –role of caspases. **4 hours**

8. Cell motility: Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism. 4 **hours**

Books:

1. Cell biology: A laboratory handbook Vol 1, 2, 3 (2006) by Celis. J.E. (Academic Press, UK).
2. Stryer, L. (1995). Biochemistry, 4th edition, W.H. Freeman and Co., New York.
3. Nelson, D.L. and Cox, M.M. (2000). Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York.
4. Damal, J., Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Scientific American Books, New York.

Course Title: Cell Biology-LAB

Course Code: BTY514

L	T	P	Credits	Marks
0	0	3	2	50

- Microscopy: Bright field.
- Instrumental methods for cell biology-centrifugation, chromatography.
- Preparation of permanent slides of cell division.
- Vital staining for visualizing cell organelles.

Course Title: Recombinant DNA technology
Course Code: BTY551

L	T	P	Credits	Marks
4	**0**	**0**	**4**	**100**

Course objective: The basic objective of the paper is to present the principles of gene manipulation and its associated technologies. How developments in gene manipulation have revolutionized medicine, agriculture and health.

- Introduction and scope of Recombinant DNA Technology. **2 hours**

- DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases. **8 hours**

- Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA. **4 hours**

- Cloning and expression vector: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors. **10 hours**

- Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes. **4 hours**

- DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone. **6 hours**

- Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. **4 hours**

- Expression of cloned genes :Expression of cloned genes in *E. coli*, *Bacillus subtilis*, s*treptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes. **8 hours**

- Protein-Protein interactions-Phage display (*in vivo*, *in vitro* and *in planta*, Yeast two hybrid system, Yeast three hybrid system. Bicomplementation and Florescence Resonance Energy Transfer (FRET). **3 hours**

- Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, random mutagenesis, site-directed mutagenesis and protein engineering. **4 hours**

- Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope. **4 hours**

- Applications of r-DNA technology in industry, agriculture and forensic science. **3 hours**

Recommended Books:

1. Brown, T.A. *Gene cloning and DNA analysis: An introduction*. 5th Edition. Wiley-Blackwell. 2010. Print.
2. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.
3. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes.* 3rd Edition. W.H. Freeman & Company. 2006. Print.
4. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics.* 7th Edition. Oxford University Press. 2006. Print.
5. Lodge, J., Lund, P. and Minchin, S. Gene Cloning: Principles and Applications. 1st Edition. Taylor & Francis. 2006. Print.
6. Glick, B.R., Pasternak, J.J. and Patten, C.L. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition. ASM Press. 2009. Print.

Course Title: Recombinant DNA technology-LAB
Course Code: BTY555

L	T	P	Credits	Marks
0	**0**	**3**	**2**	**50**

1. Preparation and purification of pUC plasmid.
2. Preparation and purification of genomic DNA.
3. Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
4. Gene cloning.
5. Bacterial transformation.
6. Southern blotting and hybridization with non-radioactive probes.
7. Amplification of DNA with PCR Temperature cycler.

Course Title: Biostatistics
Course Code: BTY525

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: The course aims to develop expertise in the application of statistical methods applied to biological data obtained in experimental findings.

- Brief description and tabulation of data and its graphical representation. Measures of Central Tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation, Quartile Deviation), combined mean and variance, covariance, Graphs (Bar Chart, Pie Chart, Box Plot, Histogram, Ogive, scatter plot) Probability: Experimental probability, probability when outcomes are equally likely, subjective probabilities. **12 hours**
- Probability (Addition and Multiplication Theorem), Bayes theorem, Binomial, Poisson and Normal distribution. Correlation and linear regression **8 hours**
- Random variables and distributions, Discrete and continuous random variables, Cumulative distribution function, Probability mass function and probability, Density function, Expectation of random variable– experimental Approach and theoretical approach. **10 hours**
- Formulation of Hypothesis (One-tailed & Two-tailed), Type I and Type II errors, power of a test, Significance of a test, P-value testing, Hypothesis Testing (students T-test, Chi-square test). Analysis of variance (ANOVA) one and two way. Pearson correlation test. **8 hours**
- Biological experimental designs- CRD, RBD, factorial designs, latin square designs. **6 hours**
- Application of statistics biological experimental design: Data collection and explanation and conclusion case studies. **8 hours**
- Sampling theory and different techniques,Applications of statistical methods using statistical software , SAS. **8 hours**

Books:

1. Banerjee, P.K. *Introduction to Biostatistics.* 4th Edition. S. Chand & Co. Ltd. 2013. Print.
2. Sokal, R.R. and Rohlf, F.J. *Introduction to Biostatistics*. 2nd Edition. Dover Publications. 2009. Print.
3. Daniel, W.W. and Cross, C.L. *Biostatistics: A foundation for analysis in the Health Sciences*. 10th Edition. John Wiley and Sons. 2013. Print.
4. Arora, P.N. and Malhan, P.K. *Biostatistics*. Himalaya Publishing House. 2012. Print.
5. Forthfer, R.H., Lee, E.S. and Hernandez, M. *Introduction to Biostatistics*. Academic Press. 2006. Print.
6. Gupta, S.P. *Statistical Methods*. 43rd Edition. S.Chand & Co. 2013. Print.

Course Title: Biostatistics – LAB
Course Code: BTY557

L	T	P	Credits	Marks
0	**0**	**3**	**2**	**50**

Experiments based on measures of central tendency.
Experiments based on measures of dispersion.
Experiments based on analysis of data obtained in lab for different biological experiments
Questions based on various distributions like Binomial, Poisson, Bernoulli.
Practical on question of probability.
Practical based on hypothesis testing.
Biological experimental designs- CRD, RBD, factorial designs, latin square designs.

Course Title: Biochemical and Environmental Toxicology
Paper Code: BCH601

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course introduces students to basic concepts of toxicology and mechanism of action of various toxins, along with various techniques used in toxicology.

Unit A (15 hours)

Definition, scope and relationship of toxicology to other sciences. Nature of toxic effects. Acute and chronic exposure.

Dose: response relationship, determination of LD-50, no effect observe level, acceptable daily intake, bioavailability, volume of distribution, plasma half life, total body burden, total body clearane. Synergism and antagonism

Unit B (15 hours)

Metabolism of toxicant- Introduction, absorption and distribution. Cytochorome P-450, MFO system and their role in xenobiotic metabolism. Non-microsomal oxidation. Phase-I and Phase-II reactions, conjugations, glucoronide conjugates, conjugations catalysed by sulfotransfereases, methyl transferases and acetyl transferases. Glutathione conjugation and amino acid conjugations.

Unit C (15 hours)

Toxicity testing- Decision-tree protocol, Ames test, Host mediated assay and dominant lethal test,

Drosophila sex linked recessive lethal test, micronucleus test.

Unit D (15 hours)

Toxicity of pesticides-Classes of pesticides: organoclorine, organophosphates and carbamates. DDT: metabolism, toxicity, persistence and bioaccumulation. Organophosphats-metabolism and mechanism of insecticidal action.

Metal toxicity-Toxicity of lead and its effect on heme synthesis. Toxicology of various forms of mercury.

Drug toxicity-Paracetamol, metabolism and its toxic effects.

Books Recommended:

1. Frenhe LY, Lu's Basic toxicology 4th Ed. (2002),

2. A. Wallace Hayes, Principle & Methods of Toxicology 5th Ed. (2008)

3. E. Hodgson & R.C. Smart, Introduction to Biochemical Toxicology 3rd. Ed. 2001.

4. Curtis D. Klassen, Casarett & Doull's Toxicology, the Basic science of Poison 7th Ed.

Course Title: Biochemical and Environmental Toxicology Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH609

Experiments:

1. Qualitative detection of various toxicants in biological samples:

Phenothiazine derivatives, Organochlorine compounds (Fujiwara test), Phenol, Methanol, Arsenic (As), Antimony (Sb), Selenium (Se), Mercury (Hg), Bismuth (Bi), Fluoride (F), Boron (Bo), Gutzeit test for Antimony (Sb) and Arsenic (As), Spot test for metal toxicants.

2. Quantitative determination of Salicylate, Paracetamol (acetaminophen), Sulphonamide in biological samples.

3. Enzyme assay in toxic conditions:

GOT (AST), GPT (ALT), Acid phosphatase, Alkaline phosphatase, Acetyl cholinesterase etc.

4. Construction of dose-response curves.

5. Determination of LD50 value of a toxicant.

6. Induction of hepatotoxicity / diabetes / skin lesions / teratogenesis.

7. Organ / tissue morphology / histopathology

8. Assay of toxicant biotransformation enzyme-cytochrome P450.

9. Test for teratogenecity / carcinogenecity / Ames test.

10. Assay of biomarkers of environmental pollution / toxicity.

Course Title: Genetics and Genomics
Paper Code: BCH525

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to basic concepts of genetics and transmission of genetic information.

Unit A (15 hours)

Model systems in Genetic Analysis: Bacteriophage, *E. coli, Neurospora crassa, yeast, Arabidopsis thaliana,* Maize, *Drosophila, C. elegans, Danio rerio, Homo sapiens* - General outline of life cycle, importance in Genetic analysis.

Laws of inheritance: Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance. Allelic and non-allelic interactions: Concept of alleles, types of dominance, lethal alleles, multiple alleles, test of allelism, complementation; Epistasis.

Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping. Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination.

Unit B (15 hours)

Quantitative inheritance – Concept, Genes and Environment - heritability, penetrance and expressivity.

Cytoplasmic inheritance – Basis and mechanism, role of organellar genes.

Mutation – Classification, mechanism, repair, role in genetic analysis and evolution.

Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation. Meiotic consequences in structural heterozygotes, role in speciation and evolution.

Unit C (15 hours)

Human genome - Gross structure and Content of the human genome**,** Protein-coding and non-coding genes**,** Complexity of splicing, splicing regulation, diversity of isoforms**,** Telomeres and centromeres**,** Transposable elements**,** Regulatory sequences and control of gene expression**,**

Genetic variation among humans - Origins of variation**,** Spread of variation through population**,** Genetic variation across the human population**,** SNPs, indels and structural variants**,** Geographic distribution of variation, What is "race"?**,** Admixture**,** Recombination and haplotype structure of human genome Reconstruction of recent and distant history with genetics**,** Mitochondria and Y chromosomal history, Case study - Genghis Khan, Use of DNA in forensics

Human evolution - Comparison of human genome to other primates and mammals, Archaic humans**,** Neanderthals and Denisovans**,** Interbreeding between modern and archaic humans**,** Human-specific traits**,** Selection along human lineage

Unit D (15 hours)

Phenotype and Disease - allelic variation linked to disease, OMIM**,** inferring phenotype from genotype: what's possible, what are the limitations**,** mitochondrial diseases, somatic variation/heteroplasmy in mtDNA, sex-linked traits, dosage compensation and phenotypic variation

Mapping – GWAS**,** Common vs. rare variation in human disease and its impact on mapping**,** "missing" heritability of traits

Cancer genomics - extent of somatic variation**,** types of variation seen in cancer, targeted therapeutics.

Personal genomics.

Recommended Books

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1- 4292-2943-8.

4. For the Genomics portion – no texts, only primary research articles and review articles will be assigned.

Course Title: Genetics and Genomics Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH526

Experiments:

1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (*Phlox, Allium* and *Rhoeo*).

2. Extraction of genomic DNA from plants by CTAB method.

3. Analysis of molecular polymorphism in parental lines and derived mapping population

using different types of molecular markers.

4. Construction of a linkage map using available data.

5. Mutagenesis experiments in E. coli.

6. Experiments in *Neurospora* / *Drosophila* genetics.

Course Title: Biology of Cancer
Paper Code: BCH528

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to mechanism of cancer and tumorigenesis.

Unit A (15 hours)

Introduction to Cancer

Nature of Cancer, Classification of tumors, Altered energy metabolism in tumors, Cancers induced by specific lifestyles and chemical agents, Mutagens

Tumor Viruses

Rous Sarcoma Virus (RSV), Oncogenes, *myc, src*, proto-oncogenes.

Growth Factors, Receptors and Cancer

EGF Receptor – Receptor Tyrosine Kinases and their mechanism of action, transphosphorylation, G proteins – Ras.

Signaling pathways and Cancer

Ras-regulated signalling pathways, Jak-STAT pathway, Wnt-β-catenin pathway and cell proliferation, GPCRs, Negative and Positive feedback controls in signalling pathways.

Unit B (15 hours)

Tumor Suppressor Genes

Retinoblastoma tumor and the genetic puzzle of tumor suppressor genes, Identification of tumor suppressor genes, Inheritance of mutant tumor suppressor genes, Promoter methylation in inactivation of tumor suppressor genes.

Cell Cycle and Cancer

Control of cell cycle, Regulator proteins of cell cycle, Role of Cyclins and CDKs in cell cycle control, E2F-Rb axis and cell cycle control, role of Myc protein in proliferation/differentiation decision, Perturbation of pRb function in human cancers.

p53 and Apoptosis

p53 and its discovery, stabilization of p53 by DNA damage and deregulated growth, Mdm2 protein, Role of p53 as a transcription factor, Causes of cell death, Apoptosis and its dependence on mitochondria, Necrosis and autophagy – two additional forks in the road of tumor progression

Unit C (15 hours)

Cell Immortalization and Tumorigenesis

Need for immortality in cancer cells, role of telomeres in limiting proliferation of cultured cells, expression of telomerase in incipient cancer cells, maintenance of telomeres in immortalized cells without telomerase, biology of telomerase-negative mice.

Multi-step Tumorigenesis

Development of human cancers, evidence of multi-step tumorigenesis, Darwinian evolution in tumorigenesis, Tumor stem cells and tumorigenesis, role of inflammation in tumorigenesis.

Unit D (15 hours)

Invasion and Metastasis

Colonization, EMT transition, Role of TFs, proteases, and Small Ras-like GTPases in EMT, Metastasis and Bone cancer.

Cancer Treatment and Therapy

Major pillars of cancer treatment – surgery, radiotherapy and chemotherapy. Development of drugs against cancer, Clinical trials and their phases, Rational drug design and design of cancer drugs, Case study – Gleevec.

Recommended Books:

1. Weinberg, Robert. The Biology of Cancer (2013). 2nd Edition. Garland Science. ISBN: 9780815342205.

Course Title: Regulation of Gene Expression
Paper Code: BCH627

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to mechanisms of gene regulation in prokaryotes and eukaryotes.

Unit A (15 hours)

Introduction to Gene Expression

Central dogma, tools and techniques – DNA separation techniques, DNA Sequencing, DNA microarrays, PCR and RT-PCR, Chromatin Immunoprecipitation (ChIP), Gene Knockouts and transgenics.

The Operon

lac operon, *cis* and *trans*-acting mutations, *lac* repressor, inducer molecule, *trp* operon, Attenuation

Unit B (15 hours)

Bacteriophage and Gene Expression

Lytic and Lysogenic modes of development, Lambda repressor protein and its function, Antitermination

Unit C (15 hours)

Eukaryotic Transcription Regulation

Gene activation in eukaryotes, role of activators and repressors, nucleosome organization at gene promoter, histone acetylation and transcription activation, Yeast *GAL* genes – a model for activation and repression

Unit D (15 hours)

Epigenetic effects

Heterochromatin and its interaction with histones, Role of Polycomb and Trithorax proteins, CpG islands, Role of DNA methylation in imprinting, inheritance of epigenetic effects.

Regulatory RNA

Riboswitches, ncRNAs and regulation of gene expression, Regulator RNAs in bacteria, RNAi, MicroRNAs and regulation of gene expression in prokaryotes.

Recommended Books:

1. Krebs, J.E., Goldstein, E.S., and Kilpatrick, S.T. Lewin's Genes XI (2014). 11th Edition. Jones and Bartlett Learning. ISBN: 9781449659073.

Course Title: Clinical Biochemistry
Paper Code: BCH 603

L	T	P	Credits	Marks
4	0	0	3	75

Course Objective: This course covers various aspects of clinical biochemistry with relevance to their mechanistic aspects and diagnostic applications.

Unit A (15 hours)

Diagnostic enzymology-enzyme determination in serum/plasma, urine and cells. Clinically important enzymes, use of isoenzymes in diagnosis.

Function tests: Hepatic: Tests based upon the metabolism of carbohydrates, lipids, protein and detoxification. Differential diagnosis of jaundice

Renal: GFR and its clinical importance, clearance tests (urea and creatinine) Intestinal: Malabsorption of fats, carbohydrates and proteins.

Pancreas: amylase, lipase and trypsin assays in serum

Unit B (15 hours)

Disorders of metabolism:

Carbohydrates- glycogen storage diseases, galactosemia

Amino acids- disorders of glycine, sulfur containing amino acids, aromatic amino acids, histidine, branched chain amino acids and proline, disorders of propionate and methylmalonate metabolism. Disorders in urea biosynthesis.

Unit C (15 hours)

Lipids: hyperlipoproteinemia, hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick disease, Gaucher's disease, Krabb's disease, Metachromatic leukodystrophy and Fabry's Disease, Wolman's Disease.

Disorders of porphyrin and heme metabolism

Unit D (15 hours)

Myocardial infarction and atherosclerosis Quality control in clinical Biochemistry

Water & electrolyte balance, acid base balance

Recommended Books:

1. Dennis L. Kasper, Eugene Braunwal, Stephen Hauser, and Dan Longo Harrison's Principles of Internal Medicine 16th Ed (Two-Volume Set)

2. Becket, G. Walker, S. Rae; P and Ashby, P Clinical Biochemistry, 7th Ed, Blackwell Publishing.

3. John B. Stanbury et al, Metabolic Basis of Inherited Disease, Mcgraw-hill Book Company 5th Ed.

4. Marshell W.J. and Bangert, S.K. Clinical Chemistry 6th Ed.(2008) International edition MOSBY, Elsevier,

5. Burtis, C.A., Awood, E.R. and Bruns, D.E. TIETZ Text book of Clinical Chemistry and Molecular Diagnosis, 4th Ed. Elsevier.

6. Bishop, M.L., Fody, E.P and Schoeff, L. Clinical Chemistry- Principles, Procedures, Correlations. 5th Ed. Lippincort Willimy & Wilkins.

7. Lieberman, M and Marks, A.D. MARK'S Medical Biochemistry, A Clinical Approach, 3rd Ed. Lippin Williman wilkins

8. Bhagwan, N.V., Medical Biochemistry 4th Ed. Academic press.

Course Title: Clinical Biochemistry Laboratory

Paper Code: BCH604

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Fractionation of cell organelles from liver and plant tissues

2. Preparation of Cytochrome C from goat heart

3. Isolation of NAD from brewer's yeast

4. Isolation and estimation of RNA and DNA from yeast, liver, and plants

5. Extraction, separation and determination of absorption spectra of plant pigments

6. Isolation and estimation of serum cholesterol

7. Qualitative and quantitative analysis of:

(i) Saliva (α-amylase)

(ii) Urine (urea, uric acid, glucose, proteins, Bence-Jones proteins, Cl^-, PO_3^{-3}, Ca^{+2})

8. Experiments on blood

(a) Identification and count of blood corpuscles

(b) Estimation of haemoglobin

(c) Determination of A/G ratio in serum

(d) Serum creatinine and uric acid

(e) Serum enzyme assays: alkaline phosphates, SGOT, SGPT

9. Gel Electrophoresis of serum proteins

Course Title: Plant Biochemistry
Paper Code: BCH 605

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of biochemistry involved in plant physiology and metabolism.

Unit A (15 hours)

Plant Cell wall: Chemical and physical composition of higher plant cell wall

Photosynthesis: Introduction, photosynthetic pigments, biosynthesis of chlorophyll and its regulation, absorption of sunlight and transfer of the excitation energy of the photons to the reaction canters, van Niel's equation, Hill equation, electron transport in photosynthetic reaction center of purple bacterium, Red drop and Emerson enhancement effect, photosynthetic electron transport chain- Non-cyclic, cyclic and pseudocyclic, reagents affecting photosynthetic electron flow- electron acceptors, electron donors, inhibitors of electron flow and herbicides as inhibitors of photosynthesis, regulation of energy distribution between PS I and PS II, Photophosphorylation- chemiosmotic mechanism, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation. Transport of light- generated ATP from the chloroplast into the cytosol.

Unit B (15 hours)

Pathway of CO_2 assimilation and its regulation in C3, C4, & CAM plants

Photorespiration- pathway and its role

Sucrose and starch: Biosynthesis and regulation of Starch (in chloroplasts and amyloplasts), degradation of starch, biosynthesis and degradation of sucrose, and role of fructose 2, 6-bisphosphate in carbon partitioning between sucrose and starch

Plant mitochondrial electron transport chain: Electron transport complexes and pathway of electron flow in plant mitochondria and cyanide - resistant respiratory pathway.

Unit C (15 hours)

Nitrate Assimilation- nitrate uptake, nitrate & nitrite reductases and regulation of nitrate assimilation. Sulphate assimilation: sulphate uptake and assimilation of sulphate into cysteine

Biological N2-fixation: N2 - fixing organisms, structure and mechanism of action of nitrogenase, A brief account of legume-Rhizobium symbiosis, Leghaemoglobin, strategies for protection of nitrogenase against the inhibitory effect of oxygen, hydrogen evolution and uptake, ammonia assimilation, nif genes of Klebsiella pneumoniae including their regulation, synthesis of amides and ureides.

Unit D (15 hours)

Biochemical defense mechanisms in plants, plant hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ABA and ethylene

Recommended Books:

1. Biochemistry and Molecular Biology of Plants by Bob, B. Buchanan, W. Gruissen and R.L.Jones (2000). Published by American Society of Plant Physiologists and distributed by Panima Educational Book Agency, New Delhi.

2. Plant Biochemistry and Molecular Biology, 2nd edition, by Peter J. Lea and Richard C. Leegood (1999). John Wiley and Sons.

3. Plant Biochemistry & Molecular Biology, 3rd ed., by Hans –Walter Heldt (2005), Academic Press

4. Introduction to Plant Biochemistry, T.W. Goodwin and E.I. Mercer (1983). Pergamon Press,

5. Plant physiology, 2nd edition, by L. Taiz and E-Zeigler (1998), Sinauer Associates, Inc., Publishers

Course Title: Nutritional Biochemistry
Paper Code: BCH607

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course is intended to cover all the basic aspects of biochemistry relevant in human nutrition.

Unit A (15 hours)

Basic concepts – Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements. Specific dynamic action of proteins.

Unit B (15 hours)

Elements of nutrition – Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions.

Unit C (15 hours)

Minerals – Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.

Unit D (15 hours)

Malnutrition – Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.

Starvation – Techniques for the study of starvation. Protein metabolism in prolonged fasting.

Obesity – Definition, Genetic and environmental factors leading to obesity.

Recommended Books:

1. Harper's Biochemistry, 26th edition, by R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W.Rodwell (2003) Prentice Hall International.

2. Textbook of Biochemistry with Clinical Correlations, 5th ed. by T.M. Devlin (2002), Wiley-Liss.

3. Foundations and Clinical Applications of Nutrition by M. Grodner et al. (1996) Mosby

4. Modern Nutrition in Health & Disease, 9th edition, by Maurice E. Shils, James A. Oslon, M. Shihe and A. Catherine Ross (1999) Lippincott Williams & Wilkins, New York

Course Title: Nutritional Biochemistry Laboratory
Paper Code: BCH608

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Analysis of milk and milk products- lactose content of milk by phosphomolybdic acid. Lactose content by benedict titration. Protein content of milk by biuret method. Phosphatase test for pasteurization. Dry weight of milk powder.

2. Phosphorus content of milk powder. Calcium content of milk powder. Riboflavin content of milk powder. Vitamin a content of milk powder.

3. Analysis of cereal products: - dry weight of cereal powder. Ash content of cereal powder. Protein content of cereal powder by Kjeldahl method. Carbohydrate content of cereal powder.

4. Analysis of fats oils:- iodine number, Vitamin A, Vitamin E, Vitamin D, Rancidity of Fat.

5. Detection of adulterants of food: - $NaHCO_3$ in milk. Glucose in milk. Starch in milk. Borax in milk. Argemone oil in oil. Mineral oil in vegetable oil. Dalda in ghee.

6. Chemical estimation of thiamine, riboflavin and niacin in foodstuffs.

Course Title: Concepts in Immunology
Paper Code: BCH 625

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of immunology.

Unit A (15 hours)

Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory.

Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors; Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); Markers of suppressor / regulatory cells - CD4+ CD25+ Foxp3+ Treg , iNKT

Unit B (15 hours)

Genetic organization: Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2). Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors. Peptide loading and expression of MHC-I and MHC-II molecules; Hybridoma technology and monoclonal antibodies, antibody engineering.

Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, 1L-10, 1L-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB.

Unit C (15 hours)

Tolerance and autoimmunity: Central and peripheral tolerance, and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases.

Unit D (15 hours)

Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement and phagocytic cells; Comparative study of Type I-V hypersensitivities with examples.

Transplantation and tumor immunology: Alloreactive response; Graft rejection and GVHD; HLA-matching; Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors.

Recommended Books:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6th edition. New York. WH Freeman; 2006.

2. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S: Saunders Elsevier; 2007.

3. Immunobiology: The immune system in health and disease by Janeway CA,Travers P,Walport M, Shlomchik MJ: 6th edition. New York. Garland Science Publishing; 2005.

4. Medical Microbiology and Immunology by Levinson W, Jawetz E: Lange publication; 2001.

5. Fundamental Immunology by Paul WE: 4th edition. New York. Raven Press; 2000.

6. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11th edition. Blackwell Publishing/Oxford Univ. Press; 2006.

Course Title: Concepts in Immunology Laboratory

Paper Code: BCH626

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. To perform immunoelectrophoresis.
2. To perform radial immunodiffusion assay.
3. To perform rocket immunoelectrophoresis.
4. To stain a tissue by immunohistochemical reaction
5. To study quantitative precipitation assay
6. To perform dot-ELISA.
7. To perform latex agglutination test
8. To perform western blotting.
9. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

Course Title: Principles of Neurobiology

Paper Code: BCH629

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of neurobiology.

Unit A (15 hours)

Introduction

Brain and behaviour. Nerve cells, neural circuitry and behavior, genes and behaviour.

Cell and Molecular Biology of the Neuron

Cells of the nervous system, ion channels, Membrane potential and the passive electrical properties of the neuron, Action potential.

Synaptic transmission

Signals at the nerve-muscle synapse: directly gated transmission, synaptic integration in the CNS. Second messengers and modulation of synaptic transmission, neurotransmitters, diseases of the motor and nerve unit.

Neural basis of cognition

Organization of CNS, functional organization of perception and movement, internal representations of space and action, organization of cognition, cognitive functions of the premotor systems.

Perception

Sensory coding, somatosensory system, touch, pain, constructive nature of visual processing, Low, Intermediate, and High-level visual processing, visual processing and action, auditory CNS.

Movement

Organization and planning of movement, The motor unit and muscle action, spinal reflexes, locomotion, voluntary movement – primary motor cortex, control of gaze, vestibular system, posture, The cerebellum, The Basal Ganglia. Genetic mechanisms in degenerative diseases of the nervous system.

Unconscious and Conscious Processing of Neural Information

Sensory, Motor, and Reflex functions of the brain stem, modulatory functions of the brain stem, autonomic motor system and the hypothalamus, emotions and feelings, seizures and epilepsy, sleep and dreaming.

Development and Emergence of Behaviour

Patterning the nervous system, differentiation and survival of the nerve cells, growth and guidance of axons, formation and elimination of synapses, experience and refinement of synaptic connections, sexual differentiation of the nervous system. The Aging brain.

Recommended books:

1. Kandel, E.R., Schwartz, J.H., Jessell, T.M., Siegelbaum, S.A., and Hudspeth, A.J. Principles of Neural Science (5th edition, 2012). McGraw Hill Education. ISBN: 978-0071390118

Course Title: Principles of Cell Signaling
Paper Code: BCH521

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of signal transduction in various living systems.

Topics:

1. Introduction
2. G-protein coupled receptors
3. Receptor tyrosine kinases (RTKs)
4. Small G proteins
5. Phospholipid signalling
6. PI3Kinase and Protein Kinase B
7. Adenylate cyclase and Protein Kinase A
8. Ca^{2+}-activated kinases
9. Signaling scaffolds
10. TOR signalling
11. Visual transduction
12. Cell Death Signaling

Recommended Books:

Most of the readings will be assigned from relevant research papers and review articles of topical interest.

Course Title: Critical Review of Scientific Literature
Paper Code: BCH622

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of clear and concise writing important for scientific communication.

Topics:

1. Introduction to scientific literature and writing
2. Scientific writing and editing: basic guidelines
3. Getting funded: writing proposals
4. How to read a scientific paper
5. Critique of a scientific paper
6. Journal Clubs and Laboratory meetings
7. Writing a scientific paper

Recommended Books:

Most of the readings will be assigned from relevant research papers and review articles of topical interest.

Course Title: Computational Techniques for Biologists
Paper Code: BCH521

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of computational techniques commonly used in biological data analysis.

Topics:

Unit A (15 hours)

Manipulating text files, Regular Expressions

The Shell - Command-line Operations, Handling Text in the Shell, Scripting with the Shell

Unit B (15 hours)

Python and Programming - Components of Programming, Beginning Python Programming, Decisions and Loops, Reading & Writing Files, Merging Files, Modules and Libraries, Debugging Strategies

Unit C (15 hours)

- **Selecting and Combining Tools**
- **Data Organization and Databases**
- **Advanced Shell and Pipelines**

Unit D (15 hours)

Graphics - Graphical Concepts, Working with Vector Art, Working with Pixel Images.

Recommended Books:

1. Haddock, S.D. and Dunn, Casey (2010). Practical Computing for Biologists. Sinauer Associates. ISBN: 978-0878933914.

Course Title: Computational Techniques for Biologists Laboratory
Paper Code: BCH522

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Python programming
2. Manipulation of genome sequences
3. Retrieval and access of major sequence repositories
4. Analysis of DNA and protein sequences
5. Programming exercises based on regular expressions
6. Programming exercises related to sequence databases and their manipulation.