## Name of the Programme M.Sc (H) Bioinformatics 2 years {Session: 2024-2026}

### Semester-Wise Programme structure

| Sr. No. | Year 1 | | Year 2 | |
|---|---|---|---|---|
| | **Semester 1** | **Semester 2** | **Semester 3** | **Semester 4** |
| 1 | Concepts in Genetics [CU:4, L-4, P-0] {CC} | Concepts of programming with Python [CU:4, L-3, P-1] {CC} | Artificial intelligence and Machine learning [CU:4, L-3, P-1] {CC} | Structure Based Drug Design and Discovery [CU:4, L-4, P-0] ] {CC} |
| 2 | Linux and Bash Scripting [CU:4, L-2, P-2] {CC} | Omics Studies and Data Analysis [CU:4, L-3, P-1] {CC} | Database Management Systems and Tools [CU:4, L-3, P-1] {CC} | Genetic Engineering and RDT [CU:4, L-4, P-0] ] {CC} |
| 3 | Tools for Genome analysis [CU:4, L-3, P-1] {CC} | Molecular Biology & Gene Expression [CU:4,L-4, P-0] {CC} | Medicinal Chemistry [CU:4, L-4, P-0] {CC} | Concepts of Immunoinformatics [CU:4, L-4, P-0] ] MOOC [CU:4, L-4, P-0] ] |
| 4 | Metabolism of Biomolecules [CU:4, L-4, P-0] {CC} | Biostatistics and Visualization with R [CU:4, L-2, P-2] {SE} | Elements of Network biology [CU:2, L-2, P-0] ] {CC} | Dissertation Work [CU:12, L-0, P-12] {NTCC} |
| 5 | Advanced Cell Biology [CU:4, L-4, P-0] {SE} | Version Control with Git [CU:4, L-3, P-1] {SE} | Research Paper Presentation [CU:2, L-0, P-2] ] {NTCC} | |
| 6 | IPR, Biosafety and Ethics [CU:4, L-4, P-0] {SE} | Immunology & Immunotechniques [CU:4, L-4, P-0] {SE} | Dissertation Work(Course Code) [CU:8, L-0, P-8] ] {NTCC} | |
| 7 | Self-Development and Interpersonal Skills [CU:1,L-1] {VAC} | CONFLICT RESOLUTION & MANAGEMENT [CU:1,L-1] {VAC} | | |
| 8 | Foreign Business Language (French/German) [CU:1, L-1,] {VAC} | Foreign Business Language (French/German) [CU:1,L-1] {VAC} | | |
| **Credits** | **26** | **26** | **24** | **24** |
| **Total Programme Credits** | | | | **100** |

| | |
|---|---|
| **AC** | **Allied Course** |
| **AEC** | **Ability Enhancement Course** |
| **CC** | **Core Course** |
| **GE** | **General Elective** |
| **OE** | **Open Elective** |
| **SC** | **Skill component** |
| **SE** | **Specialization Elective Course** |
| **SEC** | **Skill Enhancement Course** |
| **VAC** | **Value Added Course** |
| **NTCC** | **Non Teaching Credit Course** |
| **CU** | **Credit Unit** |
| **L;T;P** | **Lecture ; Tutorial ; Practical** |
| **H** | **Honours** |

**Programme structure for M.Sc. (H) Bioinformatics - 2 years (1st Semester)**

| Sr. No | Course Code | Course Title | Course Type | Credits | | | | | Credit Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | FW | SW | |
| 1 | | Concepts in Genetics | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| 2 | BIF606 | Linux and Bash Scripting | Core Courses | 2 | 0 | 2 | 0 | 0 | 4 |
| 3 | | Tools for Genome analysis | Core Courses | 3 | 0 | 1 | 0 | 0 | 4 |
| | BCH609 | Metabolism of Biomolecules | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| | BCH601<br>BTY602 | *Students will choose any two**<br>1. Advanced Cell Biology<br>2. IPR, Biosafety and Ethics<br>3. MOOC | Specialization Elective Course | 4<br>4 | 0<br>0 | 0<br>0 | 0<br>0 | 0<br>0 | 4<br>4 |
| 6 | PSY601 | Self-Development and Interpersonal Skills | Value Added Courses | 1 | 0 | 0 | 0 | 0 | 1 |
| 7 | FOL101/FOL 102 | Foreign Business Language (French/German) | Value Added Courses | 1 | 0 | 0 | 0 | 0 | 1 |

# Concepts in Genetics

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Objectives:** After studying this course, the students will be able to understand the basics of genetics.

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Mendelian Genetics** | **18 hrs** |
| Brief history of genetics, Mendel and his experiments; Principles of segregation and independent assortment and their chromosomal basis; Test cross; Application of laws of probability to Mendelian inheritance. Understanding Punnett square.<br>Phenomenon of Dominance and Dominance relationships (complete dominance, incomplete dominance, and co-dominance), Multiple allelism; Lethal alleles; Pleiotropy; Epistasis; Penetrance and expressivity; Phenocopy; Polygenic inheritance, Pleiotropism, Modifier/Modifying genes. Inheritance patterns in Human (Sex-linked, Autosomal, Unifactorial, Multifactorial). | |
| **Unit II: Non- Mendelian Genetics** | **18 hrs** |
| Introduction to Genomic imprinting, maternal effects, Maternal inheritance in mitochondria and chloroplast, Cytoplasmic Male Sterility (CMS) in maize, Sex determination, Dosage compensation with reference to X-inactivation in man, sex-linked, sex limited, sex influenced traits. Manifesting heterozygotes, mosaics, chimeras, hermaphrodites, Kappa Particles in Paramecium, Sigma factor in *Drosophila*<br>**Linkage & crossing over**: Chromosome theory of Linkage, kinds of linkage, linkage groups, Sutton's view on linkage, Morgan's view on linkage, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns**,** types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over. | |
| **Unit III: Chromatin structure and chromosomal anomalies** | **18 hrs** |
| Chromosome structure, DNA packaging in eukaryotic cell: nucleosome, solenoid, chromatin loops, chromosomal territories, histone and non-histone proteins, DNA modifications and their role in gene regulation.<br>Types of chromosomes, Variation in chromosome structure and number: Deficiency, duplication, translocation, inversions, monosomy, nullisomy, trisomy, tetrasomy, haploidy, polyploidy.<br>Origin and transmission of chromosomal aberrations. | |
| **Unit IV: Genetic Mapping** | **18 hrs** |
| Use of sexual process in bacteria and bacteriophages in genetic mapping, Linkage mapping in Drosophila including determination of linkage groups, determination of map distance, determination of gene order, Tetrad analysis in Neurospora crassa; genetic mapping in haploid and diploid eukaryotes and multi-factorial inheritance and quantitative traits, cytological mapping. Hardy-Weinberg principle and effect of selection, mutation, migration and genetic drift on Hardy-Weinberg equilibrium. | |

**Course Learning Outcomes:**

1. Understand basic genetics and Mendelian principles and various exceptions to it.
2. Understanding Non-mendelian genetics.
3. Understanding structural and numerical chromosomal anomalies.
4. Perceive knowledge of gene and chromosome mapping.

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Gardner EJ, Simmons MJ, Snustad DP | Principles of Genetics | Wiley-India | 6th/2008 | 978-0471291312 | 480 |
| Snustad DP, Simmons MJ | Principles of Genetics | John Wiley and Sons Inc. | 6th/2011 | 978-0470388259 0470388250 | 740 |
| Griffith AJF, Wessler SR, Lewontin RC, Carroll SB | Introduction to Genetic Analysis | W. H. Freeman and Co., New York | 2007 | 978-0716768876 0716768879 | 800 |
| Strickberger, M.W | Genetics | Prentice-Hall India Pvt. Ltd., New Delhi | 1999 | 8120309499 978-8120309494 | 864 |
| Tamarin R.H | Principles of Genetics | Tata McGrawHill, New York | 2012 | 0072325305 | 697 |

## BIF606: Linux and Bash Scripting

| L | T | P | Total Credits |
|---|---|---|---|
| 2 | 0 | 2 | 4 |

**Course Objectives:** The aim of this course is to teach students to apply the knowledge and the fundamentals of Linux and Bash scripting.

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Linux** | **09 hrs** |
| Introduction to Linux and Linux kernel, Linux distributions, Shell, Directory and File commands: Directory structure, Directory Commands, Disk usage of a Specific Directory, File commands, Moving and renaming Files, Important Files and Directories, File and Directory Security | |
| **Unit II: Linux Search Tools** | **09 hrs** |
| Finding Files using attributes: ls, find command, Files Age, files by size, strings within a Text File, Strings within Binary files, Find Processes,Text file processing with Grep, awk | |
| **Unit III: Shell Scripting** | **09 hrs** |
| Programming with Linux, Shell, Command Aliases, User Defined Variables, Evaluating Expressions, Using Quotes in Shell Scripts, Exit Status, Command Line Arguments, Redirection of Standard Input and Output, Pipes, Conditional Statements, Test command, Loops, The case statement | |
| **Unit IV: Linux administration** | **09 hrs** |
| Shutting down and Changing Runlevels, Adding and Removing Users, Get Process Status, Find processes by Pattern or User, Display Active Processes, Kill a Process, Switch User | |

**Course Learning Outcomes:** At the end of the course, the students will learn to:

1. Learn basics of Linux
2. Learn searching and working with text patterns in Linux
3. Learn Shell scripting
4. Learn Linux Administration

**List of Practicals**

1. Install and setup a Linux Distribution
2. Make new files and folders

3. Copy and Move files and folders
4. Use R-sync to backup files and folders
5. Find files with specific attributes
6. Find and Kill specific processes
7. Add and Remove users
8. Use Bash scripting to automate common tasks

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Donald K. Burleson | Easy Linux Commands | SPD | 2010 | 8184043295 | 196 |
| Eric Metthes | Classic Shell Scripting | O'Reilly | 2015 | 978-0-596-00595-5 | 568 |

**Tools for Genome Analysis**

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to teach students to apply the knowledge and basic concepts of biology and computer science..

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to databases** | **13 H** |
| Scope and applications of bioinformatics, Biological Databases – Primary, Secondary and Composite databases: Genbank, EMBL, DDBJ, Uniprot, Swissprot, PIR, PDB, Genpepts, SCOP, Pfam. NCBI, EBI, DDBJ. nucleotide sequence flat files. Sequence formats: Genbank, FASTA, ASN. Information retrieval from biological databases- NCBI resource, Entrez, Pubmed, MEDLINE.<br><br>. | |
| **Unit-II Pairwise and Multiple sequence alignment** | **13 H** |
| Alignment of pairs of sequences; Introduction- Definition of sequence alignment, Methods - Dot matrix sequence comparison. Dynamic programming algorithm for sequence alignment – Global Alignment: Needleman- Wunsch, Local Alignment: Smith-Waterman, Gap penalty, Assessing the significance of an alignmentDynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL, and PILEUP. Purpose and applications of multiple sequence alignment | |
| **Unit III: Scoring matrices and Database search** | **14 H** |
| Similarity searches - PAM and BlOSUM matrix, Dayhoff substitution matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM<br>Database searching for similar sequences. Sequence similarity search, FASTA sequence database similarity search, BLAST sequence database similarity search, variants of BLAST search, and other methods of comparing database of sequences and patterns. | |
| **Unit IV: Phylogeny** | **14 H** |

| | |
|---|---|
| Phylogenetic analysis: Basic terminology in Phylogenetics<br>Introduction to phylogenetic analysis and its application, Phylogenetic tree terminology and topologies<br>Methods of Phylogenetic Tree Construction: Distance Based Methods: NJ, FM & UPGMA<br>Character Based Methods: Maximum Parsimony & Maximum Likelihood Brief introduction to Bootstrapping & Jackknifing.<br>Introduction to Phylip and MEGA packages. | |

**Course Learning Outcomes:** at the end of the course, the students will learn to:

1. Build an understanding about the significance and applications of bioinformatic tools.
2. Apply algorithms for pairwise and multiple sequence alignment.
3. Analyze and examine the various searching techniques with matrices and databases.
4. Analyze and examine the various methods of Phylogenetic tree construction

**List of Practicals**

1. Extracting DNA and protein sequences from biological database in FASTA format
2. Searching Domain Databases: CDD, ProDOM3.
3. Performing Multiple sequence alignment with Clustal W
4. Database similarity search using BLAST to find sequences similar to query sequence.
5. Using different substitution matrices like PAM and BLOSUM to perform sequence similarity search
6. Building Phylogenetic tree using distance based method & character based methods by PHYLIP or MEGA
7. Tree evaluation

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN |
|---|---|---|---|---|
| Xiong, Jing | Essentials of Bioinformatics | Cambridge University | 2007 | 978-8126541256 |
| Mount, D.W. | Bioinformatics: Sequence and Genome Analysis | Cold Springer Harbor Lab Press | 2004 | 978-9746520706 |
| Lesk, A.M. | Introduction to Bioinformatics | Oxford University Press | 2014 | 978-8170221548 |
| Hooman H Rashidi, Lukas K Buehler | Bioinformatics Basics | CRC Press | 1999 | 978-0849323751 |

## BCH609: Metabolism of Biomolecules

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 0 |

**Objectives:** After studying this course, the students will be able to refresh their knowledge of biomolecules and their metabolism.

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Carbohydrate metabolism** | **18 hrs** |
| Structure, function, properties, reactions, and classification of carbohydrates; Glycosidic linkage – types, occurrence, and functions of glycoconjugates, Carbohydrate metabolism – degradation and synthesis of carbohydrates, glycolysis, gluconeogenesis, glycogenesis, TCA cycle, Electron transport chain, regulation of carbohydrate metabolism and central carbon metabolism. | |
| **Unit II: Protein metabolism** | **18 hrs** |
| **Amino-acids, peptides, and proteins** – Classification, biological role, Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Overview of primary, secondary, tertiary, and quaternary structure of proteins, denaturation of proteins. Amino acid metabolism – biosynthesis and catabolism, amino acids as carbon pool, Autophagy, Protein maturation and secretion | |
| **Unit III: Nucleic acid metabolism** | **18 hrs** |
| Nucleic acids - Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations. Nucleotides – Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. | |
| **Unit IV: Fat metabolism** | **18 hrs** |

| | |
|---|---|
| Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins and lipoproteins. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). Biosynthesis and degradation of tri-acylglycerols, phospholipids and sphingolipids, α-, ß- and ω- oxidation of fatty acids, | |

**Course Learning Outcomes:**

1. Understand carbohydrate metabolism.
2. Understand protein metabolism
3. Understand nucleic acid metabolism
4. Understand fat metabolism.

**Pedagogy for Course Delivery**

Lectures: 60 sessions
Presentation / Seminar: 4 sessions
Class Test: 2 sessions
Surprise Test: 6 sessions
Total: 72 sessions

**Text/Reference Books**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN | Pages |
|---|---|---|---|---|---|
| Finar, I. L. | Organic Chemistry (Volume 1 & 2) | Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). | 2002 | 1. 978-8177585421 | 966 pages |
| Voet, D. and Voet, J. | Biochemistry | Wiley | 4th edition,2013 | 9781118092446 | 1616 pages |
| D.L. Nelson and M.M. Cox | Lehninger Principles of Biochemistry | McMillan North Publication | 4th Edition 20 | 978-1319108243 | 1328 pages |

| | | | | | |
|---|---|---|---|---|---|
| L. Stryer | Biochemistry | Freeman &Co. New York. | 5th Edition | 978-0716746843 | 1050 pages |

## BCH601: Advanced Cell Biology

| L | T | P/S | Total Credit Units |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:** To develop an advanced understanding of the cell, cellular signaling and communications and its genome organization.

**Course Contents/syllabus:**

| | Hours |
|---|---|
| **Unit I: Cell wall and Cell membrane** | **18 hrs** |
| **Cell wall and Cell Membrane:** Physical structure of model membranes in prokaryotes and eukaryotes, and their constituents; structural organization and functions of cell organelles.<br><br>**Transport of nutrients:** Ions and macromolecules across membranes. Different classes of pumps and their mechanism. Cellular energy transactions. | |
| **Unit II: Organization of genomes** | **18 hrs** |
| **Organization of genomes**: Genes and chromosomes, Operon, unique and repetitive DNA, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.<br><br>**Cell division and cell cycle:** Mitosis and meiosis, Cell cycle and its regulation, Apoptosis, Necrosis ,Autophagy and other forms of cell death.<br><br>Contribution of Nobel laureates in elucidation of the DNA structure,cell death and cell cycle.<br><br>**Cellular basis of differentiation and Development:** Meiosis, | |

| | |
|---|---|
| gametogenesis, fertilization and up to the formation of three germinal layers | |
| **Unit III: Cell signaling** | **18 hrs** |
| **Cell signaling:** Hormones and their receptors, cell surface receptor, and signalling mechanisms, bacterial chemotaxis and quorum sensing.<br><br>**Cell transformation and cancer:** Oncogenes and proto-oncogenes, tumor suppressor genes, metastasis. Therapeutic interventions of uncontrolled cell growth. | |
| **Unit IV: Cellular communication** | **18 hrs** |
| **Cellular communication**: General principles of cell communication, cell adhesion and roles of different adhesion molecules, tight junctions, communicating junctions, neurotransmission and its regulation. | |

**Course Learning Outcomes:**

- Understand about different component of cell, and cellular signalling and communication mechanisms in the cell.
- Discuss the basic differences in genome of prokaryotic and eukaryotic cells.
- Evaluate various modes of cell signaling and cell transformation mechanisms.
- Analyze the knowledge of nutrient transport mechanisms and cellular basis of differentiation and cellular development.

**Pedagogy for Course Delivery:**

Lectures: 50 sessions
Presentation / Seminar: 2
Class Test: 2 sessions
Quiz: 6 sessions
Total: 60 sessions

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN | Pages |
|---|---|---|---|---|---|
| De-Robertis, F.D.P. and De-Robertis | Cell and Molecular Biology, Saunders, Philadelphia. | New York: Lippincott Williams & Wilkins, | 2011 | 9780781734936, 0781734932 | 734 |

| | | | | | |
|---|---|---|---|---|---|
| Jr. E.M.F. | | | | | |

## BTY602: IPR, Biosafety and Bioethics

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to IPR and Patent Database** | **18 hrs** |
| **Types of IP:** Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications.<br><br>**Protection of New GMOs:** International framework for the protection of IP. IPs of relevance to Biotechnology and few Case Studies.<br>**Patent databases**: Invention in context of "prior art"; Searching national/International Databases; Analysis and report formation | |
| **Unit II: Types of patent and patent application** | **18 hrs** |
| **Types of patents:** Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application | |
| **Unit III: Biosafety, GMOs and Biodiversity Act** | **18 hrs** |
| **Biosafety**: Introduction; Historical Background: Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India;<br><br>**Definition of GMOs & LMOs:** Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis;<br><br>**Risk Assessment:** Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.<br><br>**Biodiversity Act 2002:** Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA); Conservation strategies for seed gene bank; Climate change and conservation of plant genetic resources; Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts.<br><br>**Biodiversity Legislation in India;** Indian Biodiversity Act and provisions on | |

| | |
|---|---|
| crop | |
| **Unit IV: Bioethics, Ethics and the law issues** | **18 hrs** |
| **Bioethics:** Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology;<br><br>**Ethics and the Law Issues:** types and policies; Research concerns; Emerging issues: Biotechnology's Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy – To Regulate or Not to Regulate; Improving public understanding of biotechnology products to correct misconceptions. | |

**Course Learning Outcomes:**

- Understand IPR and its database.
- Evaluate different types of patents and policies
- Compare the biosafety methods and differences between GMOs and LMOs.
- Perceive knowledge of Bioethics and laws.

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| D N Choudhary | Evolution of patent laws: "developing countries' perspective | Delhi Capital Law House | 2006 | OCLC Number: 255182178 | 476 |

**PSY611: Self-Development and Interpersonal Skills**

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course Objectives:** The objective of this course is to introduce the student to effective self management so that they can think and act in right manner. They should act as a dynamic leader and motivator by understanding themselves as well as other in more refined manner.

.

**Course Contents/syllabus:**

| | Teaching time |
|---|---|
| **Unit I: Understanding Self and Worth** | **5 hrs** |
| Formation of self concept Dimension of Self Components of self; Self Competency;<br>Meaning and Nature of Self Esteem; Importance & need of Self Esteem; Steps to enhance Self Esteem; Self Esteem at work | |
| **Unit II: Emotional Intelligence: Brain Power** | **4 hrs** |
| Introduction to EI; Difference between IQ, EQ and SQ Relevance of EI at workplace; Self assessment, analysis and action plan | |
| **Unit III: Managing Emotions and Building Interpersonal Competence** | **5 hrs** |
| Need and relevance of Emotions; Healthy and Unhealthy expression of emotions Anger: Conceptualization and Cycle<br>Developing emotional and interpersonal competence; Self assessment, analysis and action plan | |
| **Unit IV: Leading Through Positive Attitude** | **4 hrs** |
| Understanding Attitudes; Formation of Attitudes; Types of Attitudes; Effects of Attitude on:<br>Behavior, Perception, Motivation, Stress, Adjustment, Time Management, Effective Performance<br>Building Positive Attitude | |

**Course Learning Outcomes:** At the end of this course, the students will be able to:

- To apply cutting edge scientific insights about human behaviour, and learn how to change human behavior by altering the "context" in which people act rather than how they think
- Understand state-of-the-art methodological and statistical approaches that are necessary to evaluate the effectiveness of behavioral change.
- Apply behavioral science knowledge and skills to develop insights on individuals and society
- Analyze the nature of human behavior and the impact of factors that influence how humans feel, think and act at an individual, group and societal level
- Evaluate the influence of values and attitudes on human behavior

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN |
|---|---|---|---|---|
| Singh A. | Achieving Behavioural Excellence for Success | Wiley Publication | 2012 | 9788126580 27 |
| Towers, Marc | Self Esteem | American Media | 1995 | 9781884926297 |
| Pedler Mike, Burgoyne John, Boydell Tom | A Manager's Guide to Self-Development | McGraw-Hill | 2006 | 978-0077114701 |
| Covey, R. Stephen | Seven habits of Highly Effective People | Simon & Schuster Ltd | 2013 | 978-1451639612 |
| Khera Shiv | You Can Win | Macmillan | 2005 | 978-0333937402 |
| Gegax Tom | Winning in the Game of Life | Harmony Books | 1999 | 978-0609603925 |
| Singh, Dalip | Emotional Intelligence at Work | Publications | 2006 | 9780761935322 |
| Goleman, Daniel | Emotional Intelligence | Bantam Books | 2007 | 9780553095036 |
| Goleman, Daniel | ing with E.I | Bantam Books | 1998 | 9780553104622 |

## FOL102: Introduction to German Culture & Language

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course Contents/syllabus:**

| | Teaching hours |
|---|---|
| **Unit-I Introduction to German Language (Einführung)** | **5 hrs** |
| Introduction to German as a global language, Self-introduction and Greetings, Die Alphabeten, Phonetics: the sound of consonants and vowels, Wie buchstabieren Sie Ihren Name? | |
| **Unit-II- Numbers and everyday conversation (die Zahl und Gespräche)** | **4 hrs** |
| Counting in German from 1-100, Simple Calculation and verb 'kosten' - Wie viel kostet das? Plural Forms, Vocabulary: Wochentage, Monate, Jahreszeiten, Ordinal numbers and the question - Wann haben Sie Geburtstag? | |
| **Unit-III- Regular verbs and nominative case: articles and pronouns (Regelmässige Verben und Nominativ Kasus: Artikel und Pronomen)** | **5 hrs** |
| Introduction to all personal pronouns and conjugation of Regular verbs Detailed exercise on regular verbs. Reading a text on regular verbs. Introduction to definite. Vocabulary: Schulsachen und Getränke, Nominative case/ Articles (der, die, das) Nominative Pronouns: - Applicability of pronouns for both persons and things. Usage of nominative Personal Pronouns Introduction of nominative possessive pronouns usage of nominative possessive pronouns | |
| **Unit-IV- The Family, Work-life and Professions (Familienmitglieder und Berufe) & Interrogative sentences (W-Fragen)** | **4 hrs** |
| The Family, Work-life and Professions (Familienmitglieder und Berufe) Vocabulary: Professions and conjugation of the verb 'sein' Introduction to simple possessive pronouns with the help of the verb 'haben' Usage of possessive pronouns. Interrogative sentences (W-Fragen) W-Fragen: who, what, where, when, which, how, how many, how much, etc. Exercises on the question pronouns | |

**Course Learning Outcomes:** At the end of this course, the students will be able to express themselves in writing and orally in basic German. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At the end of the course, the student shall be able to:

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context

3. Analyse and break-down information to create new ideas
4. Evaluate and express opinion in a given context

**Text / Reference Books:**

| Author | Title | Publisher | Year | ISBN |
|---|---|---|---|---|
| Rolf Bruseke | Starten Wir A 1 | Langers International Pvt Ltd (Max Hueber Verlag) | 2017 | 978-3190160006 |
| Giorgio Motta | Wir Plus Grundkurs Deutschfur Junge Lerner Book | Ernst Klelt Verlog | 2011 | 978-8183072120 |
| Heimy Taylor, Werner Haas | Station en Deutsch Self StudyCourse German Guide | Wiley | 2007 | 978-0470165515 |

## FOL101: Introduction to French Culture & Language

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course Contents/syllabus:**

| | Teaching hours |
|---|---|
| **Unit-I Introduction to French language** | **4 hrs** |
| • Brief introduction of French and Francophone countries<br>• Presenting oneself<br>• Getting information about someone else<br>• Greeting and taking leave<br>• Asking/giving personal information | |
| **Unit-II- A rendez-vous ; Visiting a place** | **5 hrs** |
| • Pronouncing and writing numbers in French<br>• Spell and count numbers<br>• Telling the time<br>• Temporal expressions<br>• Communicating in class<br>• Fixing an hour, place for a meeting.<br>• Describing a person.<br>• Identifying a person, object and place<br>• Describing relation in a family<br>• A specific person, object and place | |
| **Unit-III- An interview** | **5 hrs** |
| • Description of objects, people and places<br>• Nationalities<br>• Speaking about one's professions<br>• Expressing Actions using regular –er ending verbs; avoir, être; reflexive verbs –usage, conjuagation<br>• Interview of celebrity | |
| **Unit-IV- At the discotheque** | **4 hrs** |
| • Portrait by a journalist<br>• Giving a positive or negative reply<br>• Asking questions<br>• Discussion with a person<br>• Activities in a day | |

**Course Learning Outcomes:** At the end of this course, the students will be able to express themselves in writing and orally in basic French. This course content focuses on the speech of the students in a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the

language. At the end of the course, the student shall be able to :

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyse and break-down information to create new ideas
4. Evaluate and express opinion in a given context

**Text / Reference Books:**

| **Author** | **Title** | **Publisher** | **Year** | **ISBN No** |
|---|---|---|---|---|
| Christine Andant, Chaterine Metton, Annabelle Nachon, Fabienne Nugue | A Propos - A1 Livre De L'Eleve, Cahier D' Exercices | Langers International Private Limited | 2010 | 978-9380809069 |
| Manjiri Khandekar and Roopa Luktuke | Jumelage - 1 Methode De Fraincais - French | Langers Internation al Private Limited | 2020 | 978-938080 9854 |
| Michael Magne, Marie-Laure Lions-Olivieri | Version Originale 1: Cahier d'exercices | Maison Des Langues | 2010 | 978848 443561 7 |

**Programme structure for M.Sc. (H) Bioinformatics - 2 years (2nd Semester)**

| Sr. No | Course Code | Course Title | Course Type | Credits | | | | | Credit Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | FW | SW | |
| 1 | | Concepts of programming with Python | Core Courses | 3 | 0 | 1 | 0 | 0 | 4 |
| 2 | | Omics Studies and Data Analysis | Core Courses | 3 | 0 | 1 | 0 | 0 | 4 |
| 3 | HGM603 | Molecular Biology & Gene Expression | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| | | *Students will choose any **three** from the given choices** | Specialization Elective Course | | | | | | |
| | | Biostatistics and Visualization with R | | 2 | 0 | 2 | 0 | 0 | 4 |
| | BIF607 | Version Control with Git | | 3 | 0 | 1 | 0 | 0 | 4 |
| | IMM601 | Immunology & Immunotechniques | | 4 | 0 | 0 | 0 | 0 | 4 |
| | | MOOC | | | | | | | |
| 6 | PSY611 | Behavioural Science | Value Added Courses | 1 | 0 | 0 | 0 | 0 | 1 |
| 7 | FOL101/FOL102 | Foreign Business Language (French/German) | Value Added Courses | 1 | 0 | 0 | 0 | 0 | 1 |
| | | | **Total credits** | | | | | | **26** |

## Concepts of programming with Python

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to teach students to apply the knowledge and basic concepts of biology and computer science..

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Python** | **13 H** |
| Introduction to Computer programming, Computer Hardware architecture, Interpreter and compiler, Building blocks of computers, Debugging, Variables, Expressions, and Statements, Values and types, Variable names and keywords, Statements, Operators and operands | |
| **Unit II: Conditional execution, Functions and Classes** | **13 H** |
| Boolean expression, Logical operators, Conditional execution, Alternative executions, Chained conditionals, Catching exceptions with try and except, Function calls, Built-in functions, Type conversion functions, Math functions, Random numbers, Adding new functions, Definitions and uses, Flow of execution, Parameters and arguments, fruitful and void functions, classes | |
| **Unit III: Iterations, strings, Files, Lists** | **14 H** |
| Updating Variables, While statement, Infinite Loops, Finishing iterations with continue, Definite loops using for, Strings, string slices, immutable strings, Looping and counting strings, The in operator with strings, String comparison, String methods, Parsing string, Opening files, Text files and Lines, getting user input for file names, searching through a file, writing files, Lists | |
| **Unit IV: Dictionaries, Tuples, Regular Expression** | **14 H** |
| Dictionaries and files, Looping over dictionaries, text parsing, Immutability of tuples, comparing tuples, Dictionary and Tuples, Multiple assignment with dictionaries, tuples as keys in Dictionaries, Sequences, Character matching in regular expressions, extracting data with regular expressions | |

**Course Learning Outcomes:** at the end of the course, the students will:

1. Basics of Computer programming with Python
2. Master conditional execution and functions
3. Acquire skills in working with Iterations, strings, Files, Lists.
4. Understand Dictionaries, Tuples, Regular Expression

**List of Practicals**

1. Introduction to Python and Basic Syntax:
    1. Setting up Python environment
    2. Introduction to Python interpreter
    3. Writing and executing basic Python programs
    4. Understanding variables, expressions, and statements

5. Debugging Python programs

2. Conditional Execution and Functions:
    1. Writing Python programs using conditional statements (if, elif, else)
    2. Implementing logical operators in Python
    3. Introduction to functions in Python
    4. Writing and calling functions with and without parameters
    5. Handling exceptions using try and except blocks
3. Loops and Strings:
    1. Implementing while loops in Python
    2. Writing programs using for loops
    3. Working with strings in Python
    4. String manipulation (slicing, concatenation, methods)
4. Lists and File Operations:
    1. Understanding lists and list operations
    2. Writing Python programs using lists
    3. Performing list manipulation (appending, slicing, sorting, etc.)
    4. Reading and writing text files using Python
5. Dictionaries and Tuples:
    1. Introduction to dictionaries in Python
    2. Writing Python programs using dictionaries
    3. Understanding tuple data structure
    4. Implementing tuple operations
    5. Using tuples as keys in dictionaries
6. Regular Expressions:
    1. Introduction to regular expressions
    2. Writing Python programs using regular expressions
    3. Character matching with regular expressions
    4. Extracting data from strings using regular expressions
    5. Parsing text files using regular expressions
7. Classes and Object-Oriented Programming (OOP):
    1. Introduction to classes and objects
    2. Writing Python programs using classes
    3. Defining attributes and methods in classes
    4. Creating objects and calling methods
    5. Understanding inheritance and polymorphism in Python

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN |
|---|---|---|---|---|
| Charles Severance | Python for Everybody | SPD | 2017 | 248 |
| Daniel Zingaro | Learn to Code by Solving Problems | No Starch Press | 2021 | 336 |

## Omics Studies and Data Analysis

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to teach students the scope of omics research and methods in genomics and transcriptomics.

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Omics Data and Data format** | **18 hrs** |
| Overview of multi-omics studies: concepts and applications, Introduction to genomics, transcriptomics, proteomics, and metabolomics, Integration of multi-omics data sets, Challenges and opportunities in multi-omics data analysis, Biological Data Sources: NCBI, ENSEMBL, TCGA, GenBank, Short Read Archive, UniProt. UCSC Genome Browser, FlyBase, RNA-central, Common data formats and conversion | |
| **Unit II: Omics technology** | **18 hrs** |
| Technologies for Genomics, proteomics, transcriptomics. Normalization techniques for transcriptomics, proteomics, and metabolomics data, integration of multi-omics data sets, , Sequence Ontology, Gene Ontology, Visualizing data, Sequencing instruments, Types of Sequencing instruments, Paired-end sequencings, Sequencing Data preparation, Sequencing coverage, Short Read Archive (SRA), Quality Control, adapter trimming | |
| **Unit III: Sequence alignment and Data analysis** | **18 hrs** |
| Proteomics data analysis, Sequence alignment, Generation of sequening alignment, alignment scores, percent identity, CIGAR string, Global and local alignments, BLAST, Short Read Alignment, bwa aligner, bowtie aligner, Multiple Sequence aligner, SAM/BAM format | |
| **Unit IV: Genomic Variation and Data Visualization** | **18 hrs** |
| Visualizing large scale genomic variations, Variation calling, Multi-sample variant calling, Variant Call Format (VCF), Variant annotation and effect prediction. RNA-Seq Analysis, Chip-seq Analysis, Sequence assembly, Whole genome assembly, Metagenomics: taxonomies, classifying 16s sequences, neonatal microbiome, Heatmaps, scatter plots, and volcano plots | |

**Course Learning Outcomes:** At the end of the course, the students will learn to:

1. Comprehensive understanding of Omics data.
2. Learning Experimental and bio-informatic workflows in Omics data generation and analysis.
3. Learn the concepts of data analysis in proteomics.
4. Understand the concepts of RNA seq data analysis.

### List of Practicals

**1.** To annotate genome of a prokaryotic organism.

2. To annotate genome of a eukaryotic organism.
3. To understand data type of transcriptomics, proteomics and metabolomics
4. Data cleaning and developing volcano plots
5. Data analysis of RNA-seq, ChIP-seq, and Proteome-MS

## Text / Reference Books:

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Preeti Arivaradarajan and Gauri Misra | Omics Approaches, Technologies And Applications | Springer | 2018 | ISBN: 978-981-13-2925-8 | |

## HGM603: Molecular Biology and Gene Expression

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Learning Objective**: The objective of this course is to teach students the molecular details of the process of DNA replication, transcription and translation in prokaryotes and eukaryotes and regulation of gene expression.

**Course content and syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: DNA Replication** | **18 hrs** |
| DNA replication in Prokaryotes: Initiation, Elongation and Termination. Regulation of replication.<br>DNA replication in Eukaryotes: Initiation, Elongation and Termination. End-Replication problem. | |
| **Unit II: RNA Transcription** | **18 hrs** |
| RNA synthesis and processing in prokaryotes and eukaryotes: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, spilicing, and polyadenylarion, structure and function of different types of RNA, non-coding RNA, RNA transport. | |
| **Unit III: Translation of Proteins** | **18 hrs** |
| Protein synthesis and processing in prokaryotes and eukaryotes: Ribosome structure, genetic code, aminoacylation of tRNA, tRNA-identity aminoacyl tRNA synthetases, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, translation proof-reading, translational inhibitors. Post-translational modifications of proteins. | |
| **Unit IV: Regulation of Gene Expression** | **18 hrs** |
| Regulation of Gene Expression in Bacteria: Concept of operon, lac operon, catabolite repression, trp operon<br>Phages: control of lytic and lysogenic cycles<br>Regulation of Gene Expression in Eukaryotes: Regulatory promoters, enhancers and silencers. Transcription activator protein. Role of mediator protein in transcription. Gal4 operon. Chromatin remodeling and Epigenetic modifications. | |

**Course Learning Outcomes:**

1. Molecular mechanisms of DNA replication in prokaryotes and Eukaryotes
2. DNA transcription in prokaryotes and eukaryotes
3. Protein synthesis in prokaryotes and eukaryotes

4. regulation of gene expression

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Watson, JD., Baker, TA., Stephen, PB., Alexander, G., Levine, M., Losick R. | Molecular Biology of the Gene | Pearson Education | 7th Ed | 978-9332585478 | 912 |
| Tropp, B.E. | Molecular Biology Genes to proteins | Jones and Bartlet | 4th Ed. | 978-93-80853-49-9 | 1096 |

## Biostatistics and Visualization with R

| L | T | P | Total Credits |
|---|---|---|---|
| 2 | 0 | 2 | 4 |

**Course Objectives** To learn Biostatistics as well as Visualization with R

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to R and Data Import** | **13 hrs** |
| Introduction to R programming language, R data structures: vectors, matrices, data frames. Introduction to RStudio IDE, Importing data into R: Importing data from text files (CSV, TSV), Excel files, and databases, Importing data from databases | |
| **Unit II: Data Manipulation and Basic Statistics** | **13 hrs** |
| Data manipulation with dplyr and tidyr packages, Basic statistical analysis in R, Descriptive statistics: mean, median, standard deviation, Data aggregation and summarization, Filtering, sorting, and selecting data, Grouping and summarizing data, Basic statistical analysis, Hypothesis testing, Calculating descriptive statistics, Data aggregation and summarization | |
| **Unit III: Data Visualization with ggplot2** | **14 hrs** |
| Introduction to data visualization, Grammar of graphics and ggplot2 syntax, Creating basic plots: scatter plots, bar plots, line plots, Customizing plots: adding titles, labels, and themes, Creating scatter plots, bar plots, and line plots, Customizing plot aesthetics: colors, labels, themes, Advanced plotting techniques with ggplot2, Adding layers to plots, Faceting and arranging plots | |
| **Unit IV: Advanced Data Analysis and Visualization** | **14 hrs** |
| Advanced data manipulation with dplyr and tidyr, Statistical modeling with linear regression and logistic regression, Interactive data visualization with Shiny, Advanced data manipulation with dplyr and tidyr: Reshaping and pivoting data, Joining and merging data sets, Statistical modeling with R, Introduction to linear regression, Introduction to logistic regression | |

**Course Learning Outcomes:** At the end of the course, the students will learn to:

1. To understand the fundamentals of the R programming language.
2. To learn how to import, clean, and manipulate data in R.
3. To gain practical experience in data analysis and visualization using R.
4. To apply statistical analysis techniques to real-world data sets.

**List of Practicals**

1. Importing data from various formats (CSV, Excel, text files)
2. Exporting data to different formats
3. Perform Basic statistics with R
4. Perform Hypothesis testing with R
5. Fitting linear regression models
6. Assessing model fit and diagnostics

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| ROBERT I. KABACOF | R in Action: Data analysis and graphics with R and Tidyverse | Manning Publications | 2022 | ISBN: 1617296058 | |

**BIF607: Version Control with Git**

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to teach students to apply the knowledge and the fundamentals of Version Control with Git

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Thinking in Versions and Git Basics** | **13 hrs** |
| Introduction, The Git Workflow, Creating new repository, Adding and removing Files, Commit, Git Checkout, Git Revert and Reset | |
| **Unit II: Git Branches** | **14 hrs** |
| Git Branches Introduction, Usage scenarios, Starting a new Branch, Naming Branches, Editing Branches, Merging Branches, Merge Commits, Handling Merge Commits | |
| **Unit III: Using Git Remotes** | **14 hrs** |
| Git Hub, Remote, remote URLs, SSH (Secure Shell), HTTPS, Git Protocol, Remote Branches, Pushing Changes, Pulling Changes, Resolving merge conflicts, Push rejection, Tracking Branches, Git fetch, Existing Branch | |
| **Unit IV: Version History** | **13 hrs** |
| Git Log, Starting Point, Viewing a range of commits, Filtering the log, Commit IDs, Commit messages, Making commits, Comparing Commits, Tagging commits, git checkout | |

**Course Learning Outcomes:** at the end of the course, the students will learn to:

1. Learn basic theory of Version control with Git
2. Learn about Git branches
3. Learn about Git Remote repositories
4. Learn to evaluate version histories with Git

**List of Practicals**

1. Record changes with Git
2. Compare changes and show commits with Git
3. Practical Branching and merging with Git

4. Create and then Resolve a conflict with Git
5. Find out when something broke/changed with git bisect

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| David Demaree | Git for Humans | A Book Apart | 2016 | 978-1-9375573-9-3 | 141 |

## IMM601: Immunology and Immunotechniques

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Learning Objective**: The objective of this course is to provide basics of immune system where students will learn the components and molecules of immunity and various immune responses at the cellular level that work together to protect the host, autoimmune disorders and Immunotechniques.

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction and Overview of Immune System** | **18 hrs** |
| Historical development of the branch "Immunology", Overview of the immune system, Molecules, cells and organs involved in immunity. Hematopoiesis, Innate immunity, adaptive immunity, Antigens, Immunogens, Haptens, Epitopes. Antigen-Antibody interactions, Discovery of immunoglobulins. | |
| **Unit II: Adaptive Immune response** | **18 hrs** |
| Humoral Immunity, Structure and function of various classes of immunoglobulins, Generation of antibody diversity, class switching among constant-region genes, B-cell activation and differentiation, B-cell receptor and the immunoglobulin superfamily, Generation of B cells, Responses, Immunological memory, Cell mediated immunity, MHC restriction and mechanism of antigen presentation, T-cell receptors, maturation, activation and differentiation, Generation of different types of T cells, Responses, Immunological memory. | |
| **Unit III: Immune Effector Mechanisms and Immune system in Health/Disease** | **18 hrs** |
| Properties of cytokines, receptors, The complement systems, mechanism of complement activation, pathology related to complement proteins, Allergy, hypersensitivity (I,II,III,IV), Tolerance, Mechanisms of induction of autoimmunity, treatment of autoimmune diseases. Immunodeficiencies, AIDS, Transplantation immunology, Tumor antigens and cancer immunotherapy, Concepts of vaccines, whole-organism vaccines, recombinant vaccines, DNA vaccine, synthetic peptide and multivalent sub-unit vaccines. | |
| **Unit IV: Immunotechniques** | **18 hrs** |
| Applications of antibodies in diagnostics and routine laboratory assay systems. Agglutination reaction, principles of western blots, radioimmunoassay, ELISA, immunohistochemistry, Development of monoclonal antibodies, Flow cytometry, immunocytes identification and purification. | |

**Course Learning Outcomes:**

1. Understanding of mechanisms used by the human body to fight foreign agents and disease-causing pathogens.
2. Students will be able to devise strategies to combat infection or diseases produced by alteredself.
3. Students will develop ability to use this knowledge in the processes of immunization, antibodyengineering, vaccine development, transplantation, and cancer therapy.
4. Students will develop ability to use various techniques of immunology in research work.

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| J. Owen, J. Punt, S. Stranford | Kuby Immunology (8th Edition) | WH Freeman and Company, USA | 2012 | 978-1319114701 | 944 |
| D. Male, J. Brostoff, D. Roth, I. Roitt | Immunology (8th Edition) | Saunders, Elsevier, USA | 2012 | 978-0702045486 | 482 |
| K. Murphy | Janeway's Immunobiology (8th Edition) | Garland Science, USA | 2011 | 978-0815342908 | 887 |
| A. Abbas, A. Lichtman, S. Pillai | Cellular and Molecular Immunology (8th Edition) | Saunders, Elsevier, USA | 2014 | 978-8131264577 | - |

# PSY611: CONFLICT RESOLUTION & MANAGEMENT

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course Contents/syllabus:**

| | No. of Session |
|---|---|
| **Unit I: Conflict Management, Resolution and Management** | **5 hrs** |
| • Meaning and Nature of Conflict<br>• Types of Conflicts<br>• Styles and Techniques of conflict management<br>• Conflict Resolution Strategies<br>• Management, Transformation, Settlement and Resolution of Conflicts | |
| **Unit II: Behavioural & Interpersonal Communication** | **4 hrs** |
| • Meaning and characteristics of interpersonal communication<br>• Process and Elements of Interpersonal Communication<br>• Culture, Identity, language and Interpersonal communication<br>• Meaning and Nature of Behavioural Communication<br>• Relevance of Behavioural Communication | |
| **Unit III: Relationship Management for Personal and professional Development** | **5 hrs** |
| • Importance of Relationships<br>• Maintaining Healthy Relationship<br>• Communication Style<br>• Types of Interpersonal Relationships | |
| **Unit IV: Stress Management** | **4 hrs** |

| | |
|---|---|
| • Understanding of Stress & GAS Model Symptoms of Stress.<br>• Individual and Organizational consequences with special focus on health Healthy and Unhealthy strategies for stress management<br>• Social support for stress management and well being<br>• Stress free, Successful and Happy Life | |

**Course Learning Outcomes:**

1. To recognize Conflict and How to Manage them.
2. To learn Communication and interpersonal behavior
3. To understand the significance & Importance of Relationship
4. To learn to live stress free and happy life.

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN | Pages |
|---|---|---|---|---|---|
| Department of English, University of Delhi | The Individual & Society | Pearson Education | 2010 | 978-8131704172 | 266 |
| Umang Malhotra | Individual, Society, and the World | iUniverse | 2004 | 978-0595662401 | 188 |
| Tonja R. Conerly & Kathleen Holmes | Introduction to Sociology 3e | Openstax | 2015 | 9781711493978 | 458 |
| Daksh Tyagi | "A Nation of Idiots" | Every Protest | 2019 | 978-8194275015 | 350 |

## FOL103: French Grammar

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: My family and my house** | **5 hrs** |
| • Descriptors/Topics<br>• Talk about your family members<br>• Usage of possessive adjectives<br>• Describe your house/apartment<br>• Prepositions of location<br>• Negation | |
| **Unit II: Lifestyle** | **4 hrs** |
| • Descriptors/Topics<br>• Talk about your hobbies and pastimes<br>• Usage of appropriate articles : definite and contracted<br>• Talk about your daily routine<br>• Usage of pronominal verbs | |
| **Unit III: In the city** | **5 hrs** |
| • Descriptors/Topics<br>• Filling up a simple form<br>• Ask for personal information | |
| • Usage of interrogative adjectives<br>• Give directions about a place<br>• Ordinal numbers<br>• Usage of demonstrative adjectives | |
| **Unit IV: Week-end** | **4 hrs** |
| • Descriptors/Topics<br>• Talk about your week-end plans<br>• Usage of disjunctive pronouns<br>• Usage of Near Future tense<br>• Talk about weather<br>• Write a simple post card | |

**Course Learning Outcomes:** At the end of this course, the students will be able to interact in a simpleway on everyday topics. This course content focuses on the speech of the students in

a lucid and a concurrent manner using appropriate vocabulary and pronunciation techniques. Extra stress will be given on their understanding of grammatical structures and the foreign accent of the language. At theend of the course, the student shall be able to:

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyze and break-down information to create new ideas
4. Evaluate and express opinion in a given context

**Text / Reference Books:**

| **Author** | **Title** | **Publisher** | **Ed/year** | **ISBN No** | **Pages** |
|---|---|---|---|---|---|
| Christine Andant, Catherine Metton, Annabelle Nachon, Fabienne Nugue | A Propos - A1,Livre de l'élève et Cahier d'exercices. | Langers International Pvt. Ltd. | 2010 | 978-9380809069 | --- |
| Collins Dictionaries | Easy Learning French Complete Grammar, Verbs and Vocabulary | Collins | 2016 | 978-0008141721 | --- |
| Nikita Desai, Samapita DeySarkar | Apprenons La Grammaire Ensemble - French | Langers International Pvt. Ltd. | 2017 | 978-8193002681 | --- |

## FOL104: German Grammar

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Time (Uhrzeit); People and the World: Land, Nationalität und Sprache** | **5 hrs** |
| • Introduction of time<br>• Read text related to time and teach the students the time expressions<br>• Exercises related to Time<br>• Adverbs of time and time related prepositions<br>• Vocabulary: Countries, Nationalities, and their languages<br>• Negation: “nicht/ kein”<br>• Ja/Nein Fragen.<br>• All the colors and color related vocabulary, adjectives, and opposites<br>• Exercises and comprehension for the same | |
| **Unit II: Irregular verbs (unregelmässige Verben)** | **4 hrs** |
| • Introduction to irregular verbs and their conjugation e.g. fahren, essen, lesen etc<br>• Read a text related to the eating habits of Germans<br>• Vocabulary: Obst, Gemüse, Kleiderstück with usage of irregular verbs<br>• Free time and hobbies<br>• Food and drinks | |
| **Unit III: Accusative case: articles and pronouns (Akkusativ Kasus: Artikel und Pronomen)** | **4 hrs** |
| • Introduction to the concept of object (Akkusativ)<br>• Formation of sentences along with the translation and difference between nominative and accusative articles<br>• Usage of accusative Definite articles<br>• Usage of accusative Indefinite articles | |
| **Unit IV: Accusative case: possessive pronouns (Akkusati Kasus: Possessivpronomen) Family and Relationship** | **5 hrs** |
| • Accusative Personal Pronouns: - Revision of the nominative personal pronouns and introduction of accusative. Applicability of pronouns for both persons and things.<br>• Usage of accusative Personal Pronouns<br>• Introduction of accusative possessive pronouns<br>• Difference between nominative and accusative possessive pronouns<br>• usage of accusative possessive pronouns | |

**Course Learning Outcomes:** After completing these modules, the students will be capable of constructing sentences with possessive and demonstrative adjectives in German. In addition, they will be proficient in formulating meaningful sentences as they will be capable of applying their knowledge of all the irregular verbs they have learnt during the session. They will also have an idea of German culture by studying about various German festivals.

At the end of the course, the student shall be able to:

1. Understand information; Express in his own words; Paraphrase; Interpret and translate.
2. Apply information in a new way in a practical context
3. Analyse and break-down information to create new ideas
4. Evaluate and express opinion in a given context

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Dora Schulz, Heinz Griesbach | Deutsche Sprachlehre Fur Auslander | Max Hueber Verlag | 1984 | 978-3190010066 | --- |
| Hartmut Aufderstrasse, Jutta Muller, Helmut Muller | Themen Aktuell: Glossar Deutsch | Max Hueber Verlag | 2003 | 978-3190816903 | --- |
| Giorgio Motta | Wir Plus Grundkurs Deutsch fur Junge Lerner Book German Guide | Goyal Publishers | 2011 | | 248 |

**Programme structure for M.Sc. (H) Bioinformatics - 2 years (3rd Semester)**

| Sr. No | Course Code | Course Title | Course Type | Credits | | | | | Credit Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | FW | SW | |
| 1 | | Artificial intelligence and Machine learning | Core Courses | 3 | 0 | 1 | 0 | 0 | 4 |
| 2 | | Database Management Systems and Tools | Core Courses | 3 | 0 | 1 | 0 | 0 | 4 |
| 3 | | Medicinal Chemistry | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| | | *Students will choose any **one** from the given choices** | Specialization Elective Course | | | | | | |
| | | Elements of Network biology | | 2 | 0 | 0 | 0 | 0 | 2 |
| | | MOOC | | 2 | 0 | 0 | 0 | 0 | 2 |
| 6 | | Research Paper Presentation | NTCC | 0 | 0 | 2 | 0 | 0 | 2 |
| 7 | | Dissertation Work | NTCC | 0 | 0 | 8 | 0 | 0 | 8 |
| | | | **Total credits** | | | | | | **24** |

**Artificial Intelligence and Machine Learning**

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to provide students with a comprehensive understanding of Artificial Intelligence (AI) and Machine Learning (ML) concepts and techniques.

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to AI and ML** | **13 hrs** |
| Introduction to Artificial Intelligence, Basics of Machine Learning, Types of Machine Learning (Supervised, Unsupervised, Reinforcement Learning), Data Preprocessing Techniques (Data Cleaning, Feature Scaling, Feature Engineering), Evaluation Metrics for Machine Learning Models | |
| **Unit II: Machine Learning Techniques** | **13 hrs** |
| Linear Regression, Logistic Regression, Decision Trees, Random Forests, Support Vector Machines, Clustering Algorithms (K-means, Hierarchical Clustering), Dimensionality Reduction Techniques (PCA, t-SNE), Ensemble Learning Methods (Bagging, Boosting) | |
| **Unit III: Deep Learning Fundamentals** | **14 hrs** |
| Introduction to Neural Networks, Feedforward Neural Networks, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs), Transfer Learning, Hyperparameter Tuning, Regularization Techniques (L1, L2, Dropout), Optimization Algorithms (Gradient Descent, Adam, RMSprop) | |
| **Unit IV: Advanced Topics in AI and ML** | **14 hrs** |
| Natural Language Processing (NLP), Time Series Analysis, Reinforcement Learning Algorithms (Q-learning, SARSA), Model Deployment and Serving, Ethical Considerations in AI and ML, Explainable AI (XAI), Federated Learning, Meta-Learning | |

**Course Learning Outcomes:** at the end of the course, the students will learn to:

1. Master AI and ML basics, including learning types and model evaluation.
2. Develop expertise in key ML algorithms like linear regression and decision trees.
3. Delve into deep learning fundamentals, covering neural networks and optimization.
4. Explore advanced AI areas like natural language processing and reinforcement learning.

**List of Practicals**

1. Introduction to Data Preprocessing Techniques in Bioinformatics
2. Implementing Linear Regression for Bioinformatics Data Analysis
3. Clustering Analysis of Biological Data using K-means Algorithm
4. Building a Convolutional Neural Network for Genomic Sequence Classification
5. Exploring Dimensionality Reduction Techniques for Gene Expression Data

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Vinod Chandra S. S and Anand Hareendran S | **Artificial Intelligence and Machine Learning** | PHI Learning | 2014 | 9788120349346 | 449 |
| Ian Goodfellow, Yoshua Bengio, Aaron Courville | **Deep Learning** | MIT Press | 2016 | 9780262035613 | 800 |

**Database Management System and tools**

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to acquire proficiency in database management, enabling efficient data storage, retrieval, and manipulation for effective information management.

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Databases** | **18 H** |
| Relational and Non-relational databases. Introduction to SQL. Introduction to MySQL. Creating and Populating a Database. Query Primer: Its mechanics and clauses. Filtering: Condition evaluation, building condition, condition types | |
| **Unit II: Working with Multiple tables and sets** | **18 H** |
| Querying multiple tables: Join, Cartesian product, inner joins, self-joins. Working with sets: set theory primer, set operators, set operation rules. Data generation, manipulation and conversion | |
| **Unit III: Grouping and Aggregates** | **18 H** |
| Grouping concepts, aggregate functions, implicit v/s explicit groups, counting distinct values, generating groups, group filter conditions. Subqueries: Introduction, types, non-correlated subqueries, correlated subqueries. Joins: Outer joins, cross joins, natural joins. Conditional logic: case expression, examples of case expression. Transactions | |
| **Unit IV: Indexes and Constraints** | **18 H** |
| Indexes: Types, uses. Constraints: Constraint creation. Views: their uses, data security, data aggregation, hiding complexity, updating views | |

**Course Learning Outcomes:** At the end of the course, the students will:

1. Demonstrate proficiency in designing and implementing SQL databases.
2. Efficiently retrieve and manipulate data using SQL queries.
3. Ensure data integrity and security in SQL database management.
4. Optimize database performance for improved system efficiency.

**List of Practicals:**

1. Give an example of a) Self join b) Equi join c) Non-equi Join d) Outer join. Create a query to display the employee number and name of the employees who earn more than the average salary. Sort the result in ascending order of salary.
2. Explain the concept of view by taking an example or writing a Query in SQL. Write a Query to
a) Create a user with password
b) Grant system privileges to the user
c) Create a manager role and then allows the manager to create tables and views
d) Grant query and privileges to the user on employee table
e) Grant privileges to update specific column to user and roles
f) Revoke the privileges given to user on employee table
3. Write a program in pl/sql to explain following:
a) Cursor b) Exception handling c) Procedure and functions d) Triggers
4. Design employee information system demonstrating the use of database connectivity with oracle or access

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN |
|---|---|---|---|---|
| Alan Beaulieu | Learning SQL Generate, Manipulate, and Retrieve Data | O'Reilly | 2005 | 978-93-5213-978-1 |
| Conrad Bessant, Ian Shadforth and Darren Oakley | Building Bioinformatics Solutions With Perl, R, and MySQL | Oxford University Press | 2009 | 978-0-19-958690-5 |

## Medicinal Chemistry

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:** To understand the concepts of Medicinal Chemistry and drug discovery

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit-1-Drugs: Overview** | **18 hrs** |
| Introduction, Drug targets, Intramolecular bonding forces (Electrostatic, ionic, hydrogen bonding, Van der Waals interactions, Dipole-dipole and ion-dipole interactions, repulsive interactions) Role of water and hydrophobic interactions Classification of drugs, Naming of drugs and medicines. | |
| **Unit-2- Drug targets: Structure and Functions** | **18 hrs** |
| Enzymes: Structure and function, Catalytic role of enzymes, Regulation of enzyme, Isoenzyme, Enzyme kinetics<br>Receptors: Structure and Functions, Role of receptor, receptor types and subtypes, receptor activation, Ion channel receptors, Kinase-linked receptors, Intracellular receptors. | |
| **Unit-3-Pharmacokinetics and related topics** | **18 hrs** |
| Three phases of drug action, drug absorption, drug distribution, drug metabolism, drug excretion, Drug administration, Drug dosing, (half-life, tolerance, bioavailability, steady state concentration), Formulation, drug delivery. | |
| **Unit-4- Drug design and discovery** | **18 hrs** |
| Optimizing hydrophilic/hydrophobic properties, Making drugs resistant to chemical, enzymatic degradation, drug metabolism. Targeting drugs, Reducing toxicity.<br>Concept of prodrug, prodrug to improve membrane permeability, prolong drug activity, masking drug toxicity and side effects, modulate water solubility, Targeted prodrugs, prodrugs activated by external influence. | |

**Course Learning Outcomes:**

- Knowledge of important stages in drug discovery
- Assessment of drugs for therapeutic purpose
- Important aspect of key interactions of drugs with receptors
- Knowledge of prodrug, and their various parameters for improved activity

**Text / Reference Books:**

| Authors | Title | Publisher | Ed/year | ISBN No |
|---|---|---|---|---|
| Graham L. Patrick | An introduction to Medicinal Chemistry, Fifth Edition | Oxford Press | 2013 | |
| R. B. Silverman | The Organic Chemistry of Drug Design and Drug Action | Elsevier Inc, | 2015 | |
| W. B. Pratt, P. Taylor | Principles of Drug Action | Churchill Livingstone | 1990 | |

# Elements of Network Biology

| L | T | P | Total Credits |
|---|---|---|---|
| 1 | 0 | 1 | 2 |

**Course Objectives:** The aim of this course is to teach students Network Biology

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Network Biology** | **3 H** |
| Introduction to network biology: concepts and applications, Overview of biological networks: protein-protein interaction networks, gene regulatory networks, metabolic networks, Network representations and properties | |
| **Unit II: Network modeling** | **5 H** |
| Network Modeling: Network modeling approaches: deterministic and stochastic models, Modeling protein-protein interaction networks, Modeling gene regulatory networks, Modeling metabolic networks | |
| **Unit III: Network Analysis Techniques** | **5 H** |
| Network Analysis Techniques: Network visualization and analysis tools, Network motifs and modules, Centrality measures and network hubs, Community detection algorithms | |
| **Unit IV: Applications of Network Biology** | **5 H** |
| Applications of Network Biology: Network-based analysis of cellular processes, Network-based disease gene prioritization, Drug target identification using network biology, Case studies and applications of network biology in biomedical researchs | |

**Course Learning Outcomes:** At the end of the course, the students will:

1. Basics of Network Biology
2. Modeling Biological Networks
3. Network Analysis Techniques
4. Applying Network Biology to disease network

**List of Practicals**

1. Network Visualization with Cytoscape:
   A. Introduction to Cytoscape interface
   B. Importing network data into Cytoscape
   C. Basic network visualization and styling (node color, size, shape, edge color, width, etc.)

D. Layouts: Understanding and applying different network layouts (e.g., force-directed, circular, hierarchical)

2. Network Analysis:
   A. Degree distribution analysis
   B. Centrality measures: Betweenness, closeness, and degree centrality
   C. Clustering coefficient analysis
   D. Shortest path analysis
3. Functional Enrichment Analysis:
   A. Importing and mapping gene expression data onto a network
   B. Functional enrichment analysis using Gene Ontology (GO) terms
   C. Visualizing enriched pathways and biological processes on the network
4. Network Integration:
   A. Integration of multiple networks
   B. Visualizing and analyzing protein-protein interaction (PPI) networks
   C. Overlaying different types of data on the network (e.g., gene expression, mutations, drug targets)
5. Network Motif Analysis:
   A. Introduction to network motifs
   B. Detecting and analyzing network motifs using Cytoscape plugins
   C. Understanding the biological significance of network motifs
6. Network Modeling and Simulation:
   A. Introduction to network modeling using Cytoscape
   B. Simulating network dynamics (e.g., Boolean network modeling, Fuzzy logic modeling)
   C. Predicting network behavior under different conditions and perturbations

**Text / Reference Books:**

| AUTHOR | TITLE | Publisher | Year of publication | ISBN |
|---|---|---|---|---|
| Charles Severance | Python for Everybody | SPD | 2017 | 248 |
| Tiago Antao | Bioinformatics with Python Cookbook | Packt Publishing | 2022 | 360 |

## NTCC: Research Paper Presentation

| L | T | P | Total Credits |
|---|---|---|---|
| 0 | 0 | 2 | 2 |

**Course content and syllabus**

Students will present the latest research/review article published in a reputed international peer-reviewed journal.

## NTCC- Dissertation Work

| L | T | P | Total Credits |
|---|---|---|---|
| 0 | 0 | 8 | 8 |

**Course content and syllabus**

The students will undertake research work under the supervision of a faculty member.

**Programme structure for M.Sc. (H) Bioinformatics - 2 years (4th Semester)**

| Sr. No | Course Code | Course Title | Course Type | Credits | | | | | Credit Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | FW | SW | |
| 1 | | Structure Based Drug Design and Discovery | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| 2 | | Genetic Engineering and RDT | Core Courses | 4 | 0 | 0 | 0 | 0 | 4 |
| | | *Students will choose any **one** from the given choices** | Specialization Elective Course | | | | | | |
| | | Concepts in Immunoinformatics | | 4 | 0 | 0 | 0 | 0 | 4 |
| | | MOOC | | 4 | 0 | 0 | 0 | 0 | 4 |
| 7 | | Dissertation Work | NTCC | 0 | 0 | 12 | 0 | 0 | 12 |

**Total Credits** **24**

## Structure Based Drug Design and Discovery

| L | T | P | Total Credits |
|---|---|---|---|
| 3 | 0 | 1 | 4 |

**Course Objectives:** The aim of this course is to teach Computer-aided Drug design.

**Course Contents/syllabus:**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Molecular Modelling and Drug Design** | **18 hrs** |
| Introduction to applications of Bioinformatics in drug discovery, Basics of molecular modeling and its significance, Introduction to drug design and its importance, Overview of computational methods in drug discovery, Software tools used in molecular modeling and drug design | |
| **Unit II: Protein Structure Prediction, Virtual Screening, and Molecular Docking** | **18 hrs** |
| Introduction to protein structure prediction methods, Homology modeling and its applications, Virtual screening, Ligand library preparation, OpenBabel, Introduction to molecular docking, Principles and algorithms of Virtual screening and molecular docking, Hands-on practice of Virtual screening and molecular docking | |
| **Unit III: Molecular Dynamics Simulations and Ligand-Protein Interactions** | **18 hrs** |
| Introduction to molecular dynamics simulations, Principles and algorithms of molecular dynamics simulations, Force-fields, Components of a force field equation, Non-bonded interactions – deriving partial charges, Lennard-Jones potential and parameterization, Non-bonded interactions – deriving partial charges, Lennard-Jones potential and parameterization. Introduction to water models (SPC, TIP3P, TIP4P, BF and ST2) and united atom force fields. Hands-on practice on molecular dynamics simulation software, Analysis of ligand-protein interactions, Binding affinity prediction and scoring functions | |
| **Unit IV: Quantitative Structure-Activity Relationship (QSAR) Studies and Drug Design Strategies** | **18 hrs** |
| Introduction to QSAR studies, Principles and applications of QSAR in drug discovery, Hands-on practice on QSAR software, Introduction to drug design strategies, Case studies and applications of computer-aided drug design | |

**Course Learning Outcomes:** At the end of the course, the students will learn:

1. To understand the principles of molecular modeling and computer-aided drug design.
2. To learn various computational methods used in drug discovery.
3. To gain practical experience in molecular docking, molecular dynamics simulations, and QSAR studies.
4. To understand the basics of protein structure prediction and ligand-protein interactions.
5. To explore different strategies in drug design.

**List of Practicals**

1. Molecular Modeling Software set: PyMol, AutoDock, GROMACS, etc
2. Homology Modeling
3. Molecular Docking
4. Molecular Dynamics Simulations
5. Analysis of Molecular Dynamics Trajectory: Visualizing molecular dynamics trajectory, Analyzing protein dynamics, root mean square deviation (RMSD), and root mean square fluctuation (RMSF)
6. Quantitative Structure-Activity Relationship (QSAR)
7. Predicting biological activity using QSAR models, Virtual screening of compound libraries, Identifying potential drug candidates

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Jenny Gu, Philip Bourne | Structural Bioinformatics, 2nd Edition | Wiley Blackwell | 2018 | 8126574712 | 1034 |
| Sonsoles Martín-Santamaría | Computational Tools for Chemical Biology | Royal Society of Chemistry | 2017 | 978-1-78262-700-5 | 378 |

# Genetic Engineering and Recombinant DNA Technology

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Genetic Recombination** | **18 hrs** |
| Basic laws of Mendelian Genetics, Yeast Genetics as a tool to understand unlinked and liked genes, Tetrad analysis, linkage analysis, Measurement of genetic distance, Single nucleotide polymorphisms, Haplotype analysis, Haplotype as a tool for measuring genetic variation and relatedness, | |
| **Unit II: Genetic manipulation mechanisms** | **18 hrs** |
| Restriction-Modification systems in bacteria, cloning by complementation and selection, screening versus selection, Molecular mechanism of genetic recombination- homologous recombination, non homologous end-joining, RecBCD, Rec A and RuvABC systems, Eukaryotic recombinases like Rad51, Cre-Lox system of recombination, Gene knockout and knock-in strategies, CRISPR, TALENs, ZFN nucleases, Gene therapy | |
| **Unit III: Gene knock-down strategies** | **18 hrs** |
| Heterochromatin and euchromatin, Anti-sense methods of gene silencing, RNA interference, discovery and mechanisms in plants, animals and yeast, role of Dicer, Rdp and Ago1, Role in RNA degradation and link with heterochromatin silencing, miRNA and translational suppression and applications, gene silencing and DNA methylation, X-inactivation, role of RNA in X-inactivation | |
| **Unit IV: Other genetic manipulation approaches** | **18 hrs** |
| Other recombination systems, like RNA splicing, protein splicing, RNA editing, DNA cloning vectors in bacteria, yeast, plants and animals, bacteriophage vectors and systems of transformation, Design of expression vectors in different species, library construction vectors, DNA elimination in Trypanosomes | |

**Course Learning Outcomes:**

Students will be able to:

1. Understand basic concepts of DNA integrity and genetic alterations.
2. Understand the concept of DNA cloning and vector
3. Understanding objectives and methods of knock-in and knockout techniques
4. Understand various genetic tools available for genetic manipulation in different organism

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| J. Sambrook, E. F. Fritsch, and T. Maniatis, 2nd Edn., | Molecular cloning: A laboratory manual, | Cold Spring Harbor Laboratory Press | 3rd Ed | 978-0879695767 | 2344 |
| T.A. Brown | Gene Cloning and DNA Analysis - An introduction | Wiley - Blackwell | 2010 | 9781405181730 | 338 |
| D. Voet, J. G Voet and C. W. Pratt | Fundamentals of Biochemistry, 5th Edition | John Wiley | 5th edition, 2016 | 978-1-118-91840-1 | 1184 |
| D.L. Nelson and M.M. Cox | Lehninger Principles of Biochemistry | Mcmillan | 8th Edition | 13: 978-1-319-32234-2 (epub) | 4381 |

## Concepts in Immunoinformatics

| L | T | P | Total Credits |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Objectives:** The aim of this course is to provide students with a comprehensive understanding of immunology, major histocompatibility complex (MHC) and human leukocyte antigen (HLA) systems, vaccine design principles, and the utilization of immunoinformatics tools and databases for advancing research and development in immunology and vaccine design.

**Course content and syllabus**

| | Teaching Hours |
|---|---|
| **Unit I: Introduction to Immunology** | **18 hrs** |
| Introduction to immune System, Immune cell types, Hematopoiesis, B and T lymphocytes, NK cells, Lymphoid organs (primary and secondary), Inflammation, Innate Immune system, Adaptive immune system.<br>Antibody structure, Generation of antibody diversity, Major histocompatibility complex, Antigen presentation, APCs, T-cell development, negative/positive selection, co-stimulatory molecules. Humoral immunity/Cell-mediated immunity, T cell subtypes. B-cell maturation/activation BCR signaling, memory B and T cell. Autoimmunity, host vs graft reaction.<br>Active immunization vaccines, Vaccine production, passive immunization, polyclonal and monoclonal antibodies. | |
| **Unit II: Immunoinformatics tools and databases** | **18 hrs** |
| Databases & tools: MHCDB(NCBI), IEDB, The IMGT/HLA Database, IPD (The Immuno Polymorphism Database), BciPep, Epitome, CED, Ag-Ab database, Allergen Databases. MHC– Molecular Affinity and QSAR Models, Machine learning for MHC-Binding Peptides, Static Energy Analysis of MHC Class I and Class II Peptide-Binding Affinity | |
| **Unit III: MHC and HLA: Structure, Polymorphism, and Epitope Prediction** | **18 hrs** |
| Major Histocompatibility Complex: Structure and functions of MHC class I and II, MHC polymorphism, MHC supertypes, MHC peptides- Specificity, characterization, MHCpeptide designing tool.<br>HLA: HLA-peptide interactions, Antigen Processing in the MHC Class I Pathway, Processing of MHC Class II Epitopes, Sequential and Conformational Epitopes, Epitope Prediction algorithms - T cell and B cell epitope prediction tool. | |
| **Unit IV: Vaccine Design and Development** | **18 hrs** |
| Rational vaccine design: Reverse vaccinology, Prediction of immunogenicity, Toxoid as vaccine, Conjugate vaccine, DNA vaccine, Recombinant vector vaccines and Personalised vaccines.<br>Structure-based Vaccine design: tools and techniques, Antigenicity | |

| | |
|---|---|
| modification, Epitope replacement, germline targeting, Epitope focussing, hyperglycosylation, chimeric fusion, epitope scaffold, Antigen display and delivery platforms - multivalent display, co-display, immunomodulation. | |

**Course Learning Outcomes:** at the end of the course, the students will be able to:

1. Understand the principles of immunological processes, including immune cell types, antigen recognition, and immune regulation.

2. Effectively utilize immunoinformatics tools and databases for accessing, analyzing, and interpreting immunological data.

3. Analyze antigen presentation, epitope prediction, and immune recognition using MHC and HLA systems.

4. Evaluate diverse vaccine design strategies, including rational, structural-based, and personalized approaches.

**Text / Reference Books:**

| Author | Title | Publisher | Ed/year | ISBN No | Pages |
|---|---|---|---|---|---|
| Flower, Darren R | Immunoinformatics: predicting immunogenicity in silico | Humana Press, New Jersey | 2007 | 9781588296993 | 438 |
| Namrata Tomar | Immunoinformatics | Humana Press, New Jersey | 2014 | 9781493911158 | 586 |

## Dissertation Work

| L | T | P | Total Credits |
|---|---|---|---|
| 0 | 0 | 12 | 12 |

**Course content and syllabus**

The students will undertake research work under the supervision of a faculty me