

SAURASHTRA UNIVERSITY, RAJKOT



Accredited Grade “A” by NAAC (CGPA 3.05)

COURSE STRUCTURE & SYLLABUS

FOR

UNDERGRADUATE PROGRAMME

IN

BIOINFORMATICS

Semester V & VI

(Faculty of Science)

[As per Choice Based Credit System (CBCS) as recommended by UGC]

Effective from June - 2021

Annexure – “B”

SAURASHTRA UNIVERSITY
SCIENCE FACULTYSubject: **BIOINFORMATICS**

| Sr. No. | Level | Semester | Course Group | Course (Paper) Title | Course (Paper) No. | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks | Course (Paper) Unique Code |
|---------|-------|----------|--------------|---|--------------------|--------|----------------|----------------|-----------------------|-------------|----------------------------|
| 01 | UG | 05 | Core | BI.501 Genomics | BI-501 | 6 | 30 | 70 | 50 | 150 | 1603 2200 0105 0100 |
| 02 | UG | 05 | Core | BI.502 Applied Genomics & Transcriptomics | BI-502 | 6 | 30 | 70 | 50 | 150 | 1603 2200 0105 0200 |
| 03 | UG | 05 | Core | BI.503 Proteomics | BI-503 | 6 | 30 | 70 | 50 | 150 | 1603 2200 0105 0300 |
| 04 | UG | 05 | Core | BI.504 Advanced Omics Technology | BI-504 | 6 | 30 | 70 | 50 | 150 | 1603 2200 0105 0400 |
| 05 | UG | 05 | Core | BI.505 Python & R Programming | BI-505 | 6 | 30 | 70 | 50 | 150 | 1603 2200 0105 0500 |
| 06 | UG | 06 | Core | Bioinformatics Project | BI-601 | 30 | 225 | - | 525 | 750 | 1603 2200 0106 0100 |

**SKELETON OF COMPLETE COURSE CONTENT OF
UNDER GRADUATE BIOINFORMATICS
SEMESTER V & IV**

| SEMESTER | PAPER NO. & CODE | TITLE OF THE PAPER | CREDIT |
|-----------------|-----------------------------|------------------------------------|---------------|
| V | BI-501 (Theory) | Genomics | 4 |
| | BI-501 (Practical) | -do- | 2 |
| | BI-502 (Theory) | Applied Genomics & Transcriptomics | 4 |
| | BI-502 (Practical) | -do- | 2 |
| | BI-503 (Theory) | Proteomics | 4 |
| | BI-503 (Practical) | -do- | 2 |
| | BI-504 (Theory) | Advanced Omics Technology | 4 |
| | BI-504 (Practical) | -do- | 2 |
| | BI-505 (Theory) | Python & R Programming | 4 |
| | BI-505 (Practical) | -do- | 2 |
| VI | BI-601 (Practical) | Bioinformatics Project | 30 |

FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Genomics (BI.501)

Course (Paper) Unique Code: 1603 2200 0105 0100

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|------------------------|-----------------|---------------------|---------------|-----------------------|-----------------------|------------------------------|--------------------|
| Bachelor of Science | 05 | Core | 6 | 30 | 70 | 50 | 150 |

Course Objective:

- To uncover basics of Genomics and Genome Analysis

COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 501
SEMESTER- V

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|--------------------|----------|-------------|--------|-------------------|----------------|----------------|-------------|
| V | BI-501 (Theory) | Genomics | 5 | 4 | 2.5 hrs | 30 | 70 | 100 |
| V | BI-501 (Practical) | Genomics | 3 | 2 | One day per batch | 15 | 35 | 50 |
| Total credits | | | | 6 | Total marks | | | 150 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 5 lectures / week / theory paper / semester.
3. Each lecture will be of 55 mins.
4. There will be 1 practical / week / paper / batch. Each practical will be of 3 periods
5. Each semester theory paper will be of “five” units. There will be 40 hrs. of theory teaching / paper / semester.
6. Each Theory Paper / Semester will be of 100 Marks. There will be 30 marks for internal evaluation and 70 marks for external evaluation. Each Practical Paper / Semester will be of 50 Marks with 15 marks for internal and 35 marks for external evaluation. So, Total Marks of Theory and Practical for each Paper will be 150. (100 + 50 = 150)

**SKELETON OF THEORY EXAMINATION PAPER -EXTERNAL
(SEMESTER –V)**

| | | |
|---|----------------|----------|
| Total five questions. One question from each unit. Each question having equal weightage of 14 Marks | | |
| a) Four One mark questions (All compulsory) | 4 x 1= 4 Marks | 14 Marks |
| b) Answer specifically- (attempt any one out of two) | 1 x 2= 2 Marks | |
| c) Short Questions - (attempt any one out of two) | 1 x 3= 3 Marks | |
| d) Answer in detail – (attempt any one out of two) | 1 x 5= 5 Marks | |

General Instructions

1. Time duration of each theory paper will be of two and half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be internal option for all the questions (as shown in table above)
4. All questions are compulsory

BI.501 Genomics **(Theory)**

Unit I: Genomics- Basics

- Genomics: Introduction and Branches, Genome Size, Sequence complexity
- Genome structure in viruses and prokaryotes
- Organization of organelle genomes
- Organization of nuclear DNA in eukaryotes
- Gene families
- HUGO Gene Nomenclature Committee
- Gene Ontology Consortium

Unit II: Genome sequencing

- A field guide to whole-genome sequencing, assembly and annotation
- The sequence of sequencers: The history of sequencing DNA
- High Throughput Sequencing: An Overview of Sequencing Chemistry
- Coming of age: ten years of next generation sequencing technologies
- Comparison of Next-Generation Sequencing Systems
- Applications of next-generation sequencing technologies
- ChIP-seq analysis

Unit III: Exome Sequencing & Sequence Assembly

- Exome Sequencing: Current and Future Perspectives
- Novel bioinformatic developments for exome sequencing
- Review of Current Methods, Applications, and Data Management for the Bioinformatics Analysis of Whole Exome Sequencing
- Sequence Assembly
- Recent advances in sequence assembly: principles and applications
- New advances in sequence assembly
- List of (genome) sequence assembly software

Unit IV: Genome annotation

- Gene Prediction Methods and tools
- Genome annotation
- NCBI Prokaryotic & Eukaryotic Genome Annotation Pipeline
- The Ensembl gene annotation system
- An optimized approach for annotation of large eukaryotic genomic sequences using genetic algorithm.

- Fast Genome-Wide Functional Annotation through Orthology Assignment by eggNOG-Mapper
- KAAS: an automatic genome annotation and pathway reconstruction server

Unit V: Pseudogenes & Pharmacogenomics

- Pseudogenes & its prediction tools
- Pseudogenes and Their Genome-Wide Prediction in Plants
- SNP: Introduction, Databases & detection software
- Overview of Personalized medicine, Web Resources for Pharmacogenomics
- Basic concepts of Epigenomics

BI.501 Genomics **(Practical)**

Based on the theory syllabus

References:

1. Abugessaisa I, Kasukawa T, Kawaji H. Genome Annotation. *Methods Mol Biol.* 2017;1525:107-121. PubMed PMID: 27896719.
2. Ambaradar S, Gupta R, Trakroo D, Lal R, Vakhlu J. High Throughput Sequencing: An Overview of Sequencing Chemistry. *Indian J Microbiol.* 2016 Dec;56(4):394-404. Epub 2016 Jul 9. Review. PubMed PMID: 27784934; PubMed Central PMCID: PMC5061697.
3. Bao R, Huang L, Andrade J, Tan W, Kibbe WA, Jiang H, Feng G. Review of current methods, applications, and data management for the bioinformatics analysis of whole exome sequencing. *Cancer Inform.* 2014 Sep 21;13(Suppl 2):67-82. doi: 10.4137/CIN.S13779. eCollection 2014. Review. PubMed PMID: 25288881; PubMed Central PMCID: PMC4179624.
4. Bronwen L. Aken, et al; The Ensembl gene annotation system, Database, Volume 2016, 1 January 2016, baw093, <https://doi.org/10.1093/database/baw093>
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6. ChIP-seq analysis: <https://www.ebi.ac.uk/training/online/course/ebi-next-generation-sequencing-practical-course/gene-regulation/chip-seq-analysis>
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13. Huang X. Sequence Assembly. *Methods Mol Biol*. 2017;1525:35-45. PubMed PMID: 27896716.
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15. Koonin EV, Galperin MY. Sequence - Evolution - Function: Computational Approaches in Comparative Genomics. Boston: Kluwer Academic; 2003. Chapter 5, Genome Annotation and Analysis. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK20253/>
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24. The NCBI Eukaryotic Genome Annotation Pipeline: https://www.ncbi.nlm.nih.gov/genome/annotation_euk/process/
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Annexure – “C”

FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Applied Genomics & Transcriptomics (BI-502)

Course (Paper) Unique Code: 1603 2200 0103 0200

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|---------------------|----------|--------------|--------|----------------|----------------|-----------------------|-------------|
| Bachelor of Science | 05 | Core | 6 | 30 | 70 | 50 | 150 |

Course Objective:

- To understand Applied Genomics & Gene expression analysis

COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 502
SEMESTER- V

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|--------------------|------------------------------------|-------------|--------|-------------------|----------------|----------------|-------------|
| I | BI-502 (Theory) | Applied Genomics & Transcriptomics | 5 | 4 | 2.5 hrs | 30 | 70 | 100 |
| I | BI-502 (Practical) | Applied Genomics & Transcriptomics | 3 | 2 | One day per batch | 15 | 35 | 50 |
| Total credits | | | | 6 | Total marks | | | 150 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 5 lectures / week / theory paper / semester.
3. Each lecture will be of 55 mins.
4. There will be 1 practical / week / paper / batch. Each practical will be of 3 periods
5. Each semester theory paper will be of “five” units. There will be 50 hrs. of theory teaching / paper / semester.
6. Each Theory Paper / Semester will be of 100 Marks. There will be 30 marks for internal evaluation and 70 marks for external evaluation. Each Practical Paper / Semester will be of 50 Marks with 15 marks for internal and 35 marks for external evaluation. So, Total Marks of Theory and Practical for each Paper will be 150. (100 + 50 = 150)

**SKELETON OF THEORY EXAMINATION PAPER -EXTERNAL
(SEMESTER- V)**

| | | |
|---|----------------|----------|
| Total five questions. One question from each unit. Each question having equal weightage of 14 Marks | | |
| a) Four One mark questions (All compulsory) | 4 x 1= 4 Marks | 14 Marks |
| b) Answer specifically- (attempt any one out of two) | 1 x 2= 2 Marks | |
| c) Short Questions - (attempt any one out of two) | 1 x 3= 3 Marks | |
| d) Answer in detail – (attempt any one out of two) | 1 x 5= 5 Marks | |

General Instructions

1. Time duration of each theory paper will be of two and half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be internal option for all the questions (as shown in table above)
4. All questions are compulsory

BI.502 Applied Genomics & Transcriptomics

(Theory)

Unit I: Applied Genomics-1

- Subtractive Genomics & Reverse Vaccinology approaches
- Overview of Comparative Genomics; Comparative Genomics of prokaryotes, Organelles & Eukaryotes
- Overview of Pangenomics; A brief review of software tools for pangenomics
- Computational polypharmacology: a new paradigm for drug discovery
- A Survey on the Computational Approaches to Identify Drug Targets in the Postgenomic Era

Unit II: Applied Genomics-2 (Metagenomics)

- Metagenomics-Introduction
- Metagenomics: The Next Culture-Independent Game Changer
- Marine metagenomics as a source for bioprospecting
- Metagenomic Assembly: Overview, Challenges and Applications
- EBI Metagenomics
- Databases of the marine metagenomics

Unit III: Applied Genomics-3 (Microbiomics)

- The human microbiome
- Structure and function of the human skin microbiome
- Application of metagenomics in the human gut microbiome
- The potential impact of gut microbiota on your health: Current status and future challenges.
- Ecology of the Oral Microbiome: Beyond Bacteria.
- Gut Microbiota and Salivary Diagnostics: The Mouth Is Salivating to Tell Us Something.

Unit IV: Transcriptomics – Basics & ncRNAs

- Transcription of Protein-Coding Genes and Formation of Functional mRNA
- The Decoding of mRNA by tRNAs
- List of RNAs & Overview of Non-coding RNA
- Gene Family: Non-coding RNAs
- Current Research on Non-Coding Ribonucleic Acid (RNA)
- Noncoding RNAs: Clinical and Therapeutic Applications
- A Review on Recent Computational Methods for Predicting Noncoding RNAs

Unit V: Transcriptomics technologies

- Transcriptomics technologies
- RNA sequencing: advances, challenges and opportunities
- Transcriptome analysis using next-generation sequencing
- Transcriptomics in the RNA-seq era
- A survey of best practices for RNA-seq data analysis
- RNA-Seq bioinformatics tools

BI.502 Applied Genomics & Transcriptomics

(Practical)

Based on the theory syllabus

References:

1. Appels, R., Nystrom, J., Webster, H., & Keeble-Gagnere, G. (2015). Discoveries and advances in plant and animal genomics. *Functional & Integrative Genomics*, 15(2), 121–129. <http://doi.org/10.1007/s10142-015-0434-3>
2. Baker JL, Bor B, Agnello M, Shi W, He X. Ecology of the Oral Microbiome: Beyond Bacteria. *Trends Microbiol.* 2017 May;25(5):362-374. doi: 10.1016/j.tim.2016.12.012. Epub 2017 Jan 11. Review. PubMed PMID: 28089325; PubMed Central PMCID: PMC5687246.
3. Barh, D., Tiwari, S., Jain, N., Ali, A., Santos, A. R., Misra, A. N., ... & Kumar, A. (2011). In silico subtractive genomics for target identification in human bacterial pathogens. *Drug Development Research*, 72(2), 162-177.
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- 10.1186/s13059-016-0881-8. Review. Erratum in: *Genome Biol.* 2016;17(1):181. PubMed PMID: 26813401; PubMed Central PMCID: PMC4728800.
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Annexure – “C”

FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Proteomics (BI-503)

Course (Paper) Unique Code: 1603 2200 0105 0300

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|------------------------|-----------------|---------------------|---------------|-----------------------|-----------------------|------------------------------|--------------------|
| Bachelor of Science | 05 | Core | 6 | 30 | 70 | 50 | 150 |

Course Objective:

- To understand Proteomics and its technology

COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 503
SEMESTER- V

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|--------------------|------------|-------------|--------|-------------------|----------------|----------------|-------------|
| V | BI-503 (Theory) | Proteomics | 5 | 4 | 2.5 hrs | 30 | 70 | 100 |
| V | BI-503 (Practical) | Proteomics | 3 | 2 | One day per batch | 15 | 35 | 50 |
| Total credits | | | | 6 | Total marks | | | 150 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 5 lectures / week / theory paper / semester.
3. Each lecture will be of 55 mins.
4. There will be 1 practical / week / paper / batch. Each practical will be of 3 periods
5. Each semester theory paper will be of “five” units. There will be 50 hrs. of theory teaching / paper / semester.
6. Each Theory Paper / Semester will be of 100 Marks. There will be 30 marks for internal evaluation and 70 marks for external evaluation. Each Practical Paper / Semester will be of 50 Marks with 15 marks for internal and 35 marks for external evaluation. So, Total Marks of Theory and Practical for each Paper will be 150. (100 + 50 = 150)

**SKELETON OF THEORY EXAMINATION PAPER -EXTERNAL
(SEMESTER- V)**

| | | |
|---|----------------|----------|
| Total five questions. One question from each unit. Each question having equal weightage of 14 Marks | | |
| a) Four One mark questions (All compulsory) | 4 x 1= 4 Marks | 14 Marks |
| b) Answer specifically- (attempt any one out of two) | 1 x 2= 2 Marks | |
| c) Short Questions - (attempt any one out of two) | 1 x 3= 3 Marks | |
| d) Answer in detail – (attempt any one out of two) | 1 x 5= 5 Marks | |

General Instructions

1. Time duration of each theory paper will be of two and half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be internal option for all the questions (as shown in table above)
4. All questions are compulsory

BI.503 Proteomics **(Theory)**

Unit I: Proteomics- Basics & Strategies for protein separation

- The origin and scope of proteomics
- Post-translational modification
- Proteomics: Technologies and Their Applications.
- General principles of protein separation in proteomics
- Principles of two-dimensional gel electrophoresis
- The application of 2DGE in proteomics
- Principles of multidimensional liquid chromatography
- Multidimensional liquid chromatography strategies in proteomics

Unit II: Strategies for protein identification & quantitation

- Protein identification with antibodies
- Determination of protein sequences by chemical degradation
- Mass spectrometry—basic principles and instrumentation
- Protein identification using data from mass spectra
- Quantitative proteomics based on 2DGE
- Multiplexed in-gel proteomics
- Quantitative mass spectrometry

Unit III: Interaction proteomics

- Methods to study protein–protein interactions, Library-based methods for the global analysis of binary interactions
- Two-hybrid/protein complementation assays; Modified two-hybrid systems for membrane, cytosolic, and extracellular proteins
- Bacterial and mammalian Two-hybrid systems, Lumier and mappit high- throughput two-hybrid platform
- Adapted hybrid assays for different types of interactions, Systematic complex analysis by tandem affinity purification–mass spectrometry
- Analysis of protein interaction data, Protein interaction maps, Protein interactions with small molecules

Unit IV: Protein modification in proteomics, Protein microarrays & Applications of proteomics

- Phosphoproteomics, analysis of phosphoproteins by mass spectrometry, Quantitative analysis of phosphoproteins
- Glycoproteomics

- The evolution of protein microarrays, Different types of protein microarrays
- Diagnostic applications of proteomics, Applications of proteomics in drug development
- Proteomics in agriculture, Proteomics in industry—improving the yield of secondary metabolism
- Overview of Biomarker, Biomarker discovery, Technologies for Discovery of Biomarkers
- Transcription factor proteomics-Tools, applications, and challenges

Unit V: Data Analysis

- Proteomics resources at the EBI & ExPASy
- A Golden Age for Working with Public Proteomics Data
- Bioinformatic analysis of proteomics data
- Functional annotation and biological interpretation of proteomics data
- Web Resources for Mass Spectrometry-based Proteomics
- Protein post-translational modifications: In silico prediction tools and molecular modeling
- Glycobioinformatics: Current strategies and tools for data mining in MS-based glycoproteomics

BI.503 Proteomics **(Practical)**

Based on the theory syllabus

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Annexure – “C”

FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Advanced Omics Technology (BI-504)

Course (Paper) Unique Code: 1603 2200 0105 0500

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|------------------------|-----------------|---------------------|---------------|-----------------------|-----------------------|------------------------------|--------------------|
| Bachelor of Science | 05 | Core | 6 | 30 | 70 | 50 | 150 |

Course Objective:

- To understand the multiomics technology

COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 504
SEMESTER- V

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|--------------------|---------------------------|-------------|--------|-------------------|----------------|----------------|-------------|
| V | BI-504 (Theory) | Advanced Omics Technology | 5 | 4 | 2.5 hrs | 30 | 70 | 100 |
| V | BI-504 (Practical) | Advanced Omics Technology | 3 | 2 | One day per batch | 15 | 35 | 50 |
| Total credits | | | | 6 | Total marks | | | 150 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 5 lectures / week / theory paper / semester.
3. Each lecture will be of 55 mins.
4. There will be 1 practical / week / paper / batch. Each practical will be of 3 periods
5. Each semester theory paper will be of “five” units. There will be 50 hrs. of theory teaching / paper / semester.
6. Each Theory Paper / Semester will be of 100 Marks. There will be 30 marks for internal evaluation and 70 marks for external evaluation. Each Practical Paper / Semester will be of 50 Marks with 15 marks for internal and 35 marks for external evaluation. So, Total Marks of Theory and Practical for each Paper will be 150. (100 + 50 = 150)

**SKELETON OF THEORY EXAMINATION PAPER -EXTERNAL
(SEMESTER- V)**

| | | |
|---|----------------|----------|
| Total five questions. One question from each unit. Each question having equal weightage of 14 Marks | | |
| a) Four One mark questions (All compulsory) | 4 x 1= 4 Marks | 14 Marks |
| b) Answer specifically- (attempt any one out of two) | 1 x 2= 2 Marks | |
| c) Short Questions - (attempt any one out of two) | 1 x 3= 3 Marks | |
| d) Answer in detail – (attempt any one out of two) | 1 x 5= 5 Marks | |

General Instructions

1. Time duration of each theory paper will be of two and half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be internal option for all the questions (as shown in table above)
4. All questions are compulsory

BI.504 Advanced Omics Technology **(Theory)**

Unit I: Peptidomics-1 (Biologically active peptides)

- Current peptidomics: Applications, purification, identification, quantification, and functional analysis
- Plant Peptides: Bioactivity, Opportunities and Challenges
- Overview of any two examples of Plant Peptides (from the Book Handbook of Biologically Active Peptides (Second Edition))
- Antimicrobial Peptides
- Overview of Antimicrobial Peptides: Cathelicidins, Class II Non-Lantibiotic, Colicins, Defensins, Lantibiotics, Microcins, Nonribosomal Peptide Synthesis, Peptaibols
- Introduction to Bacteriocin & its type / Classes, Genetics and Regulation of Bacteriocin Synthesis, Mode of Action, Applications of Bacteriocins

Unit II: Peptidomics-2 (Biologically active peptides)

Overview of any one examples from the each of the following categories of peptides (from the Book Handbook of Biologically Active Peptides (Second Edition)):

- Fungal Peptides (Fungal Toxins), Invertebrate Peptides (Allatotropin), Amphibian/Skin Peptides (Bombesin Peptides), Venom Peptides (Snake Peptides), Cancer/Anticancer Peptides (Gastrin), Vaccine Peptides (Novel Tumor Derived Peptides in Vaccines)

Unit III: Peptidomics-3 (Biologically active peptides)

- Overview of any one examples from the each of the following categories of peptides (from the Book Handbook of Biologically Active Peptides (Second Edition)): Immune/Inflammatory Peptides (Chemokines), Brain Peptides (CCK), Endocrine Peptides (Leptin), Ingestive Peptides (Insulin), Renal Peptides (Prolactin), Opiate Peptides (Exorphin), Neurotrophic Peptides (Erythropoietin), Blood-Brain Peptides (Opioid Peptides)
- In Silico Search for Biologically Active Peptides
- Pheromone Peptides, Prebiotic Peptides
- Allergen Peptides, Recombinant Allergens and Hypoallergens for Allergen-Specific Immunotherapy
- In silico Identification of Potential Peptides or Allergen Shot Candidates Against *Aspergillus fumigatus*

Unit IV: Secretomics, Lipidomics, Metabolomics & Extremophilic Proteomics

- Secretomics-Overview; Methodologies to decipher the cell secretome

- Lipidomics-Overview; Techniques, Applications, and Outcomes Related to Biomedical Sciences; Prospects from a technological perspective
- Metabolomics-Overview, Metabolomics techniques and technologies, Analytical platform and Analysis of metabolomic data
- Overview of Extremophiles; Extremozymes: A Potential Source for Industrial Applications
- Stability and solubility of proteins from extremophiles, Survival Mechanisms of Extremophiles, Protein Adaptations in Archaeal Extremophiles

Unit V: Interactomics

- Interactome & Interactomics – Overview; Interactomics: Connecting the dots
- Interactomics: toward protein function and regulation; Proteome-Scale Human Interactomics
- Pathway analysis- Overview; Integrating Networks and Proteomics: Moving Forward; Pathway and network analysis in proteomics
- Introduction to Network Analysis in Systems Biology
- List of visualization tools for network biology

BI.504 Advanced Omics Technology **(Practical)**

Based on the theory syllabus

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FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Python & R Programming (BI-505)

Course (Paper) Unique Code: 1603 2200 0106 0100

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|------------------------|-----------------|---------------------|---------------|-----------------------|-----------------------|------------------------------|--------------------|
| Bachelor of Science | 05 | Core | 6 | 30 | 70 | 50 | 150 |

Course Objective:

- To understand the Basics & Advanced of Python & R Programming

COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 505
SEMESTER- V

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|--------------------|------------------------|-------------|--------|-------------------|----------------|----------------|-------------|
| V | BI-505 (Theory) | Python & R Programming | 5 | 4 | 2.5 hrs | 30 | 70 | 100 |
| V | BI-505 (Practical) | Python & R Programming | 3 | 2 | One day per batch | 15 | 35 | 50 |
| Total credits | | | | 6 | Total marks | | | 150 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 5 lectures / week / theory paper / semester.
3. Each lecture will be of 55 mins.
4. There will be 1 practical / week / paper / batch. Each practical will be of 3 periods
5. Each semester theory paper will be of “five” units. There will be 50 hrs. of theory teaching / paper / semester.
6. Each Theory Paper / Semester will be of 100 Marks. There will be 30 marks for internal evaluation and 70 marks for external evaluation. Each Practical Paper / Semester will be of 50 Marks with 15 marks for internal and 35 marks for external evaluation. So, Total Marks of Theory and Practical for each Paper will be 150. (100 + 50 = 150)

**SKELETON OF THEORY EXAMINATION PAPER -EXTERNAL
(SEMESTER- V)**

| | | |
|---|----------------|----------|
| Total five questions. One question from each unit. Each question having equal weightage of 14 Marks | | |
| a) Four One mark questions (All compulsory) | 4 x 1= 4 Marks | 14 Marks |
| b) Answer specifically- (attempt any one out of two) | 1 x 2= 2 Marks | |
| c) Short Questions - (attempt any one out of two) | 1 x 3= 3 Marks | |
| d) Answer in detail – (attempt any one out of two) | 1 x 5= 5 Marks | |

General Instructions

1. Time duration of each theory paper will be of two and half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be internal option for all the questions (as shown in table above)
4. All questions are compulsory

BI.505 Python & R Programming (Theory)

Unit I: Scripting languages for Bioinformatics-Python: Basics-1

- Difference between Programming Language and Scripting Language
- Basics of scripting languages for Bioinformatics
- Basics Bash Shell Scripting
- Printing and manipulating text
- Reading and writing files

Unit II: Python: Basics-2

- Lists and loops
- Writing our own functions
- Conditional tests
- Regular expressions
- Dictionaries
- Files, programs, and user input

Unit III: Advanced Python

- Introduction
- Recursion and trees
- Complex data structures
- Object oriented Python
- Functional Python
- Iterators, comprehensions & generators
- Exception handling

Unit IV: R Programming-1

- Comparison of statistical packages
- Overview of Statistical Analysis Software (SAS), Statistical Package for the Social Sciences (SPSS)
- Introduction and preliminaries
- Simple manipulations; numbers and vectors
- Objects, their modes and attributes
- Ordered and unordered factors
- Arrays and matrices, Lists and data frames

Unit V: R Programming-2 & Bioconductor

- Reading data from files
- Probability distributions
- Grouping, loops and conditional execution
- Writing your own functions
- Statistical models in R, Graphical procedures
- Packages, OS facilities
- Bioconductor Workflows: Annotations, Gene expression, Single Cell, Genomic Variants, Epigenetics, Proteomics, Resource Querying

BI.505 Python & R Programming (Practical)

Based on the theory syllabus

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FACULTY OF SCIENCE

Syllabus

Subject: **BIOINFORMATICS**

Course (Paper) Name & No.: Bioinformatics Project (BI-601)

Course (Paper) Unique Code: 1603 2200 0106 0100

External Exam Time Duration: 2 Hours and 30 minutes

| Name of Program | Semester | Course Group | Credit | Internal Marks | External Marks | Practical /Viva Marks | Total Marks |
|------------------------|-----------------|---------------------|---------------|-----------------------|-----------------------|------------------------------|--------------------|
| Bachelor of Science | 06 | Core | 30 | 225 | -- | 525 | 750 |

Course Objective:

- To do research on any areas of Bioinformatics

**COURSE STRUCTURE FOR UG PROGRAMME
BIOINFORMATICS- 601
SEMESTER- VI**

| Semester | Course | Title | Hours /week | Credit | Exam duration | Internal marks | External marks | Total marks |
|---------------|-----------------------|------------------------|-------------|--------|-------------------|----------------|----------------|-------------|
| VI | BI-601 (Practical) | Bioinformatics Project | 40 | 30 | One day per batch | 225 | 525 | 750 |
| Total credits | | | | 30 | Total marks | | | 750 |

General instructions

1. The medium of instruction will be English for theory and practical courses
2. There will be 40 practical lecture / week / semester.
3. Each lecture will be of 55 mins.
4. This Bioinformatics Project Work marks Carries total 750 marks, among that 225 marks are internal and 525 marks are external

**SKELETON OF BIOINFORMATICS PROJECT VIVA EXAMINATION PAPER -
EXTERNAL
(SEMESTER- VI)**

| Subject code | Subject | Internal | Maximum Marks | | | |
|-----------------------|------------------------|----------|----------------|--------------|------|------------|
| | | | External | | | |
| Project | | | Project Report | Presentation | Viva | Total |
| BI-601 (Practical) | Bioinformatics Project | 225 | 175 | 175 | 175 | 750 |

**SKELETON OF BIOINFORMATICS PROJECT EXAMINATION PAPER -
INTERNAL
(SEMESTER- VI)**

Project Internal Marks: Total = 225 Marks

| S.No | Subject | Max. Mark |
|------|--|------------|
| 1 | Monthly Report (4 Months X 30 Marks) | 120 |
| 2 | Seminar (Review Article) | 25 |
| 3 | Seminar – Research work (Mid Term – After 2 Months of work) | 25 |
| 4 | Seminar – Research work (Preliminary Exam - After 4 Months of work) | 25 |
| 5 | Attendance | 15 |
| 6 | Discipline and involvement in the Project | 15 |
| | Total >> | 225 |

General Instructions

Students need to do Bioinformatics research work and submit the report in the prescribed format. Also, they need to present their work in the external examination.

BI.601 Bioinformatics Project (Practical)

Students need to do Bioinformatics research work and submit the report in the prescribed format. Also, they need to present their work in the external examination.