Sant Gadge Baba Amravati

University Amravati

NEPv23 M.Sc.

Bioinformatics

Programme

Objective:

1. The program aims to utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
2. The program aims to impart extensive understanding and learning of theoretical concepts in Life Sciences.
3. Each semester includes at least one core course in life sciences along with computational biology in each semester.
4. Basic practical methodology is incorporated as practical sessions in Laboratory courses in each semester.
5. Developing and implementing computational logic, learning programming languages, algorithms and software for progressive life science solutions.
6. Better understanding of dynamic biological processes and their understanding at molecular level enabled through and correlated using internet and Bioinformatics.
7. To develop skilled bioinformatics professionals who have life science background and who are simultaneously proficient in pharmacogenomics, Drug delivery System and Parasitology.
8. To introduce new age concepts of big data in the 'omics' era and their analysis.

Programme Specific Outcomes (PSO):

1. Students undertaking the course shall have fundamental knowledge in theoretical Biochemistry, Cell Biology, Molecular Biology, genomic, computational biology and Genetics.
2. They will possess basic biochemistry and computational biology practical skills and its application in research and industry.
3. Students undertaking the course shall have fundamental knowledge in theoretical Cell Biology, Biochemistry, Mathematics, Statistics, Parasitology and database management, possess basic practical skills in these fields and its application in research and industry.
4. Students will learn on various aspects in Biotechnology and have hands on skills in Molecular Techniques.
5. Students will learn basic mathematical and statistical concepts and learn to apply them in aiding life science research and analysis.
6. As beginners the students will learn to use a computer, internet, scope and applications of bioinformatics.
7. Students will later learn to use the vast array of biological databases and their resources. Knowledge in life sciences would be the key and tools, methodologies and softwares used in bioinformatics will give them a comprehensive edge in data analysis.

8. Differential skills on basis of bioinformatics and computational biology proficiency would be later validated through academic supervision and systematically guided according to their skill.
9. Students as a part of curriculum will learn many programming languages from basic C, HTML etc. to PERL, PYTHON, R Programming, etc.
10. Students will be able to use free software, operating systems, work in command line environments and extensively work in databases, their creation and management. This will be ideal for job opportunities for them in IT enabled services as well.
11. Drug discovery strategies from life science point of view and the concerted computational approach are learned, evaluated and practiced through experimental sessions and thoroughly learned.
12. Students learn Genomics and Proteomics as primary subjects in their quest for biological repositories of information where in they will find their data which they will later analyze using next generation techniques for prediction of function and annotation.
13. Students also learn basics of data mining, machine learning, and artificial neural networks as a part of curriculum in bioinformatics which can be considered as a stepping stone in comprehending industry demands and hype surrounding big data analysis.

Employability Skills:

After completion of Programme in Bioinformatics the student/s would be placed in

1. PhD. in Bioinformatics
2. Post-Doctoral fellow.
3. Data Scientist
4. Drug delivery system analyst
5. Pharmacogenomics industry
6. As a Computational Biologist.
7. Biotechnology industry as a biomolecular engineer
8. Senior Software Engineer
9. Bioinformatics Engineer
10. Bioinformatics Analyst
11. Parasitic informatician
12. As an academician
13. As a computer programmer.
14. As expert in genomics and proteomics industries.
15. As a primer designer.

Scheme of Teaching, Learning & Examination leading to Two Years PG Degree Master of Science in the Programme Bioinformatics following Three Years UG Programme wef 2023-24
Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option
(M.Sc. Part II) Semester III

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	Contemporary Applied Technological Advancements in Research relevant/supportive to Major DSC-I.3	**Th-Major**	BINF 02	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
2	DSC-II.3 Chemo-informatics	**Th-Major**	BINF 301	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
2	DSC-III.3 Molecular Modeling and Drug Designing	**Th-Major**	BINF 302	**3**			**3**	**3**		**3**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
3	DSE-III /MOOC (Elective Option) Bio-programming I	**Th-Major Elective**	BINF 303	**3**			**3**	**3**		**3**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
																	Minimum Passing Marks		
4	DSC-I.3 Lab/Pr	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
5	DSC-II.3 Lab	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
5	DSC-III.3 Lab	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
6	DSE-III Lab /MOOC Lab	**Pr-Major Elective**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
7	**Research Project Phase-I**	**Major**			**2**	**4**	**6**	**2**	**2**	**4**				**50**	**--**	**50**	**25**		**P**
8	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**															
	TOTAL									**22**						**600+50**			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory: Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC I.3	**Technological Advances in Research**	**04**

Cos:

1. Understand concepts and definitions of educational research
2. Select a tentative research problem that will be subsequently developed into a research proposal
3. Know and use library reference sources and services
4. Understand how to develop Chapter One of the thesis/dissertation

Unit-I	Introduction to Philosophy: definition, nature and scope, concept, branches Ethics: Definition, moral philosophy, nature of moral judgmentsand reactions. Advance research in Botany Referencing and Citation of references.
Unit-II	Ethics with respect to science and research Intellectual honesty and research integrity in relation to Botany Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing Selective reporting and misrepresentation of data
Unit-III	Publication ethics: definition, introduction and importance Best practices/standards setting initiatives and guidelines:COPE, WAME etc. Conflicts of interest Publication misconduct: Definition, concept, problems thatlead to unethical behavior and vice versa, types Violation of publication ethics, authorship and contributorship Identification of publication misconduct, complaints andappeals Predatory publishers and journals
Unit-IV	Viability and Adverse drug reaction in drug response, Multiple inherited genetic factors influence the outcome of drug treatments, Association studies in pharmacogenomics, Strategies for pharmacogenomics Association studies, Benefits of Pharmacogenomics in Drug R & D.
Unit-V	Platform technologies and Pharmaceutical process, its applications to the pharmaceutical industry, Understanding biology and diseases, Target identification and validation, Drug candidate identification

	and optimization, safety and toxicology studies. The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.
Unit-VI	**Targeting Methods Nanoparticle:** Introduction, Preparation, Evaluation Liposomes: Introduction, Preparation, Evaluation. **Micro Capsules / Micro Spheres Microsphere:** Introduction, Types, preparation, Evaluation Monoclonal Antibodies: Introduction, preparation, Application Niosomes: Introduction, preparation, Application Aquasomes: Introduction, preparation, Application Phytosome: Introduction, preparation, Application Electrosomes: Introduction, preparation, Application.

Suggested Reading:

1. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
2. Bird, A. (2006). Philosophy of Science. Routledge.
3. Chaddah, P. (2018). Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized. ISBN: 978-938748086 Indian National Science Academy (INSA) (2019).
4. Ethics in Science Education, Research and Governance. ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf
5. MacIntyre, Alasdair (1967). A Short History of Ethics. London. National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
6. Resnik, D.B. (2011). What is Ethics in Research & Why is it Important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Learning Outcome:

Students would be able to

1. Students who complete this course will be able to understand and comprehend the basics in research methodology and applying them in research/ project work.
2. This course will help them to select an appropriate research design.
3. With the help of this course, students will be able to take up and implement a research project/ study.
4. The course will also enable them to collect the data, edit it properly and analyse it accordingly. Thus, it will facilitate students' prosperity in higher education.
5. The Students will develop skills in qualitative and quantitative data analysis and presentation.
6. Students will be able to demonstrate the ability to choose methods appropriate to research objectives

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC II.3	**Chemo-informatics**	**03**

Cos :

2. Have the knowledge of the basic ligand/structure based approaches.
3. Understand the basic algorithms used in the established software to carry out the most common CADD project.
4. Understand the importance of proper use of various parameters in cheminformatics application programs.
5. Practical use of various computational tools available for computer aided drug design including 2D/3D structural database.

Unit-I : (Introduction to Chemo-informatics)	Chemo-informatics: Introduction, scope and application, Basics of Chemo-informatics, Current Chemo-informatics resources for synthetic polymers, pigments. Primary, secondary and tertiary sources of chemical information, Databases: Chemical Structure Databases (PubChem, Binding database, Drugbank), Database search methods: chemical indexing, proximity searching, 2D and 3D structure and substructure searching. Drawing the Chemical Structure: 2D & 3D drawing tools (ACD Chemsketch) Structure optimization.
Unit-II : (Introduction to Chemo-informatics)	Introduction to quantum methods, combinatorial chemistry (library design, synthesis), spectroscopic methods and analytical techniques, Representation of Molecules and Chemical Reactions: Different types of Notations, SMILES Coding, Structure of Mol files and Sd files (Molecular converter, SMILES Translator). Similarity search of the molecule (Zinc Database).
Unit-III : (Introduction to Chemo-informatics)	Analysis and use of chemical reaction information, chemical property information, spectroscopic information, analytical chemistry information, chemical safety information, QSAR- Data Analysis, Structure-Activity Relationships, 2D QSAR, 3D QSAR, QSPR, Statistical methods used in QSAR, Lead Identification, Molecular Descriptor Analysis.
Unit-IV : (Introduction to Chemo-informatics)	Target Identification: Molecular Modeling and Structure Elucidation: Homology Modelling (Modeller 9v7, PROCHECK), Visualization and validation of the Molecule (Rasmol, Pymol Discovery studio), Applications of Chemo- informatics in Drug Research - Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties.
Unit-V : (Introduction to Chemo-informatics)	Drug Discovery: Structure based drug designing, Docking Studies (Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds, Library docking)
Unit-VI : (Introduction to Chemo-informatics)	Pharmacophore - Based Drug Design, Pharmacophore Modeling (Identification of pharmacophore features, Building 2D/3D pharmacophore hypothesis), Toxicity Analysis-Pharmacological Properties (Absorption,

	Distribution and Toxicity), Global Properties (Oral Bioavailability and Drug-Likeness) (ADME, OSIRIS, and MOLINSPIRATION)

Suggested Reading:

1. Bajorath J (2004), "Chemoinformatics: Concepts, Methods and Tools for Drug Discovery" Humana Press
2. Leach A, Gillet V, "An Introduction to Chemoinformatics" Revised edition, Springer
3. Gasteiger J. Engel T. "A textbook of Chemoinformatics" Wiley- VCH GmbH & Co. KGaA
4. Bunin B. Siesel B. Guillermo M. "Chemoinformatics: Theory, practice & products", Springer
5. Lavine B. (2005), "Chemometrics and chemoinformatics" American Chemical Society
6. Casteiger J. and Engel T (2003) "Chemoinformatics" Wiley-VCH
7. Bunin Barry A. SieselBrian,MoralesGuillermo,Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006. ISBN: 1402050003.
8. Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: WileyVCH; 1st edition. 2003. ISBN: 3527306811.
9. Leach Andrew R., Valerie J. Gillet. An introduction to chemoinformatics. Publisher: Kluwer academic, 2003. ISBN: 1402013477.
10. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes), 2003. Publisher: Wiley-VCH. ISBN: 3527306803.

Learning Outcome:

- To impart knowledge on chemical databases, various advanced techniques and tools like docking, QSAR studies etc employed in computational drug discovery
- Introduction about the basic concepts of cheminformatics
- Explain about various approaches used in the design of pharmacophores
- Describe about the concepts of SAR & QSAR
- Explain various techniques used in virtual screening
- Describe about various techniques used in Structure Based Drug Design

Part B

Syllabus Prescribed for 2022 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester III

Code of the Course Subject **Title of the Course/ Subject** **No. of periods/ week**

DSC III.3 **Molecular Modeling and Drug Design** **03**

Cos :

15. A Molecular Modeling and Drug Design is structure-based drug design and the biophysical aspects of macromolecule and small molecule interactions.
16. A working knowledge of the molecular modeling tools and databases used to produce models that facilitate the understanding of macromolecular interactions.
17. The skills required for working in the pharmaceutical industry and for further study in the areas of molecular structure and interaction.

Unit-I : (Concepts in Molecular Modeling)	Introduction; Coordinate System; potential energy surfaces molecular graphics; Computer hardware and software; Mathematical concepts – introduction of molecular mechanics & quantum mechanics
Unit-II : (Molecular Mechanics)	Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, Vander Waals and non-bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Calculating thermodynamic properties using force field; Transferability of force field parameters, treatment of delocalized pi system; Force field for metals and inorganic systems – Application of energy minimization
Unit-III : (Molecular Dynamics Simulation Methods)	Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time-dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation. Introduction, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzman velocity, time steps, duration of the MD run. Ligand protein interactions using Gromacs.
Unit-IV : (Molecular Modeling in Drug Discovery)	Deriving and using 3D pharmacophore; Molecular Docking; Structure based methods to identify lead compounds; de novo ligand design; Applications of 3D Database Searching and Docking, Finding new drug targets to treat diseases – Pharmacophore identification - Structure based drug design - Molecular Simulations

Unit-V : (Structure Activity Relationship)	QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations
Unit-VI : (Structure Activity Relationship)	Druggable Targets, Macromolecular modeling- Ab initio modeling; Phyre 2 server. Homology Modeling; Modeller. Threading; RAPTOR. Validation of the Model – Ramachandran Plot. PROCHECK. Binding site; Q-Site finder, Catalytic site atlas. Molecular docking; ArgusLab, AutoDock, GLIDE. Drug-receptor interaction. Pymol, Rasmol viewer.

Suggested Reading:

21. Andrew R. Leach (2001) "Molecular Modeling – Principles and Applications"; Second Edition, Prentice Hall, USA
22. Fenniri, H. (2000) "Combinatorial Chemistry – A practical approach", Oxford University Press, UK.
23. Gordon, E.M. and Kerwin, J.F. (1998) "Combinatorial chemistry and molecular diversity in drug discovery"; Wiley-Liss Publishers
24. Lednicer, D. (1998) "Strategies for Organic Drug Discovery Synthesis and Design"; Wiley International Publishers
25. Swatz, M.E. (2000) "Analytical techniques in Combinatorial Chemistry"; Marcel Dekker Publishers

Learning Outcome:

This course will be able to demonstrate:

1. An understanding of the general concepts of macromolecule interactions.
2. A solid grounding in the mathematics that underpin the methods used.
3. A working knowledge of the methods and tools used in molecular modelling.
4. Knowledge of the experimental techniques that support molecular models.
5. Strong skills in the critical analysis and synthesis of scientific information.
6. The ability to conduct independent research, place findings in context and suggest new research ideas.
7. How to conduct an independent research project and how to report research data in formats suitable for publication.

ELECTIVE OPTIONS FOR NEP-20

Part B

Syllabus Prescribed for 2023 **PG. Programme**

YearProgramme **M.Sc.**

Semester III

Code of the Course	**Title of the Course/ Subject**	**No. of periods/ week**
SubjectDSE III		

Cos :

14. Student would know about the properties of DNA, RNA, and proteins, the relationships amongthese molecules, and some biological questions that have puzzled researchers.
15. Student would know how to convert a biological question into a computational problem that can besolved using computers.
16. Student would know how to read and understand solutions to computational problems, which willbe formalized as a series of tasks (an algorithm).
17. Student would learn about general approachesfor solving computational problems, and will be able to apply these approaches to newproblems encounter.

Unit-I : (Introduction to PERL)	Introduction to PERL, History and uses, PERL Basics, Data types, Basic Operators, Control Statements: if, if else, if elsif else, Loops: do, while, until, for, foreach, labels, lists, Arrays and associative arrays.
Unit-II : (Introduction to PERL)	Pattern matching: Regular expressions, Subroutines and functions: structure and invocations, scope Files and I\O: file handles, opening, closing, reading and writing, formats, manipulating files, Perl Modules: CPAN, Bioperl, obtaining and installing, Object oriented PERL
Unit-III : (Introduction to ODBC)	DBM Databases and DBM Hashes, Design of DBI, DBI Methods, DBI Environment Variables, DBD Interface Modules, Fixed Length Random-Access Databases, Variable-Length Databases, Win32 Database Interface, Perl Graphics, Using the GD.pm graphics lib
Unit-IV : (Introduction to HTML and CGI)	Basics structure of HTML, Basics HTML TAGS, URL Encoding, CGI Environment Variables, Handling forms, Accessing form Input, Extra Path Information, CGI.pm Module, Passing Parameters via CGI, Less Typing, Sever Side Includes, Debugging CGI programs, Stepping through programs, Breakpoints, Line Action

Unit-V : (**HTML References Tags**)	HTML Tag List, HTML Attributes, Global Attributes, Browser Support, Events, Colors, Canvas, Audio/Video, Doctypes, Character Sets, URL Encode, Lang Codes, Messages, Methods.
Unit-VI : (**NET Programming**)	Event driven programming, History of VB.Net, Features of VB.Net, Architecture of VB.Net [.Net server, framework, services etc.]. 1.2 Net Framework: framework components, classes, CLR, VB.Net IDE, VB.Net: Variables, Keywords, constants, Data types, Conditional statements, looping statements, case control statements.

Suggested Reading:

13. Arun Jagota (2004) "Perl for Bioinformatics" Arun Jagota
14. D. Curtis Jamison (2003) "Perl programming for biologists" Wiley- IEEE
15. D. Curtis Jamison (2008) "Perl Programming For Bioinformatics & Biologists" Wiley-India
16. James D. Tisdall (2003) "Mastering Perl for bioinformatics" O'Reilly Media, Inc
17. Jules J Berman (2008) "Perl: The Programming Language" Jones & Bartlett Learning
18. Randal L. Schwartz, Tom Phoenix, Brian D. Foy (2008) "Learning Perl" O'Reilly Media, Inc
19. Vittal R. Srinivas (2005) "Bioinformatics: A Modern Approach" PHI Learning Pvt. Ltd

Learning Outcome:

1. Basic Applications of Computer; Components of Computer System.
2. Concept of Internet; WWW and Web Browsers; Search Engines
3. Data analysis by different computational techniques
4. Concepts of computer programming languages like C, JAVA helps in solving different complex problem in biology or data analysis
5. Writing scripting for different data analysis
6. Command line scripting in DOS and LINUX
7. Writing script in R programming to solve biological problem.

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Bioinformatics

Semester 1 Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicem/hands-on/Activity)	**(No. of Periods/Week)**
Practical VII	Practical Based on DSC I.3 & II.3	**04**

CO:

1. To develop logical understanding of the subject.
2. To create the ability to model, solve and interpret Molecular Modelling, Drug Design, Chemo-informatics , Bio- Programming and Research Methodology, IPR and Bioethics problems.

3. To provide an overview of functions of complex variable which helps in solvingmany biological problems
4. Fundamentals of Computer, Basic Applications of Computer; Components of Computer System.
5. Concept of Computing, Data and Information
6. Data structure and its relevance to biological science
7. Communication using the Internet: Basic of Computer networks; LAN, MAN, WAN;
8. Concept of Internet; WWW and Web Browsers; Search Engines; Understanding URL
9. Design & Structure of biological databases
10. ntroduction to PERL as scripting language; variables; Array; Initialization and manipulation
11. Arithmetic and logical operators; Conditional statement and Loops; Regular Expressions; Function and subroutines
12. Application of PERL in Bioinformatics; concatenating DNA fragments; DNA to RNA; Reading protein Files; Finding motifs; ORFs; DNA to protein

List of Practical's based on Advance Research Methodology

1. Abstract writing
2. Plagiarism checking
3. Referencing styles
4. Mendeley citation management tool
5. Google scholar
6. Drug absorption, distribution, metabolism and excretion

*** List of Practical/Laboratory**

Experiments/Activities Molecular Modelling, Drug Design, etc.

1	Binding site identification
2	Pharmacophore identification
3	Rigid body docking using Autodock and ADT
4	Molecular dynamics simulations using Gromacs
5	Visual Molecular Dynamics (VMD)
6	Advance Visualization with (Discovery Studio)
7	Receptor and Ligand Optimization
8	Conformational Analysis
9	Chemo-informatics Software
a.	AMBER
b.	ArgusLab 3.0
c.	BABEL
d.	Chemos
e.	VEGA
f.	PubChem
g.	ChemSketch
10	Chemo-informatics databases
11	Chemical structure representation
12	Smiles - Simplified Molecular Input Line Entry System
13	Molecular Dimension Limited (MDL) file format for chemical connectivity
14	Chemical Structure similarity
15	Fingerprints and search for substructure similarity using expasy
16	Generation of 3D structures from 2D representations
17	3D structure similarity

18	Elements of molecular descriptors
19	Writing Pseudo Codes
20	Working with Objects, Arrays, Conditionals and Loops
21	Creating Classes and Applications in Java
22	Managing Simple Events and Interactivity
23	Creating User Interfaces with AWT, Modifiers

Learning Outcome:

1. Research, inquiry and analytical thinking abilities
2. The capability and motivation for intellectual development
3. Ethical, social and professional understanding
4. Effective research communication
5. Teamwork, collaborative and management skills
6. be able to describe the process of drug discovery and development
7. be able to discuss the challenges faced in each step of the drugdiscovery process
8. have gained a basic knowledge of computational methods used in drug

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATIPRACTICAL EXAMINATION

M.Sc. II Bioinformatics, Semester- III (NEP-20)PRACTICAL VII:- (Technological Advances in Research and Chemo-informatics)

TIME: -6 Hrs. **Maximum Marks: -50 + 50 = 100**

Q.1. Perform Major Experiment in Technological Advances in Research. **15**

Q.2. Perform Major Experiment in Technological Advances in Research. **10**

Q.3. Perform Major Experiment Chemo-informatics. **15**

Q.4. Perform Major Experiment in Chemo-informatics **10**

Q.5. Internal marks: Practical Record (20); Viva voce (20); Student overall performance and Activity – Industrial visit report /Monograph and Attendance **50**

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for 2022 Year **PG Programme**
Programme: M. Sc. Bioinformatics

Semester 1 Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical VII Cheminformatics:	Practical Based on DSC III.3	**02**

Sant Gadge Baba Amravati University, Amravati Practical Examination
Bioinformatics Semester- IV (NEP-20)
Practical VIII **Bioprogramme**
M.Sc. II Bioinformatics, Semester- III (NEP-20)PRACTICAL VIII:- (Molecular Modeling and drug designing)

Time 6hrs **Marks-25+25=50**

Q.1: Major experiment on Molecular Modeling and drug designing 20 Marks

Q.2: Minor Experiment on Molecular Modeling and drug designing 05 Marks

Practical Internal

Q.3: Viva-Voce 10

Q.4: Practical Record, Attendance and Assignments 15

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for 2022 Year **PG**
Programme:

Programme

: M. Sc. Bioinformatics

Semester 1 Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical VIII	Practical Based on DSE III.3	**02**

Sant Gadge Baba Amravati University, Amravati Practical Examination
Bioinformatics Semester- III (NEP-20)

Practical IX
Bioprogramming-I

Time 6hrs **Marks-25+25=50**

Q.1: Major experiment on Bioprogramming-I	20 Marks
Q.2: Minor Experiment on Bioiprogramming-I	05 Marks

Practical Internal

Q.3: Viva-Voce	10
Q.4: Practical Record, Attendance and Assignments	15

List of Practical/Laboratory Experiments/Activities etc.

1.	Exercise in Structured Programming: Basic Operators and Control Flow, Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope (my, local, our), Function/Subroutines, System and User Function, The local Operator, Variable-length Parameter Lists, Notes on Lexical Variable, File handle and File Tests, stat and stat Functions, Formats, Directory Access & Manipulation, Process Management, Formatting Data, System Information
2.	Exercise in Regular Expressions: Uses of Regular Expressions, Patterns, Single-Character Patterns, Grouping Patterns (Sequence, Multipliers, Parentheses as memory, Alternation) Anchoring Patterns, Precedence, Matching Operators, Ignoring Case, Different Delimiter, Variable Interpolation, Special Read-Only Variables, Substitutions, Split and Join Functions, Dynamic Programming, Approximate String Matching
3.	Exercise in CGI: URL Encoding, CGI Environment Variables, Handling forms, Accessing form Input, Extra Path Information, CGI.pm Module, Passing Parameters via CGI, Less Typing, Sever Side Includes, Debugging CGI programs, Stepping through programs, Breakpoints, Line Action
4.	Exercise in CPAN Database Modules: DBM Databases and DBM Hashes, Design of DBI, DBI Methods, DBI Environment Variables, DBD Interface Modules, Fixed Length Random-Access Databases, Variable-Length Databases, Win32 Database Interface, Perl Graphics, Using the GD.pm graphics library
5.	Exercise in Bioperl: Installing Bioperl, General Bioperl Classes, Sequences (Bio::SeqClass, Sequence Manipulation), features and Location Classes (Extracting CDS), Alignments (AlignIO), Analysis (Blast, Genscan),Databases (Database Classes, Accessing a local database), Implementing REBASE
6.	Exercise in HTML: Basics structure of HTML, Formatting text with HTML, Adding local and remote links, Adding graphics, creating lists in HTML, Creating tables in HTML, Frames, and Forms.
	Learning Outcome: 1. Right use of microscopes. 2. Identification and description of parasites. 3. Using computers and internet. 4. Characterize methods of resistance and appropriate treatment 5. or each disease. 6. Conducting documentary about some parasites throughout the Kingdom.

Scheme of Teaching, Learning & Examination leading to Two Years PG Degree Master of Science in the Programme Bioinformatics following Three Years UG Programme wef 2023-24
Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option
(M.Sc. Part II) Semester IV

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-I.4 Proteomics	Th-Major	BINF 401	4			4	4		4	3	30	70			100	12	28	P
2	DSC-II.4 Bioprogramming-II	Th-Major	BINF 402	4			4	4		4	3	30	70			100	12	28	P
3	DSC- III.4 System Biology	Th-Major	BINF 403	3			3	3		3	3	30	70			100	12	28	P
4	DSE-IV /MOOC (Elective Options) Parasite Informatics	Th- Major Elective	BINF 401	3			3	3		3	3	30	70			100	12	28	P
																	Minimum Passing Marks		
5	DSC-I.4 Laboratory	Pr-Major				2	2		1	1	3			25	25	50	25		P
6	DSC-II.4 & DSC-III.4 Laboratory	Pr-Major				2	2		1	1	3			25	25	50	25		P
7	DSE-IV Laboratory/MOOC Lab	Pr- Major Elective				2	2		1	1	3			25	25	50	25		P
8	**Research Project Phase-II**	Major			2	8	10	2	4	6	3			75	75	150	75		P

9	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**															
	TOTAL									**24**						**550+150**			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC I.4	**Proteomics**	**04**

Cos :

This course will introduce the concepts of Proteomics – its principles and techniques which play a significant role in modern systems biology and related areas. Proteomics deals with the qualitative and quantitative analysis of the proteins that express in a biological system. This course introduces the basics of evolution of proteomics as an area, the experimental aspects of tools and techniques in addressing systems level applications. As a result of this course, the students will have strong foundations and first hand scientific understanding of current trends in Proteomics.

Unit-I : (Introduction to Proteomics)	Introduction to Proteomics: Scope and Application, Complexity of the problem: Post translational modification, Phosphorylation, Methods of studying proteins, protein-protein interactions (Y2H), Practical application of proteomics and current research technology, Protein databases.
Unit-II : (The Proteome and Proteome technology)	Introduction of proteome technologies; Expression proteomics (express profile); Protein separation technology - 2D-Gel Electrophoresis, liquid chromotagraphy, use of affinity chromatography in; X-ray diffraction, NMR, mass spectroscopy and its uses in protein identification; Forward and Reverse Proteomics, Protein microarray and it types.
Unit-III : (Computational Protein Structure Prediction)	Secondary structure: Basic principles on which the prediction methods of first, second and third generation are based; algorithms of Chou Fasman, GOR methods; concepts in measuring the accuracy of predictions (Q3, Segment overlap, Mathew's correlation coefficient etc.) Tertiary Structure: Theoretical basis of the methods for structure prediction, choice of appropriate prediction approach; basic principles and protocol of Homology Modeling; Databases of models; Basic principles for fold recognition, threading approaches, basic principles of ab-initio structure prediction and the broad approaches, Structure Validation methods
Unit-IV : (Comparative Proteomics)	Protein structure comparison and classification: classes, folds; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP database, VAST and DALI. Visualization of structures using Rasmol or SPDBViewer or CHIME, Basic concepts in molecular modeling, different types of computer representations of molecules, Concepts of force fields: representations of atoms and atomic interactions, Protein Sequence alignment and it tools, Genomics and Proteomics
Unit-V : (Advance Proteomics)	Molecular force field model, molecular dynamics, MD simulation, gromacs software, hydrogen bonds, Protein structure minimization, Protein structure comparison and its algorithms. Solvent accessible surface area (SASA).
Unit-VI : (Advance Proteomics)	Prediction of protein domains, motifs, and functional sites. Functional annotation of protein structures: ligand binding sites, active sites. Active site databases. Introduction to biological pathways and pathway databases: KEGG, Reactome. Enrichment analysis of proteomic data using pathway databases.
Suggested Reading:	

1. Azuaje F., Dopazo J., (2005) “Data analysis and visualization in genomics andproteomics” John Wiley and Sons
2. Dubitzky W. Granzow M. Berrar D (2007) “Fundamentals of data mining in genomicsand proteomics”
3. Gu Jenny, Bourne P. (2009) “Structural bioinformatics” Wiley- Blackwell
4. Kraj A, Silberring J, (2008) “Proteomics: introduction to methods and applications”John Wiley & Sons
5. Liebler D.C, (2002), “Introduction to proteomics: tools for the new biology” HumanaPress
6. Mishra N.C., (2010), “Introduction to Proteomics: Principles and Applications” JohnWiley and Sons
7. Pennington S.R., Dunn M. J. (2001), “Proteomics: from protein sequence to function”BIOS
8. Reinders J, Sickmann A., (2009) “Proteomics: methods and protocols” Humana Press
9. Suhai S. (2000) “Genomics and proteomics: functional and computational aspects”Springer
10. Veetstra T.D., Yates J.R. (2006) “Proteomics for biological discovery” John Wiley andSons
11. Polanski A., Kimmel M. (2007) “Bioinformatics” Springer Verlag Berlin Heibel berg

Learning Outcome

After successfully completing this course, you will have the following competences:

1. Practical and theoretical knowledge in proteomics.
2. Knowledge about common workflows for the large-scale analysis of proteins.
3. Fundamental knowledge about quantification of proteomes.
4. Understanding how to identify proteins from mass spectrometry data.
5. Able to evaluate MS/MS data including de novo sequencing.
6. Insight into the analysis of post-translational modifications and protein-protein interactions.
7. On-hands experience with in-gel digestions, LC-ESI and MALDI mass spectrometry
    a. and protein identification.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC II.4	**Bioprogramming-II**	**04**

Cos :

10. To facilitate the students in gaining programming skills.
11. To enable the students to design and execute Java, C++ and Perl scripts
12. To interpolate biological demands through programming

Unit I : (Introduction to Java)	Basics of JAVA, History, an overview of JAVA, Object Oriented Programming, Data types- Variables and Arrays, the simple types, floating point types, Operators, Control statements, Class fundamentals, Declaring objects, Assigning object reference variables, Introducing methods, Constructors, Garbage collection, using objects as parameters, Introducing Access control, Understanding static; Nested and inner classes. The object class, Packages: Packages, Defining a package, Understanding class path, Access protection: Importing packages,
Unit II : (Introduction to Java)	Inheritance: Basics, Member access and inheritance. Using super: to call super class constructors, Creating a multilevel hierarchy.

	Implementing interfaces, Applying interfaces, Exception Handling: Fundamentals, Exception types, Using try and catch, finaly. Multiple catch clauses, Nested statements, throw, throws; Java's built in exceptions, Creating own exception subclasses, Using exceptions
Unit III : (Introduction to Unix & Linux)	Introduction to Unix & Linux, History of Unix & Linux, Basic Concepts of Operating Systems, Kernel, shell and file system structure, Basic Concepts of Linux, Basic Commands of Linux,
Unit IV : (Introduction to Unix & Linux)	The UNIX File system and Shell Intro: The Shell - Executing commands and command options, Interactive features: job control, history; The UNIX file system, File Utilities (cp, mv, rm, etc.), cmp, diff, Editors: vi; Processes and Filters: Process Utilities (ps, kill, wait, sleep); Filters: cat, head, tail, sort, uniq; Regular Expressions and Sed: Regular expressions, grep, fgrep, egrep, Sed.
Unit V : R-Programming	Introduction to R: What is R? – Why R? – Advantages of R over Other Programming Languages - R Studio: R command Prompt, R script file, comments – Handling Packages in R: Installing a R Package, Few commands to get started: installed. packages(), package Description(), help(), find. package(), library() - Input and Output – Entering Data from keyboard – Printing fewer digits or more digits – Special Values functions : NA, Inf and –inf. R Data Types: Vectors, Lists, Matrices, Arrays, Factors,
Unit VI R-Programming	Data Frame – R - Variables: Variable assignment, Data types of Variable, Finding Variable ls(), Deleting Variables – R Operators: Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators, Miscellaneous Operators - R Decision Making: if statement, if – else statement, if – else if statement, switch statement – R Loops: repeat loop, while loop, for loop – Loop control statement: break statement, next statement.

Suggested Reading:

11. Benjamin, Cummings and Booch, G. (1994) "Object Oriented Design and Applications"; Second edition, Addison Wesley Publishers.
12. Horstmann, C.S. (2000) "Computing Concepts with Java 2 Essentials"; Second Edition, John Wiley Publishers
13. Naughton, P. and Schildt, H. (1999) "Java-2: The complete Reference"; Third Edition, McGraw Hill Publishers.
14. Bal H, Hujol J, (2007) "Java for bioinformatics and biomedical application" Springer Japan
15. Lindsey C. S., Tolliver J.S., Lindblad T, (2005) "JavaTech: an introduction to scientific and technical computing with JAVA" Cambridge University Press
16. Srinivas V.R. (2005) "Bioinformatics: A modern Approach" PHI learning Pvt. Ltd

Learning Outcome:

1. Learn the basics of programing
2. Relate the necessity for programming in biology
3. Handling biological concepts with C++ and Perl scripts
4. Apply programing to analyze genomic sequences
5. Understand Bio-Perl and their application in bioinformatics to handle the complex data

PartB

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/Subject**	**No. of periods/week**
DSCIII.4	**System Biology**	**04**

Cos:

This course aims to introduce students to contemporary Systems Biology focused on mammalian cells, their constituents, and their functions. Biology is transitioning from molecular to modular. As our knowledge of the genome and gene expression deepens, and as we develop lists of molecules (proteins, lipids, ions) involved in cellular processes, we need to understand how these molecules interact with each other to form modules that act as discrete functional systems. These systems underlie core subcellular processes such as signal transduction, transcription, motility, and electrical excitability. In turn, these processes come together to exhibit cellular behaviors such as secretion, proliferation, and action potentials.

Unit-I : (Introduction to System Biology)	Introduction to Systems Biology, Biological Networks, Analysis of Biological Networks, Need for System Analysis in Biology, System Biology Approaches, Dynamic Analysis, Organization of Living Cells, Components vs. Systems, Systems Biology Markup Language (SBML)
Unit-II:(System Kinetics)	Biochemical Reaction Kinetics, Rate Equation Approach, Elementary Reactions, Complex Reaction, Michaelis-Menten Equation for Enzyme Kinetics, Stochastic Modeling and Simulation, Ki and Km Values of Enzyme, Enzyme Assay and Its Types.
Unit-III : (Reconstruction of Biochemical Networks)	Metabolic network modeling, Metabolic network simulation, Flux balance analysis, Regulation of metabolic networks, Signaling Networks, Applications of are construction, KEGG, Reactome, Brenda databases; Cell designer software.
Unit IV: (Applications of systems biology)	Overview of systems biology and its applications, Historical development and key concepts. Importance and potential impact in medicine, biotechnology, and environmental science. Disease mechanism understanding using systems biology approaches, Current research trends in systems biology.
Unit V: (Introduction to Synthetic Biology)	Synthetic Biology - Introduction, Emergence of Synthetic biology, Tools in Synthetic biology. Genetic engineering, Biosensors and its applications, Synthetic Life: Synthia; E-cell and V-cell Simulations and Applications. ethical concerns in the field of synthetic biology.
Unit VI:(Systems Neuroscience)	The principles, methods, and applications of systems neuroscience, focusing on understanding the structure and function of the nervous system at the system and circuit levels. Topics include neural circuits, sensory processing, motor control, cognition, and neurological disorders.

	The course emphasizes interdisciplinary approaches, integrating neurobiology, physiology, anatomy, and computational neuroscience.

Suggested Reading:

i. B. O. Palsson "System Biology – Properties of Reconstructed Networks" Cambridge University Press
ii. Olaf Wolkenhauer. (2010) "System Biology – Dynamic Pathway Modeling"
iii. Andres Kriete, Roland Eils (2006) "Computational systems biology" Academic Press
iv. Andrzej K. Konopka (2007) "Systems biology: principles, methods, and concepts" CRC Press/Taylor & Francis
v. Lilia Alberghina (2008) "Systems biology: definitions and perspectives" 2 Edition, Springer
vi. Uri Alon (2007) "An introduction to systems biology: design principles of biological circuits" Chapman & Hall/CRC
vii. W. N. Venables, D. M. Smith; "An Introduction to R (Version 2.8.1.)", R developer Core team.Bergman N. H. (2007),"Comparative genomics" Volume 2, Humana Press
viii. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human Genome Project" John Wiley and Sons
ix. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare
x. Clark M (2000), "Comparative genomics" Springer
xi. Kitano, H. (2002). Systems Biology: A Brief Overview.
xii. Kandel, E. R., Schwartz, J. H., & Jessell, T. M. (2012). Principles of Neural Science.
xiii. Purves, D., Augustine, G. J., Fitzpatrick, D., Hall, W. C., LaMantia, A. S., & White, L. E. (2011). Neuroscience.
xiv. Shepherd, G. M. (2013). Neurobiology.
xv. Squire, L. R., Berg, D., Bloom, F. E., Du Lac, S., Ghosh, A., & Spitzer, N. C. (2012). Fundamental Neuroscience.
xvi. Dayan, P., & AbBINFt, L. F. (2001). Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems.

Learning Outcome:

1. Describe the principles of systems biology
2. Describe key cellular processes like transcription, translation, signaling and protein secretion in a quantitative fashion
3. Use matrix notation to describe the stoichiometry of metabolic networks
4. Describe metabolic network reconstruction based on biochemical and genomic information
5. Describe how genome-scale metabolic models (GEMs) can be used for analysis of cellular physiology
6. Describe how constraints and objective functions are underlying principles of flux balance analysis
7. Describe the use of genome-scale metabolic models in research on human disease
8. Describe how meta-omics data can be analyzed
9. Describe the principles of RNAseq
10. Describe the principles of proteomics
11. Describe the principles of metabolomics

ELECTIVE OPTION FOR NEP-20

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSE IV	**Parasite Bioinformatics**	**03**

Cos :

1. General concept of parasitology.
2. Knowledge of some parasitic diseases that could be transmitted between animals andman (Zoonotic diseases).
3. Knowledge how to protect man and domestic animals from parasites and theirtreatment.
4. Basic knowledge of parasitism, the different biological inter-relationships and the hostparasite relationships.
5. Knowledge of different parasitic examples from all phyla (Protozoa & Metazoa), theirmorphology, biology, life cycles, diagnosis, treatment & control.
6. Dissemination of health awareness of these parasitic diseases.

Unit-I : (Introductionto Parasitic Diseases)	Biology of Parasites - Life Cycle, Infectivity, Demographic distribution of strains (Malaria, Leishmaniasis, Trypanosoma, Filariasis), Role of bioinformatics in Diseasesmonitoring.
Unit-II : (Introduction to Parasitic Diseases)	Parasite Genome and Proteome Databases (AnoBase, ENSEMBL, PlasmoDB), Vectors of parasites – Biology of vectors; Giardiasis , Sleeping sickness, Chagas disease, Parasite-specific genes/ gene products (e.g. house-keeping genes, genes essential for survival), Resistant Genes.
Unit-III : (Techniques tostudy Parasitic Diseases)	Full Genome Comparison, Gene Prediction, Signal sequence prediction, Protein sequence comparison and analysis, Protein structure comparison and analysis, Micro Array and Proteomics Data Analysis, Structural genomics of parasites.
Unit-IV : (Introduction toHost-parasite interaction)	Host-parasite interaction: Recognition and entry processes of different pathogens like bacteria and viruses into animal and plant host cells; alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen- induced diseases in animals and plants; cell-cell fusion in BINFh normal and abnormal cells.
Unit-V : (Introduction to Host-parasite interaction)	Host-Parasite and Host-Vector-Parasite Interactions, Pathway databases (KEGG, BioCyc, Pathguide, REACTOME), Multi-Drug Resistance - Mechanism of MDR: genomic, molecular, cellular, Identification of genes responsible for MDR, Approaches to novel drug discovery for parasite, Challenges and opportunities in vaccine

	development, Plant Parasites and diseases - Diseaseresistance genes of plants, Plant-pathogen interactions.
Unit-VI : (Parasite immunology)	Immunity to infection Antigen processing and presentation, MHC, complement system. Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group. Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.

Suggested Reading:

1. Bush, A. O., Fernandez, J. C., Esch, G.W. & Seed, R. J., "Parasitism", Cambridge University Press, 2001.
2. Melville, S.E., "Parasite genomics protocols", New Jersey. Humana Press, 2004.
3. Latey, A.N, Pune, "A modern textbook of Parasitology", Narendra prakashan, 1991.
4. Wyler, D.J. "Modern parasite biology: cellular immunological and molecular aspects", Ed., 1990.

Learning Outcome:

1. Identify parasitism, parasites and their examples.
2. Describe parasitic diseases and modes of diagnosis.
3. Trace control of parasitic infections.
4. Understand host-parasite relationship.

OPTION FOR OTHER STREAM/FACULTY

Part B

Syllabus Prescribed for 2022 Year **PG. Programme**

Programme **M.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
OEC II	**Language for Bioinformatics**	**04**

Cos :

3. Able to apply design principles to develop web based applications specially for biological data analysis Familiarity CO-2
4. To understand working on world wide web through implementations Familiarity and Assessment CO-3
5. Use various methods from computational biology to implement their programmatic versions Assessment CO-4
6. Able to design new web pages and web sites Assessment and Usage CO-5
7. Able to developed programs to describe and analyze problems in biology

Unit-I: (Language)	Introduction to Internet and World Wide Web. An overview of scripting languages, with applications towards biological data and sequence analysis. Complexity of DNA problems and their computational implications and applications. Introduction to HTML, DHTML, XML. accessing different objects of the HTML page, Dynamic page generation, Cascading Style Sheets (CSS).
Unit-II: (Language)	JAVASCRIPT: Document object model, Elements of the document object model, basic principles of JS, object based programming using JavaScript; data types and structures, array and string handling, function implementations, XML: DTD, XML schemas, XML document structure, retrieving data from database in XML format; various bio based versions of XML.
Unit III: (Language)	PHP: PHP beginning to advanced level, data types, array and string handling, mathematical expressions and functions in PHP, PHP programming (implementation of object model), Database connectivity using PHP.
Unit-VI :(Language)	Programming basics, Sequences and Strings: Storing a DNA sequence, Concatenation, Transcription, Translation, Arrays and Scalar list, Strings to Array, Operations on Strings, Subroutines and Command line arguments
Unit-V :(Language)	Calling modules, Hashes, Data Structures in Perl, Reading files and writing output formats, Regular expressions and Perl Operations, Parsing genbank, PDB, BLAST, and other file formats, Object-oriented programming, Complex Data Structures, Relational Databases.
Unit-VI :(Language)	General Introduction to Python and the class. Using the command interpreter and development environment., Python differences. Introduction to git and GitHub, Basic data types. Functions: definition and use, arguments, block structure, scope, recursion, Modules and import Conditionals and Boolean expressions Sequences: Strings, Tuples, Lists, Iteration, looping and control flow. String methods and formatting, Dictionaries, Sets and Mutability. List and Dict Comprehensions, Advanced Argument passing, Lambda, Multiple inheritance, Properties, Special methods, Emulating built-in types, Iterators and Generators, Decorators, Context Managers, Regular expression.

Suggested Reading:

4. Beginning Perl for Bioinformatics By James Tisdall, O'Reilly Media (2001)
5. Mastering Perl for Bioinformatics By James Tisdall, O'Reilly Media (2003)
6. Python For Bioinformatics By Sebastian Bassi, Chapman and Hall (2010)
7. HTML the complete reference, 2004, TMH.
8. Beginning PHP and Professional PHP, 2009, Wrox, Wiley Dreamtech.
9. JavaScript: The complete Reference, 2004, TMH.

Learning Outcome:

1. Students will demonstrate the ability to identify, formulate and solve computer systemsengineering problems.
2. Students will demonstrate the ability to design and experiment both in hardware andsoftware, analyze and interpret data.
3. Students will demonstrate an ability to analyze the given problems and design solutions,as per the needs and specifications.
4. Students will develop confidence for self education and ability for lifelong learning
5. Students will be capable of participating and succeeding in competitive examinations.

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Bioinformatics

Semester 1 Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical X	Practical Based on DSC I.4, II.4 & III.4	**04**

	Proteomics
1	Protein Sequence Database- Uniprot
2	Protein Structure Database-PDB
3	Advanced Visualization Software and 3D representations-pymol
4	Secondary Structure Prediction- GORIV
5	Homology based comparative protein modeling
6	Energy minimizations using SPDBV
7	Validation of models
A.	WHATIF
B.	PROSA
C.	PROCHECK
D.	VERIFY 3D
8	Protein Structure Alignment
9	Protein model building using Modeller9v7
10	Discovery Studio
	Bioprogramming-II
11	DNA sequence handling using JAVA
12	Control statements in JAVA
13	Loops in JAVA
14	Linux Basic Commands- dir, cp, mv, sudo, rm, sort, cat
15	Bash Scripting-for -do, echo, etc
16	Linux Grep command for pattern matching
	System Biology
17	Microbial Genome Database
18	MLVA
19	DSMZ
20	RIDOM
21	GPMS
22	Reactome
23	KEGG
24	BioCyc
	Learning Outcome: 1. Proteomics: - Proficiency in accessing and analyzing protein sequence and structure databases. - Ability to visualize and analyze protein structures using advanced software tools. - Skills in predicting secondary protein structures and performing comparative modeling. 2. Bioinformatics Programming (Java and Bash): - Competence in handling DNA sequences and implementing control flow in Java. - Proficiency in using Linux commands and Bash scripting for automation and data manipulation. 3. Model Validation and Structure Analysis: - Mastery in validating protein models and assessing their quality using specialized software. - Ability to align protein structures and perform energy minimization for structural refinement. 4. Microbial Genomics and Systems Biology: - Familiarity with microbial genome databases and genotyping techniques like MLVA. - Understanding of key databases like DSMZ, Reactome, and KEGG for systems biology research.

Parasite Informatics:

Parasite Bioinformatics
ICTV database
Parasite Genome and Proteome Databases.
Genome Comparison
Gene Prediction (Parasite)
Signal sequence prediction (Parasite)
Protein sequence comparison and analysis
Protein structure comparison and analysis (from parasite genome)

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II Bioinformatics, Semester- IV (NEP-20) PRACTICAL

X :- (Proteomics, Bioprogramming-II & System biology)

TIME: -6 Hrs. **Maximum Marks: -50 + 50 = 100**

Q.1.	Perform Major Experiment in Proteomics.	**15**
Q.2.	Perform Minor Experiment in **Proteomics**.	**10**
Q.3.	Perform Major Experiment in **Bioprogramming-II**.	**15**
Q.4.	Perform Major Experiment in System Biology.	**10**
Q.5.	**Internal marks:** Practical Record (20); Viva voce (20); Student overall performance and Activity – Industrial visit report /Monograph and Attendance (10)	**50**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II Bioinformatics, Semester- IV (NEP-20) PRACTICAL

XI:- (DSE-IV.4 Parasite Bioinformatics)

TIME: -6 Hrs. **Maximum Marks: -25 + 25 = 50**

Q.1.	Perform Major Experiment in Parasite Bioinformatics.	**15**
Q.2.	Perform Minor Experiment in Parasite Bioinformatics.	**10**
Q.5.	**Internal marks:** Practical Record (20); Viva voce (20); Student overall performance and Activity – Industrial visit report /Monograph and Attendance (10)	**25**

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Bioinformatics

Semester 1 Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical XII	Project Work	**10**

CO:

1. Identify and discuss the role and importance of research in the bioinformatics.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Learning Outcome:

1. Explain key research concepts and issues
2. Read, comprehend, and explain research articles in their academic discipline.
3. Able to formulate new research problem.

Seminars: Two theory classes/ week. Student have to submit script of the seminar.

Projects: Project to the students will be distributed at the beginning of third semester with the consent of HOD and shall be examined during the period of practical examination in IV semester. The student will develop the skill for designing the programs related to Bioinformatics. For this, variety of small research projects designed by the teachers based on the interest of the student and capabilities should be worked out.

The projects should be based on following topics

- Biological database designing
- Biological software designing
- Biological tool designing
- Chemo-informatics
- Comparative genomics and proteomics
- Drug designing
- Molecular modeling
- Parasite bioinformatics
- Pharmaco-informatics
- Plant bioinformatics
- Structural biology
- System biology
- Vaccine designing
- Any recent biological research topics

Semester-IV

Distribution of Practical Marks for Practical-VIII:- (Project Work)
Distribution of Marks for Project :-
Total Marks - 150 (Time : 3 Hrs per Week)
***Following content will consider for internal and external marks 75 + 75 = 150 Marks**

(1) Hypothesis
(2) Viva based on the project (Presentation).
(3) Depth of Work
(4) Conduct of project work
(5) Project Record
(6) Internal (Pre Defence Viva and Seminar)

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Total 150 Marks

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