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

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
0	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively If students wish to opt Minor Course of UG as Major for PG, **balance 12 Credits** Course will have to be completed **(As and when applicable)**	**Th-Prq**		**0**	**0**	**0**	**0**	**Additional Credits to be earned = (1) minus(2) (1). Credits from Major DSC Courses in UG (minus) (2).The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG**			**2**	**15**	**35**			**50**	**06**	**14**	**P**
1	Research Methodology and IPR	**Th-Major**	BINF 01	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
2	DSC-I.1 Introduction to Bioinformatics	**Th-Major**	BINF 101	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
3	DSC-II.1 Mathematics and Biostatistics	**Th-Major**	BINF 102	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
	DSC-III.1 Cell and Molecular Biology	**Th-Major**	BINF 103	**3**			**3**	**3**		**3**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
4	DSE-I /MOOC (Elective Options) Computer for Biologists, Database Management	**Th-Major Elective**	BINF 104	**3**			**3**	**3**		**3**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
																	Minimum Passing Marks		**Grade**
5	DSC-I.1 Lab	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
6	DSC-II.1 Lab	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
6	DSC-III.1 Lab	**Pr-Major**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
7	DSE-I Laboratory/MOOC Lab	**Pr-Major Elective**				**2**	**2**		**1**	**1**	**3**			**25**	**25**	**50**	**25**		**P**
8	# On Job Training, Internship/ Apprenticeship; Field projects **Related to Major @ during vacations cumulatively**	**Related to DSC**		**120 Hours cumulatively during vacations of Semester I and Semester II**						**4***									**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									**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 : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

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 I

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
BINF-01	**Research Methodology, IPR and Bioethics**	**04**

Cos :

1. Identify an appropriate research problem in their interesting domain.
2. Understand ethical issues Understand the Preparation of a research project thesis report.
3. Understand the Preparation of a research project thesis report
4. Understand the law of patent and copyrights.
5. Understand the Adequate knowledge on IPR

Unit I : (Research Methodology)	Research and Technical Writing: What is research? The process of research – various types of research – research methodology – Hypothesis – research writing – basic principles;
Unit II : (Research Methodology)	Publication process – peer review - Journal impact factors – popular journals in Computational Biology & Bioinformatics (brief overview of their scope), Professional Societies in the field – their role in research and knowledge dissemination, Open Access Publications, Concept of ethics – its application in Scientific Research and Academics, Solving ethical conflicts, moral reasoning & ethical theories, responsibilities and rights.
Unit III : (Intellectual Property Rights)	General principles of Intellectual property rights (IPR); Patents and methods; application of patents; Legal implications; International treaties for protection of IP – Bern, Paris, TRIPS, WIPO treaties, Biodiversity convention, etc
Unit IV : (Intellectual Property Rights)	Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development; International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT; Scope of Patent Rights; Licensing and transfer of technology. Patent information and databases, Geographical Indications
Unit V : (Bioethics)	The legal and socioeconomic impacts of biotechnology; public education of the process of the processes of biotechnology involved in generating new forms of life for informed decision making; Biosafety regulation and national

	and international guidelines; rDNA guidelines; Experimental protocol approval; levels of containment
Unit VI: (Bioethics)	Environmental aspects of biotechnology applications; Use of genetically modified organisms and their release in environment; Special procedures for rDNA-based product production; Biodiversity and farmers rights; Beneficial applications and development of research focus to the need of the poor; Identification of directions for yield effect in agriculture, aquaculture, etc; Bioremediation

Suggested Reading:

1. Sasson, A. (1988) "Biotechnologies and Development", UNESCO Publications
2. Sasson, A. (1993) "Biotechnologies in developing countries present and future"; UNESCO Publishers
3. Singh, K. "Intellectual Property Rights on Biotechnology"; BCIL, New Delhi
4. Halbert, (2007) "Resisting Intellectual Property" Taylor & Francis Ltd
5. Ramappa T., "Intellectual Property Rights Under WTO", S. Chand

Learning Outcome:

1. Understand the research problem and research process.
2. Understand research ethics .
3. Prepare a well-structured research paper and scientific presentations
4. Explore on various IPR components and process of filing.
5. Understand the adequate knowledge on patent and rights.

Part B

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

Programme **M.Sc. Bioinformatics**

Semester I

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSE I.1	**Introduction to Bioinformatics**	**03**

Cos :

6. Demonstrate **mastery of the core concepts of Bioinformatics**, including computational biology, database design and implementation, and probability and statistics.
7. The student/s would be able to acquire ability to apply skills in a professional environment via an industrial or academic internship in Bioinformatics.
8. Be able to effectively handle the computers and utilized for computational biology

Unit-I : (Introduction to Bioinformatics)	Introduction to Computational Biology and Bioinformatics; Different definitions of Bioinformatics, Bioinformatics – A

.	multidisciplinary Approach, History of Bioinformatics, Emergence of bioinformatics as a separate discipline; Application of Bioinformatics, Scope of Bioinformatics, some of the biological problems that require computational methods for their solution; Role of internet and www in bioinformatics.
Unit-II: (Biological Data Acquisition)	The form of biological information; DNA sequencing methods – basic DNA sequencing, automated DNA sequencing, shotgun DNA sequencing; DNA sequencing by capillary array and electrophoresis; Types of DNA sequences – genomic DNA, cDNA, recombinant DNA, Expressed sequence tags (ESTs), Genomic survey sequences (GSSs); RNA sequencing methods; Types of RNA; Protein structure determination methods.
. **Unit-III: (Databases: Format and Annotation)**	Biological databases indexing and specification of search terms; Common sequencing file formats – NBRF/ PIR, FASTA, FASTQ; Files for multiple sequence alignment – multiple sequence format (MSF), ALN format; Files for structural data – PDB format and cn3D files; Annotated sequence databases – primary sequence databases (GenBank-NCBI, the nucleotide sequence database-EMBL, DNA sequence databank of Japan-DDBJ; organisms specific databases (EcoGene, SGD, MatDB, TAIR, FlyBase, OMIM, etc.); Protein sequence and structure databases (PDB, SWISS-Uniprot PROT and TrEMBL).
Unit-IV: (Data: Access, Retrieval and Submission)	Data access – standard search engines, Data retrieval tools – Entrez, DBGET and SRS (sequence retrieval systems), FTP, API GETWAY; Submission of new and revised data using BankIt & Sequin.
Unit-V:(Sequence Similarity Searches)	Sequence homology as product of molecular evolution; Sequence similarity searches methods (Pairwise and Multiple Sequence alignment); Significance of sequence alignment; Sequence alignment – global, & local and free-space; Alignment scores and gap penalties; Measurement of sequence similarity; Similarity and homology
Unit- VI Python	Basic data types – Strings, Lists, Tuples – Lists and Tuples – Strings and Unicode strings. Buffers – Dictionaries – Numbers – Type conversions – Files. Indentation – Line structure – Block structure – Special objects
Suggested Reading:	
6. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide" 7. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1) 8. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India.	
Learning Outcome:	

	1. To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis. 2. Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics. 3. Explain about the methods to characterize and manage the different types of Biological data. 4. Classify different types of Biological Databases and file formats. 5. Introduction to the basics of sequence alignment and analysis. 6. Overview about biological macromolecular structures determination methods.

Part B		
Syllabus Prescribed for 2023 Year		**PG. Programme**
Programme		**M.Sc. Bioinformatics**
Semester I		
Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC II.1	**Mathematics and Biostatistics**	**04**
Cos : The main objective of this course is to provide students with the foundations of mathematical algorithms, probabilistic and statistical analysis mostly used in varied applications in biological sciences and science like disease modeling, metabolomics, genomics and computer networks etc.		
Unit-I : (Mathematics)	Calculus: Limits, Complete Differentials, Partial differentials of functions with one variable and multiple variables. Integration: Definite and non-definite integral; Series, Logarithms Mathematical Techniques Ordinary differential equations (first order), Partial differential equations- example from biology. Special functions - Bessel, Legendre.	
Unit-II : (Mathematics)	2D Coordinate geometry: Equation of a line, circle, ellipse, parabola, hyperbola 3D Geometry: Equation of sphere, cone Trigonometric functions: Sin, Cos, Tan, Co~ Series expansion of these. Functions and other related functions Vector -Addition, subtraction, dot, cross, scalar triple product, divergence, curl of a vector, equation of normal Matrix algebra: Addition, subtraction, multiplication, transpose inverse, and conjugate of matrix etc. Logic: Boolean logic Addition, subtraction, multiplication and division using binary, octal and hexadecimal systems Fundamentals of Set theory Fourier transform, Laplace Transform & other standard transforms.	
Unit-III : (Biostatistics)	Scope of biostatistics, definition, data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency	

	curve, logarithmic curves). Sampling & selection bias, probability sampling, random sampling, sampling designs, descriptive statistics: Measures of central tendency (arithmetic mean, geometric mean, harmonic mean, median, mode); Partition value, Measures of dispersion (range, quartile deviation, mean deviation and standard deviation), coefficient of variation.
Unit-IV : (Biostatistics)	Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential), Axioms, models, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/multi-allele finger print systems. Discrete probability distributions - Binomial, Poisson, geometric – derivations, Central limit theorem. Continuous probability distribution– normal, exponential, gamma distributions, beta and Weibull distributions, T & F distributions.
Unit-V : (Biostatistics)	Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, simultaneous confidence intervals, parametric tests [t-test, F-test, Chi Squared test for i) goodness of fit, ii) independence of distributes]. Analysis of variance (one- way and two-way classifications). Case studies of statistical designs of biological experiments (CRD, RBD, LSD).
Unit- VI: (Biostatics)	Data Input and Output. Data manipulation commands. Date functions. Frequencies, descriptive statistics, crosstabulations. Statistical analysis: independent samples 't' test, paired 't' test, ANOVA, chi square, Fisher's exact test, McNemar chi-square test, correlation and regression. Non-parametric methods: Mann Whitney U test, Wilcoxon Signed rank test, Spearman's correlation

Suggested Reading:

1. Animesh K. Datta (2007) "Basic Biostatistics and it's application" First Edition, New Central Book Agency, Ltd, Kolkata.
2. Batschelet E. (1992), "Introduction to Mathematics for Life Sciences", 3rd Edition, Springer- Verlag
3. H. Nell and D. quading. Pure Mathematics (Advance level Mathematics), Vol. 1, 2, 3 Cambridge University Press, 2002.
4. Narayanan, S. and Manicavachaagam Pillai, T.S. (1993) "Calculus, Vol. I and II"; Vishwanathan Printers and Publishers.
5. Nell H. (2002), "Pure Mathematics (Advance level Mathematics)", Vol. 1, 2, 3 Cambridge University Press
6. Parihar and Parihar (2007) "Biostatistics and Biometery" First Edition, Student Edition, Jodhpur
7. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to Biostatistics", 2nd edition, Prestographik, Vellore, India.
8. Warren, J; Gregory, E; Grant, R (2004), "Statistical Methods in Bioinformatics", 1st edition, Springer.
9. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition.

Learning Outcome:

1. Recognize the importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines;

2. Be familiar with a variety of examples where mathematics or statistics helps accurately explain abstract or physical phenomena; 3. Recognize and appreciate the connections between theory and applications; 4. Be able to independently read mathematical and statistical literature of various types, including survey articles, scholarly books, and online sources; and 5. Be life-long learners who are able to independently expand their mathematical or statistical expertise when needed, or for interest's sake.

Part B

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

Programme **M.Sc. Bioinformatics**

Semester I

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC III.1	**Cell and Molecular Biology**	**03**

Cos :

1. To provide comprehensive background of Salient features of Nucleic Acids and DNA model to the course learners.
2. To impart detailed understanding of key events of molecular biology comprising of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
3. To provide adequate knowledge about cell cycle regulation to the course learners.
4. To give detailed explanation of structural organization cell organelles and its role in biological system to the course learners.
5. To develop comprehensive understanding regarding DNA Repair Mechanisms in the course learners.

Unit-I: (Cell Biology)	Architecture of prokaryotic and eukaryotic cells, Structure of animal and plant cell, cell organelles, structure of cell wall and plasma membrane, Cell cycle, Molecular mechanics of cell cycle in eukaryotes, Cell division – mitosis and meiosis, Types of cells and its functions.
Unit-II : (Cell Biology) .	Structure of Cytolplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles, Cell to cell integration, Cell locomotion (Ameoboid, Flagella, Cillar), Components of blood
Unit-III : (Cell Biology)	Cell process and mechanics, Nucleus- Ultrastructure of nucleolus, Nuclear pore complex (NCP), Import and export mechanism through NCP. Chromosome- Structural organization of chromosome, chromatids, nucleosome model, DNA binding protein interaction.

Unit-IV:(Molecular Biology)	Concept of gene Central dogma, updated central dogma, molecular structure of nucleic acids – structure & forms of DNA & RNA, Replication: structure & function of DNA polymerases, replication in prokaryotes and eukaryotes, replication of chromatin. Transcription - components of transcription machinery, RNA polymerases, processing of RNA. Transcription in prokaryotes & eukaryotes, genetic code, Translation – mechanism, post-translational modification
Unit-V: (Molecular Biology)	Gene Regulation in Eukaryotes- Transcription level control, Processing level control, Translational level control- UTR, Splicing, Silencing, Chromatic remodeling.
Unit-VI: (Molecular Biology)	Gene regulation in prokaryotes – Operon concept, Lactose, Histidine and Tryptophan operon, Gene regulation in eukaryotes – Transcriptional level, translational level control.

Suggested Reading:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K and Walter, P. (2002) "Molecular Cell Biology of the Cell", Fourth Edition, Garland Science, Taylor and Francis Group, USA.
2. De Robertes and De Robertis (2002) "Cell and Molecular Biology", Saunders College, Philadelphia, USA
3. Karp, G. (2005) "Cell and Molecular Biology: Concepts and Experiments"; Fourth Edition, Wiley Publishing Co. USA
4. Krieger, M. (2003) "Molecular Cell Biology"; Fifth Edition, W.H. Freeman and Co., New York.
5. Lewin, B. (2004) "Genes VIII"; Eighth edition, Pearson Education International.
6. Lodish, H., Scott, M.P., Matsudaira, P., Darnell, J., Zipursky, L., Kaiser, C.A., Berk, A. (2003) "Molecular Biology of the Cell" Fifth Edition, W. H. Freeman and Company, England.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. (2002) Molecular Biology of the Cell, 4th edition,: Garland Science; New York
8. Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.
9. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, (2007) Molecular Cell Biology, Sixth Edition W. H. Freeman and Company, New York, , ISBN-13: 978-0-716-77601-7

Learning Outcome:

1. Understand and appreciate the diversity of life as it evolved over time by processes of mutation, selection and genetic change.
2. Illustrate that fundamental structural units define the function of all living things.
3. Explain that the growth, development, and behavior of organisms are activated through the expression of genetic information in context.
4. Summarize that biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of physics.
5. Illustrate that living systems are interconnected and interacting across scales of space and time.

6. Design a scientific process and employ the scientific method, demonstrating that biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.
7. Execute quantitative analysis to interpret biological data.
8. Construct and utilize predictive models to study and describe complex biological systems.
9. Apply concepts from other sciences in order to interpret biological phenomena.
10. Communicate biological concepts and understanding to members of a diverse scientific community as well as to the general public.
11. Identify social and historical dimensions of biological investigation.

ELECTIVE OPTION FOR NEP-20

Part B

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

Programme **M.Sc. Bioinformatics**

Semester I

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSE I	**Computer for Biologists**	**03**

Cos :

1. Students will know how to convert a biological question into a computational problem that can be solved using computers.
2. Student would be able to read and understand solutions to computational problems, which will be formalized as a series of tasks (an algorithm).
3. Student can learn about general approaches for solving computational problems.

Unit-I: (Introduction to Computer)	Block Structure of a computer, characteristics of computers, classification of computers, Storage devices, Types of memory, Input and Output devices, Operating system – windows, linux, System drivers and software, Application software, Window – Introduction, features, desktop: Background screensaver, Customizing desktop, creating, moving, deleting icon.
Unit-II: (Introduction to MS-Office)	MS-Word: Introduction to word, features, page setup, views, text formatting, Auto correct, spell check, grammar, table, tabs, indentation, mail merge, print preview, printing of document, hyperlink. MS-PowerPoint: Introduction to power point, features, Creation of new presentation, adding slides and text, Editing slide text, saving presentation, text effect, animation, modifying objects and adding images, preparing to deliver a presentation. MS- Excel: Introduction to Excel, features, creating and formatting worksheet, Inserting data, entering mathematical formulas and functions, auto fill

Unit-III: (Introduction to Internet and Networking)	Introduction to Internet, Type of Internet connection: Direct, dial-up, protocol: TCP/IP, FTP, HTTP, Domain name, electronic mail address, WWW, Search engine, Browser: Internet explorer, Mozilla, Google chrome. Networking: Needs and objectives, LAN- Introduction, classification, topology. Topology – Bus, Tree, Ring, Star, Hybrid, WAN, MAN.
Unit-IV: (Introduction to C programming)	Algorithms, flow-charts, programming languages, compilation, linking and loading, testing and debugging, documentation, Introduction to C programming, C variable, constant, and operators, data types, arithmetic operators, logical operators.
Unit-V: (Introduction to C programming)	Condition: if, if else, while, do while, switch, Nested condition, Looping: for, while, do while, nested loop. Introduction to Array, Array initialization, bound checking, passing array element to a function, initializing a 2-dimensional array, sorting; Introduction to File Handling : Opening a file, Closing a file, Reading and Writing into a file, Appending to a file.
Unit-VI: (Introduction to C programming)	Inheritance: Concept of inheritance – base class and derived class – overriding of member functions – abstract class – public and private inheritance – Levels of inheritance and multiple inheritance – inheritance and graphic shapes – virtual function and friend function.

Suggested Reading:

1. Allen K. R. (2003) "Window 2000 complete" BPB publication, India
2. Balaguru swamy S. (2006) "Programming in ANSI C" Tata Mcgraw Hill
3. Kanetkar Y. (2008) "Let us C" BPB publication, India
4. Rajaraman V. (2006) "Fundamental of Computers"
5. Sharma S (2006) "Fundamental of Computer" BPB publication, India

Learning Outcome:

By the end of the course students will be able to

1. Understand different components of system software and Hardware.
2. Understand intermediate code generation in context of language designing.
3. Recognize operating system functions such as memory management as pertaining to run time storage management
4. Describe the general architecture of computers.
5. Describe process management, scheduling and synchronizations.
6. Understand and analyze theory and implementation of processes, memory management, physical and virtual memory, scheduling, file management and security.

Syllabus Prescribed for 2023 Year **PG Programme**

Programme: M. Sc. Bioinformatics

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

COs:

1. Adapt basic knowledge on various techniques and areas of applications in bioinformatics.
2. Analyze common problem in bioinformatics, alignment techniques, ethical issues, publicdata sources, and evolutionary modelling.
3. Discover the practical use of tools for specific bioinformatic areas.
4. Analyze cell structure and its functions
5. Illustrate the structure and functions of biomolecules

Mathematics and Biostatistics

1.	Calculation of measures of central tendency- Arithmetic mean, median and mode.
2.	Computation of partition values - Quartiles, Deciles and percentiles.
3.	Geometric mean and harmonic mean.
4.	Measure of dispersion- Range, Quartile deviation and mean deviation.
5.	Standard deviation and coefficient of variation.
6.	Calculation of coefficient of correlation.
7.	Computation of rank correlation coefficient.
8.	Fitting of straight line.
9.	Line of regression and regression coefficient.
10.	Fitting of Binomial distribution.
11.	Fitting of Normal distribution.
12.	Fitting of Poisson distribution.

Mathematics and Biostatistics:

Distributions: Fitting of binomial, Poisson, Normal, negative binomial, hypergeometric, lognormal distributions. Statistical inference: Critical regions and power curves concerning testing of hypothesis on the parameters of binomial and normal distributions (one and two sided), test for correlation coefficient, test for trends of proportion, multiple comparison test, chi-square test of independence and goodness of fit, test for homogeneity, fisher's exact test, Sequential Probability ratio tests for parameters of binomial, poisson and exponential distributions.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc . I (Bioinformatics) , SEMESTER – I (NEP-20)

PRACTICAL I: Introduction to Bioinformatics and Mathematics and Statistics

PRACTICAL SCHEDULE

Time: 6 hrs. **Marks – 50+50=100**

Q.1. Major experiment based on Bioinformatics 15
Q.2. Minor experiment based on Bioinformatics 10
Q.3. Major experiment based on Statics. 15
Q.4. Minor experiment based on Bioinformatics. 10

Practical Internal

Q.8. Record/ Assignments 20
Q.9.Viva Voce 20
Q.10. Attendance, 10

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

Semester I Code of the Course/Subject	**Title of the Course/Subject**	**(No. of Periods/Week)**

	(Laboratory/Practical/practicum/hands-on/Activity)	
-Practical – II	Practical based on DSC III.1	02

Cell and Molecular Biology

13.	To study morphology of Bacteria by Gram staining
14.	To study morphology of Fungi and Yeast
15.	Preparation of pure culture by stick plate method
16.	Estimation of protein and carbohydrates
17.	Restriction digestion of plant genomics DNA
18.	Isolation & Purification of genomic DNA from plants
19.	Isolation of DNA fragment from Agarose gel
20.	Agarose gel electrophoresis of chromosomal & plasmid DNA
21.	Estimation of DNA
22.	Estimation of RNA
23.	Paper Chromatography
24.	Demonstration of some biological Instruments
25.	Study of some chromosomal stages during mitosis.
	Learning Outcome: 1. Apply knowledge of bioinformatics in a practical project. 2. Develop the ability for critical assessment of scientific research publications in bioinformatics. 3. Build an understanding of the research process in general, such as research methods, scientific writing, and research ethics. 4. Evaluate the main databases at the NCBI and EBI resources

Sant Gadge Baba Amravati University, Amravati
Practical Examination Bioinformatics Semester- I (NEP-20)
Practical II
Cell and Molecular Biology

Time 6hrs Marks-25+25=50

Q.1: Major experiment on Molecular Biology 20 Marks

Q.2: Minor Experiment on Cell Biology 05 Marks

Practical Internal

Q.3: Viva-Voce 10

Q.4: Practical Record, Attendance and Assignments 15

*** List of Practical/Laboratory Experiments/Activities etc.**

Semester 1 **Code of the Course/Subject**	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical II	Practical based on DSE-I	**06**

COs:

1. To get exposed to computational methods, tools and algorithms employed for Biological Data Interpretation
2. Explain about the concept of pairwise sequence alignment , algorithms and tools for pairwise alignment
3. Describe about Multiple Sequence Alignment, its significance, algorithms and tools used for MSA
4. Describe about the various techniques, algorithms and tools used for Phylogenetic Analysis
5. Explain about various computational methods and tools used for protein secondary structure prediction and genome analysis
6. Explain about various techniques used in genomics and proteomics

*** List of Practical/Laboratory Experiments/Activities etc.**

1	DOS Commands - Internal Commands: Viewing a directory, Changing Directory, Renaming a Directory - File operations: Creating files, removing a file, renaming files, viewing a file - External commands: Copying a disk, Comparing disks.
2	Overview of different versions of Windows -Working with Windows- Desktop Basic Layout, Icons, Opening Windows, Window Characteristics, Window Controls, Resize Windows, Arrange Windows, Taskbar.
3	Working with Programs: Basic Program Layout, WordPad Program, Scrolling in Documents, Moving Insertion Point, Delete & Insert Key, Selecting Text, Cut, Copy & Paste, Working with Multiple Programs.
4	Files & Folders: Organization, View Folder Structure, Working with Folders, Search for Files, Organizing Workspace - Personal Desktop, Shortcuts, Start Menu, Start Properties, Display as Menu, Taskbar, Quick Launch.
5	Windows Properties - Navigating Control Panel, Changing Theme, Desktop Settings, Screen Saver Settings, Appearance Settings, Display Settings, Mouse Settings.
6	Working with documents: Creating a document, Manage files and folders for documents, working with icons, editing documents - Text formatting and alignment, Indentation.
7	Paragraph formatting - Margins, tabs and page numbering.
8	Working with tables and borders - Printing - Working with Images and Text - Find and replace text - Mail merge.
9	Creating and formatting a presentation -Creation of a new Presentation, Adding Slides and Text to a Presentation, Editing Slide Text, Saving a Presentation, and Running a Slide Show- Adding Tables and charting data - Modifying objects and adding Images, Preparing to deliver a presentation.
10	Creating and modifying a worksheet- Formatting Worksheets - Working with multiple worksheets - Performing Calculations
11	Surfing information using Search Engines, Saving web pages to a disk, Composing E-mail, Sending E-mail.
12	C Programming: Flowcharts, Algorithm, Keywords, Identifiers, variables, Constants, Scope of Life of variables- Local and Global variables. Data types, Expressions, Operators - Arithmetic operators, Logical operators, Relational, conditional, Bitwise operators - Input/ Output Library functions. Declaration statement
13	l statement: If statement, If… Else statement, Nesting of If…Else statement, Switch statement - Iteration statements.
14	Arrays: Concept of Single and Multidimensional arrays, Array declaration, and initialization of arrays.
15	Functions: User defined and library functions
16	File Handling: Opening a file, Closing a file, Reading and Writing into a file, Appending to a file

17	SRS of Biological Databases
a.	National Center for Biotechnology Information (NCBI)
b.	Nucleotide/ Genome Databases
c.	Protein Sequence Database
d.	Structure databases
e.	Protein Pattern Databases
18	Different file formats
a.	Genbank
b.	Genpept
c.	FASTA
d.	EMBL
e.	NBRF/PIR, GDE
19	Entrez and Literature Searches.
a.	PubMed
b.	PubMed central
c.	OMIM / OMIA
d.	Citation matcher
20	File format conversion
a.	FmtSeq
b.	Seqret (EMBOSS)
c.	Sequence Manipulation Suite
21	Protein Structure Database – NCBI-Structure , Swiss-Prot, PDB, PDB file format
22	Sequence Alignment - BLAST, BLAT
23	Sequence Analysis
a.	Dot Plot
b.	Pairwise alignment
c.	Multiple Sequence Alignment
24	Phylogenetic analysis using PHYLIP, Phylodraw, Treeview,
25	Softwares
a.	BioEdit.
b.	GeneDoc
c.	ClustalW / X, MEGA
26	Visualization Tool
a.	RasMol
b.	Cn3D
c.	MolMol
27	Submission Tools for new and revised data
	Learning Outcome: Students should be able to apply basic bioinformatics tools for DNA/RNA/protein sequence alignments, finding gene/protein homolog, designing primers, identifying mutations, reconstructing phylogenetic trees, etc.

Sant Gadge Baba Amravati University, Amravati
Practical Examination Bioinformatics Semester- I (NEP-20)
Practical III
Computer for Biologists, Database management system

Time 6hrs | Marks-25+25=50

Q.1: Major experiment on Databases	20 Marks
Q.2: Minor Experiment on Database management	05 Marks
Practical Internal	
Q.3: Viva-Voce	10
Q.4: Practical Record, Attendance and Assignments	15

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 I) Semester II

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.2 Techniques in Bioinformatics	Th-Major	BOT 201	4			4	4		4	3	30	70			100	12	28	P
2	DSC-II.2 Biochemistry	Th-Major	BOT 202	4			4	4		4	3	30	70			100	12	28	P
3	DSC-III.2 Genomics	Th-Major	BOT 203	3			3	3		3	3	30	70			100	12	28	P
4	DSE-II/MOOC (Elective Option) Biological Database Management System	Th-Major Elective	BOT 204	3			3	3		3	3	30	70			100	12	28	P
																	Minimum Passing Marks		
5	DSC-I.2 Lab	Pr-Major				2	2		1	1	3			25	25	50	25		P
6	DSC-II.2 Lab	Pr-Major				2	2		1	1	3			25	25	50	25		P
7	DSC-III.2 Lab	Pr-Major				2	2		1	1	3			25	25	50	25		P
8	DSE-II Laboratory/MOOC Lab	Pr-Major Elective				2	2		1	1	3			25	25	50	25		P
9	# On Job Training, Internship/ Apprenticeship; Field projects **Related to Major @ during vacations cumulatively**	Related to Major		120 Hours cumulatively during vacations of Semester I and Semester II						4*									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															
				Exit Option with a PG Diploma with 4 Credits On-the-job training/internship in the respective Major subject • **Student has to earn Total minimum 4 Credits cumulatively during Vacations of Semester I and Semester II from internship in order to exit after First Year with PG Diploma (42-44 Credits) after Three Year UG Degree**														

	TOTAL								**18+4***						**550**			

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 : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II.

This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

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 II

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC I.2	**Techniques in Bioinformatics**	**04**

Cos :

4. To gain knowledge about various Biological databases that provide information about nucleic acids and protein.
5. Introduction to Biological databases and database systems.
6. Overview about types and Biological data and database search tools.
7. Describe about the different types of Biological databases.
8. Explain about different types of protein and other organism specific databases.
9. Overview about pathway and enzyme databases, Sequence submission tools.

Unit-I: (Biological Databases)	Primary Sequence & Structure Databases: Genbank, SwissProt/Uniprot, EMBL, PIR, PDB, MMDB, NDB, CSD, KEGG etc. Derived (Secondary) Databases of Sequences and Structure: Prosite, PRODOM, PRINTS, Pfam, BLOCK, INTERPRO etc. SSOP, CATH, DSSP, FSSP, RNAbase, Genome Databases (at NCBI, EBI, TIGR, SANGER), High- throughput genomics sequences (EST, STS, GSS), ENSEMBL.
Unit-II: (Advanced techniques)	Algorithms for searching sequence patterns: MeMe, PHI-BLAST, SCanProsite and PRATT; Algorithms for generation of sequence profiles: Profile Analysis method of Gribskov, HMMER, PSI-BLAST; Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics, SNP arrays.
Unit III: (Signals in DNA)	Introduction, DNA linguistics, Convey equation, Consensus, CG-islands, HMM, Gibbs sampling, Gene Promoter, Enhancers, Gene Prediction – introduction, statistical approaches, Spliced alignment, Reverse gene finding, some other problems.
Unit-VI : (Genome Rearrangement)	Introduction, Deletion, Insertion, Inversion, Translocation, Capping chromosomes, Caps and tails, Genome duplication, Genome rearrangment tools, Synteny and Rearrangement.
Unit-V : (DNA microarray)	DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases DNA microarray: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches)
Unit-VI : (Primer Designing)	Gene amplification and PCR: Basic principles and methodologies of PCR,

	design of PCR primers, RT-PCR and Real-Time PCR and their utility. Primer design for PCR, Primer design for general cloning, Design of forward and reverse primer.

Suggested Reading:

6. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide to the analysis of genes and proteins" John Wiley and Sons
7. Des Higgins, Willie R. Taylor, Willie Taylor (2000) "Bioinformatics: sequence, structure, and databanks : a practical approach" Oxford University Press
8. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969- 712-1)
9. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India.
10. Stanley Letovsky (1999) "Bioinformatics: databases and systems" Springer

Learning Outcome:

1. Basic algorithms used in Pairwise and Multiple alignments.
2. Understanding the methodologies used for database searching, and determining the accuracies of database search.
3. Application of probabilistic model to determine important patterns.
4. Prediction of structure from sequence and subsequently testing the accuracy of predicted structures.
5. Determine the protein function from sequence through analyzing data.
6. Analysis and development of models for better interpretation of biological data to extract knowledge.

Part B

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

Programme **M.Sc. Bioinformatics**

Semester II

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC II.2	**Biochemistry**	**04**

Cos :

1. The cells of living organisms contain thousands of bio-molecules. From this course the students will know the structure-function relationship of these molecules, and their importance with regard to maintenance and perpetuation of the living systems.

Unit-I : (Biochemistry)	Water- Water as the universal biological solvent, concept of osmolarity, water relationship Carbohydrates- Monosaccharides, oligosaccharides, polysaccharides, peptidoglycans, proteoglycans and glycoproteins, biological importance of carbohydrates. Lipids- Fatty acids, acylglycerols, phospholipids, sphingolipids, sterols, membrane Icoprenoids, Icosanoids and their biological significance.

Unit-II: (Biochemistry)	Levels of protein structure – primary, secondary, tertiary and quaternary with examples; alpha helix, beta sheet and beta turn; domains and structural motifs; Ramchandran plot, Rossmann fold, Immunoglobulin fold; Double helical structure of DNA – DNA polymorphism; types of RNA and its secondary and tertiary structure.
Unit-III: (Biochemistry)	Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination; Post transcriptional modification Translation- Genetic code- Prokaryotic and eukaryotic, Translation - translational machinery- Mechanism of initiation- elongation and termination- Regulation of translation.
Unit-IV : (Biochemistry)	Diffusion and Osmosis, Osmotic pressure, osmolarity of fluids and electrolyte balance. Donnan membrane equilibrium, dialysis. Viscosity, Measurement and applications, Surface tension, Measurements and viscosity of blood, Electrochemical Techniques - principles of redox reactions, Centrifugation principles, basic principles and laws of sedimentation. Preparative and analytical ultracentrifuges, Sedimentation equilibrium methods, Types of separation methods in preparative centrifuges, Differential and density gradient centrifugation, Absorption Spectroscopy basic principles.
Unit-V: (Biochemistry) .	Introduction to enzymes: Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- lock and key model, induced fit model. Features of active site, activation energy, Rate enhancement through transition state stabilization, Chemical mechanism for transition state stabilization. Enzyme specificity and types. Enzyme Commission system of classification and nomenclature of enzymes (Class subclass and sub sub class with one example).
Unit-VI: (Biochemistry)	**Structure and functions of Biomembranes:** Structures (Models) and functions- properties, thermodynamics and transport types-passive, active and co-transport, pumps, membrane selectivity-electrolytes and non-electrolytes, creation of membrane- Artificial membrane (liposomes). Signal transduction mechanisms- stimuli (ligands, mechanical forces, osmolarity, temperature and light), receptors (GPCRs, tyrosine kinases, acetylcholinesterase) and second messengers (calcium, lipid messengers and nitric oxide) with reference to major pathways.

Suggested Reading:

1. Banwell, C.N. (1983) "Fundamentals of Molecular Spectroscopy"; Tata McGraw Hill Publishing Company, New Delhi, India.
2. Cantor, C.R. and Schimmel, P. (1985) "Biophysical Chemistry Vol. 1 and 2"; W.H. Freeman and Company, New York, US.
3. Freifelder, D. (1982) "Physical Biochemistry"; W.H. Freeman and Company, New York, USA.
4. Horton, R, Moran, L, Scrinmgeour, G, Perry, M, Ravon, D (2005) "Principles of Biocehmistry", 4th edition, Prentice-Hall of India, Kolkata.
5. Leach, A.R. (1992) "Molecular Dynamics Simulation", John Wiley and Sons, New York, USA
6. Narayanan, P (1999) "Introductory Biophysics"; New Age Publishing House, Mumbai, India.

7. Palmer, T (2004)"Enzyme: Biochemistry, Biotechnology, Clinical Chemistry" Affiliated-East-West Press, India.
8. Resnick, R., Halliday, D. and Walker (2001) "Fundamentals of Physics", Sixth edition, John Wiley and Sons, USA.
9. Roy R. N. (2007) "A text book of Biophysics" First Edition, New Central Book Agency, Ltd, Kolkata.
10. Satyanarayana, U (2005) "Biochemistry", Books Allied (P) Ltd, Kolkata.
11. Talwar, GP, Srivastava LM, (Editor) (2003) "Textbook of Biochemistry and Human Biology", 3rd edition, Prentice-Hall of India Pvt Ltd, New Delhi.
12. Tipler, P.A. (1999) "Physics for Engineers and Scientists"; Fourth edition, W.H. Freeman and Company, USA.
13. VasanthaPattabhi and N. Gautham. (2001) "Biophysics"; Narosa Publishing Company, New Delhi, India.
14. Voet, D (2004), "Biochemistry", 3rd edition, Wiley, USA.

Learning Outcome:

1. Students will explain/describe the synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation at the epigenetic, transcriptional, translational, and post-translational levels including RNA and protein folding, modification, and degradation. Regulation by non-coding RNAs will be tied to the developmental and physiological functioning of the organism.
2. Students will analyze structural-functional relationships of genes and proteins from bacteria to eukaryotes using genomic methods based on evolutionary relationships.
3. Students will use current biochemical and molecular techniques to plan and carry out experiments.

Part B

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

Programme **M.Sc. Bioinformatics**

Semester II

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC III.2	**Genomics**	**03**

Cos :

6. Familiarize students with genomic methods.
7. Encourage students to think on genomic scale.
8. Excite students about hottest areas of biology.
9. Demystify modern genomics methods and concepts.
10. Discover basic biology in the context of theoretical and applied genomics
11. research.
12. Know the broad applications of genomics.
13. Become proficient with basic web-based tools to "do" genomics.
14. Appreciate the benefits of using math and computer sciences to understandbiology in genome scale.

Unit-I : (Introduction to Genomics)	Introduction to genomics- scope and application, Computational genomics, Organization of the prokaryotic and eukaryotic genomes, Genome maps and types, current

	sequencing technologies, partial sequencing, gene identification, gene prediction rules and software, Genome databases; Annotation of genome, Genome diversity: taxonomy and significance of genomes – bacteria, yeast, Caenorhabditis, Homo sapiens, Arabidopsis, etc.
Unit-II : (Functional Genomics)	Microarray - Gene Expression, methods for gene expression analysis; DNA array for global expression profile; Types of DNA array, Array databases; Applications of DNA microarray – analysis of gene expression, differential gene expression under different conditions and during development of organisms, Human Genome Project - Construction of physical maps; Basics of radiation hybrid maps; Sequencing of the entire human genome, annotation and analysis of genome sequences: sequence repeats, transposable elements, gene structure, Pseudogenes
Unit-III : (Computational Genome Analysis)	Introduction to genome analysis, Gene analysis; gene order; chromosome rearrangement; compositional analysis; clustering of genes; composite genes; Basics of Single Nucleotide Polymorphisms, detection and its implications; dbSNP and other SNP related database, Gene Prediction method, Perdition of ORFs, Prediction of signal sequence (Promoter, Primers, Splice site, UTR etc); BLAST, PSI BLAST, PHI BLAST; Epitope prediction.
Unit-IV : (Comparative Genomics)	Relevance of comparative genomics; orthologs and paralogs; Comparative genomics of prokaryotes; Minimal genome; Vertical and horizontal gene transfer, Comparative genomics of organelles; Comparative genomics of eukaryotes, Differences and similarities in genomes of organisms; Genome comparison tool, Applications and scope of comparative genomics.
Unit-V: (Phylogenetic analysis)	Phylogenetics, cladistics and ontology; Phylogenetic representations – graphs, trees and cladograms; Steps in phylogenetic analysis; Methods of phylogenetic analysis – similarity and distance tables, distance matrix method;
Unit-VI: (Phylogenetic analysis)	Method of calculation of distance matrix (UPGMA, WPGMA); The Neighbour Joining Method; The Margoliash method; Character-based Methods – maximum parsimony, maximum likelihood; Reliability of Phylogenetic trees; Steps in constructing alignments and phylogenies; Limitations of phylogenetic algorithms; Phylogenetic softwares – PAUP, PHYLIP, MacClade.
Suggested Reading:	
1. Bergman N. H. (2007),"Comparative genomics" Volume 2, Humana Press 2. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human Genome Project" John Wiley and Sons 3. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare 4. Clark M (2000), "Comparative genomics" Springer 5. Griffiths A. J. F., Miller J.H., Suzuki D.T., (2000) "An Introduction to Genetic Analysis" W.H. Freeman and Co., Publishers.	

6. Pevsner J (2009), "Bioinformatics and functional genomics", Edition 2, John Wiley and Sons
7. Primrose S. B., Twyman R. M. (2004), "Genomics: applications in human biology" Wiley-Blackwell
8. Primrose S. B., Twyman R. M. (2006), "Principles of gene manipulation and genomics" Wiley-Blackwell
9. Saccone C., Pesole G., (2003), "Handbook of comparative genomics: principle and methodology" John Wiley and Sons
10. Suhai S (2000), "Genomics and proteomics: functional and computational aspects" Springer.

Learning outcome:

1. Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
2. Existing software effectively to extract information from large databases and to use this information in computer modeling
3. Problem-solving skills, including the ability to develop new algorithms and analysis methods.
4. An understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries

ELECTIVE OPTIONS FOR NEP-20

Part B

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

Programme **M.Sc. Bioinformatics**

Semester II

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSE II	**Biological Database Management System**	**03**

Cos :

9. Understand the basic concepts and the applications of database systems.
10. Master the basics of SQL and construct queries using SQL.
11. Understand the relational database design principles.
12. Familiar with the basic issues of transaction processing and concurrency control.
13. Familiar with database storage structures and access techniques.

Unit I : (Introduction to BDBMS)	Database & Database users, Characteristics of Database, Database System applications, Database System Versus File Systems, Concepts and Architecture, Data Models, Schemas & Instances, DBMS architecture and Data, Independence, Database languages & Interfaces, View of Data, Data Models, Database Languages, Database, Users and Administrators, Database System Structure

Unit II : (Introduction Data models)	ER Model: Keys, Constraints, Design Issues, Extended ER features, Reductions of ER Schema to Tables. Relational Model: Structure, Relational Algebra; Hierarchical Model, Network Model, Object Oriented Model
Unit-III : (Structured Query Language)	Basic Structure, Set Operations, Aggregate Functions, Null Values, Nested Sub queries, Views, Integrity: Domain constraints, Joined Relations, Data-Definition Language, Embedded SQL, Dynamic SQL; Locking techniques, Granularity of Data Items – Database System Architecture and information retrieval: Centralized and Client-Server Architecture, Distributed DBMS, Data Mining, Data Integration, Data Warehousing
Unit IV : (Relational Database and Storage)	Pitfalls in Relational Design Database, Functional dependencies, Decomposition Normal Forms – 1NF, 2NF, 3NF & Boyce- Codd NF, Overall Database Design Process, Multi-valued Dependencies, Data Storage – Ordered indices, Static Hashing, Dynamic Hashing - Transaction Management – Security and Authorization.
Unit V : (Introduction to MySQL)	Introduction to MySQL, basics installation, server technology architecture, Basic MySQL datatype, Database languages, Transaction Management, Storage Management, Database Administrator, Database Users, Overall System Structure, MySQL connectivity
Unit VI : (Artificial Neural Network)	Artificial Neural Network: Historic evolution – Perceptron, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, Applications of ANN.

Suggested Reading:

9. Date, C.J. (2000) "An introduction to Database systems"; Seventh Edition, Addison Wesley Publishers.
10. Elmasri and Navathe (2004) "Fundamentals of Database systems" Fourth Edition, Addison Wesley Publishers.
11. Silberschatz, A., Korth, H.F. and Sudarshan, S. (2002) "Database system Concepts"; Fourth Edition, McGraw Hill Publishers.
12. Ullman, J. D. (2001) "Principles of Database systems"; Second Edition, Galgotia Publications

Learning Outcome:

1. Calculation processes of arithmetic mean, geometric mean,harmonic mean, median, mode etc. and other measures ofcentral tendency and their application in real life
2. Quantitative measures of dispersion of variables and their reallife applications
3. Different testing procedures for hypothesis testing
4. Different operation un matrix analysis

5. Data storage and data management in database 6. Writing script using SQL for creating, manipulating anddeleting data from database

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 IV	Practical based on DSC I.2 & DSc- II.2	**04**

CO:

1. To impart knowledge of methods and techniques for biomolecules separation and purification.

*** List of Practical/Laboratory Experiments/Activities etc.**

Biochemistry

1	Experiment based on Osmosis by using Potato Osmoscope
2	SDS-PAGE Analysis of Protein
3	Calculation of Viscosity Index
4	Measurement of Surface Tension
5	Working and Principle of Biological Instruments (Ultra centrifuge, NMR Spectroscopy, Mass Spectroscopy, Electron Microscopy and Scanning Electron Microscopy)
6	Trypsin inhibitor activity.
7	To demonstrate kinetic behavior of enzymes by using spectrophotometer.
8	Separation of lipids by thin layer chromatography.
9	To study the characteristics of UV absorption spectra of Proteins.
10	To prepare the buffers & measurement of pH.
11	To determine the titration curve of amino acids & calculate the pKa values.
12	To determine the Tm of DNA.
13	Denaturation & Renaturation of DNA.
14	To determine the osmotic fragility of RBC.
15	Qualitative tests for-carbohydrates, proteins, amino acids and lipids.
16	Preparation of standard buffers and determination of pH.
17	Verification of Beer-Lambert's Law.
18	Estimation of carbohydrate by anthrone method.
19	Estimation of blood glucose by Folin-Wu method.
20	Estimation of amino acids by ninhydrin method.
21	Separation of amino acids and sugars using paper and thin layer chromatography.
22	Determination of saponification value and iodine number of fats.
23	Estimation of ascorbic acid.
24	Titration curve for amino acids and determination of pK value.
25	Sorenson-formol titration for amino acid estimation

Techniques in Bioinformatics

1	Primary Sequence & Structure Databases
a.	Genbank
b.	SwissProt/Uniprot
c.	EMBL
d.	PIR
e.	PDB
f.	MMDB
g.	NDB
h.	CSD
i.	KEGG - pathway database
j.	PHI-BLAST
k.	PSI-BLAST
l.	Identification of SNPs
m.	SNP database (DbSNP)
n.	DNA Microarray Analysis
o.	GenSprings GX
	Learning Outcome: 1. Foster interdisciplinary research in the fields such as computer science, biosciences,mathematics, chemistry and physical sciences 2. Interpret biological information computationally 3. Develop programming skills in the languages of C++, Perl, Python and R 4. Analyse genomic data and contribute to personalised medicine 5. Demonstrate entrepreneurial skills 6. Establish Bioinformatics start-ups

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

PRACTICAL IV:- (Techniques in Bioinformatics and Biochemistry)

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

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

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 V	Practical based on DSC III.2	**02**

Genomics

26	Sequence Analysis
27	Gene Analysis and identification
28	Genome databases
29	Annotation of genome
30	Perdition of ORFs
31	dbSNP and other SNP related database
32	Promoter prediction
33	Primers designing
34	Splice site prediction
35	UTR prediction
36	BioEdit
37	GENSCAN
38	GeneMark
39	Samtools, bedtools
40	NCBI SRA
41	Sequin, NGS data analysis
42	Glimmer
43	Phylogenetic analysis using PHYLIP, Phylodraw, PAUP, Treeview, JalView.
	Learning Outcome: 1. Understand the principles of various fields of chemistry and biology (organic chemistry, analytical chemistry, biochemistry, genetics, metabolism, and molecular biology) 2. Apply modern instrumentation theory and practice to biochemical problems 3. Recognize potential laboratory safety concerns and address them using appropriate techniques.

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

PRACTICAL V: - **(Genomics)**

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

Q.1. To perform any one analytical experiment. **15**

Q.2. To perform given experiment on databases. **10**

Q.3. **Internal marks :** Practical Record (10); Viva voce (10); Student overall performance and Activity – Industrial visit report / Monograph and Attendance (05) **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 – VI	Practical based on Paper DSE-II	**02**

CO:

1. To impart knowledge of biological molecules, databases, using advanced computer and physicochemical methods.

*** List of Practical/Laboratory Experiments/Activities etc.**

1	Structure Query Language
2	Exercise in RDBMS (MYSQL)
a.	Data Definition Language (DDL) statements: Creating database, Selecting database, Deleting database, Creating table,Modifying Table, Deleting table
b.	Data Manipulation statements: Inserting, updating and deleting records Retrieving Records Retrieving specific rows and columns
c.	Use of MySQL operators - Arithmetic operators, Comparison Operators, Logical operators,, Math functions, Aggregate functions
d.	String operations
e.	Limiting, Sorting and grouping query results
f.	Handling null values
g.	Renaming or aliasing table and column names
h.	Using subqueries
i.	Using Joins - joining a table to itself, joining multiple tables
j.	Use of Indexes
k.	Security Management
l.	Granting and Revoking rights on tables

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

PRACTICAL V: - **(Genomics)**

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

Q.1.	To perform any one analytical experiment.	**15**
Q.2.	To perform given experiment on databases.	**10**
Q.3.	**Internal marks :** Practical Record (10); Viva voce (10); Student overall performance and Activity – Industrial visit report / Monograph and Attendance (05)	**25**

Open Elective for other stream/ faculty

Part B		
Syllabus Prescribed for 2022 Year		**PG. Programme**
Programme		**M.Sc. Bioinformatics**
Semester II		
Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
OEC I	**Pharmacogenomics**	**04**

Cos :

1. The course intends to provide knowledge about pharmacogenomics and drug design using genomic applications for drug action and toxicity.
2. To understand how individualization of drug therapy can be achieved based on a person's genetic makeup while reducing unwanted drug effects.

Unit-I: (Pharmacogenomics and personalized medicine)	Pharmacogenetics- Roots of pharmacogenomics and it is not just pharmacogenomics, Genetic drug response profiles, the effect of drugs on Gene expression, pharmacogenomics in drug discovery and drug development. Concept of individualized drug therapy, Drivers and the promise of personalized medicine, Strategies for application of pharmacogenomics to customize therapy, Barriers.
Unit-II: (Human Genomics)	Expressed sequence Tags (EST) and computational biology, Microbial genomics, computational analysis of whole genomes, computational genome analysis, Genomic differences that affect the outcome of host pathogen interactions, Protein coding genes, repeat elements, genome duplication, analysis of proteome, DNA variation, Biological complexity. Single nucleotide polymorphisms (SNP's) in Pharmacogenomics - approaches, number and types of SNPs, Study design for analysis, Analytical issues, Development of markers.

Unit III: (Drug Design)	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-VI : (Genomic applications) .	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-V : (Drug Targeting)	**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. Martin M. Zdanowicz, M.M. "Concepts in Pharmacogenomics" Second Edition, American Society of Health-System Pharmacists, 2017.
2. Licinio, J and Wong, Ma-Li. "Pharmacogenomics: The Search for the Individualized Therapies", Wiley-Blackwell, 2009.
3. Yan Q, "Pharmacogenomics in Drug Discovery and Development" Humana Press, 2nd Edition, 2014.

Learning Outcome:

1. Student would be able explain the basic principles of pharmacology and genomics as they pertain to pharmacogenomics.
2. Student would be able distinguish the different considerations applying to genes involved in pharmacokinetics versus pharmacodynamics, and how this impacts the way that these genes are studied.
3. Student would be able understand the impact of emerging technologies, such as next generation sequencing, on discovery and implementation of pharmacogenomics.
4. Student would be able understand several specific examples of important pharmacogenomics and their implementation in clinical practice.
5. Student would be able apply the available information resources for gene-drug interactions in informatics projects.
6. Student would be able understand the issues and challenges of implementing pharmacogenomics in the clinic.

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**	BOT 02	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
2	DSC-II.3 System Biology	**Th-Major**	BOT 301	**4**			**4**	**4**		**4**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
2	DSC-III.3 Parasite Bioinformatics	**Th-Major**	BOT 302	**3**			**3**	**3**		**3**	**3**	**30**	**70**			**100**	**12**	**28**	**P**
3	DSE-III /MOOC (Elective Option) Bio-programming I	**Th-Major Elective**	BOT 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**						**500**			

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
5. Understand how to develop Chapter Two of the thesis/dissertation
6. Understand how to develop Chapter Three of the thesis/dissertation

Unit-I	1.1 Introduction to Philosophy: definition, nature and scope, concept, branches 1.2 Ethics: Definition, moral philosophy, nature of moral judgments and reactions. 1.3 Advance research in Botany 1.4 Referencing and Citation of references.
Unit-II	2.1 Ethics with respect to science and research 2.2 Intellectual honesty and research integrity in relation to Botany 2.3 Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) 2.4 Redundant publications: duplicate and overlapping publications, salami slicing 2.5 Selective reporting and misrepresentation of data
Unit-III	3.1 Publication ethics: definition, introduction and importance 3.2 Best practices/standards setting initiatives and guidelines: COPE, WAME etc. 3.3 Conflicts of interest 3.4 Publication misconduct: Definition, concept, problems that lead to unethical behavior and vice versa, types 3.5 Violation of publication ethics, authorship and contributorship 3.6 Identification of publication misconduct, complaints and appeals 3.7 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 III

Code of the Course Subject	**Title of the Course/ Subject**	**No. of periods/ week**
DSC II.3	**System Biology**	**04**

Cos :

This course would be able to introduce the student to contemporary Systems Biology focused on mammalian cells, their constituents and their functions. Biology is moving from molecular to modular. As our knowledge of our genome and gene expression deepens and 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)	System Biology – Introduction, 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 EK, Stochastic Modelling 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 a reconstruction, KEGG, Reactome, Brenda databases; Cell designer software.
Unit IV : (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 V : (Introduction to R programming)	R programming – Introduction and preliminaries, Simple manipulation, Objects and Modules, Orders, Arrays, Lists, Reading data from files, Loops and conditions, Functions creation, Packages.
Unit VI: (UNIX)	UNIX - File system - Overview - Text processing - Commands and Operation - UNIX filenames and file protections - working with directories - loops and IF statements - Different File Editors - Mastering the special features of the UNIX system - Advanced Unix commands - Configuring services in Unix - - Networking Utilities Introduction to Linux - System Processes - User

	Management - Types of users, Creating users- Granting Rights - File Quota, File-System Management and Layout - Login Process- Linux shells (bash and tcsh) - Shell Programming Networking on Linux - Printing and print sharing- ftp service, http service.

Suggested Reading:

11. B. O. Palsson "System Biology – Properties of Reconstructed Networks" Cambridge University Press
12. Olaf Wolkenhauer. (2010) "System Biology – Dynamic Pathway Modeling"
13. Andres Kriete, Roland Eils (2006) "Computational systems biology" Academic Press
14. Andrzej K. Konopka (2007) "Systems biology: principles, methods, and concepts" CRC Press/Taylor & Francis
15. Lilia Alberghina (2008) "Systems biology: definitions and perspectives" 2 Edition, Springer
16. Uri Alon (2007) "An introduction to systems biology: design principles of biological circuits" Chapman & Hall/CRC
17. 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
18. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human Genome Project" John Wiley and Sons
19. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare
20. Clark M (2000), "Comparative genomics" Springer

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

Part B

Syllabus Prescribed for 2023 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	**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 : (Introduction to Parasitic Diseases)	Biology of Parasites - Life Cycle, Infectivity, Demographic distribution of strains (Malaria, Leishmaniasis, Trypanosoma, Filariasis), Role of bioinformatics in Diseases monitoring.
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 to study 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 to Host-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 both 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 - Disease resistance 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.

ELECTIVE OPTIONS FOR NEP-20

Part B

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

Programme — **M.Sc. Bioinformatics**

Semester III

Code of the Course Subject	Title of the Course/ Subject	No. of periods/ week
DSE III	**Bio-Programming – I**	**03**

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 Programing**)	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 ComputerSystem.

2. Concept of Internet; WWW and Web Browsers; SearchEngines
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/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical VII	Practical Based on DSC I.3 & II.3	**04**

CO:

1. Fundamentals of Computer, Basic Applications of Computer; Components of Computer System.
2. Concept of Computing, Data and Information
3. Basics of Operating System; Popular Operating Systems(Windows, Linux, DOS);
4. Data structure and its relevance to biological science
5. Communication using the Internet: Basic of Computer networks; LAN, MAN, WAN;
6. Concept of Internet; WWW and Web Browsers; Search Engines; Understanding URL
7. Design & Structure of biological databases
8. Introduction to PERL as scripting language; variables; Array; Initialization and manipulation
9. Arithmetic and logical operators; Conditional statement and Loops; Regular Expressions; Function and subroutines
10. Application of PERL in Bioinformatics; concatenating DNA fragments; DNA to RNA; Reading protein Files; Finding motifs; ORFs; DNA to protein

*** List of Practical/Laboratory Experiments/Activities etc.**

1	Microbial Database
2	MLVA
3	HBMMD
4	DSMZ
5	RIDOM
6	GPMS

List of Practical's based on Advance Research Methodology

1. Basics of drug development
2. Drug absorption, distribution, metabolism and excretion
3. Drug metabolism and transporter pathways, Pharmacokinetic modeling and analysis,

4. Cellular and molecular mechanism of drug action

5. Pharmacovigilance, Adverse drug reactions, Drug Interactions

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

PRACTICAL VII:- (Advance Research Methodology and System Biology)

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

Q.1.	Perform Major Experiment in Advance Research Methodology.	**15**
Q.2.	Perform Minor Experiment in Advance Research Methodology.	**10**
Q.3.	Perform Major Experiment in System Biology.	**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

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 VIII	Practical based on DSC DSC-III.3	**04**

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 Bioinformatics Semester- III (NEP-20)
Practical VIII
Parasite Informatics

Time 6hrs Marks-25+25=50

Q.1: Major experiment on Parasite Informatics 20 Marks

Q.2: Minor Experiment on Parasite Informatics 05 Marks

Practical Internal

Q.3: Viva-Voce 10

Q.4: Practical Record, Attendance and Assignments 15

CO:

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

*** 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 theKingdom.

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

Time 6hrs | Marks-25+25=50

Q.1: Major experiment on Bio-Programing	20 Marks
Q.2: Minor Experiment on Bio-Programing	05 Marks
Practical Internal	
Q.3: Viva-Voce	10
Q.4: Practical Record, Attendance and Assignments	15

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							
												Maximum Marks					Minimum Passing		
				Teaching Period Per Week				Credits				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		4			4	4		4	3	30	70			100	12	28	P
2	DSC-II.4 IVR-programming	Th-Major		4			4	4		4	3	30	70			100	12	28	P
3	DSC- III.4 Chemo-informatics	Th-Major		3			3	3		3	3	30	70			100	12	28	P
4	DSE-IV /MOOC (Elective Options) Molecular Modeling and Drug Designing	Th-Major Elective		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 Laboratory	Pr-Major				2	2		1	1	3			25	25	50	25		P
7	DSC-III.4 Laboratory	Pr-Major				2	2		1	1	3			25	25	50	25		P
8	DSE-IV Laboratory/MOOC Lab	Pr-Major Elective				2	2		1	1	3			25	25	50	25		P
9	**Research Project Phase-II**	Major			2	8	10	2	4	6	3			75	75	150	75		P

10	**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**						**600**		

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.
Unit-VI : (Advance Proteomics)	Molecular replacement method – Isomorphous replacement method - preparing heavy atom derivatives - Anomalous scattering - Multiwave length anomalous dispersion technique - Synchrotron radiation and its implications in structure determination. Introduction to X-ray Free Electron Laser technology (XFEL), importance and applications - Cryo-electron microscopy, Fiber, Powder and Neutron diffraction - NMR- Importance of NMR in Structural Biology, CryoEM - Diffusion: Macromolecular diffusion - Ultracentrifugation - density gradient methods - Light Scattering: Experimental results on some proteins and nucleic acids - determination of radius of gyration and end to end distance Electrophoresis -Chromatography: General principles - types - applications to macromolecules Application of X-ray crystallography in drug design
Suggested Reading:	

2. Azuaje F., Dopazo J., (2005) “Data analysis and visualization in genomics and proteomics” John Wiley and Sons
3. Dubitzky W. Granzow M. Berrar D (2007) “Fundamentals of data mining in genomics and proteomics”
4. Gu Jenny, Bourne P. (2009) “Structural bioinformatics” Wiley- Blackwell
5. Kraj A, Silberring J, (2008) “Proteomics: introduction to methods and applications” John Wiley & Sons
6. Liebler D.C, (2002), “Introduction to proteomics: tools for the new biology” Humana Press
7. Mishra N.C., (2010), “Introduction to Proteomics: Principles and Applications” John Wiley and Sons
8. Pennington S.R., Dunn M. J. (2001), “Proteomics: from protein sequence to function” BIOS
9. Reinders J, Sickmann A., (2009) “Proteomics: methods and protocols” Humana Press
10. Suhai S. (2000) “Genomics and proteomics: functional and computational aspects” Springer
11. Veetstra T.D., Yates J.R. (2006) “Proteomics for biological discovery” John Wiley and Sons
12. 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 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	**IVR programming 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, Argument passing, Retaining objects, Recursion, Introducing Access control, Understanding static; Nested and inner classes, exploring the string class, Using command line arguments.
Unit II : (Introduction to Java)	Inheritance: Basics, Member access and inheritance. Using super: to call super class constructors, Creating a multilevel hierarchy. The object class Packages and Interfaces: Packages, Defining a package, Understanding class path, Access protection: Importing packages, Defining an interface,

	Implementing interfaces, Applying interfaces, Variables in interfaces, Exception Handling: Fundamentals, Exception types, Uncaught exceptions, Using try and catch, Displaying a description of an exception. 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, Advanced Linux Commands, Installation of Linux, Interactive Installation, Kickstart Installation, Network based Installation, Startup and Shutdown scripts, Boot Sequence,Kernel Initialization
Unit IV : (Introduction to Unix & Linux**)**	The UNIX Filesystem 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.), comm, cmp, diff, Editors: vi, emacs; 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 : (Introduction to Bio-Java)	Installing Bio-Java, Symbols, Basic Sequence Manipulation (DNA to RNA, Reverse Complement, motif as regular expression), Translation (DNA to Protein, Codon to amino acid, Six frame translation), Proteomics (Calculate the mass and pI of a peptide), Sequence I/O (File Formats conversions), Locations and Features (Point Location, Range Location, Feature modifications), BLAST and FASTA (Blast and FastA Parser, extract information from parsed results), User Interfaces.
Unit VI 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, 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

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 III.4	**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

ELECTIVE OPTION FOR NEP-20

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**
DSE IV	**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.

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 VII	Practical Based on DSC I.4 & II.4	**04**

Proteomics

1	Protein Sequence Databases
2	Protein Structure Databases
3	Protein Sequence Analysis by BioEdit
4	Advanced Visualization Software and 3D representations
5	Coordinate generations and inter-conversions
6	Secondary Structure Prediction
7	GORIV
8	Online Secondary structure prediction tools
9	Fold Recognition, ab initio (Rosetta Server)
10	Homology based comparative protein modeling
11	Energy minimizations
12	Validation of models
a.	WHATIF
b.	PROSA
c.	PROCHECK
d.	VERIFY 3D
e.	RAMPAGE
f.	Protein Structure Alignment
g.	Protein Structure Comparison
h.	Modeller9v7
i.	Geno-3D
j.	Discovery Studio Server
	Learning Outcome: 1. Bioinformatics – an Overview, Definition and History.Information Networks –Internet inBioinformatics, Evolution of Bioinformatics – Scope –Potentials of Bioinformatics, Human Genome Project 2. Introduction to Biological Databases: NCBI, EMBL, PIR,SWISS-Prot, PubChem 3. Compound, KEGG-Pathway, ChEMBL, BindingDB.Analysis of Three Dimensional Structures of Proteins,RCSB-PDB. Primary and Secondary database 4. Various file formats for bio-molecular sequences: genbank,fasta, gcg, msf, nbrf-pir etc. 5. Basic concepts of sequence similarity, identity andhomology, definitions of homologues, orthologues,paralogues. 6. Scoring matrices: basic concept of a scoring matrix, PAMand BLOSUM series

IVR Pregaming-II

24	Packages and Interfaces, Exception, Multithreading
25	Streams and I/O, Using Native Methods and Libraries
26	Java Programming Tools, Working with Data Structures
27	Sequence Analysis Packages - EMBOSS, NCBI Tool Kit
28	Analysis of Biological Sequences
a.	Basic Blast
b.	Specialized Blast

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

PRACTICAL X:- (Proteomics and IVR Programing)

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

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

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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 XI Cheminformatics:	Practical Based on DSC III.4	**02**

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

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Practical Examination Bioinformatics Semester- IV (NEP-20)
Practical IX
Bioprogramme

Time 6hrs Marks-25+25=50

Q.1: Major experiment on Chemoinformatic	20 Marks
Q.2: Minor Experiment on Chemoinformatic	05 Marks
Practical Internal	
Q.3: Viva-Voce	10
Q.4: Practical Record, Attendance and Assignments	15

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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 XII	Practical Based on DSC III.4	**02**

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

*** List of Practical/Laboratory Experiments/Activities etc.**

Molecular Modelling, Drug Design

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

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 drug discovery process
8. have gained a basic knowledge of computational methods used in drug discovery

Sant Gadge Baba Amravati University, Amravati
Practical Examination Bioinformatics Semester- IV (NEP-20)
Practical XII
Molecular Modelling, Drug Design

Time 6hrs Marks-25+25=50

Q.1: Major experiment on Molecular Modeling 20 Marks

Q.2: Minor Experiment on 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 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 XIII	Practical Based on 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.