SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three Years - Six Semesters Bachelor's Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: BIOINFORMATICS
(Semesters I and II)

REVISED Syllabus
Effective from Academic Year 2024-25
(As per NEP 2020)

Contents

SantGadge Baba Amravati University, Amravati

FACULTY: Science and Technology

Teaching and Learning Scheme for the Three Year UG Degree of Bachelor of Bioinformatics

(Three Years- Six Semesters Bachelor's Degree Programme)

About Bioinformatics:

Bioinformatics emerges as an interdisciplinary realm dedicated to crafting methodologies and software tools essential for comprehending biological data. Functioning at the convergence of bioinformatics, statistics, and computer science, it employs computational techniques to dissect and elucidate intricate biological processes. While the overarching objective remains the augmentation of biological insight, what distinguishes bioinformatics is its emphasis on leveraging computationally intensive methods for this purpose. Noteworthy examples encompass pattern recognition, data mining, machine learning algorithms, and visualization. Research endeavors in this domain encompass diverse areas such as sequence alignment, gene identification, genome assembly, drug design, protein structure alignment, prediction of gene expression, protein-protein interactions, genome-wide association studies, and modeling of evolution and cell division/mitosis.

The evolution of bioinformatics extends beyond its initial focus on understanding biological processes; it now encompasses the development and enhancement of databases, algorithms, computational and statistical techniques, and theoretical frameworks tailored to address both formal and practical challenges arising from the management and analysis of biological data. The past few decades have witnessed rapid advancements in genomic and molecular research technologies, coupled with breakthroughs in information technologies, resulting in an overwhelming influx of information within the realm of molecular biology. Bioinformatics serves as the nomenclature for the amalgamation of mathematical and computing approaches dedicated to extracting insights from this wealth of biological data. Key activities within bioinformatics involve the mapping and analysis of DNA and protein sequences, alignment of such sequences for comparative purposes, and the generation and visualization of three-dimensional models depicting protein structures.

Program Objective:

1. The program is designed to proficiently utilize and comprehend biological databases, encompassing the gathering, storage, retrieval, management, analysis, and integration of biological data to foster the creation of novel knowledge.

2. The program strives to impart a comprehensive understanding of theoretical concepts in Life Sciences, ensuring an in-depth grasp of foundational principles.

3. Each semester is structured to include a core course in life sciences and computational biology, providing a balanced integration of both disciplines.

4. Practical methodology is fundamental to the program, with basic hands-on sessions incorporated into laboratory courses during every semester.

5. The curriculum emphasizes the development and application of computational logic, proficiency in programming languages, algorithms, and software tools, with a focus on innovative solutions for life science challenges.

6. A key objective is to enhance the comprehension of dynamic biological processes at the molecular level, facilitated through internet-enabled correlations and the application of Bioinformatics.

7. Introducing contemporary concepts of big data in the 'omics' era and fostering their analytical skills forms a pivotal aspect of the program, staying attuned to the evolving landscape of life sciences.

Program Educational Objectives (PEOs):

After 3 years of graduation, the graduate will:

PEO1	Adopt conceptual as well as applied knowledge and skills in the field of bioinformatics and data science for a sustainable approach to solve scientific problems.
PEO2	Express oral and Written skills to understand, learn and advance their careers through entrepreneurial orientation, research, and higher education.
PEO3	Understand the professional, ethical, and social responsibilities through lifelong learning skills with continuous improvement.

Program Outcomes (POs) :

After successful completion of the program, the graduate will be able to:

1. Science Knowledge (PO1): Apply bioinformatics knowledge to solve intricate biological problems across diverse domains, with a focus on healthcare while considering public health, safety, and addressing cultural, societal, and environmental concerns.

2. Problem Analysis (PO2): Identify, formulate, and analyze biological problems within the realms of life sciences, mathematics, and computer science. Develop solutions grounded in statistical interpretations.

3. Conduct Investigations (PO3): Utilize research-based skills and knowledge, encompassing the design of experiments, data analysis, interpretation, and information synthesis. Provide valid conclusions and execute research procedures effectively.

4. Modern Tool Usage (PO4): Employ bioinformatics tools, software, and algorithms judiciously, applying advanced techniques for product/process development that contribute to societal benefits.

5. Environment and Sustainability (PO5): Understand and implement environmentally friendly approaches within life science industries, contributing to sustainable development.

6. Ethics (PO6): Apply ethical principles, demonstrating commitment to professional ethics, responsibilities, and norms in the field of Life Sciences.

7. Individual and Teamwork (PO7): Function proficiently as an individual or within a team, effectively addressing biological problems and managing projects in multidisciplinary and interdisciplinary settings.

8. Communication (PO8): Communicate effectively within the scientific community and society at large. Demonstrate the ability to comprehend, write impactful reports, and deliver clear presentations with precise instructions.

9. Project Management and Finance (PO9): Demonstrate knowledge and understanding of life sciences and management principles. Apply these principles as a team member and leader, integrating them into one's own work.

10. Life-long Learning (PO10): Recognize the imperative for continuous learning. Possess the preparation and ability to engage in independent and life-long learning within the broader context of technological advancements and changes.

Program Specific Outcomes (PSOs) :

After successful completion of the programme, the graduates shall be able to

PSO-1: Develop a strong conceptual foundation in bioinformatics, computer science and mathematics using latest tools and software's, algorithms, and programming languages along with analytical and managerial skills to arrive at cost effective and optimum solutions.

PSO-2: Explain, design, and analyze domain specific fields for the use of databases and software packages for analysis and interpretation of biological data as required by researchers in Biotechnology and Life Science.

Bioinformatics professionals require a diverse set of employability skills to succeed in their roles, given the interdisciplinary nature of the field. These skills encompass technical proficiency, problem-solving abilities, effective communication, and a commitment to ethical standards. Here are key employability skills for bioinformatics professionals:

Employability Skills:

1. Technical Competence:
- Proficiency in programming languages (e.g., C programming, Perl, Python) and scripting for data analysis.
- Mastery of bioinformatics tools, databases, and software used for sequence analysis, structural biology, and data visualization.

2. Data Analysis and Interpretation:
- Ability to analyze complex biological data sets using statistical methods and computational techniques.
- Expertise in data interpretation, pattern recognition, and the application of machine learning algorithms.

3. Biological Knowledge:
- In-depth understanding of biological concepts, molecular biology, genetics, and related life sciences.
- Knowledge of key biological processes, pathways, and systems.

4. Problem-solving Skills:
- Capacity to identify and address biological problems through computational and analytical approaches.
- Critical thinking skills to develop innovative solutions for challenging biological questions.

5. Research Skills:
- Experience in designing and conducting experiments, as well as interpreting and validating experimental results.
- Ability to contribute to and lead research projects in bioinformatics.

6. Ethical Considerations:
- Adherence to ethical principles and guidelines in handling biological data, especially sensitive information.
- Commitment to maintaining the privacy and confidentiality of genetic and health-related data.

7. Communication Skills:
- Effective communication with colleagues, scientists, and stakeholders with varying levels of technical expertise.
- Clear and concise documentation of methods, results, and conclusions in reports and publications.

8. Collaboration and Teamwork:
- Ability to work collaboratively in multidisciplinary teams, integrating perspectives from biology, computer science, and other relevant fields.
- Strong interpersonal skills to facilitate effective teamwork.

9. Project Management:
- Planning and organizational skills to manage bioinformatics projects efficiently.
- Time management and prioritization of tasks to meet project deadlines.

10. Adaptability and Continuous Learning:

- Readiness to adapt to evolving technologies and methodologies in bioinformatics.
- Commitment to continuous learning and staying updated on advancements in the field.

11. Problem-solving Skills:

- Ability to troubleshoot technical issues and address challenges encountered during data analysis or software development.

12. Entrepreneurial Mindset:

- Business acumen and an entrepreneurial mindset for potential applications of bioinformatics in various industries, such as healthcare and biotechnology.

13. Global Awareness:

- Recognition of the global impact of bioinformatics, including awareness of international research trends and collaborations.

By possessing and continually developing these skills, bioinformatics professionals enhance their employability and contribute effectively to the dynamic and rapidly evolving field.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: BIOINFORMATICS

Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.) Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evolution & Assessment	Theory					Theory (Total)		Practical					Practical	
			External			Internal				External			Internal			
			Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks
A	Major	External & Internal	30	09	2	20	6	50	20	25	10	3	25	10	50	20
B	Minor		30	09	2	20	6	50	20	25	10	3	25	10	50	20
C	Generic/ Open Elective		30	09	2	20	6	50	20	-	-	-	-	-	-	-
D	VSC	Internal	-	-						-	-		50	20	50	20
	SEC	Internal	-	-						-	-		50	20	50	20

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks

(Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)

- **Total** **: 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

SantGadge Baba Amravati University, Amravati
FACULTY: Science and Technology
Teaching and Learning Scheme for the Three Year UG Degree of Bachelor of Bioinformatics
(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER-I

Mode Of Teaching	Vertical No	The Vertical	Type of course	Course Code	Course Name	Credit	Workload (Hrs\Week)	Vertical Workload (Hrs\Week)
Classroom Teaching/ Lab work (practical outdoor, field)	a.	Major/ Minor	Bioinformatics MJ Theory-1	104201	Introduction to Bioinformatics	2	2	6
			Bioinformatics Lab/Practical-1	104201	Practical on Theory -1	2	4	
	b.	Minor/ Major (Other subject in combination with Bioinformatics)	Theory-1	-	-	2	2	6
			Lab/Practical-2	-	-	2	4	
	c.	Generic/ Open Elective	Theory -1	104401	Cell and Molecular Biology	2	2	4
			Theory-2	104402	Operating System	2	2	
	d.	VSC	-	-	-	-	-	4
		SEC	Lab/Practical-3	104601	Computer Fundamentals and Operating system	2	4	
	e.	ACE- English	Theory	-	-	1	1	6
		ACE- MIL	Theory	-	-	1	1	
		IKS- Generic	Theory	-	-	2	2	
		VEC	Theory	-	-	2	2	
	f.	CC	Outdoor	-	-	2	4	4
		TOTAL				22	30	30

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	104201	**Introduction To Bioinformatics**	2	30	2 Hrs	30

Course Objectives:	Comprehensive understanding of the Bioinformatics field, encompassing its historical evolution, core components, and diverse applications and Ethical Issues.			
Course Outcomes:	At the end of the course, the student should be able to: CO-1: Introduce the concept of Bioinformatics CO-2: Comprehend the Historical Development of Bioinformatics CO-3: Explore the Scope of different areas of bioinformatics and Its Applications CO-4: Evaluate the Impact of Bioinformatics in Health Care and other areas CO-5: Identify and Address Ethical Issues in Bioinformatics CO-6: Investigate the Scope of Bioinformatics in Drug Design			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Bioinformatics**	8	8	Lectures, Power Point Presentation, Discussion, Demonstration, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
	1.1: History of bioinformatics			
	1.2: Importance of bioinformatics			
	1.3: Different Definitions of bioinformatics			
	1.4: Components of bioinformatics			
	1.5: Application of bioinformatics			
Unit II	**Different bioinformatics areas**	7	7	
	2.1: Genomics and its applications			
	2.2: Proteomics and its applications			
	2.3: Transcriptomics and Metabolomics			
	2.4: Phylogenetics			
	2.5: Drug Designing and Development			
Unit III	**Scope of bioinformatics**	8	8	
	3.1: Health Care and Disease diagnostics			
	3.2: Clinical and Medicinal Sciences			
	3.3: Agricultural Sciences			
	3.4: Biological Research			
	3.5: Genetic engineering and Synthetic Biology			
Unit IV	**Ethical and Legal Issues in Bioinformatics**	7	7	
	4.1: Ethical issues in Bioinformatics			
	4.2: Legal Issues in Bioinformatics			
	4.3: Privacy and Security concern in Bioinformatics			
	4.4: Ethical Consideration in Data sharing and analysis			
	4.5: Intellectual properties and legal issues			

<table>
<tr><td>References:</td><td>Lesk, M. (2008). "Introduction to Bioinformatics," 3rd Edition, Oxford University Press, ISBN-13: 978-0199208043.
Mount, D.W. (2004). "Bioinformatics: Sequence and Genome Analysis," 2nd Edition, Cold Spring Harbor Laboratory Press, ISBN-13: 978-0879697129.
Ghosh, Z., &Mallick, B. (2011). "Bioinformatics: Principles and Applications," CRC Press, ISBN-13: 978-1420069375.
Waterman, M.S. (1995). "Introduction to Computational Biology: Maps, Sequences, and Genomes," Chapman & Hall/CRC, ISBN-13: 978-0412042313.
Rashidi, H., & Buehler, L.K. (2019). "Bioinformatics Basics: Applications in Biological Science and Medicine," CRC Press, ISBN-13: 978-0367339493.
Pevzner, P. (Year). "Bioinformatics for Biologists," O'Reilly & Associates.</td></tr>
<tr><td rowspan="3">Model Questions:</td><td>Short Type :
1. Write a short note on Introduction to Bioinformatics.
2. What is application and scope in Bioinformatics.
3. Write a note on Biological research.
4. Which tools are used in protein structure prediction and analysis.
5. Write a short note on Genomics.
6. Describe scope of bioinformatics in Drug Designing and Development.
7. Explain Ethical and legal issues in Bioinformatics.
8. What is meant by the Ethical Consideration in Data Sharing and analysis.</td></tr>
<tr><td>Long Type:
1. Describe in detail about the term bioinformatics and its scope.
2. How has the historical development of bioinformatics influenced its current state and applications in modern biological research?.
3. Explain the significance of genomics in bioinformatics and provide examples of practical applications in various scientific domains.
4. Write a note on privacy and security concerns in Bioinformatics.</td></tr>
<tr><td>MCQs for Internal Assessment
1. When did the term "bioinformatics" first emerge as a recognized field of study?
A. 1950s B. 1970s C. 1990s D. 2000s
2. What is the primary significance of bioinformatics in the field of biological research?
- A. Creating graphical representations of biological data
- B. Analyzing and interpreting biological data
- C. Designing experimental protocols
- D. Conducting laboratory experiments
3. Which of the following techniques is commonly used in genomics to determine the sequence of DNA bases?
A. PCR (Polymerase Chain Reaction) B. Mass spectrometry
C. Sanger sequencing D. Western blotting
4. Phylogenetics is primarily concerned with the study of:
A. Protein structures B. Evolutionary relationships among species
C. Metabolic pathways D. Gene expression patterns
5. In bioinformatics, how is it applied to health care and disease diagnostics?
A. Analyzing agricultural data B. Studying ancient civilizations
C. Personalized medicine and diagnostics D. Understanding geological formations
6. What role does bioinformatics play in biological research?
- A. Designing laboratory equipment
- B. Analyzing data and aiding experimental design
- C. Conducting fieldwork in natural environments
- D. Developing new chemical compounds
7. What ethical considerations are relevant in bioinformatics research?
A. Maintaining data security B. Proper attribution of sources
C. Responsible data handling and analysis D. All of the above</td></tr>
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Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	104201	**Lab/Practical-1:Introduction To Bioinformatics**	2	60	4Hrs	25

The Curriculum of Lab / Practical Course shall be designed as per following template:

Course Objectives:	Practical and Hands-on experience in bioinformatics analysis.	
Course Outcomes:	At the end of completion of this course, CO-1: Understand the process of DNA sequence retrieval from biological databases. CO-2: Explore protein databases and retrieve protein information. CO-3: Participate in seminars focusing on bioinformatics topics. CO-4: Collaborate on a group project related to human diseases information. CO-5: Develop a portfolio featuring bioinformatics companies and their information. CO-6: Explore virtual labs for training in wet lab techniques.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Unit I	Detailed pointwise contents / Practical / Activity / Assignments / DNA sequence retrieval from biological databases Searching protein information and retrieving sequences from Protein databases FASTA and Genbank file format Pairwise Sequence alignment	PowerPoint Presentation, Discussion, Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Experiential Learning,
Unit II	Hand-on Experience / Experiential Learning / Field Studies / Protein structure visualization in different view Multiple sequence alignment Chemical structure sketching using online tools Genbank to FASTA file format conversion	
Unit III	Case Studies / Workshops / Seminars / Group Projects/ Simulation Exercises Seminars on Bioinformatics Group Project on Human diseases information collection Seminar on Biosafty and Bioethics Workshops on virtual PCR	
Unit IV	Portfolio Development / Capstone Projects / Entrepreneurship Exploration / Virtual Reality (VR) Training Listing out Bioinformatics companies and their information Training of wet lab techniques using virtual labs	
References:	**Reference Books:** 1. Bioinformatics: Sequence and Genome Analysis by David W. Mount 2. Introduction to Bioinformatics by Arthur M. Lesk 3. Bioinformatics For Dummies by Jean-Michel Claverie and Cedric Notredame 4. Principles of Bioinformatics by Andreas D. Baxevanis and B. F. Francis Ouellette 5. Bioinformatics Algorithms: An Active Learning Approach by Phillip Compeau and PavelPevzner **Textbooks:** 1. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean Eddy, Anders Krogh, and Graeme Mitchison 2. Introduction to Computational Biology: Maps, Sequences and Genomes by Michael S. Waterman	

	3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette 4. Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R by RöbbeWünschiers 5. Understanding Bioinformatics by MarketaZvelebil and Jeremy O. Baum Research Articles: 1. The Sequence Alignment/Map format and SAMtools by Heng Li et al. (Research Article, Bioinformatics Journal) 2. BLAST: A More Efficient Report with Usability Improvements by Christopher H. Wright et al. (Research Article, BMC Bioinformatics Journal) 3. CLUSTAL W and CLUSTAL X version 2.0 by Julie D. Thompson et al. (Research Article, Bioinformatics Journal) 4. MUSCLE: Multiple Sequence Alignment with High Accuracy and High Throughput by Robert C. Edgar (Research Article, Nucleic Acids Research Journal) 5. SWISS-MODEL: An automated protein homology-modeling server by TorstenSchwede et al. (Research Article, Nucleic Acids Research Journal)
	Digital Resources: 1. [NCBI (National Center for Biotechnology Information)](https://www.ncbi.nlm.nih.gov/) 2. [ExPASy (Expert Protein Analysis System)](https://www.expasy.org/) 3. [UniProt](https://www.uniprot.org/) 4. [EMBL-EBI (European Bioinformatics Institute)](https://www.ebi.ac.uk/) 5. [Bioinformatics.org](http://www.bioinformatics.org/) **Educational Software:** 1. CLC Genomics Workbench 2. Geneious Prime 3. BioEdit 4. MEGA (Molecular Evolutionary Genetics Analysis) 5. Jalview Databases: 1. GenBank 2. Protein Data Bank (PDB) 3. Ensembl 4. Kyoto Encyclopedia of Genes and Genomes (KEGG) 5. The Cancer Genome Atlas (TCGA)
Model Questions:	**Question Paper for External Practical Examination:** Course Title: Introduction To Bioinformatics And Computer Fundamentals Instructions: - Answer all questions. - Write your answers in the provided answer booklet. - Ensure clarity and neatness in your responses. - Use appropriate bioinformatics tools and databases wherever required. - Marks distribution is indicated for each question. Section A: Sequence Analysis 1. a) Perform a BLAST search for a given DNA sequence . - Identify the top BLAST hit and its significance. - Explain the parameters used for the BLAST search. 2. b) Align two protein sequences using ClustalW or Clustal Omega . - Interpret the alignment results. - Highlight conserved regions and sequence similarities.

	Section B: Database Retrieval and Analysis 3. a) Retrieve a protein sequence from the UniProt database . - Provide the accession number or protein name used for retrieval. - Describe the functional annotations associated with the protein. 4. b) Search for a specific gene in the GenBank database . - Identify the gene entry and its features. - Discuss any relevant information obtained from the database. **Internal Assessment:** **Instructions:** - This assessment contributes to the internal evaluation component of the course. - Answer all questions concisely and comprehensively. - Marks are allocated based on accuracy, depth of understanding, and presentation. Section A: Practical Skills 1. Perform a hands-on exercise demonstrating your proficiency with a bioinformatics tool or software. - Provide a brief description of the chosen tool or software. - Explain the steps involved in the exercise. - Discuss any challenges encountered and how they were addressed. 2. Describe your experience working with databases and retrieving biological information . - Specify the databases you have utilized. - Reflect on the relevance and significance of the retrieved information. Section B: Conceptual Understanding 3. Discuss the role of bioinformatics in modern biological research . - Highlight key applications and contributions of bioinformatics. - Analyze the challenges and future directions in the field. 4. Explain the significance of sequence alignment in bioinformatics. - Define sequence alignment and its objectives. - Describe different types of sequence alignment methods and their applications. 5. Evaluate the impact of bioinformatics in addressing global health challenges . - Provide examples of bioinformatics approaches used in health-related research. - Discuss the potential benefits and limitations of applying bioinformatics in healthcare.

Question Paper template for External Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-1	Course Code: 104201	**Based on Introduction To Bioinformatics**	**Max Marks: 25**
Question No.	**Exercise**		**Marks**
1	Exercise based on Unit I		**5**
2	Exercise based on Unit II		**5**
3	Exercise based on Unit III		**5**
4	Exercise based on Unit IV		**5**
5	Viva Voce		**5**

Question Paper template for Internal Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-1	Course Code: 104201	**Introduction To Bioinformatics**	**Max Marks: 25**

S. No.	**Assessment Criteria**	**Marks**
1	Record/ Assignments	**5**
2	Attendance	**5**
3	Participation in Activity/ Field visit	**5**
4	Viva Voce	**5**
5	Students overall performance	**5**

Generic/ Open Elective Paper-1

Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
4.5	I	104401	**Cell and Molecular Biology**	2	30	2 Hrs	30

Course Objectives:	Development and comprehensive understanding of the architecture of living cells, the concepts of biomolecules (DNA and RNA) and their processing.			
Course Outcomes:	At the end of completion of this course, CO-1: Students should be able to understand the architecture of the living cells. CO-2: Students should be able to identify the concepts of biomolecules viz DNA and RNA, its maintenance and processing inside a cell. CO-3: Students should gain in Depth knowledge about the different mechanisms involved in replication of DNA in prokaryotes and eukaryotes. CO-4: Students should understand the process of transcription of DNA to RNA in prokaryotes and eukaryotes and translation of protein from RNA in prokaryotes and eukaryotes. CO-5: Students should be able to analyze and conceptualize the fundamental principles behind the expression of genes.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**CELL BIOLOGY** 1.1 Architecture of prokaryotic and eukaryotic cells, Structure of animal and plant cell 1.2 Cell wall and plasma membrane, cell organelles 1.3 Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes, Endoplasmic Reticulum.	7	7	Black board teaching, powerpoint teaching, self study, Lectures, Discussion, Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL),
Unit II	**GENETIC MATERIAL AND ITS PACKAGING:** 1.1 Nucleic acid as genetic material, Genome organization in	8	8	

	prokaryotes and eukaryotes			Peer Teaching, Experiential Learning, Direct Instruction
	1.2 Chromatin structure and function. Heterochromatin, euchromatin.			
	1.3 Histones and non-histone proteins, general properties of histone.			
	1.4 Nucleosomes, solenoid structure, packaging of DNA, satellite DNA			
Unit III	**REPLICATION:**	7	7	
	2.1 DNA replication: mechanism, the replicons, origin, primosome&replisomes.			
	2.2 Properties of prokaryotic and eukaryotic DNA polymerases.			
	2.3 Synthesis of leading and lagging strands.			
	2.4 Difference between prokaryotic and eukaryotic replication.			
Unit IV	**TRANSCRIPTION AND TRANSLATION:**	8	8	
	4.1 Prokaryotic transcription; promoters, properties of bacterial RNA polymerase			
	4.2 Steps: initiation, elongation and termination			
	4.3 RNA processing and RNA editing. Inhibitors of transcription.			
	4.4 Ribosomes structure and function, genetic code, aminoacyltRNA synthases.			
	4.5 Formation of translation initiation complex, chain elongation, translocation & termination			
References:	Books "Essential Cell Biology" by Alberts et al. (4th Edition, 2013) Molecular Biology of the Gene, James D. Watson, Pearson/Benjamin Cummings, 2008 Molecular Biology, Robert Weaver, McGraw-Hill Education, (5th edition) Molecular Biology of the Cell. Alberts et al. Garland Science, (6th edition) Molecular Cell Biology, Harvey Lodish, W. H. Freeman, (8th edition)			
Model Questions:	Short Type : 1. What is the genetic material in cells? 2. Name two types of chromatin and their functions. 3. What is the primary function of histones?			
	4. Define nucleosomes and their role in DNA packaging. 5. What is the significance of replicons in DNA replication? 6. Name one property that distinguishes prokaryotic DNA polymerases from eukaryotic DNA polymerases. 7. What are the key steps in prokaryotic transcription? 8. Name one type of RNA polymerase involved in eukaryotic transcription.			

	Long Type: 1. What is the genetic material, and how is it organized in prokaryotes and eukaryotes? 2. Explain the structure and function of chromatin, highlighting the distinctions between heterochromatin and euchromatin. 3. What are the general properties of histones, and how do they contribute to nucleosome formation? 4. Describe the solenoid structure and packaging of DNA, including the role of satellite DNA.
	MCQs for Internal Assessment 1. What is the genetic material in most living organisms? a. Proteinsb. Carbohydrates c. Nucleic acidd. Lipids 2. In DNA replication, what is a replicon? a. A section of RNAb. A unit of DNA replication c. A type of RNA polymerased. A protein involved in transcription 3. Which enzyme is responsible for adding nucleotides during DNA replication? a. DNA ligase b. RNA polymerase c. DNA polymerase d. Helicase 4. What is the primary function of RNA polymerase in transcription? a. Synthesizing RNA from DNA template b. Synthesizing DNA from RNA template c. Repairing DNA strands d. Breaking down RNA molecules 5. Which of the following is involved in translation? a. DNA polymerase b. RNA polymerase c. Ribosomesd. Helicase 6. What is the purpose of post-translational modifications in proteins? a. DNA repairb. Enhancing transcription c. Affecting protein function and stabilityd. Initiating translation 7. Which organelle is responsible for translation in eukaryotic cells? a. Nucleusb. Mitochondria c. Endoplasmic reticulumd. Golgi apparatus 8. What is the function of an operon in gene regulation? a. DNA replicationb. Transcription initiation c. Translation termination d. Post-translational modifications

Generic/ Open Elective Paper-2

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	104402	**Operating System**	2	30	2 Hrs	30

The Curriculum of any Course shall be designed as per following template:

Course Objectives	Development of solid foundation in operating system essentials, enabling them to comprehend the inner workings of various operating systems.
Course Outcomes:	After completion of the course, the students should be able to: CO-1: Understand the working of operating system CO-2: Understand the components of operating system CO-3: Understand the types of operating system CO-4: Understand the objective of operating system

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Windows:**	8	8	Lectures, Power Point Presentation, Discussion, Demonstration, Inquiry-Based Learning, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
	1.1: Introduction, features,			
	1.2: Desktop: Background screensaver, Customizing desktop, creating, moving, deleting Icons.			
	1.3: Windows Explorer Copying, renaming, moving, deleting, operations on files and folders.			
	1.4: My computer, My documents			
	1.5: Control panel: Mouse, printer, date and time.			
Unit II	**Unix operating system:**	7	7	
	2.1: Overview of unix O.S			
	2.2: Unix file system			
	2.3: Data structure for process and memory management			
	2.4: Process states and state Transition diagram			
	2.5: Process scheduling and memory management			
	2.6: Executing and Terminating program in unix			
	2.7: Unix commands: pwd, cd, ls, mv, ln, cp, mkdir, rm, rmdir, du			
Unit III	**Linux operating system:**	8	8	
	3.1: Design principal, kernel modules			
	3.2: Process management			
	3.3: Scheduling, memory management			
	3.4: File system			
	3.5: Inter Process communication and security			
Unit IV	**Network operating system (Networking):**	7	7	
	4.1: Needs and objectives			
	4.2: LAN-Introduction			
	4.3: Classification, topology			
	4.4: Topologies – Bus, Tree, Ring, Star, Hybrid, WAN, MAN			
	4.5: Communication Protocols – Purpose, OSI model, Client Server Architecture			
References :	Computer fundamentals: B. Ram, Nas Age publication. A first course in computer: Sanjay saxena PC Software: Taxali R.K. Fundamentals of computer: V.Rajaraman, PHI Publication. Information Technology: Alexie and Mathews, Vijay Nikole Publication. IT Tool and Application: Alexie and Mathews, Vijay Niklole publication. Operating system by: Achyut S. Godbole Tata McGraw Hill publication. Operating system concept, sixth edition by Silberschutz, Galvin, Gagne Wiley publication. 157 158 Computer Fundamentals, Pradeep K. Sinha. BPB Publication.			

Model Questions:	Short Type: 1. Define Windows operating system 2. Define input and output device 3. Give notes on Unix file system 4. Types of Unix commands 5. What is Linux 6. Give application of Linux 7. Define LAN and its application 8. Define communication protocol
	Long Type : 1. Describe Control panels in computer 2. Explain data structure and memory management 3. Describe topology in Computer 4. Describe inter process communication and security
	MCQs for Internal Assessment: 1. Operating system works on which interface a) AIS b) GUI c) SCI d) None of the above 2. Input device is a) Mouse b) Printer c) Monitor d) Speaker 3. LAN stand for a) Local Area Network b) Local added Network c) Local Additional Network d) Local applicable Network 4. Topology include a) BUS b) Train c) Ringer d) Hybrid 5. Unix operating system is a) Multitasking b) Multimedia c) Multiuser d) Multifunctional 6. LINUX operating system is based on a) Open source of Operating system b) Open service operating system c) Open Server operating system d) Open Server optional system 7. MAN stand for a) Metropolitan area network b) Main Area Network c) Multimedia area network d) Moderate area network 8.Types of Network a) LAN b) WAN c) MAN d) all of the above

Bioinformatics SEC Practical

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	104601	**Computer Fundamentals and Operating system**	2	60	4Hrs	25

The Curriculum of Lab / Practical Course shall be designed as per following template:

Course Objectives:	Practical experience of basic computing skills	
Course Outcomes:	After completion of the course, the students should have: CO-1: Document Creation Proficiency CO-2: Multimedia Integration Skills CO-3: Microsoft Excel Competence CO-4: Data Tabulation and Graphical Representation	
Unit System	**Contents**	**Incorporation of Pedagogies**
Unit I	1. Creating word file in MS Word 2. Practical on Insert clip arts, smart arts and charts	PowerPoint Presentation, Discussion,

Unit II	3. Practical on MS Excel spreadsheet 4. Practical based on Tabulation and graphical representation	Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Experiential Learning
Unit III	5. Formatting of worksheet in MS word 6. Creating Graphs using formula	
Unit IV	7. Net surfing by using data 8. Downloading information from www 9. Practical on searching websites and data analysis	
References:	1. "Microsoft Word 2019 Step by Step" by Joan Lambert and Curtis Frye 2. "Word 2019 For Dummies" by Dan Gookin 3. "Microsoft Excel 2019 Step by Step" by Curtis Frye 4. "Excel 2019 Bible" by Michael Alexander and Richard Kusleika	

Question Paper template for External Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-3	Course Code: 104601	**Computer Fundamentals and Operating system**	**Max Marks: 25**
Question No.	**Exercise**		**Marks**
1	Exercise based on Unit I		**5**
2	Exercise based on Unit II		**5**
3	Exercise based on Unit III		**5**
4	Exercise based on Unit IV		**5**
5	**Viva Voce**		**5**

Question Paper template for Internal Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-3	Course Code: 104601	**Computer Fundamentals and Operating system**	**Max Marks: 25**
S. No.	**Assessment Criteria**		**Marks**
1	Record/ Assignments		**5**
2	Attendance		**5**
3	Participation in Activity/ Field visit		**5**
4	Viva Voce		**5**
5	Students overall performance		**5**

SantGadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme for the Three Year UG Degree of Bachelor of Bioinformatics
(Three Years- Six Semesters Bachelor's Degree Programme)
FIRST YEAR: SEMESTER-II

Mode Of Teaching	Vertical No	The Vertical	Type of course	Course Code	Course Name	Credit	Work load (Hrs\ Week)	Vertical Workload (Hrs\Week)
Classroom Teaching/ Lab work (practical outdoor, field)	a.	Major/ Minor	Theory-2	104202	Techniques in Bioinformatics	2	2	6
			Lab/ Practical-4	104202	Practical on Theory-2	2	4	
	b.	Minor/ Major (Other subject in combination with Bioinformatics)	Theory-2	104302	-	2	2	6
			Lab/ Practical-5	104302	-	2	4	
	c.	Generic/ Open Elective	Theory -3	104403	Basics of C Programming	2	2	4
			Theory-4	104404	Biological database management system	2	2	
	d.	VSC	Lab/ Practical-6	104501	Wetlab Techniques-I	2	4	8
		SEC	Lab/ Practical-7	104602	Bioprogramming-I	2	4	
	e.	ACE-English	Theory			1	1	4
		ACE-MIL	Theory			1	1	
		VEC	Theory			2	2	
	f.	CC	Outdoor			2	4	4
		TOTAL				22	32	32

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	104202	**Techniques In Bioinformatics**	2	30	2 Hrs	30

Course Objectives:	Introduction to biological databases and tools of different bioinformatics areas			
Course Outcomes:	After completion of the course, the students should: CO-1: Know bioinformatics basics, database navigation, and sequence analysis techniques, enabling them to proficiently use tools like BLAST and FASTA. CO-2: Get skills in protein structure prediction, understand PDB applications, and use tools like PyMOL and Chimera for molecular visualization and docking studies. CO-3: Acquire knowledge of NGS technologies, develop bioinformatics workflows, interpret genomic variations, and perform metagenomics and microbiome analysis. CO-4: Understand the importance of comparative genomics, master phylogenetic analysis, use tools like OrthoMCL and Ensembl for comparative genomics, and analyze evolutionary conservation and divergence.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Bioinformatics and Computational Tools**	8	8	Lectures, Power Point Presentation, Discussion, Demonstration, Inquiry-Based Learning, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
	1.1 Overview of Bioinformatics and its applications in life sciences.			
	1.2 Introduction to databases: NCBI, EMBL, DDBJ, UniProt, and other relevant bioinformatics databases.			
	1.3 Bioinformatics tools for sequence analysis: Local alignment, Global alignment.			
	1.4 BLAST, FASTA, and multiple sequence alignment.			
Unit II	**Structural Bioinformatics**	7	7	
	2.1 Protein structure prediction methods.			
	2.2 Structural databases: PDB (Protein Data Bank) and their applications.			
	2.3 Molecular visualization tools: PyMOL and Cn3D.			
	2.4 Docking studies and drug design using bioinformatics tools.			
Unit III	**Next-Generation Sequencing (NGS) and Bioinformatics Applications**	8	8	
	3.1 Overview of NGS technologies: Illumina, Ion Torrent, and PacBio.			
	3.2 Bioinformatics workflows for NGS data analysis.			
	3.3 Variant calling and interpretation of genomic variations.			
	3.3 Metagenomics and microbiome analysis using bioinformatics tools.			
Unit IV	**Comparative Genomics and Evolutionary Bioinformatics**	7	7	
	4.1 Comparative genomics and its significance in understanding evolutionary relationships.			

	4.2 Phylogenetic analysis and tree construction methods. 4.3 Tools for comparative genomic studies: OrthoMCL, Ensembl, and others. 4.4 Evolutionary conservation and divergence analysis using bioinformatics approaches.			
References:	1. Bioinformatics: Sequence and Genome Analysis" by David W. Mount (2004) 2. Bioinformatics For Dummies by Jean-Michel Claverie and Cedric Notredame (2006) 3. Bioinformatics: Converting Data to Knowledge" by Hui Lu and Jack Yang (2019) 4. Introduction to Bioinformatics" by Arthur M. Lesk (2013) 5. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids" by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison (1998) 6. Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and PavelPevzner (2015) 7. Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R" by RöbbeWünschiers (2018) 8. Practical Bioinformatics" by Michael Agostino (2012)			
Model Questions	**MCQs for Internal Assessment** 1. What is the main purpose of the GenBank database in bioinformatics? a. Structural prediction b. Sequence analysis c. Molecular visualization d. Evolutionary studies 2. Which bioinformatics tool is commonly used for local and global sequence alignment? a. BLAST b. FASTA c. PyMOL d. Chimera 3. What does PDB stand for in the context of structural bioinformatics? a. Protein Data Bank b. Predictive Database for Bioinformatics c. Protein Docking and Binding d. PyMOL Data Browser 4. Which tool is specifically used for predicting protein structures in structural bioinformatics? a. BLAST b. Chimera c. Docking d. Homology modeling 5. What is the primary goal of variant calling in NGS data analysis? a. Identifying genomic variations b. Studying gene expression c. Structural prediction d. Docking studies 6. Which of the following is a tool commonly used for metagenomics and microbiome analysis? a. BLAST b. OrthoMCL c. PyMOL d. QIIME 7. What is the main objective of phylogenetic analysis? a. Protein structure prediction b. Studying evolutionary relationships c. Variant calling d. Gene expression analysis 8. Which tool is used for comparative genomic studies and ortholog identification? a. BLAST b. Ensembl c. PyMOL d. FASTA			
	Short Type : 3 Marks 1. Name two bioinformatics databases and briefly explain their relevance. 2. Define local alignment and global alignment in the context of sequence analysis. 3. Mention two bioinformatics tools used for sequence analysis. 4. Briefly describe the applications of BLAST and FASTA in bioinformatics. 5. Protein structure prediction methods? 6. Name one NGS technology and explain its significance in genomics research. 7. What is the main objective of phylogenetic analysis? 8. What is the purpose of the GenBank database in bioinformatics?			
	Long Type : 6 Marks 1. Explain the significance of bioinformatics in life sciences and provide two examples of its applications. 2. Compare and contrast local alignment and global alignment in sequence analysis. 3. Discuss the applications of the Protein Data Bank (PDB) in understanding protein			

	structures. 4. Elaborate on the differences between PyMOL and Chimera as molecular visualization tools. 5. Provide an in-depth explanation of the bioinformatics workflows involved in NGS data analysis. 6. Discuss the challenges and importance of variant calling in the context of genomic variations.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	104202	**Practical on Techniques In Bioinformatics**	2	60	3Hrs	25

Course Objectives:	Practical experience of bioinformatics tools and statistics	
Course Outcomes:	CO-1: Students will develop a foundational understanding of bioinformatics tools and their relevance in biological research, enabling them to effectively utilize tools like RasMol for molecular visualization and perform statistical analysis on biological data. CO-2: Students will gain practical experience and proficiency in using essential bioinformatics tools such as BLAST and NGS data analysis techniques. CO-3: Through participation in workshops, seminars, and collaborative group projects, students will enhance their problem-solving skills and gain insights into real-world applications of bioinformatics tools, enabling them to address complex biological questions and challenges.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Unit I	Detailed pointwise contents / Practical / Activity / Assignments / 1. Introduction to Bioinformatics Tools 2. Practical on RasMol 3. Protein Structure analysis	Power Point Presentation, Discussion, Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
Unit II	Hand-on Experience / Experiential Learning / Field Studies / Hand-on training on BLAST tool 1. NGS data retrieval and quality assessment 2.. Computation of correlation coefficient for biological data	
Unit III	Case Studies / Workshops / Seminars / Group Projects/ Simulation Exercises 1. Workshop on “PrimerBLAST tool and utilization” 2. Seminars based on NGS technologies and statistics	
Unit IV	Entrepreneurship Exploration / Virtual Reality (VR) Training 1. mportance of entrepreneurship; Identifying opportunities in bioinformatics 2. Building a Professional Portfolio: curriculum vitae (CV) and different formats 3. Real-time data collection project: Ex- Environmental Monitoring, Health Monitoring, etc	
References:	1 "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri 2."Bioinformatics: Sequence and Genome Analysis" by David W. Mount Digital Resources: - [NCBI](https://www.ncbi.nlm.nih.gov/): National Center for Biotechnology Information provides access to various bioinformatics tools, databases, and resources.	

Question Paper template for External Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – II (NEP)			
Lab/Practical-4	Course Code: 104202	Techniques In Bioinformatics-I	Max Marks: 25

Question No.	Exercise	Marks
1	Exercise based on Unit I	5
2	Exercise based on Unit II	5
3	Exercise based on Unit III	5
4	Exercise based on Unit IV	5
5	Viva Voce	5

Question Paper template for Internal Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – II (NEP)			
Lab/Practical-4	**Course Code: 104202**	**Techniques In Bioinformatics-I**	**Max Marks: 25**

S. No.	Assessment Criteria	Marks
1	Record/ Assignments	5
2	Attendance	5
3	Participation in Activity/ Field visit	5
4	Viva Voce	5
5	Students overall performance	5

Generic/ Open Elective Paper-3

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	104403	**Basics of C programming**	2	30	2 Hrs	30

Course Objectives:	Learning basics of Programing			
Course Outcomes:	CO-1: Students will develop a foundational understanding of C programming, including creating basic program structures, utilizing input and output functions, and working with operators and expressions. CO-2: Learners will master control flow mechanisms in C, implementing conditional statements and looping constructs to control program execution based on conditions. CO-3: Participants will acquire the ability to organize code into modular functions, understanding function arguments, return values, scope, and lifetime of variables, and adopting modular programming principles. CO-4: Students will demonstrate proficiency in working with arrays, strings, and pointers in C, effectively managing data collections and memory for dynamic programming needs.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to C Programming:**			
	1.1 Overview of programming languages and the role of C.	7	7	Power Point Presentation, Discussion, Demonstration,
	1.2 Basic structure of a C program: Comments, variables, and data types.			

	1.3 Input and output functions: printf() and scanf().			Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
	1.4 Operators and expressions: Arithmetic, relational, and logical operators.			
Unit II	**Control Flow and Decision Making:**			
	2.1 Conditional statements: if, else if, and switch.	8	8	
	2.2 Looping constructs: while, do-while, and for loops.			
	2.3 Break and continue statements for loop control.			
	2.4 Writing and implementing simple programs using control flow statements.			
Unit III	**Functions and Modular Programming:**			
	3.1 Basics of functions: Declaration, definition, and calling.	7	7	
	3.2 Function arguments and return values.			
	3.3 Scope and lifetime of variables.			
	3.4 Modular programming: Header files and function prototypes.			
Unit IV	**Arrays, Strings, and Pointers:**			
	4.1 Introduction to arrays: Declaration, initialization, and accessing elements.	8	8	
	4.2 Working with strings: String functions and manipulation.			
	4.3 Introduction to pointers: Declaration, initialization, and dereferencing.			
	4.4 Dynamic memory allocation: malloc(), free(), and realloc().			
References:	1. C Programming Absolute Beginner's Guide by Perry and Miller (2013) 2. C Programming for the Absolute Beginner, Second Edition by Vine (2007) 3. C Programming Absolute Beginner's Guide (3rd Edition) by Perry and Miller (2014) 4. Programming in C (4th Edition)" by Kochan (2014)			
Model Questions	**MCQs for Internal Assessment** 1. What is the primary purpose of comments in a C program? a. Enhance program readability b. Execute specific code c. Declare variables d. Perform arithmetic operations 2. Which data type is used to store decimal numbers in C? a. int b. float c. char d. double 3. The function used for formatted output in C is: a. scan() b. format() c. print() d. printf() 4. In C programming, the relational operator "!=" signifies: a. Greater than b. Less than c. Not equal to d. Equal to 5. What is the purpose of the "switch" statement in C? a. Iteration b. Decision making c. Loop control d. Function definition 6. Which looping construct is suitable for situations where the loop body must execute at least once? a. for loop b. while loop c. do-while loop d. switch statement			
	Short Type : 1. What is the primary role of comments in a C program? 2. Name one data type used in C for storing whole numbers. 3. What function is used for formatted output in C? 4. What is the purpose of the "switch" statement in C?			

	Long Type : 1. Explain the significance of data types in C programming. Provide examples of at least three different data types and describe when each might be used. 2. Describe the basic structure of a C program. Include the necessary components such as comments, variables, and data types. Provide an example to illustrate the structure. 3. Discuss the role of input and output functions in C. Provide examples of using printf() and scanf() to demonstrate how these functions are used for communication between the program and the user. 4. Compare and contrast arithmetic, relational, and logical operators in C. Provide examples of how each type of operator is used in programming.

Generic/ Open Elective Paper-4

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	104404	**Biological Database Management Systems**	2	30	2 Hrs	30

Course Objectives:	Introduction to Biological Database Management System and getting skills of database building			
Course Outcomes:	CO-1: Students will gain a foundational understanding of the significance of biological databases, identify various types, and assess the applications of different BDMS tools. CO-2: Upon completion of this unit, students will be proficient in applying Entity-Relationship modeling and normalization techniques to design efficient biological databases. CO-3: By the end of this unit, students will master SQL for querying biological databases and employ advanced techniques for retrieving complex biological data. CO-4: Students will develop the ability to devise integration strategies for heterogeneous biological databases, leveraging ontologies and Semantic Web technologies for enhanced interoperability.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Biological Database Management Systems**	8	8	Board teaching, Power Point Presentation, Discussion, Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Peer Teaching, Experiential Learning, Direct Instruction.
	1.1 Overview of Biological Databases and their significance in life sciences.			
	1.2 Types of Biological Databases: Genomic, Proteomic, Metabolic, and Pathway databases.			
	1.3 Introduction to Database Management Systems (DBMS) in the context of biology.			
	1.4 Comparison of different BDMS tools and their applications.			
Unit II	**Data Modeling and Design in BDMS**	7	7	
	2.1 Basics of data modeling for biological databases.			
	2.2 Entity-Relationship (ER) modeling and its application in BDMS.			
	2.3 Normalization and de-normalization processes in biological databases.			
	2.4 Design principles for efficient storage and retrieval of biological data.			
Unit III	**Querying and Retrieval in BDMS**	8	8	
	3.1 SQL and its application in querying			

	biological databases.			
	3.2 Advanced querying techniques for complex biological data.			
	3.3 Full-text searching and indexing strategies in BDMS.			
	3.4 Data retrieval challenges and optimization in biological databases.			
Unit IV	**Integration and Interoperability in BDMS**	7	7	
	4.1 Strategies for integrating heterogeneous biological databases.			
	4.2 Ontologies and Semantic Web technologies in BDMS.			
	4.3 Interoperability standards and data exchange formats.			
	4.4 Case studies on successful integration of different biological databases.			
References	1. Database System Concepts" by Silberschatz, Korth, and Sudarshan (2019, 7th Edition). 2. Fundamentals of Database Systems" by Elmasri and Navathe (2019, 7th Edition). 3. Database Management Systems" by Ramakrishnan and Gehrke (2002, 3rd Edition). 4. SQL Performance Explained" by Markus Winand (2012, 2nd Edition). 5. Biological Database Modeling" Jake Chen, Amandeep S. Sidhu 2011			
Model Question	**MCQs for Internal Assessment** 1. What does the acronym "SQL" stand for in the context of databases? a. Structured Query Language b. Simple Query Language c. Systematic Question Language d. Sequential Query Logic 2. In a relational database, what is a primary key? a. A key used for decryptionb. A unique identifier for a record in a table c. A foreign key in another tabled. A key for sorting records 3. Which of the following is a non-relational database model? a. MySQLb. MongoDBc. Oracled. PostgreSQL 4. What is the purpose of the GROUP BY clause in SQL? a. To filter records based on a condition b. To sort records in descending order c. To group rows based on common values in a column d. To join multiple tables			
	Short Type : 1. Define "ACID" properties in the context of database transactions. 2. What is the purpose of the SELECT statement in SQL? 3. Explain the difference between primary key and foreign key constraints. 4. Define normalization in the context of relational database design.			
	Long Type : 1. Discuss the importance of normalization in relational database design and provide an example of a situation where normalization would be beneficial. 2. Compare and contrast the advantages and disadvantages of using a relational database management system (RDBMS) versus a NoSQL database in specific application scenarios. 3. Explain the concept of a database transaction and discuss the role of the COMMIT and ROLLBACK statements in ensuring data consistency.			

Bioinformatics VSC Practical

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	104501	**Wet-Lab Techniques-I**	2	60	4Hrs	25

Course Objectives:	Introduction of different wet-lab techniques	
Course Outcomes:	After completion of the course: CO-1: Students should demonstrate proficiency in handling microscopes, adjusting magnification, and focusing. CO-2: Students should be able to identify and distinguish cyanobacteria and fungi under the microscope based on their morphological characteristics. CO-3: Gain a deeper understanding of microscopic techniques, including proper slide preparation and observation methods. CO-4: Students should interpret microscopic observations effectively, recognizing cellular structures and features that differentiate various microorganisms. CO-5: The microscopic skills acquired should be applied in the context of Gram staining, enabling students to identify and differentiate between Gram-positive and Gram-negative bacteria.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Unit I	1. Demonstration of Microscope 2. Introduction to basic Lab Instruments	PowerPoint Presentation, Discussion, Demonstration, Interactive Multimedia, Collaborative Learning, Problem-Based Learning (PBL), Experiential Learning,
Unit II	Identification of Cyanobacteria and fungi Gram Staining of bacteria	
Unit III	Paper Chromatography Centrifugation	
Unit IV	Demonstration of Gel Electrophoresis Working experience with Spectrophotometer	
References	- "Microbiology: Principles and Explorations" by Jacquelyn G. Black - "Brock Biology of Microorganisms" by Michael T. Madigan, John M. Martinko, et al. - Digital Resources: - "Laboratory Techniques in Microbiology and Biotechnology" by WulfCrueger, Annelie - "Introduction to Modern Liquid Chromatography" by L. R. Snyder, J. J. Kirkland, and J. W. Dolan - "Spectrophotometry and Spectrofluorimetry: A Practical Approach" by Christina Kanakis	

TEMPLATE FOR EXTERNAL PRACTICAL

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-6	**Course Code: 104501**	**WetLab Techniques**	**Max Marks: 25**
Question No.	Exercise		Marks
1	Exercise based on Unit I		5
2	Exercise based on Unit II		5
3	Exercise based on Unit III		5
4	Exercise based on Unit IV		5
5	Viva Voce		5

TEMPLATE FOR INTERNAL PRACTICAL

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – I (NEP)			
Lab/Practical-6	**Course Code: 104501**	**WetLab Techniques**	**Max Marks: 25**
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Viva Voce		5
5	Students overall performance		5

Bioinformatics SEC Practical

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	**104602**	**Bioprogramming-I**	2	60	4Hrs	25

The Curriculum of Lab / Practical Course:

Course Objectives:	Learning of biological data handling using programming.	
Course Outcomes:	CO-1: Develop programming skills in C for sequence manipulation and file handling. CO-2: Understand the principles of DNA/RNA sequences and the rules governing their manipulation. CO-3: Gain proficiency in handling FASTA files and working with biological data. CO-4: Acquire skills in API handling and data retrieval using C programming. CO-5: Develop competence in SQL for creating and manipulating database tables.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Unit I	1. C program for calculation of DNA sequence length 2. C programme for DNA to RNA sequence conversion	Power Point Presentation, Hands on training, Demonstration, Interactive Multimedia, Experiential Learning,
Unit II	3. C programme for Valid DNA sequence identification 4. C programme for DNA pattern matching	
Unit III	5. FASTA file handling using C programming 6. API handling using C programming	
Unit IV	7. Create table using SQL 8. Different SQL commands	
References	1. "Introduction to Bioinformatics" by Arthur M. Lesk 2. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount 3. "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and PavelPevzner 4. "Bioinformatics For Dummies" by Jean-Michel Claverie and Cedric Notredame	

TEMPLATE FOR EXTERNAL PRACTICAL

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – II (NEP)			
Lab/Practical-7	**Course Code: 104602**	**Bioprogramming-I**	**Max Marks: 25**
Question No.	**Exercise**		**Marks**
1	Exercise based on Unit I		5
2	Exercise based on Unit II		5
3	Exercise based on Unit III		5
4	Exercise based on Unit IV		5
5	Viva Voce		5

TEMPLATE FOR INTERNAL PRACTICAL

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Bioinformatics), SEMESTER – II (NEP)			
Lab/Practical-7	**Course Code: 104602**	**Bioprogramming-I**	**Max Marks: 25**
S. No.	**Assessment Criteria**		**Marks**
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Viva Voce		5
5	Students overall performance		5

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three Years - Six Semesters Bachelor's Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: BIOINFORMATICS
(Semesters III and IV)

REVISED Syllabus
Effective from Academic Year 2026-27
(As per NEP 2020)

Contents

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: BIOINFORMATICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.) Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evolution & Assessment	Theory					Theory (Total)		Practical					Practical	
			External			Internal				External			Internal			
			Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks
A	Major	External & Internal	30	09	2	20	6	50	20	25	10	3	25	10	50	20
	IKS Major Specific		30	09	2	20	6	50	20	-	-	-	-	-	-	-
B	Minor		30	09	2	20	6	50	20	25	10	3	25	10	50	20
C	Generic/ Open Elective		30	09	2	20	6	50	20	-	-	-	-	-	-	-
D	VSC	Internal	-	-						-	-		50	20	50	20
	SEC	Internal	-	-						-	-		50	20	50	20
F	Internship/Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages /levels. A detailed SOP for this assessment process shall be prescribed separately.													
	FP/CEP															
	CC															

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks

(Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)

- **Total : 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

Evaluation and Assessment for FP/CEP:

- Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks)
- Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks)
- Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks)
- Total 50 Marks

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY (SCIENCE GROUP)
Teaching and Learning Scheme: for the Degree of Bachelor of Science (B.Sc)
Three Years/Four Years- (Six/Eight Semesters) Bachelor's Degree Programme
SUB-BIOINFORMATICS

SEECOND YEAR: Level 5.0-SEMESTER – III (T & L Credit Scheme)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/ Week)	Vertical Workload (Hrs/ Week)
Classroom Teaching/ Lab work (Practical)/ Outdoor/ Field)	A.	Major	Bioinformatics MJTheory-3	104203	Fundamentals of Biochemistry	2	2	**10**
			Bioinformatics MJTheory-4	104204	Fundamentals of Microbiology	2	2	
			Bioinformatics MJLab/ Practical-8	104205	Experiments related to MJ Th-3 and MJ Th-4	2	4	
		IKS-Major Specific	Bioinformatics MJTheory	104206	Nutritional Science	2	2	
	B.	Minor	Bioinformatics MNTheory-3	104301	Basics of Biomolecules	2	2	**6**
			Bioinformatics MNLab/ Practical-9	104302	Practical on Basics of Biomolecules	2	4	
	C.	Generic /Open elective Course	Bioinformatics OE Theory-5	104405	Health and Nutrition	2	2	**2**
	D.	VSC	Bioinformatics VSC-2Lab/ Practical-10	104502	Clinical Techniques	2	4	**4**
	F.	FP/CES	Bioinformatics FP/CEP-1 Project	104701	Field Project / CE Services in Bioinformatics: Phase-I	2	4	**8**
		CC	Outdoor		Separate SOP will be released	2	4	

Field Projects (FP)/ Internship/ Apprenticeship/ Community Engagement and Service (CES) corresponding to the Major (Core) Subject, Co-curricular Courses (CC)and Research Project:
These verticals of Major are to be completed by the student under the supervision of mentor faculty as per Teaching Learning Scheme.

Bioinformatics MJ Theory 3-104203				
FUNDAMENTALS OF BIOCHEMISTRY				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. To provide basic knowledge of Biochemistry 2. To provide information of biochemical. 3. To provide information of chemical structures of carbohydrate, and their structural and metabolic role in cellular system 4. To provide knowledge of lipids,, types of fatty acids and their function 5.Students will learn about protein and enzymes and their actions			
Course Outcomes:	By the end of the course students will be able to CO1. Interpret molecular structure and interactions present in, carbohydrates. CO2. Acknowledge the information on lipids, its component and various form CO3. Analyze the protein with basic building blocks, structures and biological functions. CO4. Understand the importance of enzyme, mechanism of enzyme action and its types			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Carbohydrates:**	**7**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Introduction.			
	1.2 Classification (Mono, Di, Tri).			
	1.3 Mucopolysaccharides.			
	1.4 Proteoglycans and Glycoprotein's.			
	1.5 Application and Scope of Carbohydrates.			
Unit II	**Lipids:**	**8**	**8**	
	2.1 Introduction to Lipids and Fatty Acids.			
	2.2 Saturated and Unsaturated Fatty acids.			
	2.3 Simple and Compound lipids.			
	2.4 Glycolipids, Isoprenoids and Steroids.			
	2.5 Biological functions of lipids.			
Unit III	**Proteins:**	**7**	**7**	
	3.1Introduction.			
	3.2 Basic building blocks of proteins.			
	3.3 Structures of Proteins.			
	3.4 Denaturation and Renaturation.			
	3.5 Biological function of Proteins.			
Unit IV	**Enzymes:**	**8**	**8**	
	4.1Basic Characteristics and Properties.			
	4.2 Holoenzymes and Apoenzymes.			
	4.3 Mechanisms of Enzyme Action.			
	4.4 Factors affecting rate of enzyme catalyzed reaction.			
	4.5 Enzyme Kinetics, km value.			
References :	1. Voet, D.J., Voet, J.G., Pratt, C.W., Principles of Biochemistry, John Wiley, (2008).			

	2. Berg, J.M., and Tymoczko, J.L., Stryer, L., Biochemistry, W.H. Freeman (2007). 3. Garrett, R.H., Grisham, C.M., Biochemistry, Brooks/Cole, Cengage Learning, (2010). 4. Conn, E.E., and Stump, F., Outlines of Biochemistry, John Wiley (2006).
Model Questions:	**Short Type:** 1.Explain the terms pH, buffers, Molarity. 2. What is osmolarity? 3. What are Mucopolysaccharides? 4. Differentiate between Proteoglycans and Glycoproteins. 5. What are Isoprenoids? 6. Describe about simple and compound lipids. 7. What are the biological functions of protein?
	Long Type: 1. Explain properties of Water including its structure, polarity and ionization. 2. What are Carbohydrates? Give its classification of carbohydrates 3.What are lipids? Give the classification of lipid along with the biological functions. 4.Give details on Proteins structure and its functions. 5.Describe Enzymes, give the factors affecting the reactivity enzyme in reactions. 6.Explain the TCA cycle and add a short note on its regulation. 7. What is EMP pathway? Give the EMP pathway in detail.

Bioinformatics MJ Theory 4-104204				
FUNDAMENTALS OF MICROBIOLOGY				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. Learning of basic modern microbial sciences. 2. To understand the bacteria, its classification and uses 3.To understand structure of Virus, its classification and function 4. To provide information about microbial caused diseases and its prevention			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of microbiology and its history CO2. Get to know about harmful and useful bacteria with its classification CO3. Know the structure and function of viruses CO4. Diseases cause by microbes such as bacterial disease, viral disease			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**History of Microbiology**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Introduction to Microbiology			
	1.2 The Rise of Microbiology			
	1.3 Key Figures and Discoveries			
	1.4 Modern Microbiology			
Unit II	**Bacteria**	**8hrs**	**8**	
	2.1 Harmful and useful bacteria			
	2.2 Ultrastructure of Bacterial cell			
	2.3 Classification of Bacteria			
	2.4 Reproduction in bacteria			
Unit III	**Virus**	**7hrs**	**7**	
	3.1 Virus: Introduction and Types			
	3.2 Structure and function of virus			

	3.3 Classification of Virus			
	3.4 Virus reproduction			
Unit IV	**Microbial Disease**			
	4.1Microbes and diseases			
	4.2 Bacterial disease	**8hrs**	**8**	
	4.3 Viral disease			
	4.4 Preventions			
References :	1. Fundamentals of Microbiology by Jeffrey C. Pommerville. 2. Microbiology: Principles and Explorations by Tortora, Funke, and Cases. 3. Medical Microbiology by David Greenwood, Richard Slack, John Peutherer, and Mike Barer. 4. Sherris Medical Microbiology by Kenneth J. Ryan and C. George Ray. 5. NCBI Bookshelf: The National Institutes of Health (NIH) (.gov) offers a variety of microbiology resources, including "Medical Microbiology". 6. Black, J.G. 2005. Microbiology: Principles and Explorations. 6th ed, John Wiley and Sons, New York. 7. Prescott, L.M., Harley, J.P. & Klein, D.A. 2002. Microbiology. 5th ed, McGraw Hill, New York.			
Model Questions:	**Short Type:** 1. What are the key characteristics of microbes? 2. What are the main groups of microorganisms? 3. What are the key characteristics of bacteria? 4. What are the key characteristics of viruses? 5. How do microbes interact with their environment? 6. What are some examples of microbial diseases?			
	Long Type: 1. What is the microbiome? How do microbes interact with their environment? 2. What are the different types of media used in microbiology? Explain in details 3. Explain what is viruses structure and function with its classification. 4.What are the harmful and useful bacteria? Give the details of ultrastructure of bacteria with diagram. 5. Explain the microbial diseases in details with preventions.			

Bioinformatics MJ Lab/Practical 8-104205	
Experiments related to Bioinformatics MJ Th3 and MJ Th4	
Credit :02	**Workload (Hrs/Week): 04**
Course Objectives:	1. To understand the Practical experience of Biochemistry and Microbiology 2.To provide hands on practical on Biochemistry 3. To provide practical training of Microbiology 4. To learn different chemical test for biochemical analysis
Course Outcomes:	After completion of the course: Students will be able to observe the positive or the negative results for the respective practical's .i.e. CO-1: Student could retrieve the glucose and sucrose level in the solution after performing different tests. With the help of Benedict reagents the glucose level is estimated in a particular solution. Will learn how to separate sugar will the help

	of Paper chromatography. CO-2: By this experiment students will experience handling different apparatus and calculating saponification value of oil with the help of respective formula CO-3: This practical hold the students to deal with protein, they can retrieve the R value with the help of paper chromatography CO-4: Will deal with bacteria, handling Microscope, and stating of bacteria.	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1. Qualitative test for Carbohydrates.	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. Estimation of glucose by Benedict's method	
	3. Separation of Sugar by Paper Chromatography.	
	4. Determination of Saponification value of oil.	
	5. Estimation of glycine	
	6. Qualitative test for Protein by using Biuret Method.	
	7. Qualitative test for Amino Acid (Glycine) by formal titration method.	
	8. Separation of Amino Acid by Paper Chromatography.	
Part B:	1. Microscopic Examination of bacteria 2. Monochrome/ simple staining 3. Negative staining	
References:	Textbooks: "Biochemistry: Essential Concepts" by Charles C. Hardin and James A. Knopp. "Fundamentals of Biochemistry: A Practical Approach" by Naren Kumar Dutta. "Microbiology A Laboratory Manual, Global Edition" by Cappuccino. "Basic Practical Microbiology – A Manual" by the Microbiology Society. Laboratory Manuals: "Laboratory Manual of Biochemistry". "Practical Microbiology" by ELTE TTK. "A practical manual on Fundamentals of Plant Biochemistry". General Microbiology Resources: "Basic Microbiology" by ScienceDirect.	

Bioinformatics IKS MJ Specific Theory 4 - 104206	
NUTRITIONAL SCIENCE	
Credit :02	**Workload (Hrs/Week): 02**
Course Objectives:	1.To provide basic information about Nutrition, metabolism and nutritional requirement 2. To learn about component of adequate diet, vitamins and balanced diet 3. To provide information fat soluble and water soluble vitamins 4. Students learn the classification, types and importance of vitamins and
Course Outcomes:	By the end of the course students will be able to: CO-1. Get to know the nutrition's, its daily requirement for humans & cause of malnutrition. CO-2. Acknowledge the elements of nutrition, vitamins, mineral, dietary fibre and balanced diet. CO-3. Learn the general characters of fat-soluble vitamins with its classification and day to day requirements. CO-4. Know about waters soluble vitamins, its history with occurrence, structure

	and properties.			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Nutrition**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Principles of Nutrition			
	1.2 Energy metabolism			
	1.3 Nutritional requirements			
	1.4 Malnutrition			
Unit II	**Elements of Nutrition**	**8hrs**	**8**	
	2.1 Components of Adequate Diet			
	2.2 Dietary Fibres			
	2.3 Vitamins			
	2.4 Minerals			
	2.5 Balanced Diet			
Unit III	**Fat-soluble vitamins**	**7hrs**	**7**	
	3.1 Definition,			
	3.2 General Charachtersitics			
	3.3 Classification of fat soluble vitamins			
	3.4 Daily Requirements of Vitamins			
	3.5 Deficiency disease of Vitamins			
Unit IV	**Water-soluble vitamins**	**8hrs**	**8**	
	4.1 Water soluble Vitamins types			
	4.2 History and Occurrence			
	4.3 Structure and properties			
	4.4 Metabolism and Deficiency			
References :	1. Charley, H (1982) Food science (2nd edition) John Willey & Sons, New York, ISBN no- 0471097209 2. Potter, N and Hotchkins, JH (1996) Food science fifth edition, CBS publishers and Distributors New Delhi 3. Pomeranz'y (Ed) (1981) functional properties of Academic Food components (2nd edition) press, New York ISBN no. 13: 9780125612807 4. Duckworth R.B. waters relation to foods. Academic press London ISBN No. -0-12-223150-3 5. Fulters G W (1999) New food product Development, From concept to market place CRC press, New york. 6. ISBN-13 978-01995 6689)			
Model Questions:	**Short Type:** 1. What are principles of nutrition. 2. Give the nutritional requirements in human 3. Give short note on vitamins and minerals. 4. Define fat-soluble vitamins and its general characteristics. 5. Explain water soluble vitamins in short.			
	Long Type: 1. Describe the energy metabolism? Give the nutritional requirements of humans in details. 2.What is Adequate diet? Give details on dietary fibre? 3. What are fat soluble Vitamins? Give its classification. 4. What is on deficiency of vitamins? give its causes, symptoms and cure. 5. Which are the water soluble vitamins? Give its structure and properties.			

Bioinformatics MN Theory 3– 104301				
BASICS OF BIOMOLECULES				
Credit :02 **Workload (Hrs/Week): 02**				
Course Objectives:	1. Provide information of Biomoleculesto understand its uses 2. To provide knowledge of metabolism, biosynthesis 3. to provide basic concept of biomolecules, Carbohydrates, lipids and their function			
Course Outcomes:	After completion of the course students would able be to CO-1. Summarize the basic concepts of water as biomolecules. CO-2. Explain the metabolism and lipid and protein biosynthesis. CO-3. Relate metabolism of carbohydrates, protein and lipids CO-4. Basics of protein and enzyme and their characteristic			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Water:**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Introduction to Water.			
	1.2 Concept of Osmolarity.			
	13 pH and Buffer solution.			
	1.4 Molarity and Normality.			
	.5 Weak Acid and Bases.			
Unit II	**Metabolism:**	**8hrs**	**8**	
	1.1 Introduction to Metabolism.			
	1.2 ATP (Structure).			
	1.3 Lipid Biosynthesis.			
	1.4 Protein Biosynthesis.			
Unit III	**Lipid & Carbohydrates:**	**7hrs**	**7**	
	1.1 Introduction to lipid and fatty acid.			
	1.2 Simple & compound lipid.			
	1.3 Carbohydrates.			
	1.4 Classification of Carbohydrates.			
	1.5 Biological function of lipid and carbohydrates.			
Unit IV	**Proteins and Enzymes:**	**8hrs**	**8**	
	1.1 Basic Building blocks of Proteins.			
	1.2 Structures of proteins			
	1.3 General characters and properties of Enzymes.			
	1.4 Holoenzymes and Isoenzymes.			
References :	1. "Chemistry of Biomolecules" by R J Simond. 2. Introduction to Mass Spectrometry of Biomolecules" by Marko Jovanovic. 3."Organic Chemistry Volume 2: Chemistry of Polymers and Biomolecules" by Chittaranjan Bhakta. 4."Biochemistry. Basic classes of biomolecules: What is biochemistry 5.Principles of biochemistry)" by Corles. 6."Instrumental Methods for the Analysis of Bioactive Molecules" by			

	Bhimanagouda S Patil and Federica Pellati
Model Questions:	**Short Type:** 1. Explain concept of osmolarity with example. 2.Write note on Polysaccharide's 3. Write note on Glycerophospholipids. 4. Explain Renaturation of Proteins with examples 5. Write a short note on Lipid Biosynthesis 6.Write a Short note on nomenclature of Enzymes. 7. Describe building blocks of Proteins and Polypeptide bond.
	Long Type: 1. Explain in details the concept of morality and normality with an example. 2. Explain the fatty acids. Give its classification and functions. 3.Explain the TCA cycle and add a short note on its regulation 4. Describe proteins, Explain the building blocks of proteins, also mention some of its biological function. 5. Explain the detailed characteristics of enzymes.

Bioinformatics MN Lab/Practical 9-104301		
Experiments related to Bioinformatics MN Th3		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1.Practical experience of Basics of Biomolecules 2.To provide practical knowledge of estimate different blood tests 3.To provide hands on training of Blood sugar, plasma protein and albumin test 4.To preparation of different buffer solution and electrolytes	
Course Outcomes:	After completion of the course: Students will be able to observe the positive or the negative results for the respective practical. Co-1: Understand the normal abnormal range of sugar, glucose level Co-2; Understand the pathological test and its result analysis. Co-3: Hands on experience on pathological test	
Sr. No.	**Content**	**Incorporation of Pedagogies**
1	Estimation of Blood Sugar	Lectures, Power point presentation, Discussion, Practical instruction, Practical Demonstration, Collaborative learning, Problem based learning (PBL), Experimental learning. Direct instructions,
2	Glucose tolerance test	
3	Estimation of Plasma proteins, albumin.	
4	Estimation of Cholesterol and its types	
5	Estimation of triglycerides.	
6	Preparation of different Buffer of different pH range.	
7	To measure the pH of given sample by using pH meter/strips.	
8	Estimation of Electrolytes (sodium, potassium and chloride)	

References:	1. Principles of Biochemistry – 7th edition Leininger, Nelson Cox Macmillan worth Publishers, 2013. 2. Textbook of Biochemistry-West & Todd.4th edition, Macmillan, 1966. 3. Harper's Biochemistry 29th edition, McGraw Hill, 2012. 4. Fundamentals of Biochemistry –.11th edition Agarwal O.P., Goel Publishing House, 2008. 5. Essentials of Biochemistry –2nd edition A.I. Jain. S.Chand publications, 2004. 6. Chemistry of Biomolecules, S. P. Bhutani, 2010. 7. Fundamentals of biochemistry, J.L. Jain, 2005. 8. Introductory Experiments on Biomolecules and their Interactions, Robert K. 2015.

Bioinformatics OE- Theory 5-104405				
HEALTH AND NUTRITION				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. It aims to equip students with knowledge and skills to understand the fundamentals of nutrition. 2. To understand the impact on health, and how to apply this knowledge to promote well-being and prevent diseases. 3. To provide basic knowledge of health and Nutrition 4. To understand the need of food production, nutritional and food security			
Course Outcomes:	Students will be able to acknowledge: CO1: Relation between the health and concept of nutrition. CO2: Problems regarding various nutrition deficiency, its causes and prevention CO3: Nutrition importance, its education and communication programmes. CO4: Production of food, security and various schemes such as PDS, AAY etc.			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Health and Nutrition** 1.1 Concept of Nutrition and its relation to Health 1.2 Defination and Concept of Health 1.3 Responsibility of Health- Inddividual, community, state, international 1.4 Right to health, Indicators of health	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
Unit II	**Problems in Human Nutrition** 2.1 Problems in Human Nutrition – Low birth weight, Protein energy malnutrition. 2.2 Vitamin A deficiency, 2.3 Nutritional anaemia- prophylaxis againstnutritionalanaemias, 2.4 Iodine deficiency- control of Iodine deficiency disorders	**8hrs**	**8**	
Unit III	**Nutrition Education and**	**7hrs**	**7**	

	Communication			
	3.1 Nutrition education – Definition, meaning and importance			
	3.2 Methods of Nutrition education.			
	3.3 Problems of Nutrition Education Programmes.			
	3.4 Process of communication- types and methods inhealth communication			
Unit IV	**Food Production, food and nutritional Security:**	**8hrs**	**8**	
	4.1 Food Production			
	4.2 food and nutritionalSecurity			
	4.3 Public Distribution system (PDS)			
	4.4 Antyodaya Anna Yojana (AAY), Annapurna Scheme			
References:	1. Antia F.P. and Philip Abraham(2001) Clinical Nutrition and Dietetics, Oxford Publishing Company. 2.B.Srilakshmi,(2007):Dietetics,publishedbyK.K.GuptaforNewageInternationalPvt.Ltd.New Delhi. 3. Benion M. :Clinical Nutrition, Harper and Row Publishing M.Y 4. Plummer, D. T., (1987): 3rd Ed., An Introduction to Practical Biochemistry, McGraw- Hill Publishing Co. Ltd. 5. Raghuramulu, N., Madhavan Nair and K. Kalyanasundram, S. (1983) A manual of Laboratory Techniques NIN, ICMR. 6. Voet D. Voet, J.G. & Prat. C.W. (1999): Fundamentals of biochemistry. 7. Winton, A.L., and Winton, K.B., (1999) Techniques of Food Analysis Allied Scientific Publishers. 8. Varley, H., Goweklock, A.H. and Bell, M. (1980): 5th Ed. Practical Clinical Biochemistry, Heinemann Medical Books Ltd			
Model Questions:	**Short Type:** 1. Explain in short in Nutrition. 2. Give note on Vitamin A deficiency. 3. Describe the methods of Nutrition education. 4. Explain in short food and nutrition security. 5. Public Distribution System			
	Long Type: 1. Explain the concept of health? Give the right to health and indicators of health in details 2. What are the various problems in human health? explain the nutritional anaemia 3. What is the process of communication in Nutrition education? Give details of its types and methods in health communication. 4. Explain food production and nutritional security? what is Annapurna Scheme 5. Explain Public Distribution system (PDS) and Antyodaya Anna Yojana (AAY) in details.			

Bioinformatics VSC-2 Lab/Practical 10-104301		
CLINICAL TECHNIQUES		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. Provide Practical experience of clinical techniques 2. Provide skill development techniques of clinical laboratory 3. Provides practical experience of RBC, WBC count 4.Provide practical training on kidney function test	
Course Outcomes:	After completion of the course: Students will be able to observe the positive or the negative results for the respective practical To understand RBC, WBC and Blood pressure count To Understand different function tests	
Unit System	**Content**	**Incorporation of Pedagogies**
	1. Haemoglobin Estimation	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. RBC count, Total WBC count	
	3. Measurement of TPR	
	4. Measurement of Blood Pressure	
	5.Separation of Serum and plasma from whole blood.	
	6. Liver function tests (SGPT/SGOT/Alkaline Phosphatase/Serum bilirubin)	
	7. Cardiac function tests (Serum Cholesterol, CPK, Triglycerides)	
	8. LDL-Cholesterol, HDLCholesterol, LDH	
	9. Kidney function tests (Blood urea, Serum creatinine, Serum Na+, K+)	
	10. Bleeding Time and Clotting time.	
References:	SOFTWARE/LEARNING WEBSITES 1. https://teachmeanatomy.info/ 2. https://www.lonestar.edu/anatomy-and- 3. https://www.bartleby.com/107/ 4. https://www.getbodysmart.com/ 5. https://aclandanatomy.com	
Model Questions:	Question Paper for External Practical Examination: 1. One major exercise and one minor exercise should be conduct from the list 2. One field project/assignment should be conduct by the students 3. Hands on training/ workshop/seminar should be conduct Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.	

Bioinformatics FP/CES-1 Project – 104701	
Field Project / CE Services in Bioinformatics: Phase-I	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1.To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or Community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community Service activities. 3. To encourage students to integrate physics concepts with Interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences.
Course Outcomes:	1. Students will be able to apply Bioinformatics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events.
Guidelines/SOP for Selection and Implementation of Field Projects / CE Services	
1.Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to physics and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• Statistical Methods: Students will learn and apply appropriate statistical methods to analyze data. • Interpretation of Results: Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• Report Format: A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • Data Presentation: Data should be presented clearly and accurately using tables, graphs, and figures. • Oral Presentation: Students will be required to present their findings to peers and faculty.
4. CE Services (Community Engagement)	• Community Needs: Projects may focus on addressing specific community needs or challenges relevant to physics. • Collaboration: Students can collaborate with local organizations to implement their projects. • Impact Assessment: The impact of the project on the community should be evaluated.

5.Evaluation and Assessment	• Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks) • Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks) • Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks) • Total 50 Mark
6.Examples of Field Projects/CE Services in Bioinformatics	• Survey of Blood Group types in local area of Districts • Survey on Haemoglobin percentage at local area • Survey on clinical diagnostics diseases around the area • Survey on Community health services provided in local area • Survey on pathology and clinical laboratories in local area • Survey on clinical instruments used for pathological tests • Survey on frequently occurred diseases in local area • Survey on sanitary health and habits of local area peoples

SantGadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY (SCIENCE GROUP)
Teaching and Learning Scheme: for the Degree of Bachelor of Science (B.Sc)
Three Years/Four Years- (Six/Eight Semesters) Bachelor's Degree Programme
SUB-BIOINFORMATICS

SEECOND YEAR: Level 5.0-SEMESTER – IV (T & L Credit Scheme)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/ Week)
Classroom Teaching/ Lab work (Practical) / Outdoor/ Field)	a.	Major	Theory-5	104207	Fundamental of Molecular Biology	2	2	**10**
			Theory-6	104208	Genetics	2	2	
			Theory-	104209	Cell Biology	2	2	
			Lab/ Practical-11	104210	Practical on Molecular Biology, Genetics and cell biology	2	4	
	b.	Minor	Theory-4	104303	Immunology	2	2	**6**
			Lab/ Practical-12	104304	Practical on Immunology	2	4	
	c.	Generic /Open elective Course	Theory-6	104406	Computational Biology	2	2	**2**
	d.	VSC	Lab/ Practical-13	104503	Microbial Techniques	2	4	**8**
	f.	FP/CES	Project	104702		2	4	**8**
		CC	Outdoor			2	4	

Field Projects (FP)/ Internship/ Apprenticeship/ Community Engagement and Service (CES) corresponding to the Major (Core) Subject, Co-curricular Courses (CC)and Research Project:
These verticals of Major are to be completed by the student under the supervision of mentor faculty as per Teaching Learning Scheme.

Bioinformatics MJ Theory 5-104207				
FUNDAMENTALS OF MOLECULAR BIOLOGY				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. To understand the molecular structures of DNA, RNA, its types, 2.To learn the fundamentals of Genomes, genome sequence and recombinant technology 3.To understand the mechanism of protein synthesis			
Course Outcomes:	CO-1: Understand the structure of DNA, RNA and various forms of DNA CO-2: Explore Genomics with the study of Genome sequencing methods CO-3: Translational study of Prokaryotic and Eukaryotic organism CO-4: The students will learn about the immune system including organs, cells and receptors.			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Structure of DNA:**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 DNA and forms of DNA (A,B,C,D and Z)			
	1.2 Secondary Structure of RNA.			
	1.3 Replication in Eukaryotes.			
	1.4 Structural Organization of Eukaryotic Genomes.			
Unit II	**Fundamentals of Genome:**	**8hrs**	**8**	
	2.1 Structural, Comparative, Functional Genomics			
	2.2 Genome Sequencing Methods.			
	2.3 Introduction to Genome analysis.			
	2.4 Regulation of gene expression in eukaryotes.			
Unit III	**Protein Synthesis**	**7hrs**	**7**	
	3.1 Central Dogma of Protein synthesis			
	3.2 Transcription			
	3.3. Translation			
	3.4 Ribosomes : types and uses			
Unit IV	**Recombinant DNA technology**	**8hrs**	**8**	
	4.1 Restriction endonucleases			
	4.2 Recombinant DNA			
	4.3 Gene cloaning			
	4.4 Vectors; Ideal characters			
	4.5 Plasmid, Cosmid and Bacteriophase			
References :	1.Buchanan B.B, Gruissem W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plants.. American Society of Plant Physiologists Maryland, USA. 2.Darnell J. 2000. Molecular Cell Biology (Fourth Edition) W.H. Freeman and Company, New USA			

	3. Devi P.2008-Principle and Methods of plant Molecular Biology, Biochemistry and Genetics Agrobios, Jodhpur, India. 4. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and ScneIne., USA. 4. LodishEtal 2004 (Fifth Edition). Molecular Cell Biology, WH Freeman and company, New York
Model Questions:	**Short answer question:** 1. Draw structure of DNA 2. Describe structure of RNA 3.Write notes on functional genomes 4. Give genome sequence methods 5. Give Structure of Prokaryotic Ribosome 6. Describe initiation of translation in Eukaryotes 7. Write notes on plasmid 8. Write notes on Gene cloning
	Long answer question: 1. Describe replication in Eukaryotes 2. Explain genome analysis 3. Describe structure of Eukaryotes ribosome and its application 4. Explain different types of restriction endonucleases
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests)- 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report- 10 Marks

Bioinformatics MJ Theory 6-104208				
GENETICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. Students will learn about basics of Genetics, its tools and techniques with its application in various fields of Genetic Engineering 2. Students will understand replication, mutation 3. Students will get advanced knowledge of tools of techniques used in Genetic engineering			
Course Outcomes:	By the end of the course students will be able to CO-1. Learn the concepts of Gene, process and modes of DNA Replication CO-2. Acquire knowledge of Gene Regulation Mechanism CO-3. Understand the uses of various tools and techniques of Genetic Engineering CO-4. Know the numerous applications of Genetics in various fields			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Gene: Multiplication and Expression.**	**7hrs**	**7**	Lectures, Power point presentation,
	1.1 Concept of gene.			
	1.2 DNA Replication.			

	1.3 Modes of Replication.			Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.4 Experiment of Meselson and Stahl.			
Unit II	**Mutation**	**8hrs**	**8**	
	2.1 Mutational theory of Hugo De Vries			
	2.2 Mutation types			
	2.3 Chromosomal Mutation.			
	2.4 Random vs. Directed Mutation.			
	2.5 Physical Mutagens (X-rays, Gamma-rays, UV light).			
Unit III	**Genetic Engineering: Tools & Techniques.**	**7hrs**	**7**	
	3.1 Introduction to basic technique of genetic engineering.			
	3.2 Definition, Method and Applications of gene mapping.			
	3.3DNA sequencing (by microarray)			
	3.4. PCR			
Unit IV	**Application of Genetic Engineering:**	**8hrs**	**8**	
	4.1 Healthcare biotechnology.			
	4.2 Agricultural biotechnology.			
	4.3 Environmental biotechnology.			
	4.4 Application in Pharmaceutical industries			

References :	1.Buchanan B.B, Gruissem W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA. 2.Darnell J. 2000. Molecular Cell Biology (Fourth Edition) W.H. Freeman and Company, New USA 3. Devi P.2008-Principle and Methods of plant Molecular Biology, Biochemistry and Genetics Agrobios, Jodhpur, India. 4. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and ScneIne., USA. 4. LodishEtal 2004 (Fifth Edition). Molecular Cell Biology, WH Freeman and company, New York 5. Gupta P.K (1995) Genetics and Cytogenetics. Rastogi Publications, Meerut. 6.Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai. 7. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana. 8. Verma P.S. and Agarwal V.K.(1991), Genetics. S Chand Comp. Ltd. New Delhi
Model Questions:	**Short answer question** 1. Define replication and give types of DNA replication 2. Describe Meselson and Stahl Experiment 3. Give types of Mutation 4. Give examples of physical mutagens 5. Give application of gene mapping 6. Write notes on PCR 7. Give application of healthcare biotechnology 8. Give application of Environment biotechnology
	Long answer question: 1. Describe DNA replication 2. Describe Chromosomal types of mutation 3. Explain methods of Gene mapping

	4. Describe biotechnology application in pharmaceutical industries.
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests)- 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report- 10 Marks

Bioinformatics MJ Theory -104210				
CELL BIOLOGY				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	4. Students will learn about basics of Genetics, its tools and techniques with its application in various fields of Genetic Engineering 5. Students will understand replication, mutation 6. Students will get advanced knowledge of tools of techniques used in Genetic engineering			
Course Outcomes:	By the end of the course students will be able to CO-1. Learn the concepts of Gene, process and modes of DNA Replication CO-2. Acquire knowledge of Gene Regulation Mechanism CO-3. Understand the uses of various tools and techniques of Genetic Engineering CO-4. Know the numerous applications of Genetics in various fields			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Cell**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1.Definition of cell			
	1.2 Cell types and structure			
	1.3 Cellular organization			
	1.4 Cell function			
Unit II	**Cell Division**	**8hrs**	**8**	
	2.1 Cell division cycle			
	2.2 Cellular division types			
	2.3 Mitosis : Stages and importance			
	2.4 Meiosis : Stages and importance			
	2.5 Significance of Cell division			
		7hrs	**7**	
Unit III	**Cell Organelles**			
	3.1 Plasma membrane : Structure and function			
	3.2 Mitochondria: Structure and function			
	3.3 Chloroplast: Structure and Function			
	3.4 Endoplasmic Reticulum: Structure, types and Function			
Unit IV	**Cell Nucleus**	**8hrs**	**8**	
	4.1 Nuclear membrane			
	4.2 Nucleolus			
	4.3 Chromosome types			

	4.4 Chromosome composition			
	4.5 Function of Nucleus			
References :	1.Darnell J. 2000. Molecular Cell Biology (Fourth Edition) W.H. Freeman and Company, New USA 2. Devi P.2008-Principle and Methods of plant Molecular Biology, Biochemistry and Genetics Agrobios, Jodhpur, India. 3. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and ScneIne., USA.			
Model Questions:	Short Question Long Question			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests)- 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report- 10 Marks			

Bioinformatics MJ Lab/Practical 11-104209		
Experiments related to Bioinformatics MJ Th-5, MJTh-6and Major Theory		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	Students will learn about basics of Molecular biology and Genetics, its tools and techniques with its application in various fields of Genetic Engineering	
Course Outcomes:	By the end of the course students will be able to CO-1. Understand type of blood group and Rh factor CO-2. Estimation of DNA and RNA CO-3. Understand the uses of various tools and techniques of Genetic Engineering CO-4. Understand the genetics problems and monohybrid and dihybrid cross	
Unit System	**Content**	**Incorporation of Pedagogies**
Molecular Biology	1. Identification of Blood Group and Rh factor.	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. Separation of Lymphocytes from human blood.	
	3. Estimation of DNA by Diphenyl Amine reagent	
	4. Estimation of RNA by Orcinol reagent.	
Genetics	1.To prove Mendel's Monohybrid ratio.	
	2.To prove Mendel's Dihybrid ratio.	
	3.Problems based on Interaction of genes	
	4. Survey of Dominant and Recessive characters	
Cell biology	1. Study of Cell division Mitosis from Onion root tips	
	2. Study of Meiosis from Anther of Flower	
	3. Study cell types of plant	
	4. Study cell types of Animals	
References:	1.Buchanan B.B, Gruissem W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plants. 2. American Society of Plant Physiologists Maryland, USA. 2.Darnell J. 2000. Molecular Cell Biology (Fourth Edition) W.H. Freeman and Company, New USA 3. Devi P.2008-Principle and Methods of plant Molecular Biology, Biochemistry and	

	Genetics Agrobios, Jodhpur, India. 4. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and ScneIne., USA. 5. LodishEtal 2004 (Fifth Edition). Molecular Cell Biology, WH Freeman and company, New York 6. Gupta P.K (1995) Genetics and Cytogenetics. Rastogi Publications, Meerut. 7.Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai. 8. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana. 9. Verma P.S. and Agarwal V.K.(1991), Genetics. S Chand Comp. Ltd. Ramnagar, New Delhi
Model Questions:	Question Paper for External Practical Examination: 1. one major exercise and one minor exercise should be conduct from the list 2. One field project/assignment should be conduct by the students 3. Hands on training/ workshop/seminar should be conduct Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.

Bioinformatics MN Theory 4-104302				
IMMUNOLOGY				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. Students will learn about basics of Immunology and its significance 2. Students will learn about antigen antibody and their reaction 3. To understand the different techniques like ELISA and RIA 4. To learn about Immunity types and its importanst			
Course Outcomes:	On completion of the course, the student should be able to understands CO1- overviews of immune system CO2- types of immunity and its functions CO3- the antigen, immunogens and antigenicity CO4- theimmunoglobulins, its classes, antigen-antibody interaction.			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Overview of Immune system**	**7**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning.
	1.1 Definition, scope and significance of immunology			
	1.2 Lymph and lymphatic system			
	1.3 Non-specific resistance to disease			
	1.4 Natural killer cells, phagocytosis			
Unit II	**Types of immunity**	**8**	**8**	
	2.1 Innate immunity			
	2.2 Adaptive immunity			
	2.3 Passive immunity			
	2.4 Active immunity			
Unit III	**Antigen**	**7**	**7**	
	3.1 Immunogens			

	3.2 Chemical nature of antigen			Direct instructions.
	3.3 Adjuvant and Haptane			
	3.4 Antigenicity and immunogenicity			
Unit IV	**Immunoglobulin**			
	4.1 Classification of immunoglobulins			
	4.2 Antigen antibody interaction			
	4.3 Cytokines, Intereukins and Interferon	**8**	**8**	
	4.4 ELISA and RIA			
	4.5 Importance of Immunoglobulins			
References :	1 .Roilt, I. Essential immunology. 9th Edition. USA. Blackwell Science Ltd. 1997. 114 2. Lydyard, P., Whelan, Al and Fasger, MlW. Instant notes in immunology. 2nd Edition. USA. Garland Science/ BIOS Scientific Publishers Ltd.2004. 3. Abbas AK, 2011, Cellular and Molecular Immunology 7th Ed. Elsevier Health Sciences India. 4.Murphy K, 2011 Janeway'sImmunobiology. 8th Ed. Garland Science Publishers, New York. 5. Richard Coico, Geoffrey Sunshine 2008 Immunology: A Short Course, 6th Edition Wiley- Blackwell 6. SudhaGangal 2013 Textbook of Basic and Clinical Immunology Orient Blackswan Private Limited - New Delhi			
Model Questions:	Short answer question 1. Give account on phagocytosis 2. Write notes on nonspecific resistance to disease 3. Differentiate innate and acquired immunity 4. write note on antigenicity 5. Give types of Immunoglobins 6. Write notes on RIA.			
	Long answer question 1. Describe immunology scope and significance 2. Describe innate and acquired immunity 3. Explain antigenicity and immunogenicity 4. Explain ELISA			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks Distribution of Internal marks: 1. CAT (Best 2 out of 3 tests)- 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report- 10 Marks			

<table>
<tr><th colspan="3">Bioinformatics MN- Lab/Practical 12-104303</th></tr>
<tr><th colspan="3">Practical based on Immunology</th></tr>
<tr><th colspan="3">Credit :02 Workload (Hrs/Week): 04</th></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. Students will learn about basics of Immunology
2. Students will learn about practical methods of immunology
3. To understand the different Immunological test
4. To perform the Blood related test</td></tr>
<tr><td>Course Outcomes:</td><td colspan="2">On completion of the course, the student should be able to:
1. Acquired knowledge and understanding of the immunological concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
2. Students can perform the blood group test
3. Students can perform different microbial test</td></tr>
<tr><td>Unit System</td><td>Content</td><td>Incorporation of Pedagogies</td></tr>
<tr><td rowspan="8">Immunology</td><td>1. Preparation of Blood smear slide by using Leishman stain.</td><td rowspan="8">Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions.</td></tr>
<tr><td>2. e-Demonstration of lymphoid organs</td></tr>
<tr><td>3. Histological study of Spleen, thymus and lymph node through slides or photographs</td></tr>
<tr><td>4.ABO blood group type and Rh Factor</td></tr>
<tr><td>5. Demonstration of ELISA</td></tr>
<tr><td>6.Total count of W.B.C.</td></tr>
<tr><td>7. Estimation of Haemoglobin percentage</td></tr>
<tr><td></td></tr>
<tr><td>References:</td><td colspan="2">1 .Roilt, I. Essential immunology. 9th Edition. USA. Blackwell Science Ltd. 1997. 114
2. Lydyard, P., Whelan, Al and Fasger, MlW. Instant notes in immunology. 2nd Edition.USA. Garland Science/ BIOS Scientific Publishers Ltd.2004.
3. Abbas AK, 2011, Cellular and Molecular Immunology 7th Ed. Elsevier Health Sciences India.
4.Murphy K, 2011 Janeway’sImmunobiology. 8th Ed. Garland Science Publishers, New York.
5. Richard Coico, Geoffrey Sunshine 2008 Immunology: A Short Course, 6th Edition Wiley- Blackwell
6. SudhaGangal 2013 Textbook of Basic and Clinical Immunology OrientBlackswanPrivate Limited - New Delhi</td></tr>
<tr><td>Model Questions:</td><td colspan="2">Question Paper for External Practical Examination:
1. one major exercise and one minor exercise should be conduct from the list
2. One field project/assignment should be conduct by the students
3. Hands on training/ workshop/seminar should be conduct
Instructions: -Answer all questions. -Write your answers in the provided booklet. - Ensure the clarity and neatness in your responses.</td></tr>
</table>

Bioinformatics OE Theory 6-104406				
Bioinformatics : Computational Biology				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1.Students will learn about Computational Biology 2. Students will understand the operating system and Bioinformatics tools 3. Students can understand the Sequence alignment 4. Students can understand			
Course Outcomes:	Student would able to understand CO1. Understand Computational Biology CO2. Understand Bioinformatics tools CO3. Understand sequence analysis and its application CO4. Understand Biological databaseand its uses in bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Computational Biology**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Computer Role in Biochemical Research			
	1.2 Hardware and software Recommendation			
	1.3 Introduction to Bioinformatics			
	1.4 Application of Bioinformatics			
Unit II	**Biological database**	**8hrs**	**8**	
	1. 1.Biological Database: Introduction, definition and use			
	1.2. Primary Database			
	1.3.Secondary database			
	1.4. Integrated/Specialized database			
	1.5 Applications of Biological Database in Bioinformatics			
Unit III	**Sequence Analysis**	**7hrs**	**7**	
	3.1 Introduction to Sequence Alignment and Its Significance			
	3.2 Pairwise and Multiple Sequence Alignment: Features and Methods			
	3.3 Local and Global Alignment and Algorithm: Features, Algorithm			
	3.4 Database Similarity Searches: BLAST, FASTA,			
Unit IV	**Tools and Techniques**	**8hrs**	**8**	
	4.1 Bioinformatics Tools			
	4.2 Data formats / File Formats: GenBank, PDB, FASTA, FASTQ			
	4.3 Bioinformatics Pipeline Concept: Components, Applications, Workflow			
	4.4 Comparative between Tools and Databases			

References :	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide to the analysis of genes and proteins" John Wiley and Sons 2. Des Higgins, Willie R. Taylor, Willie Taylor (2000) "Bioinformatics: sequence, structure, and databanks : a practical approach" Oxford University Press 3. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969- 712-1) 4. J. Setubal and J. Meidanis(1997) Introduction to Computational Molecular Biology, PWS Publishing Co 5.Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide"
Model Questions:	**Long Answer question:** 1. Describe pairwise sequence alignment. 2. Describe Multiple Sequence Alignment 3. Explain types of biological data. 4. Explain the importance and application of biological database.
	Short answer Question: 1 What is bioinformatics tools? 2. Give a note on sequence alignment. 3. What is BLAST 4. Give note on biological database. 5. Give note on GenBank. 6. Give note on DDBJ.

Bioinformatics VSC- Lab/Practical-13-104503		
MICROBIAL TECHNIQUES **Credit :02 Workload (Hrs/Week): 04**		
Course Objectives:	1. Students will learn microbial techniques like isolation of pathogens from sources 2. Students will learn microbial analysis 3. Students will learn Physiochemical parameters of water analysis and 4. Students will learn microbial culture	
Course Outcomes:	After completion of this course, students will be able to: CO1: isolate pathogens from polluted water. CO2: demonstrate isolation and assay of colliphages and human enteric viruses. CO3: differentiate between faecal and non-faecal coliforms from polluted water. CO4: examine and estimate physic-chemical parameters of water..	
Unit System	**Content**	**Incorporation of Pedagogies**
	1.Isolate pathogens from polluted water	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct
	2. Demonstrate isolation and assay of coliphages and human enteric viruses	
	3. Differentiate between faecal and non-faecal coliforms from polluted water	
	4.Examine and estimate physic-chemical parameters of water	
	5. Isolation of Salmonella from polluted water	

	6. Isolation of phage from sewage water.	instructions.
References:	1. Microbiology Lewis. (Harper) 2. Microbiology - Fundamentals & Application - Purohit. (Agro Botanical Pub.) 3. Industrial Microbiology - Casida (Wiley Eastern pub.) 4. Press Scott and Dunn's Industrial Microbiology. 5. Microbiology –Anantnarayan&Panikar (Orient Longman)	
Model Questions:	Question Paper for External Practical Examination: 1. one major exercise and one minor exercise should be conduct from the list 2. One field project/assignment should be conduct by the students 3. Hands on training/ workshop/seminar should be conduct Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.	

Bioinformatics FP/CES-2 Project – 104702	
Field Project / CE Services in Bioinformatics: Phase-II	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1.To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or Community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community Service activities. 3. To encourage students to integrate physics concepts with Interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To instill a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply Bioinformatics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5.Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community wellbeing
Guidelines/SOP for Selection and Implementation of Field Projects / CE Services	
1.Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to physics and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough

	literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• Statistical Methods: Students will learn and apply appropriate statistical methods to analyze data. • Interpretation of Results: Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• Report Format: A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • Data Presentation: Data should be presented clearly and accurately using tables, graphs, and figures. • Oral Presentation: Students will be required to present their findings to peers and faculty.
4. CE Services (Community Engagement)	• Community Needs: Projects may focus on addressing specific community needs or challenges relevant to physics. • Collaboration: Students can collaborate with local organizations to implement their projects. • Impact Assessment: The impact of the project on the community should be evaluated.
5.Evaluation and Assessment	• Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks) • Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks) • Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks) • Total 50 Mark
6.Examples of Field Projects/CE Services in Bioinformatics	• Microbial disease survey in local area • Microbial infection survey in local area • Disease causes and life style in local area • Survey of Water pollution causes due to microbial infection • Water causes diseases at local area • Survey of Pathology and microbial identification methods

Note: The extended portion of the Field Project/CE Services in Bioinformatics from Phase-I may be carried forward as Field Project/CE Services in Bioinformatics: Phase-II in the fourth semester, subject to the approval of the assigned faculty mentor.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three Years - Six Semesters Bachelor's Degree Programme
3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: BIOINFORMATICS
(Semesters V and VI)

Effective from Academic Year 2026-27
(As per NEP 2020)

Contents

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
Subject: BIOINFORMATICS
Teaching and Learning Scheme for the Degree of Bachelor of Science (B.Sc.) Three Years / Four Years - (Six/Eight Semesters) Bachelor Degree Programme

Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evolution & Assessment	Theory					Theory (Total)		Practical					Practical	
			External			Internal				External			Internal			
			Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Duration (Hrs)	Max Marks	Min Marks	Max Marks	Min Marks
A	Major	External & Internal	30	09	2	20	6	50	20	25	10	3	25	10	50	20
	Major elective		30	09	2	20	6	50	20	25	10	3	25	10	50	20
B	Minor		30	09	2	20	6	50	20	25	10	3	25	10	50	20
C	Generic / Open Elective															
D	VSC	Internal	-	-						-	-		50	20	50	20
	SEC	Internal	-	-						-	-		50	20	50	20
F	Internship/Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages /levels. A detailed SOP for this assessment process shall be prescribed separately.													
	FP/CEP															
	CC															

Internal Assessment for Theory/Practical/Laboratory:

All the internal assessments should be conducted on the basis of Continuous Assessment Tests (CAT).

Continuous Assessment Tests (CAT):

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under i. Three CAT each of 10 Marks (Theory) and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iii. Total Performance in CAT (i.e.40 %) shall be based on the best two out of three in CAT examinations

iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

External Assessment for Practical (Major/Minor Lab):

- Experiment Performance : 20 Marks
- Viva-Voce : 05 Marks
- **Total : 25 Marks**
- Duration of Examination : 03 Hrs.

Internal Assessment for Practical (Major/Minor Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 05 Marks
- **Total : 25 Marks**

Internal Assessment for Practical (SEC/VSC Lab):

- Internal Assessment based on CAT : 20 Marks
- Record Book : 10 Marks
- End Semester Examination : 20 Marks

(Experiment/ Demonstration/ Hands on Activity Performance: 15 Marks + Viva-Voce: 05 Marks)

- **Total : 50 Marks**
- Duration of End Semester Examination : 03 Hrs.

Evaluation and Assessment for FP/CEP:

- Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks)
- Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks)
- Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks)
- Total 50 Marks

Note: The external assessments of theory courses will be conducted in accordance with the guidelines issued by the SGBA University.

Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY (SCIENCE GROUP)
Teaching and Learning Scheme: for the Degree of Bachelor of Science (B.Sc)
Three Years/Four Years- (Six/Eight Semesters) Bachelor's Degree Programme
SUB-BIOINFORMATICS

SEECOND YEAR: Level 5.5-SEMESTER – V (T & L Credit Scheme)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/ Week)	Vertical Workload (Hrs/ Week)
Classroom Teaching/ Lab work (Practical) / Outdoor/ Field)	A.	Major	Bioinformatics MJ Theory-7	104211	Metabolomics	2	2	**16**
			Bioinformatics MJTheory-8	104212	Biological Database	2	2	
			Bioinformatics MJTheory-9	104213	Genomics	2	2	
			Bioinformatics MJ Lab/Practical-15	104214	Practical on Th-7,8 & 9	2	4	
		Major (Elective)	Bioinformatics MJ Theory-1	104215	Phylogenetics	2	2	
			Bioinformatics MJ Lab/Practical-16	104216	Practical on Phylogenetics	2	2	
			Bioinformatics MJ Theory-2	104217	Chemo-Informatics	2	2	
			Bioinformatics MJ Lab/Practical-17	104218	Practical on Chemo-Informatics	2	4	
	B.	Minor	Bioinformatics MN Theory-5	104305	Proteomics and Genomics	2	2	**6**
			Bioinformatics MN Lab/Practical-18	104306	Practical on Proteomics and Genomics	2	4	
	C.	GOEC	-	-	-	-	-	
	D.	VSC	Bioinformatics VSC-2 Lab/Practical-19	104504	Protein Sequence analysis and prediction	2	4	**8**
		SEC	Bioinformatics SEC-2 Lab/Practical-20	104604	SNP Analysis	2	4	
	E	VEC	-	-	-	-	-	**-**
	F.	FP/CES	Bioinformatics FP/CEP-1 Project	104703	Field Project / CE Services in Bioinformatics: Phase-III	2	4	**4**
		AI	Theory	-	Fundamental of Artificial Intelligence	Grading	2	2
		Total				**22**	**36**	**36**

Field Projects (FP)/ Internship/ Apprenticeship/ Community Engagement and Service (CES) corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research Project:
These verticals of Major are to be completed by the student under the supervision of mentor faculty as per Teaching Learning Scheme.

Bioinformatics MJ Theory -7, Code-104211				
METABOLOMICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. To provide basic knowledge of Metabolomics 2. To provide information of Metabolomics tools 3. To provide information of chemical structures of carbohydrate, and their structural and metabolic role in cellular system 4. To provide knowledge of Glucose , types of fatty acids and their function 5.Students will learn about metabolomics types and database			
Course Outcomes:	By the end of the course students will be able to CO1. Interpret molecular structure and interactions present biological pathways CO2. Acknowledge the information on Metabolomics, its database and application CO3. Analyze the metabolomics with basic building blocks, structures and biological functions. CO4. Understand the importance of metabolomics database and tools			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Basic Concepts of Metabolomics**	**7**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1. Metabolomics: (Definition, introduction, scope)			
	1.2. History & Development of Metabolomics			
	1.3. Metabolomics Workflow			
	1.4. Applications of Metabolomics			
Unit II	**Metabolites**	**8**	**8**	
	2.1.Introduction of Metabolites			
	2.2.Types of Metabolites:Primary metabolites, Secondary metabolites			
	2.3.Metabolic Networks:Structure and components, Types of metabolic network			
	2.4.Properties of Metabolic Network			
	2.5.Metabolomics Data Formats: mzML, mzXML, mzData, netCDF, CSV			
Unit III	**Metabolic Pathways**	**7**	**7**	
	3.1.Glycolysis, Gluconeogenesis			
	3.2.TCA cycle, HMP Pathway			
	3.3. Calvin cycle			
	3.4. Electron Transport Chain,			
	3.5. Amino acid catabolism			
Unit IV	**Metabolomics Databases and Tools**	**8**	**8**	
	4.1. KEGG and EMP database: types of data, applications			
	4.2. BRENDA database, METLIN: types of data, applications			
	4.3. EcoCyc&MetaCyc database: types and applications			

	4.4. Metabolic disease database - HMDB, MPMP, types and applications			
	4.5. Data visualization tools: Metabo Analyst, PathVisio			

References:	1. Metabolomics perspectives for clinical medicine, volume IIDanutaDudzik, Víctor González-Ruiz, Hector Gallart-Ayala, Julia Kuligowski 2. Metabolomics and Transcriptomics in Biomarker Discovery: Mass Spectrometric Techniques in Volatilome Research 3.The Handbook of Metabonomics and Metabolomics: Edited by John C. Lindon, Jeremy K. Nicholson, and Elaine Holmes. 4. Metabolomics in Practice: Written by Michael Lämmerhofer and Wolfram Weckwerth. 5. The Handbook of Metabolic Phenotyping: This updated text by Lindon et al.
Model Questions:	**<u>Short Type</u>** 1. Give note on history and development of metabolomics. 2. What is metabolomics? 3. What is properties of metabolic network? 4. Give note on structure of metabolic network. 5. Give note on gluconeogenesis. 6. Give note on BRENDA database. 7. Give note on EMP.
	<u>Long Type</u> 1. Explain metabolomics with applications & scope. 2. Describe metabolomics workflow. 3. Explain metabolites. 4. Explain metabolic network. 5. Describe amino acid catabolism. 6. Explain TCA cycle. 7. Describe metabolic disease databases.
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests)- 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report- 10 Marks

Bioinformatics MJ Theory -8-104212	
BIOLOGICAL DATABASE	
Credit :02	**Workload (Hrs/Week): 02**
Course Objectives :	1. Learning of Bioinformatics database sciences. 2. To understand the Biological database, its types and uses 3.To understand its classification and application 4. To provide information about Biological database, its uses in Bioinformatics
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Biological database CO2. Get to know about Protein sequence database CO3. Know the Nucleic acid sequence database CO4. Understand the Genome browser, biodiversity database etc.

Unit System	Content	Work load Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Concept of Biological Database**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1. 1.Biological Database: Introduction, definition and use			
	1.2. Biological Data: Genomic, Proteomics, Structural, Metabolic			
	1.3.Biological Database: Primary, Secondary, Integrated/Composite, Specialized			
	1.4. Applications of Biological Database in Bioinformatics			
Unit II	**Nucleic Acid Sequence Database**	**8hrs**	**8**	
	2.1. GenBank: (Introduction, Data Content, Types of Data, file format)			
	2.2. DDBJ: (Introduction, Organization, Data collection, Specialized Databases)			
	2.3. ENA/EMBL:(Introduction: EMBL/ENA, Type of Data, Application)			
	2.4. Ref-Seq:(Introduction, Applications, Types of Records)			
Unit III	**Protein Sequence Databanks**	**7hrs**	**7**	
	3.1. Uniprot: Introduction, Components and Resources			
	3.2. Uniprot databases- Uniprot KB/ UniRef			
	3.3. PIR: Introduction, Types of Data, Database Structure, Applications			
	3.4. PDB - Protein DataBank: Types of Data, File Formats, Structural Features, Applications			
	3.5. BIOGRID& STRING: Types of Data, Features, Applications			
Unit IV	**Other Biological Databases**			
	4.1. Genome Browsers: Genome Browsers - UCSC, ENSEMBL, NCBI Genome Data Viewer			
	4.2. Biodiversity Databases: ITIS, GBIF, NCBI Taxonomy Database			
	4.3. Enzyme Databases: Applications, Enzyme database - BRENDA, ENZYME			
	4.4. Metabolic Pathway Database: Applications, Metabolic Pathway Databases- KEGG, Metacyc, Ecocyc, Reactome			
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)			

	3. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India. 4. Des Higgins, Willie R. Taylor, Willie Taylor (2000) "Bioinformatics: sequence, structure, and databanks : a practical approach" Oxford University Press 5. Stanley Letovsky (1999) "Bioinformatics: databases and systems" Springer
Model Questions:	**Short Type** 1] What is database? 2] Give note on biological database. 3] Give note on GenBank. 4] Give note on DDBJ. 5] What is Ref- Seq? 6] Give note on Uniprot 7] Give note on metabolic pathway database. **Long Type** 1] Describe biological database and types of biological data. 2] Explain types of biological data. 3] Explain the importance and application of biological database. 4] Describe Protein Data Bank. 5] what is nucleic acid? Describe nucleic acid database. 6]Explain biodiversity database.
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MJ Theory 9-104213				
GENOMICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Genomics in Bioinformatics 2. To understand the Gene database, its types and uses 3.To understand its Genome analysis and its application 4. To provide information about Genome alignments and tools			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Genomics CO2. Get to know Metagenomics and Pharmacogenomics CO3. Know the application of Genomics CO4. Understand the Genome analysis, Genome analysis etc			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Concept of Genomics** 1.1Genomics: Introduction,Definition, Importance 1.2Types of Genomics: Primary Types - Structural, Functional 1.3Structural Organization of	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration , Collaborative

	Genome: Level of Genome organization			learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.4Scope and Applications of Genomics			
Unit II	**Scope of Genomic**	**8hrs**	**8**	
	2.1Metagenomics : Introduction and application			
	2.2Pharmacogenomics: Introduction and application			
	2.3Epigenomics			
	2.4 DNA microarray			
Unit III	**Genome Analysis**	**7hrs**	**7**	
	3.1 Introduction to Genome Analysis: (Introduction, Process, Advantages)			
	3.2 DNA Fragments: Introduction, Definition, Generation of DNA Fragments, Applications			
	3.3 Gene Expression:Introduction, Definitions, Steps, Regulation			
	3.4. Human Genome Project			
Unit IV	**Genome Alignments and Tools**	**8hrs**	**8**	
	4.1 FASTA and BLAST			
	4.2 PHI-BLAST, PSI-BLAST			
	4.3.Pairwise Sequence Alignment			
	4.4. Multiple Sequence Alignment			
References :	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1) 3. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India. 4. Des Higgins, Willie R. Taylor, Willie Taylor (2000) "Bioinformatics: sequence, structure, and databanks : a practical approach" Oxford University Press 5. Stanley Letovsky (1999) "Bioinformatics: databases and systems" Springer			
Model Questions:	Short Type 1. What is BLAST 2. What is Genomics? 3. Give note on DNA fragments. 4. Give note on DNA microarray. Long Type 1. Describe Multiple Sequence Alignment 2. Describe Gene expression 3. Explain structural organization of genome. 4. Describe scope and applications of genomics.			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks			

Bioinformatics MJ Lab/Practical -15-104214		
Experiments related to Bioinformatics MJ Th-7, MJ Th-8 and MJ Th-9		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of Metabolomics , Biological Database and Genomics 2.To provide hands on practical on Metabolomics 3. To provide practical training of Biological Database 4. To learn different Tools of Genomics	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different database, DDBJ, GeneBank, NDB etc CO-2: By this experiment students will experience handling different Genome browser CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with Genome sequence, BLAST, sequence alignment, etc	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1.To study metabolic pathways using KEGG.	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. To study HMDB database.	
	3.To identify metabolites using METLIN.	
	4. To retrieve metabolic data of E-coli using Ecosyc	
Part B	5. T study PIR database	
	6. Retrieval protein information from Uniprot	
	7. Querying and retrieval structural information from PDB	
	8. To study protein interaction by STRING database	
Part C	9. Sequence alignment by BLAST	
	10. To study Genome Browser - USCS, ENSEMBL	
	11. To study NCBI genome database	
References:	Textbooks: 1. Metabolomics perspectives for clinical medicine, volume IIDanutaDudzik, Víctor González-Ruiz, Hector Gallart-Ayala, Julia Kuligowski 2. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 3. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)	

Examination , Evaluation and Assessment Scheme

Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics MJ-ELECTIVE- Theory 1-104215				
PHYLOGENETICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Phylogenetic in Bioinformatics 2. To understand the construction of Phylogenetic trees 3.To understand phylogenic analysis and its application 4. To provide information about Phylogenetic softwere and tools			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Phylogenetics and its application CO2. Get to know Phylogenic tree construction and analysis CO3. Know the evolutionary concept, comparison and comparative analysis CO4. Understand the software and tools used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Basics of Phylogenetics**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Evolution and Common Ancestry: Concept, Evidences Mechanism, Importance			
	1.2 Phylogeny and Phylogenetics, Importance in Bioinformatics			
	1.3 History and Development of Phylogenetics			
	1.4 Molecular Phylogenetics: Principle, Types of Molecular Data, Molecular Clock Hypothesis			
Unit II	**Phylogenetic Representations**	**8hrs**	**8**	
	2.1 Structure of Phylogenetic Trees-Roots, Branches, Nodes, Clades			
	2.2 Data used for Phylogenetics - Morphological & Molecular			
	2.3 Phylogenetic tree types: Rooted, Unrooted, Cladogram, Phylogram,Dendogram, Ultrametric Tree			
	2.4 Steps in Phylogenetic Analysis and Tree Construction			
Unit III	**Phylogenetic Tree Visualization and Analysis**	**7hrs**	**7**	
	3.1 Software For Tree Construction and Visualization - MEGA, PhyML			
	3.2 Distance Based Methods: UPGMA, NJ			
	3.3 Character Based Methods:Maximum Parsimony, Maximum Likelihood			
	3.4 Advantages of Phylogenetics			
Unit IV	**Applications of Phylogenetics**	**8hrs**	**8**	
	4.1 Evolution - Taxonomy and			

	Classification			
	4.2 Drug and Vaccine Development			
	4.3 Forensic Science			
	4.4 Genomics and Bioinformatics			
	4.5 Agricultural Science			

References :	1."Molecular Evolution and Phylogenetics" by Masatoshi Nei and Sudhir Kumar 2.BromhamLindell. Reading the story in DNA: A Beginner's Guide to Molecular Evolution. Publisher: USA, Oxford University Press. 2008. 3."Fundamentals of Molecular Evolution" by Graur Dan and Wen - Hsiung li 4.BernardiGioorgio. Structural and Evolutionary Genomics, Volume 37: Natural Selection in Genome Evolution
Model Questions:	Short Type 1] What is Evolution? 2] Give note on molecularphylogenetics. 3] Give note on types of phylogenetic tree. 4] Define- nodes, clades, roots 5] Give note on MEGA 6] What is molecular clock Hypothesis?. 7] Give application of phylogenetics in drug development. Long Type 1] Describe phylogenetics its history and development. 2] Explain the steps in phylogenetics analysis and tree construction. 3] Describe Structure of phylogenetic tree. 4] Describe advantages of phylogenetics. 5] Explaindistance based tree construction method. 6] Explain application of phylogenetics in evolution and forensic science. 7] Explain application of phylogenetics in genomics and bioinformatics.

Examination , Evaluation and Assessment Scheme

1. External Theory - 30 Marks
2. Internal Assessment - 20 marks

Distribution of Internal marks:

1. CAT (Best 2 out of 3 tests) - 10 Marks
2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MJ Elective Lab/Practical -16-104216	
Practical on PHYLOGENETICS **Credit :02 Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of Metabolomics , Biological Database and Genomics 2.To provide hands on practical on Metabolomics 3. To provide practical training of Biological Database 4. To learn different Tools of Genomics
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different database, DDBJ, GeneBank, NDB etc CO-2: By this experiment students will experience handling different Genome browser CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with Genome sequence, BLAST, sequence alignment, etc

Unit System	Content	Incorporation of Pedagogies
Part A:	1.To perform multiple sequence alignment :Clustal-W	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2.To study software used for phylogenetic analysis : MEGA	
	3.To convert sequence data into mega format.	
	4.To calculate evolutionary distance between sequences.	
	5.To construct phylogenetic tree using UPGMA method	
	6.To construct phylogenetic tree using NJ method.	
	7.To construct phylogenetic tree using maximum parsimony method.	
	8.To generated rooted and unrooted trees.	
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2."Molecular Evolution and Phylogenetics" by Masatoshi Nei and Sudhir Kumar	
	Examination , Evaluation and Assessment Scheme	
Practical (External) 25 Marks		**Practical (Internal) 25 Marks**
Major Practical- 10		Students Performance - 10
Minor Practical -10		Students Attendance - 10
Viva-voce -05		Report/ Activity submission - 05

Bioinformatics MJ- ELECTIVE- Theory 2-104217				
CHEMOINFORMATICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Chemistry in Bioinformatics 2. To understand the Chemoinformatics 3.To understand Chemical data and its application 4. To provide information about ChemoInformatics software and tools			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Chemo informatics and its application CO2. Get to know Chemical analysis and drug database CO3. Know the Biomolecules importance in drug design CO4. Understand the software and tools used in Chemo informatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Basics of Chemistry**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL),
	1.1 Chemistry: Introduction, Branches			
	1.2 Atoms, Molecules, Chemical Bonds, and Chemical Structure			
	1.3 Biomolecules: Carbohydrates, Lipids,Proteins			
	1.4 Biomolecules: Nucleic Acids,Enzymes			

	1.5 Importance of Chemistry in Biology			Peer teaching, Experimental learning. Direct instructions.
Unit II	**Concepts of Chemo-Informatics**	**8hrs**	**8**	
	2.1 Scope of Chemo-Informatics			
	2.2 History and Development of Chemo-Informatic			
	2.3 Comparison Between Chemo-Informatics and Chemistry			
	2.4 Importance of Chemo-Informatics in Bioinformatics			
	2.5 Types of Notations : SMILES, Inchi Notations			
Unit III	**Chemo-Informatics Databases**	**7hrs**	**7**	
	3.1 PubChem: Objectives, Types of Data, Applications			
	3.2 DrugBank: Types of Data and Applications			
	3.3 ChEMBL: DatabaseTypes, Structure and Applications			
	3.4 Chemspider: Introduction, Types of Data and Applications			
Unit IV	**Applications of Chemo-Informatics**	**8hrs**	**8**	
	4.1 Drug Discovery and Development			
	4.2 Molecular Docking			
	4.3 Physicochemical Properties			
	4.4 Toxicity Prediction			
	4.5 ADMET Prediction			
References :	1.Chemoinformatics: Basic Concepts and Methods: Edited by Thomas Engel and Johann Gasteiger. 2.PracticalChemoinformatics: Authored by MuthukumarasamyKarthikeyan and Renu Vyas. 3.Chemoinformatics for Drug Discovery: Edited by Jürgen Bajorath. 4. Chemoinformatics: Theory, Practice, & Products: Co-authored by Barry A. Bunin et al. 5. Applied Chemoinformatics: Achievements and Future Opportunities: Co-edited by Thomas Engel and Johann Gasteiger.			
Model Questions:	Short Type 1] Give note on basic chemical concepts. 2] What is chemo-informatics? 3] Give importance of chemo-informatics. 4] What is PubChem? 5] What is DrugBank? 6] Give applications of chemo-informatics in molecular docking. 7] Give applications of chemo-informatics in physicochemical properties. Long Type 1] Explain biomolecules. 2] Describe chemo-informatics, its history and development. 3] Differentiate between chemistry and chemo-informatics. 4] Explain ChEMBL in detail. 5] Explain ChemSpider in detail. 6] Describe the role of chemo-informatics in ADMET prediction.			

	7] Describe the role of chemo-informatics in toxicity prediction.
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MJ Elective Lab/Practical -17-104218 **Practical on CHEMOINFORMATICS**		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of Chemistry and Chemical Database 2.To provide hands on practical on Chemical database 3. To provide practical training of Chemo informatics 4. To learn different Tools of Chemo informatics	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different database of Chemical and biochemical etc CO-2: By this experiment students will experience handling different Chemical database browser CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with PubChem, ChemSketch, DrugBank, ChemSpideetc	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1. To study basic chemo-informatics tools. 2. To search a chemical compound using PubChem. 3. To retrieve drug information from chemical databases. 4. To draw simple chemical structures using ChemSketch. 5.To study and retrieve drug information from DrugBank. 6. To study and retrieve drug information from DrugBank. 7. To study and retrieve chemical information using ChemSpide	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2.PracticalChemoinformatics: Authored by MuthukumarasamyKarthikeyan and Renu Vyas. 3. Chemoinformatics: Theory, Practice, & Products: Co-authored by Barry A. Bunin et al.	

Examination , Evaluation and Assessment Scheme	
Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics MN-Theory 5-104304				
PROTEOMICS AND GENOMICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Protein and Genome in Bioinformatics 2. To understand the Proteomics and Genomics 3.To understand Biochemical database and its application 4. To provide information about Proteomics and Genomics software and tools			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Protein and Genome and its application CO2. Get to know Protein analysis and drug database CO3. Know the Genome importance in drug design CO4. Understand the software and tools used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Concept of Proteomics** 1.1 Proteomics: Proteomics Workflow 1.2 Organization of Proteins: Primary, Secondary, Tertiary, Quaternary 1.3Types of Proteomics: Structural and Functional types, Expression 1.4 Application of Proteomics	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
Unit II	**Methods in Proteomics** 2.1Protein Secondary Structure Prediction Method -ChauFasman, GOR 2.2 Protein Tertiary Structure Prediction Method - Homology Modeling, Ab- Initio method, Fold Recognition method 2.3 Molecular Visualization of Protein :Rasmol, Cn3D, PyMOL 2.4 Protein Sequence Comparison and Analysis - PDB, SCOP, CATH	**8hrs**	**8**	
Unit III	**Concept of Genomics** 3.1 Genomics: Introduction, Importance , Metagenomics, Pharmacogennomics 3.2 Types of Genomics: Primary Types and Specialized Types 3.3 Structural Organization of Genome 3.4 Scope and Applications of Genomics	**7hrs**	**7**	
Unit IV	**Functional Genome** 4.1 Introduction to Genome Analysis: Process, Advantages	**8hrs**	**8**	

	4.2 DNA Fragments: Generation of DNA Fragments, Applications 4.3 Gene Expression: Steps, Regulation 4.4 Genome Alignments and Tools - BLAST, PHI-BLAST, PSI-BLAST 4.5 DNA Microarray: Principle, Types, Applications			
References :	1.Dubitzky W. Granzow M. Berrar D (2007) "Fundamentals of data mining in genomics and proteomics" 2. Kraj A, Silberring J, (2008) "Proteomics: introduction to methods and applications" John Wiley & Sons 3.Liebler D.C, (2002), "Introduction to proteomics: tools for the new biology" Humana Press 4. Mishra N.C., (2010), "Introduction to Proteomics: Principles and Applications" John Wiley and Sons 5.Suhai S. (2000) "Genomics and proteomics: functional and computational aspects" Springer 6.Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare			
Model Questions:	**Short Type** 1. What is proteomics? 2. Give note on types of proteomics. 3. Give note on GOR method. 4. Give note on PDB. 5. What is Genomics? 6. Give note on DNA fragments. 7. Give note on DNA microarray. **Long Type** 1. Explain organization of proteins. 2. Describe applications of proteomics. 3. Describe CATH and SCOP. 4. Explain homology modeling. 5. Explain structural organization of genome. 6. Describe scope and applications of genomics. 7. Explain alignment with PHI-BLAST and PSI-BLAST.			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks			

Bioinformatics MN Lab/Practical -18-104306		
Practical on PROTEOMICS AND GENOMICS		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of Chemistry and Chemical Database 2.To provide hands on practical on Chemical database 3. To provide practical training of Chemo informatics 4. To learn different Tools of Chemo informatics	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different database of Chemical and biochemical etc CO-2: By this experiment students will experience handling different Chemical database browser CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with PubChem, ChemSketch, DrugBank, ChemSpideetc	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1. Secondary structure prediction of protein using GOR IV, SOPMA 2. Tertiary structure prediction of protein using homology modeling. 3. Visualization of tertiary structure of protein by RasMol, Cn3D 4. Protein sequence comparison and Analysis by CATH and SCOP 5. Sequence alignment by BLAST 6. Interpretation of PHI-BLAST 7. Interpretation of PSI-BLAST 8. Study of gene expression by NCBI	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2. Kraj A, Silberring J, (2008) "Proteomics: introduction to methods and applications" John Wiley & Sons 3.Suhai S. (2000) "Genomics and proteomics: functional and computational aspects" Springer	

Examination , Evaluation and Assessment Scheme	
Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics VSC-2 Lab/Practical-19-104504		
PROTEIN SEQUENCE ANALYSIS AND PREDICTION		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	Practical experience of skill development of Protein analysis and prediction Students can learn sequence analysis and production programs	
Course Outcomes:	Develop conceptual as well as applied knowledge and skills in the field of Protein sequences and prediction Protein analysis and protein prediction for bioinformatics.	
Unit/ Sr. No.	**Content**	**Incorporation of Pedagogies**
1	1.Primary structure of Protein by PROTPRY	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. Secondary structure prediction of protein using GOR IV, SOPMA	
2	3. Tertiary structure prediction of protein using homology modeling.	
3	4. Visualization of tertiary structure of protein by RasMol, Cn3D	
4	5. Protein sequence comparison and Analysis by CATH and SCOP	
5	6. Protein sequence alignment by BLAST	
6	7. Multiple sequence alignment by Clustul Omega	
7	8. Interpretation of PHI BLAST and PSI BLAST	
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 2. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1) 3. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India.	
Model Questions:	Question Paper for External Practical Examination: 1. one major exercise and one minor exercise should be conduct from the list 2. One field project/assignment should be conduct by the students 3. Hands on training/ workshop/seminar should be conduct Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.	

<table>
<tr><th colspan="3">Bioinformatics SEC-2 Lab/Practical-20 - 104604</th></tr>
<tr><th colspan="3">SNP ANALYSIS</th></tr>
<tr><th colspan="3">Credit :02 Workload (Hrs/Week): 04</th></tr>
<tr><td>Course Objectives:</td><td colspan="2">5. Students will learn Bioinformatics database
6. Students will learn about SNP analysis
7. Students will learn about PDBSNP
8. Students will learn about genetic variation</td></tr>
<tr><td>Course Outcomes:</td><td colspan="2">After completion of this course, students will be able to:
CO1: Understand SNP analysis
CO2: Understand SNP related database
CO3: Understand gene associated with SNP
CO4: Understand DBSNP</td></tr>
<tr><td>Unit System</td><td>Content</td><td>Incorporation of Pedagogies</td></tr>
<tr><td rowspan="9"></td><td>1. Introduction to NCBI DBSNP</td><td rowspan="9">Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.</td></tr>
<tr><td>2. To search SNP by rs ID</td></tr>
<tr><td>3. To retrieve basic information of SNP</td></tr>
<tr><td>4. To find the Gene associated with SNP</td></tr>
<tr><td>5. To Locate SNP on the chromosome</td></tr>
<tr><td>6. To compare two SNP records</td></tr>
<tr><td>7. To study types of SNP</td></tr>
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<tr><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>References:</td><td colspan="2">1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) “Bioinformatics– a practical guide”
2. Mount, D. (2004) “Bioinformatics: Sequence and Genome Analysis”; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)
3. Sharma, V. Munjal, A. and Shankar, A. (2008) “A text book of Bioinformatics” first edition, Rastogi Publication, Meerut – India.</td></tr>
<tr><td>Model Questions:</td><td colspan="2">Question Paper for External Practical Examination:
1. one major exercise and one minor exercise should be conduct from the list
2. One field project/assignment should be conduct by the students
3. Hands on training/ workshop/seminar should be conduct
Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.</td></tr>
</table>

Bioinformatics FP/CES-1 Project – 104703	
Field Project / CE Services in Bioinformatics: Phase-III	
Credits: 02	**Workload (Hrs./Week): 04**
Course Objectives:	1.To provide hands-on experience in applying theoretical physics knowledge to real-world challenges through field-based projects or Community engagement (CE) services. 2. To train students in identifying, analyzing, and solving practical problems encountered in physics-related fieldwork or community Service activities. 3. To encourage students to integrate physics concepts with Interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences.
Course Outcomes:	1. Students will be able to apply Bioinformatics principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events.
Guidelines/SOP for Selection and Implementation of Field Projects / CE Services	
1.Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to Bioinformatics andalign with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify Research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out Field project is 60 hours.
2. Data Analysis and Interpretation	• Statistical Methods: Students will learn and apply appropriate statistical methods to analyse data. • Interpretation of Results: Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• Report Format: A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • Data Presentation: Data should be presented clearly and accurately using tables, graphs, and figures. • Oral Presentation: Students will be required to present their findings to peers and faculty.
4. CE Services (Community Engagement)	• Community Needs: Projects may focus on addressing specific community needs or challenges relevant to physics. • Collaboration: Students can collaborate with local organizations to implement their projects. • Impact Assessment: The impact of the project on the community

	should be evaluated.
5.Evaluation and Assessment	• Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks) • Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks) • Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks) • Total 50 Mark
6.Examples of Field Projects/CE Services in Bioinformatics	1. Querying and retrieval structural information from NDB
	2. Retrieval protein information from Uniprot
	3. Querying and retrieval structural information from PDB
	4. Study Genome Browser - USCS, ENSEMBL
	5 Construct phylogenetic tree using UPGMA method
	6. Construct phylogenetic tree using NJ method.
	7. Construct phylogenetic tree using maximum parsimony method.
	8.. Secondary structure prediction of protein using GOR IV, SOPMA
	9. Tertiary structure prediction of protein using homology modelling.
	10. Visualization of tertiary structure of protein by RasMol, Cn3D

Field Project (FP)/ Internship/ Apprenticeship/ Community Engagement and Service (CES) Corresponding to the Major(Core) subject

Research Project:

These verticals of Major are to be completed by the student under the supervision of mentor faculty as per Teaching Learning Scheme

- ❖ DNA base counter
- ❖ GC% calculator
- ❖ FASTA file reader
- ❖ Create gene database
- ❖ Generate random DNA
- ❖ Create small protein database

SantGadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY (SCIENCE GROUP)
Teaching and Learning Scheme: for the Degree of Bachelor of Science (B.Sc)
Three Years/Four Years- (Six/Eight Semesters) Bachelor's Degree Programme
SUB-BIOINFORMATICS

SEECOND YEAR: Level 5.5-SEMESTER – VI (T & L Credit Scheme)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/ Week)	Vertical Workload (Hrs/ Week)
Classroom Teaching/ Lab work (Practical)/ Outdoor/ Field)	A.	Major	Bioinformatics MJTheory-10	104219	Advanced Biocomputing	2	2	**16**
			Bioinformatics MJTheory-11	104220	Tools and Technique in Bioinformatics	2	2	
			Bioinformatics MJTheory-12	104221	SQL Programming	2	2	
			Bioinformatics MJLab/ Practical-21	104222	Practical on TH-10, 11, 12	2	4	
		Major (Elective)	Bioinformatics MJTheory-3	104223	Python Programming	2	2	
			Bioinformatics MJLab/ Practical-22	104224	Practical Python Programming	2	2	
			Bioinformatics MJTheory-4	104225	Java Programming	2	2	
			Bioinformatics MJLab/ Practical-23	104226	Practical Java Programming	2	4	
	B.	Minor	Bioinformatics MNTheory-5	104307	Advanced Bioinformatics	2	2	**6**
			Bioinformatics MNLab/ Practical-24	104308	Practical Advanced Bioinformatics	2	4	
	C.	GOEC	-	-	-	-	-	**-**
	D.	VSC	Bioinformatics VSC-2Lab/ Practical-25	104505	R Programming	2	4	**4**
	E	VEC	-	-	-	-	-	
	F.	Internship/ Apprenticeship	OJT On Job Training	104704		4	8	**8**
		CC	-	-	-	-	-	
		Total				**22**	**34**	**34**

Internship/ Apprenticeship/ Community Engagement and Service (CES) corresponding to the Major (Core) Subject, Co-curricular Courses (CC)and Research Project:
These verticals of Major are to be completed by the student under the supervision of mentor faculty as per Teaching Learning Scheme.

Bioinformatics MJ-Theory 10-104219				
ADVANCED BIOCOMPUTING				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Database in Bioinformatics 2. To understand the C++ programming 3.To understand programming application 4. To provide information about C++ and PERL			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Protein and Genome and its application CO2. Get to know Protein analysis and drug database CO3. Know the Genome importance in drug design CO4. Understand the software and tools used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Database Concepts** 1.1 Database: Types of Databases- Relational, NoSQL, Hierarchical, Network, Object Oriented) 1.2 Three Level Architecture :Physical, Logical and View Level 1.3 Data Independence, Data Models and Data Abstraction 1.4 DBMS & RDBMS: Introduction, Advantages and Disadvantages	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
Unit II	**C++ Programming** 2.1 C++ programming: History, Features, Applications 2.2 Variables: Declaration of Variable, Initialization of Variable, 2.3 Data Types: Basic- Int, char, float, double; Derived - Function, Array, Pointer 2.4 Operators: Relational, Logical, Arithmetic, Assignment	**8hrs**	**8**	
Unit III	**PERL programming - I** 3.1 PERL: (Introduction, PERL basic syntax, Features, Applications) 3.2 PERL Concept: History, Installation, Uses 3.3 PERL Data Types and Variables: Scalar, Arrays, Hashes 3.4 Use of PERL in Bioinformatics	**7hrs**	**7**	
Unit IV	**PERL programming -II** 4.1Basic Operators: Relational, Logical, Arithmetic, String, Other Specilalized Operators 4.2 Control Statements : if, else, else....if	**8hrs**	**8**	

	4.3 Loops :for, while, foreach, do...while, until 4.4 Functions: Built-In functions and User - Defined functions 4.5 Bioperl: Introduction, Uses, Features, Installation			
References:	1.HerbertSchidt, 1995. C++ The complete reference, 2nd Edtn, Osborne, MGH. 2. D. Curtis Jamison (2003) "Perl programming for biologists" Wiley- IEEE 3.Jules J Berman (2008) "Perl: The Programming Language" Jones & Bartlett Learning 4.Beginning Perl for Bioinformatics By James Tisdall, O'Reilly Media (2001) 5. Date, C.J. (2000) "An introduction to Database systems"; Seventh Edition, Addison Wesley 6. Elmasri and Navathe (2004) "Fundamentals of Database systems" Fourth Edition, Addison Wesley Publishers			
Model Questions:	**Short Type** 1] Give note on C++ programming. 2] Give note on data types in C++. 3] Give uses of PERL. 4] What is bioperl? 5] Give note on Built-In functions. 6] Give note on data abstraction. 7] Give note on Database. **Long Type** 1] Explain C++ programming with history and features. 2] Introduce PERL. Explain uses in Bioinformatics. 3] Explain data types and variables in PERL. 4] Describe loops in PERl. 5] Describe functions. 6] Explain three level architecture. 7] Explain Database languages.			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks			

Bioinformatics MJ-Theory 11-104220				
TOOLS AND TECHNIQUES IN BIOINFORMATICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning tools and techniques in Bioinformatics 2. To understand the gene prediction and protein analysis 3.To understand programming application 4. To provide information about workflow and significance			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Protein and Gene prediction CO2. Get to know Protein analysis and gene database CO3. Know the Gene, protein and tools modeling CO4. Understand the software and tools used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Tools and Techniques**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration , Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Bioinformatics Tools: Tools, comparative between Tools and Databases			
	1.2 Data formats / File Formats: GenBank, PDB, FASTA, FASTQ			
	1.3 Bioinformatics Pipeline Concept: Components, Applications, Workflow			
	1.4Genetic Markers: Types andApplications			
Unit II	**Gene Prediction and Protein Analysis**	**8hrs**	**8**	
	2.1 Gene Structure: exons, introns, ORF's			
	2.2 ORF: Concept, Tools - ORF finder, Genscan			
	2.3 Protein Motif and Domains: Types and Applications			
	2.4 Protein Motif and Domains Tools: Interpro, PROSITE, pFam			
Unit III	**Sequence Analysis**	**7hrs**	**7**	
	3.1 Introduction to Sequence Alignment and Its Significance			
	3.2 Pairwise and Multiple Sequence Alignment: Features and Methods			
	3.3 Local and Global Alignment and Algorithm: Features, Algorithm			
	3.4 Database Similarity Searches: BLAST, FASTA, PHI-BLAST, PSI-BLAST			
Unit IV	**HMM (Hidden Markov Model)**	**8hrs**	**8**	
	4.1 HMM: Basic Concept, Components			
	4.2 Application in Sequence			

	Alignment and Structure Prediction 4.3 HMMER: Functions, Workflow and Significance 4.4 HMMSTR: Workflow, Features and Significance			
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide to the analysis of genes and proteins" John Wiley and Sons 2. Des Higgins, Willie R. Taylor, Willie Taylor (2000) "Bioinformatics: sequence, structure, and databanks : a practical approach" Oxford University Press 3. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969- 712-1) 4. J. Setubal and J. Meidanis(1997) Introduction to Computational Molecular Biology, PWS Publishing Co 5.Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide"			
Model Questions:	**Short Type** 1]What is bioinformatics tools? 2] Give note on genetic markers. 3] What is ORF? 4] What is Motif? 5] Give a note on sequence alignment. 6] What is HMM? 7] Give note on HMMER. **Long Type** 1] Describe different file formats. 2] Explain protein motif and domains with tools. 3] Explain Gene structure. 4] Describe pairwise and multiple sequence alignment. 5] Explain database similarity searches. 6] Explain local and global alignment. 7] Explain HMM with applications in sequence alignment and structure prediction.			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks			

Bioinformatics MJ-Theory 12-104221				
SQL PROGRAMMING				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning tools and techniques in Bioinformatics 2. To understand the database concept 3.To understand the basic of SQL 4. To provide information about C++ and PERL			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of SQL programming CO2. Get to know Database language CO3. Know the SQL operators and basic fundamental CO4. Understand the software and language used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Database Concepts**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1.1 Database: Components and Advantages			
	1.2 Importance of Database in Bioinformatics			
	1.3 Types of Database: Relational, NoSQL, Hierarchical, Network, Object-Oriented			
	1.4 Basic Database Design: Normalization, Steps of Database Design			
Unit II	**Basics of SQL**	**8hrs**	**8**	
	2.1 SQL: Features, Basic SQL operations, Advantages			
	2.2 Data types: Numeric, Character, Date and Time, Boolean			
	2.3 Database Languages : DDL, DML, DCL, TCL			
	2.4 Attributes, Constraints, Keys			
Unit III	**SQL Fundamentals**	**7hrs**	**7**	
	3.1 Built-In Functions: Aggregate, Numeric, String			
	3.2Set Operators : Union, Intersect, Minus			
	3.3Boolean Operators : AND,OR, NOT			
	3.4SQL Clauses: Select, From, Where, Having, Group By, Order By			
Unit IV	**SQL Joins and MYSQL**	**8hrs**	**8**	
	4.1 SQL Joins: Definition, Advantages			
	4.2 Types of Joins: Inner Join, Left Join, Right Join, Full Join			
	4.3 MYSQL: Applications, Advantages and limitations			
	4.4 MYSQL installation			

References:	1.Date, C.J. (2000) "An introduction to Database systems"; Seventh Edition, Addison Wesley Publishers. 2. Elmasri and Navathe (2004) "Fundamentals of Database systems" Fourth Edition, Addison Wesley Publishers. 3. Silberschatz, A., Korth, H.F. and Sudarshan, S. (2002) "Database system Concepts"; Fourth Edition, McGraw Hill Publishers. 4. Ullman, J. D. (2001) "Principles of Database systems"; Second Edition, Galgotia Publications 5. Getting Started with SQL: A Hands-On Approach for Beginners 1st Edition, Kindle Edition
Model Questions:	**Short Type** 1] What is Database? 2]Giveimportance of database in bioinformatics. 3] What is SQL? 4] Give note on attributes. 5] Give note on Boolean operators. 6]What is aggregate function? 7] What is MYSQL? **Long Type** 1] Explain database design. 2] Describe database languages. 3] Explain built - in functions. 4] Describe set operators. 5] ExplainSQL clauses. 6] Explain SQL joins. 7] Describe MYSQL with installation.
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MJ Lab/Practical -21-104222		
Practical on theory paper 10, 11 and 12		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of 2.To provide hands on practical on 3. To provide practical training of 4. To learn different Tools of	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different etc CO-2: By this experiment students will experience handling different CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A	1. Write a PERL script to store DNA sequence.	Lectures, Power point presentation, Discussion,
	2. Write a PERL script to transcription of DNA sequence	
	3. Write a PERL script to Create an array.	

	4.Write a program to create Database	Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
Part B	5. To study GenBank file format.	
	6. To study PDB file format.	
	7. To study PHI-BLAST	
	8. To study domain using - Interpro / PFam	
Part C	9. Write a program to study Aggregate function.	
	10. Write a program to study SQL Clauses.	
	11. Write a program to study Set operators.	
	12. Write a program to perform DDL commands	
References:	1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics-a practical guide" 2. Elmasri and Navathe (2004) "Fundamentals of Database systems" Fourth Edition, Addison Wesley Publishers. 3. Silberschatz, A., Korth, H.F. and Sudarshan, S. (2002) "Database system Concepts"; Fourth Edition, McGraw Hill Publishers.	

Examination , Evaluation and Assessment Scheme

Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics MJ- ELECTIVE- Theory 3-104223				
PYTHON PROGRAMMING				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning Concepts of Python in Bioinformatics 2. To understand the Python 3.To understand application python program 4. To provide information about python software and tools			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of python and its application CO2. Get to know Python program CO3. Know the importance of Python in Bioinformatics CO4. Understand the software and tools			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Python** 1] Python: Introduction, Role of Python in Bioinformatics 2] Features and Applications of Python 3] Installation of Python 4] First Python Program	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching,
Unit II	**Python Basics** 1] Data Types: Numeric, String,	**8hrs**	**8**	

	Boolean 2] Variables: Introduction, Creating Variable, Rules for Naming Variable, Assigning Multiple Values, Changing Variable Value 3] Keywords And Indentation :Keywords- Example; Indentation- Introduction, Importance, Rules 4] Basic Syntax in Python 5] Functions: Built-in Functions, user Defined Functions, Advantages			Experimental learning. Direct instructions.
Unit III	**Python Collections (Arrays)** 1] List: Characteristics, Creating a list, Accessing elements, List operations 2] Set: Creating a set, Set operations 3] Tuples and Ranges: Creating a tuple, Accessing elements, Tuple Operations 4] Dictonaries: Characteristics, Creating dictonary, Dictonary operations	**7hrs**	**7**	
Unit IV	**Control Statements and OOP** 1] Control Statements :if, elif, if else, nested if- else 2] Loops: for, while, break, continue 3] Object Oriented Programming: Basic concept of OOP 4] Advantages of OOP	**8hrs**	**8**	
References :	1. Mark Lutz, David Ascher (2003) Learning Python. O'Reilly & Associates 2. Alan Gauld (2000) Learn To program Using Python Addison –Wesley 3. Alex Martelli (2003) Python in a Nutshell, O'Reilly. 4. "Python For Everyone", 3ed, An Indian Adaption by Cay S. Horstmann and Rance D. Necaise 5. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition , Wiley India Pvt.Ltd. 6.Benjamin, Cummings and Booch, G. (1994) "Object Oriented Design and Applications"; Second edition, Addison Wesley Publishers			
Model Questions:	Short Type 1] Give note on history of python. 2] Writefirst python program. 3] Give note on python variable. 4] What is OOP? 5] Give note on advantages of OOP 6] What is list? 7] What is set? Long Type 1] Describe features and applications of python. 2] Explain keywords and indentation of python. 3] Explain data types and variables. 4] Describe control statements in python. 5] Explain loops in python. 6] Explaindictionaries. 7] Describe tuples and ranges.			

	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MJ Elective Lab/Practical -1-1042		
Practical on PYTHON PROGRAMMING		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of 2.To provide hands on practical on Python 3. To provide practical training of Python 4. To learn different Tools of Python program	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different practical based on Python CO-2: By this experiment students will experience Python program CO-3: This practical hold the students to deal with Biological database CO-4: Will deal with python operation	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1. Write and execute first python program.	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. To demonstrate different python data types and variables.	
	3. To demonstrate control statements - if, if....else, if....elif....esle.	
	4. To demonstrate loops - for, while, break and continue.	
	5. To create simple class and object	
	6. To demonstrate python list operations.	
	7. To demonstrate python set operations.	
	8. To demonstrate range ( ) function.	
	9. To demonstrate dictionary operations.	
References:	1. "Python For Everyone", 3ed, An Indian Adaption by Cay S. Horstmann and Rance D. Necaise 2. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition , Wiley India Pvt.Ltd. 3.Benjamin, Cummings and Booch, G. (1994) "Object Oriented Design and Applications"; Second edition, Addison Wesley Publishers.	

Examination , Evaluation and Assessment Scheme	
Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics MJ- ELECTIVE- Theory 4-104225				
JAVA PROGRAMMING				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives:	1. Learning Concepts of JAVA in Bioinformatics 2. To understand the JAVA 3.To understand application JAVA program 4. To provide information about JAVA Types			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of JAVA and its application CO2. Get to know JAVA program CO3. Know the importance of JAVA in Bioinformatics CO4. Understand the software and tools			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Java**	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	1] Java :Introduction, History, Features)			
	2] Components of Java Platform Architecture (JVM, JRE, JDK)			
	3] Installation and Configuration of Java			
	4] Structure of Java Program (Writing, Compiling, Executing)			
	5] Applications of Java Programming			
Unit II	**Fundamentals of Java**	**8hrs**	**8**	
	1] Variables and Constants: (Declaration, Initialization, Naming Rules)			
	2] Data Types: (Primitive Data Types, Non-Primitive Data Types)			
	3] Operators: (Arithmetic, Logical, Relational, Assignment, Bitwise, etc.)			
	4] Input and Output in Java			
Unit III	**Control Statements and Arrays**	**7hrs**	**7**	
	1] Decision-Making Statements: (if, if-else, nested if, switch)			
	2] Looping Statements: (for loop, while loop, do-while loop)			
	3] Jump Statements: (break, continue, return)			
	4] Strings and Arrays: (One-Dimensional, Two-Dimensional, Array Manipulation)			
Unit IV	**Object-Oriented Programming in Java**	**8hrs**	**8**	
	1] Classes and Objects			
	2] Inheritance: (Single, Multilevel, Hierarchical)			
	3] Polymorphism: (Compile-Time Polymorphism, Run-Time			

	Polymorphism) 4]Basics of File Handling			
References :	1. Core Java (Volume I & II): Authored by Cay S. 2. Designing Hexagonal Architecture with Java: Authored by Alex Garcia-Giraldo. 3. Cloud Native Java: Co-authored by Josh Long and Kenny Bastani. 4. Modern Java in Action: Co-authored by Raoul-Gabriel Urma, Mario Fusco, and Alan Mycroft. 5. Java Generics and Collections: Co-authored by Maurice Naftalin and Philip Wadler. 6.Optimizing Java: Co-authored by Benjamin J. Evans, James Gough, and Chris Newland.			
Model Questions:	Short Type 1] What is Java Programming? 2] What is JVM? 3] What is JRE? 4] Give note on variables and constants in Java. 5] Give note on relational operators. 6] What is an Array? 7] Give note on File Handling. Long Type 1] Explain Structure of Java Program. 2] Describe Applications of Java Programming. 3] Explain Input and Output in Java. 4] Explain Looping Statements with example. 5] Explain Jump Statements with example. 6] Explain Inheritance. 7] Explain Polymorphism			
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks			

Bioinformatics MJ Elective Lab/Practical -23-104226 **Practical on JAVA PROGRAMMING**		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of JAVA 2.To provide hands on practical on JAVA 3. To provide practical training of JAVA 4. To learn different program of JAVA	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different practical JAVA CO-2: By this experiment students will experience CO-3: This practical hold the students to deal with database, Bioinformatics tools CO-4: Will deal with JAVA programming	
Unit System	**Content**	**Incorporation of Pedagogies**

Part A:	1]Write and execute simple Java program.	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2] To demonstrate different Java data types	
	3] To perform arithmetic operations	
	4] To perform relational operations using Java	
	5] To demonstrate decision making statements (if, if-else, nested if)	
	6] To demonstrate loops (for, while, do-while)	
	7] To demonstrate jump statements (break, continue, return)	
	8] To create simple class & objects	
	9] To create a new file using Java	
	10]To demonstrate single inheritance in Java	
References:	1. Core Java (Volume I & II): Authored by Cay S. 2. Designing Hexagonal Architecture with Java: Authored by Alex Garcia-Giraldo. 3. Cloud Native Java: Co-authored by Josh Long and Kenny Bastani.	

Examination , Evaluation and Assessment Scheme	
Practical (External) 25 Marks	**Practical (Internal) 25 Marks**
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

Bioinformatics MN-Theory 06-104307				
ADVANCED BIOINFORMATICS				
Credit :02		**Workload (Hrs/Week): 02**		
Course Objectives :	1. Learning tools and techniques in Bioinformatics 2. To understand the gene prediction and protein analysis 3.To understand programming application 4. To provide information about workflow and significance			
Course Outcomes:	By the end of the course students will be able to CO1. Know the basics of Protein and Gene prediction CO2. Get to know Protein analysis and gene database CO3. Know the Gene, protein and tools modeling CO4. Understand the software and tools used in Bioinformatics			
Unit System	**Content**	**Work load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Database Concept** 1.1 Basics of Database : Component, Types and application 1.2 Database language : DDL,DML, DCL, TCL 1.3 Biological Database: Primary, Secondary and composite 1.4 Biological Data formats: Sequence Data formats, Annotation data formats, Protein Data formats	**7hrs**	**7**	Lectures, Power point presentation, Discussion, Demonstration , Collaborative learning, Problem based learning(PBL), Peer teaching,

Unit II	**Phylogenetics**	**8hrs**	**8**	Experimental learning. Direct Instructions.
	2.1 Introduction to Phylogenetics			
	2.2 Phylogenetic Trees: Components, Types of Tree Diagrams			
	2.3 Methods of Phylogenetics Tree construction			
	2.4 Applications of Phylogenetics			
Unit III	**Applied and emerging Bioinformatics**	**7hrs**	**7**	
	3.1 System and Network Biology			
	3.2 Pathway analysis: Types of Biological pathways, Pathway Database			
	3.3 Pharmacogenomics: Introduction and application			
	3.4 AI and machine learning in Bioinformatics			
Unit IV	**Basics of PERL Programming**	**8hrs**	**8**	
	4.1 Introduction to PERL			
	4.2 PERL data, types and variable			
	4.3 PERL operators: Relational, Arithmetic, logical			
	4.4 Basic PERL programs			

References:	1.Date, C.J. (2000) "An introduction to Database systems"; Seventh Edition, Addison Wesley Publishers. 4. J. Setubal and J. Meidanis(1997) Introduction to Computational Molecular Biology, PWS Publishing Co 5.Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide"
Model Questions:	**Short Type** 1.What is database 2. What is protein data format 3. What is Phylogenetics 4. Write notes on Pharmacogenesis 5. Write basic PERL Program **Long Type** 1. Describe biological database 2. Explain Phylogenetics tree construction methods 3. Explain application of Pharmacogenesis 4. Describe PERL data types and variable
	Examination , Evaluation and Assessment Scheme 1. External Theory - 30 Marks 2. Internal Assessment - 20 marks **Distribution of Internal marks:** 1. CAT (Best 2 out of 3 tests) - 10 Marks 2. Seminar/ Field visit/ Assignment/ Survey report - 10 Marks

Bioinformatics MN Lab/Practical -24-104307		
Practical on ADVANCED BIOINFORMATICS		
Credit :02	**Workload (Hrs/Week): 04**	
Course Objectives:	1. To understand the Practical experience of database 2.To provide hands on practical on Phylogenetics 3. To provide practical training of Phylogenetics tree constructrion 4. To learn different program of PERL programming	
Course Outcomes:	After completion of the course: Students will be able to understand the respective practical's .i.e. CO-1: Student could retrieve the different practical on Database CO-2: By this experiment students will experience Phylogeneticspracticals CO-3: This practical hold the students to deal with database, treeconstruction CO-4: Will deal with PERL programming	
Unit System	**Content**	**Incorporation of Pedagogies**
Part A:	1. Write a program to perform DDL command	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.
	2. Write a program to perform DML command	
	3. Write a program to create database	
	4. To generate rooted and un-rooted tree	
	5. To construct phylogenetic tree using Distance based method	
	6. To construct phylogenetic tree using Character based method	
	7. Write a PERL program to demonstrate simple structure	
	8. Write a PERL script to store DNA/Protein sequence	
References:	1. Core Java (Volume I & II): Authored by Cay S. 2. Designing Hexagonal Architecture with Java: Authored by Alex Garcia-Giraldo. 3. Cloud Native Java: Co-authored by Josh Long and Kenny Bastani.	

Examination , Evaluation and Assessment Scheme

Practical (External) 25 Marks	Practical (Internal) 25 Marks
Major Practical- 10	Students Performance - 10
Minor Practical -10	Students Attendance - 10
Viva-voce -05	Report/ Activity submission - 05

<table>
<tr><th colspan="3">Bioinformatics VSC-2 Lab/Practical-19-104504</th></tr>
<tr><th colspan="3">R- Programming</th></tr>
<tr><th colspan="3">Credit :02 Workload (Hrs/Week): 04</th></tr>
<tr><td>Course Objectives:</td><td colspan="2">Practical experience of skill development of R-programming
Students can learn Biological sequence and its related programs</td></tr>
<tr><td>Course Outcomes:</td><td colspan="2">Develop conceptual as well as applied knowledge and skills in the field of ComputerFundamentals and Operating Systems for bioinformatics.</td></tr>
<tr><td>Unit/ Sr. No.</td><td>Content</td><td>Incorporation of Pedagogies</td></tr>
<tr><td rowspan="8">Part A:</td><td>1. To study basic R commands and different data types.</td><td rowspan="8">Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning(PBL), Peer teaching, Experimental learning. Direct instructions.</td></tr>
<tr><td>2. To create and manipulate vectors</td></tr>
<tr><td>3. To create matrix and perform operations</td></tr>
<tr><td>4. To create and access list elements</td></tr>
<tr><td>5. To create and manipulate data frames</td></tr>
<tr><td>6. To create user defined functions</td></tr>
<tr><td>7. To perform basic statistics</td></tr>
<tr><td>8. To analyse biological sequence</td></tr>
<tr><td>References:</td><td colspan="2">11.Date, C.J. (2000) “An introduction to Database systems”; Seventh Edition, Addison Wesley Publishers.
4. J. Setubal and J. Meidanis(1997) Introduction to Computational Molecular Biology, PWS Publishing Co
5.Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) “Bioinformatics– a practical guide”</td></tr>
<tr><td>Model Questions:</td><td colspan="2">Question Paper for External Practical Examination:
1. one major exercise and one minor exercise should be conduct from the list
2. One field project/assignment should be conduct by the students
3. Hands on training/ workshop/seminar should be conduct
Instructions: -Answer all questions. -Write your answers in the provided booklet. -Ensure the clarity and neatness in your responses.</td></tr>
</table>