॥ मा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० नुसार पदवी प्रथम वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२४–२५ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, या विद्यापीठा अंतर्गत येणा–या सर्व संलग्नित महाविद्यालयामध्ये शैक्षणिक वर्ष २०२४–२५ पासून पदवीस्तरावर राष्ट्रीय शैक्षणिक धोरण –२०२० लागू करण्याच्या दृष्टीकोनातून विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत येणा–या अभ्यासमंडळांनी तयार केलेल्या पदवी प्रथम वर्षाचे अभ्यासक्रमांना मा. विद्यापरिषदेने दिनांक १५ मे २०२४ रोजी संपन्न झालेल्या बैठकीतील विषय क्रमांक १५/५९–२०२४ च्या ठरावाअन्वये मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील खालील बी. एस्सी प्रथम वर्षाचे अभ्यासक्रम (Syllabus) लागू करण्यात येत आहेत.

01 B. Sc. I year - Biotechnolgy
02 B. Sc. I year – Bio-informatics
03 B. Sc. I year – Biotechnology (Vocational)
04 B. Sc. I year- Dyes and Druge
05 B. Sc. I year – Industrial Chemistry
06 B. Sc. I year – Agrochemical and Fertilizers
07 B. Sc. I year – Chemistry (General)
08 B. Sc. I year – Analytical Chemisrty
09 B. Sc. I year – Biochemistry
10 B. Sc. I year – Statistics
11 B. Sc. I year – Zoology
12 B. Sc. I year – Biotechnolgy (NMD College Hingoli)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी/विवत्रंविपदवी/२०२४–२५/123
दिनांक २०.०६.२०२४

डॉ. सरिता लोसरवार
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) मा. प्राचार्य, न्यू मॉडल डिग्री कॉलेज हिंगोली.
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

STRUCTURE AND SYLLABUS OF FOUR YEAR MULTIDISCIPLINARY

DEGREE PROGRAM WITH MULTIPLE ENTRY AND EXIT OPTION

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: BIOINFORMATICS
(Single Major)

FACULTY OF SCIENCE AND TECHNOLOGY

B. Sc. First Year
(Affiliated Colleges)

With Effect from June 2024

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement "***Enlightened Student: A Source of Immense Power***", is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve ***the 3Es, the equity, the efficiency*** and ***the excellence*** in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the cumulative grade point average (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the Choice Based Credit System (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high caliber graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP

2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science based to the discipline-specific-based curriculum. All the recommendations of the ***Sukanu Samiti*** given in the **NEP Curriculum Framework-2023** have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the **Government of Maharashtra regarding NEP-2020**. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory ***On Job Training, Internship program*** for science background students is praise worthy and certainly help the students to imbibe firsthand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. M. K. Patil

Dean
Faculty of Science and Technology

Preamble: The National Education Policy 2020 (NEP 2020) is formulated to revamp education system and lay down road map for new India. This policy is framed based on the fundamental pillars of access, equity, quality, affordability, and accountability and seeks to transform India into a thriving knowledge society and a global knowledge superpower.

Some of the important features of National Education Policy are increasing gross enrolment ratio in higher education, holistic and multidisciplinary education with multiple entry/exit options, establishment of academic bank of credit, setting up of multidisciplinary education and research Universities and National Research Foundation, expansion of open and distance learning to increase gross enrolment ratio, internationalization of education, motivated, energized and capable faculty, online and digital education and effective governance and leadership.

As per the National Education Policy, the Government of Maharashtra has proposed a model curriculum framework and an implementation plan for the State of Maharashtra. It is to suggest and facilitate the implementation of schemes and programs, which improve not only the level of academic excellence but also improve the academic and research environment in the state. The proposed curriculum framework endeavors to empower the students and help them in their pursuit for achieving overall excellence.

In view of NEP priority and in-keeping with its vision and mission, process of updating the curriculum is initiated and implemented in SRTM University at UG and PG level from the academic year 2023-2024.

Bioinformatics is an interdisciplinary field that combines biology, computer science, and statistics to analyze and interpret biological data. It involves the application of computational techniques and algorithms to store, organize, analyze, and visualize biological information, particularly genomic and proteomic data. Bioinformatics utilizes various computational tools and techniques to extract meaningful information from biological data. These include database management systems, data mining algorithms, machine learning methods, and statistical analysis. Researchers and scientists in the field of Bioinformatics use these tools to gain insights into biological processes, understand disease mechanisms, discover new drugs and therapies, and enhance our understanding of evolutionary relationships among species. Overall, Bioinformatics plays a vital role in advancing biological research by enabling the integration and analysis of large and complex datasets, ultimately contributing to discoveries and breakthroughs in fields such as genomics, proteomics, evolutionary biology, and personalized medicine.

Keeping in mind, BOS in Biotechnology and Bioinformatics has prepared the curriculum to ensure up-to-date level of understanding of Bioinformatics. Studying Bioinformatics prepares the students for their career working either in educational institutions or industries in which they can directly be involved in the teaching, research and development. Also, to ensure uniform curriculum and its quality at UG/PG level, curriculum of different Indian Universities, syllabus of NET, SET, MPSC, UPSC and the UGC model curriculum are referred to serve as a base in updating the same.

The comments or suggestions from all teachers, students and other stakeholders are welcome for upbringing this curriculum.

Salient Features:

The syllabus of B.Sc. Bioinformatics has been framed to meet the requirement of Choice Based Credit System under NEP 2020. The courses offered here in will train and orient the students in the specific fields of Bioinformatics.

The Core Courses deals with Fundamentals of Computer, Introduction to Bioinformatics, Basic Concepts in Biology, Basics of Cell and Molecular Biology, Principles of Evolution and Ecology and Ethics and Data Management in Bioinformatics.

Apart from the core courses, the Generic Elective Courses deal with Databases and Tools in Bioinformatics and Environmental Bioinformatics.

The Skill Enhancement Courses like Programming Language Concept and C Programming for Bio-computing Applications offered during this program are designed with the aim of imparting specific skills to the students which will lead to the self-employability and development of their own enterprises.
This would help students to lay a strong foundation in the field of Bioinformatics.

Overall, after completion of this course, students will also acquire fundamental knowledge and applications of Bioinformatics.

Program Educational Objectives:

The Objectives of this program are:

PEO1: To offer undergraduate program in Bioinformatics based on the needs of industries, academic and research institutions worldwide.

PEO2: To promote and popularize Bioinformatics at grass root level and attract young and budding talents.

PEO3: To expose the students to the different emerging fields of Bioinformatics.

PEO4: To update curriculum by introducing recent advances in the subject that enable the students to face NET, SET, MPSC, UPSC and other competitive examinations successfully.

PEO5: To train and orient the students so as to develop human resource for the educational institutes and other organizations.

PEO6: To inculcate analytical and application-oriented abilities to create active and frontline researchers and human resource for the industries.

PEO7: To develop specific skills amongst students for self-employability and for the development of their own enterprises.

Program Outcomes:

The Outcomes of this program are:

PO1: This Bioinformatics program shall promote and popularize Bioinformatics at grass root level and shall also attract young and budding talents.

PO2: This program will expose the students to the different emerging fields of Bioinformatics.

PO3: This will provide updated curriculum with recent advances in the subject that enable the students to face NET, SET, MPSC, UPSC and other competitive examinations successfully.

PO4: This program shall train and orient the students so as to develop human resource for the educational institutes and other organizations.

PO5: This program shall train and orient the students so as to develop active and frontline researchers and human resource for the industries.

PO6: This will also develop specific skills amongst students for self-employability and for the development of their own enterprises.

Prerequisite:

Basic knowledge of science at 12^{th} (HSC) level is required. The optional courses of this program are offered to the students registered for under-graduate programs. Such students should have the basic knowledge of Bioinformatics and willing to gain additional knowledge in the field of Bioinformatics.

Admissions to this program are given as per the University rules.

Dr. Sunita Dhudiraj Lohare
Chairman, BOS in Biotechnology and Bioinformatics
Swami Ramanand Teerth Marathwada University, Nanded.

Details of the Board of Studies Members in the subject Biotechnology and Bioinformatics under the Faculty of Science & Technology, S.R.T.M. University, Nanded.

Sr No	Name of the Member	Designation	Sr No	Address	Designation
1	Dr. Sunita Dhundiraj Lohare Shri Havgiswami Mahavidyalaya, Udgir, Dist. -Latur Mob. No. 9284161504	Chairman	2	Dr. Babasaheb S. Surwase School of Life Sciences SRTM University, Nanded Mob. No.9075829767	Member
3	Dr. Pratap V. Deshmukh Nagnath Arts, Commerce and Science College, Aundha Nagnath, Dist. Hingoli Mob. No. 9637202024	Member	4	Dr. Komal S. Gomare Dept of Biotechnology Dayanand Science College, Latur Mob. No. 9284238413	Member
5	Dr. Vaibhav D. Deshpande General Manager, Quality Corporate Office, Wockhardt, Mumbai Mob. No. 9100988260	Member	-	--	
	Invitee Members				
6	Dr Laxmikant Kamble School of Life Sciences, SRTM University, Nanded 431606. Mob. No.8669695555	Member	7	Dr M M V Baig Dept of Biotechnology, Yeshwant Mahavidyalaya, Nanded. Mob. No. 9422170641	Member
8	Dr. Sanjog T. Thul Environmental Biotechnology and Genomics Division, CSIR-NEERI). Mob. No. 9881877072	Member	9	Dr. Prashant Thakare Department of Biotechnology, SGB Amravati University, Amravati. Mob. No. 982222822	Member
10	Dr Makarand N. Cherekar Dept. of Biotechnology & Bioinformatics, MGM's College of CS and IT, Nanded. Mob: 9421454254	Member	11	Dr Arun Ingale School of Life Sciences, North Maharashtra University, PO Box 80, Umavinagar, Jalgaon Mob. No. 9822708707	Member
12	Mr. Rameshwar S. Belnor Dept. of Biotechnology & Bioinformatics, MGM's College of CS and IT, Nanded. Mob: 9096430300	Member	13	Dr Sunil Hajare Department of Biotechnology, New Model Degree College, Hingoli . Mob 8378878817	Member

B. Sc. First Year Semester I (Level 4.5)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	Practical	Total	Theory (Hrs/ Week)	Practical (Hrs/ Week)
Major Core 1	SBIOCT-1101	Fundamentals of Computer	02	--	02	02	--
	SBIOCP-1101	Lab Course based on Fundamentals of Computer	--	02	02	--	04
Major Core 2	SBIOCT-1102	Introduction to Bioinformatics	02	--	02	02	--
	SBIOCP-1102	Lab Course based on Introduction to Bioinformatics	--	02	02	--	04
Major Core 3	SBIOCT-1103	Basic Concepts in Biology	02	--	02	02	--
	SBIOCP-1103	Lab Course based on Basic Concepts in Biology	--	02	02	--	04
Generic Elective (GE) (From Other Faculty)	XDSCGE-1101	Select from Group A of Basket 3	02	--	02	02	--
Vocational & Skill Enhancement Course (Related to Major)	SBIOSC-1101	Programming Language Concept	--	02	02	--	04
Ability Enhancement Course (ENG)	AECENG-1101	L1 – Compulsory English	02	--	02	02	--
Ability Enhancement Course (MIL)	AECXXX-1101	L2–Second Language Marathi (MAR), Hindi (HIN), Urdu (URD), Kannada (KAN), Pali (PAL) (Basket 4)	02	--	02	02	--
Indian Knowledge System (IKS)	IKSXXX - 1101	Select from Basket 5	02	--	02	02	--
		Total Credits	**14**	**08**	**22**	**14**	**16**

B. Sc. First Year Semester I (Level 4.5)

Examination Scheme

[20% Continuous Assessment (CA) and 80% End Semester Assessment (ESA)]

Subject	Course Code	Course Name	Theory				Practical		Total
			Continuous Assessment (CA) Avg. of			ESA			
			Test I	Test II	(T1+T2)/2	Total	CA	ESA	
Major Core 1	SBIOCT-1101	Fundamentals of Computer	10	10	10	40	--	--	50
	SBIOCP-1101	Lab Course based on Fundamentals of Computer	--	--	--	--	20	30	50
Major Core 2	SBIOCT-1102	Introduction to Bioinformatics	10	10	10	40	--	--	50
	SBIOCP-1102	Lab Course based on Introduction to Bioinformatics	--	--	--	--	20	30	50
Major Core 3	SBIOCT-1103	Basic Concepts in Biology	10	10	10	40	--	--	50
	SBIOCP-1103	Lab Course based on Basic Concepts in Biology	--	--	--	--	20	30	50
Generic Elective (GE) (From Other Faculty)	XDSCGE-1101	Select from Group A of Basket 3	10	10	10	40	--	--	50
Vocational & Skill Enhancement Course (Related to Major)	SBIOSC-1101	Programming Language Concept	--	--	--	--	20	30	50
Ability Enhancement Course (ENG)	AECENG-1101	– L1 Compulsory English	10	10	10	40	--	--	50
Ability Enhancement Course (MIL)	AECXXX-1101	L2–Second Language Marathi (MAR), Hindi (HIN), Urdu (URD), Kannada (KAN), Pali (PAL) (Basket 4)	10	10	10	40	--	--	50
Indian Knowledge System (IKS)	IKSXXX - 1101	Select from Basket 5	10	10	10	40	--	--	50

B. Sc. First Year Semester II (Level 4.5)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	**Practical**	**Total**	**Theory** (Hrs/ Week)	**Practical** (Hrs/ Week)
Major Core 1	SBIOCT-1151	Basics of Cell and Molecular Biology	02	--	02	02	--
	SBIOCP-1151	Lab Course based on Basics of Cell and Molecular Biology	--	02	02	--	04
Major Core 2	SBIOCT-1152	Principles of Evolution and Ecology	02	--	02	02	--
	SBIOCP-1152	Lab Course based on Principles of Evolution and Ecology	--	02	02	--	04
Major Core 3	SBIOCT-1153	Ethics and Data Management in Bioinformatics	02	--	02	02	--
	SBIOCP-1153	Lab Course based on Ethics and Data Management in Bioinformatics	--	02	02	--	04
Generic Elective (GE) (From Other Faculty)	XDSCGE-1151	Select from Group B of Basket 3	02	--	02	02	--
Vocational & Skill Enhancement Course (Related to Major)	SBIOSC-1151	C Programming for Bio-computing Applications	--	02	02	--	04
Ability Enhancement Course (ENG)	AECENG-1151	L1 – Compulsory English	02	--	02	02	--
Ability Enhancement Course (MIL)	AECXXX-1151	L2–Second Language Marathi (MAR), Hindi (HIN), Urdu (URD), Kannada (KAN), Pali (PAL) (Basket 4)	02	--	02	02	--
Value Education Course (VEC)	VECCOI-1151	Constitution of India	02	--	02	02	--
		Total Credits	**14**	**08**	**22**	**14**	**16**

B.Sc. First Year Semester II (Level 4.5)

Examination Scheme

[20% Continuous Assessment (CA) and80% End Semester Assessment (ESA)]

Subject	Course Code	Course Name	Theory				Practical		Total
			Continuous Assessment (CA) Avg. of			ESA			
			Test I	Test II	(T1+T2)/2	Total	CA	ESA	
Major Core 1	SBIOCT-1151	Basics of Cell and Molecular Biology	10	10	10	40	--	--	50
	SBIOCP-1151	Lab Course based on Basics of Cell and Molecular Biology	--	--	--	--	20	30	50
Major Core 2	SBIOCT-1152	Principles of Evolution and Ecology	10	10	10	40	--	--	50
	SBIOCP-1152	Lab Course based on Principles of Evolution and Ecology	--	--	--	--	20	30	50
Major Core 3	SBIOCT-1153	Ethics and Data Management in Bioinformatics	10	10	10	40	--	--	50
	SBIOCP-1153	Lab Course based on Ethics and Data Management in Bioinformatics	--	--	--	--	20	30	50
Generic Elective (GE) (From Other Faculty)	XDSCGE-1151	Select from Group B of Basket 3	10	10	10	40	--	--	50
Vocational &Skill Enhancement Course (Related to Major)	SBIOSC-1151	C Programming for Bio-computing Applications	--	--	--	--	20	30	50
Ability Enhancement Course (ENG)	AECENG-1151	L1 – Compulsory English	10	10	10	40	--	--	50
Ability Enhancement Course (MIL)	AECXXX-1151	L2–Second Language Marathi (MAR), Hindi (HIN), Urdu (URD), Kannada (KAN), Pali (PAL) (Basket 4)	10	10	10	40	--	--	50
Value Education Course (VEC)	VECCOI-1151	Constitution of India	10	10	10	40	--	--	50

SBIOCT-1101: Fundamentals of Computer

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite: Basic knowledge about Mathematics and Computer Literacy.
Course objectives:

- To understand the fundamentals of computer science as a field of study.
- To explore the historical development and evolution of computers.
- To understand the basics of computer architecture.
- To explore the components of a computer system, including the CPU, memory, and input/output devices.

Course Outcomes: After completing this course, students shall be able to

- Define the basic components of a computer system, including hardware and software.
- Describe the functions of the central processing unit (CPU), memory, storage devices, and input/output peripherals.
- Develop digital literacy skills for effective use of computers in various contexts.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1.0**	**Introduction to Computing**	08
	1.1	History and Basics of Computing; Overview of computer systems and components;	
	1.2	Hardware vs. software; Understanding data and information	
	1.3	Operating Systems: Introduction to operating systems (Windows, macOS, Linux);	
	1.4	File management and navigation; System settings and customization	
2.0	**2.0**	**Common Software and Computer Security Basics**	08
	2.1	Word processors, spreadsheets, etc.)	
	2.2	Operating Systems: Introduction to operating systems (Windows, macOS, Linux); File management and navigation; System settings and customization	
	2.3	Introduction to common software applications (word processors, spreadsheets, etc.)	
	2.4	Common security threats; Password management; Antivirus software and updates	
3.0	**3.0**	**Networking and Internet**	08

	3.1	Basic networking concepts; Types of networks (LAN, WAN, WLAN)	
	3.2	Network devices: routers, switches, modems	
	3.3	Internet Usage: Web browsers and search engines	
	3.4	Internet Safety: Online safety and privacy	
4.0	**4.0**	**Web Technologies and Online Collaboration**	06
	4.1	Introduction to Web Technologies: Understanding URLs and web addresses	
	4.2	Basics of HTML and web page structure; Introduction to web browsers and their features	
	4.3	Introduction to cloud computing; Online collaboration platforms (Google Workspace, Microsoft 365)	
	4.4	Virtual meetings and communication tools; Ethical considerations in digital communication	
		Total	
			30

Reference Books

1. Brookshear, J. G., & Brylow, D. (2020). Computer science: an overview. Pearson.
2. Sinha, P. K., & Sinha, P. (2004). Computer fundamentals. BPB publications.
3. O'Leary Timothy, J. Microsoft Office 2000.
4. Bonaventure, O. (2011). Computer Networking: Principles, Protocols and Practice.
5. Online Resource: Cisco Networking Basics - Cisco Networking Basics.

SBIOCP-1101: Lab Course based on Fundamentals of Computer

B.Sc. Bioinformatics Marks: 50

Sr. No.	List of Experiments:
1	**Computer Hardware Exploration:** • Identify components of a computer system by disassembling and assembling a computer. • Learn to differentiate between hardware and software.
2	**Operating System Interaction:** • Perform basic operations in different operating systems (Windows, macOS, Linux). • Customize system settings and preferences.
3	**Digital Literacy Project:** • Create a digital portfolio demonstrating proficiency in productivity tools like word processors, spreadsheets, and presentation software.
4	**Home Network Setup:** • Design and set up a small home network. • Configure routers, switches, and devices to communicate.
5	**Web Development Basics:**

	• Create a simple static webpage using HTML and CSS. • Host the webpage on a local server for peer review.
6	**Online Collaboration Simulation:** • Simulate an online collaborative project using cloud-based tools (Google Workspace, Microsoft 365).

SBIOCT-1102: Introduction to Bioinformatics

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- Basic Biology Knowledge
- Fundamentals of Computer Science
- Basic Mathematics and Statistics

Course objectives:

- To understand the fundamental concepts, terminology, and applications of bioinformatics, including the history, scope, and interdisciplinary nature of the field.
- To become familiar with key biological databases and be able to retrieve and interpret biological data from various sources.
- To gain proficiency in using various bioinformatics tools and software

Course Outcomes: After completing this course,

- Students will be able to effectively search and retrieve data from major biological databases.
- They will demonstrate the ability to perform and interpret pairwise and multiple sequence alignments using bioinformatics tools such as BLAST and CLUSTAL.
- Students will gain knowledge of Application of Bioinformatics.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1.0**	**Foundations of Bioinformatics**	08
	1.1	Introduction to Bioinformatics and its role in life sciences.	
	1.2	Goal and scope of bioinformatics	
	1.3	History and evolution of bioinformatics	
	1.4	Applications of bioinformatics in biology and medicine.	
2.0	**2.0**	**Biological Databases**	08
	2.1	Types of biological databases (sequence, structure, pathway)	
	2.2	Introduction to major databases (NCBI, EMBL, DDBJ, UniProt, PDB)	
	2.3	Database searching and retrieval techniques	
	2.4	Introduction to Scientific literature databases (PubMed, PMC, PloS)	
3.0	**3.0**	**Genomic Databases and Tools**	08
	3.1	Basic Local Alignment Search Tool (BLAST)	

	3.2	Overview of genome, genome databases and their importance.	
	3.3	Examples: UCSC Genome Browser, Ensembl Genome Browser.	
	3.4	Practical application of genomic databases and tools.	
4.0	**4.0**	**Structural Bioinformatics and Proteomic Databases**	06
	4.1	Overview of protein structure databases (PDB).	
	4.2	Understanding protein databases CATH, SCOP	
	4.3	Application of Bioinformatics databases and tools.	
	4.4	Privacy and ethical issues in handling biological data.	
		Total	
			30

Reference Books

1. Attwood TK, Parry-Smith DJ. (1999). Introduction to Bioinformatics. Pearson Education.
2. Mount DW. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
3. Essential Bioinformatics" by Jin Xiong
4. **Online Resources:**
   - NCBI Handbook

EMBL-EBI Training Resources

SBIOCP-1102: Lab Course based on Introduction to Bioinformatics

B.Sc. Bioinformatics Marks: 50

Sr. No.	List of Experiments:
1	**Exploration of Major Databases:** • Guided exploration of the NCBI, EMBL (ENA), DDBJ databases. • Retrieval of nucleotide and protein sequences, exploring gene information.
2	**BLAST Searches:** • Performing Basic Local Alignment Search Tool (BLAST) searches. • Analysis of sequence similarities and identification of homologous sequences.
3	**Exploring Protein Databases:** • Utilizing protein databases such as PDB, UniProt, etc. • Retrieval of protein sequences, functional annotations, and domain information.
4	**Genome Databases and Genome Browsing:** • Exploration of genome databases • Exploration of genome browsers (e.g., UCSC Genome Browser). • Visualization of genomic features, gene structures, and regulatory elements.
5	**Variant Analysis:** • Analysis of genetic variations using databases like dbSNP. • Interpretation of single nucleotide polymorphisms (SNPs) and their effects.
6	**Exploration of Scientific Literature Databases :** • Utilizing Scientific Literature databases such as PubMed, PMC, PloS, etc.

SBIOCT-1103: Basic Concepts in Biology

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- General science background or high school level biology.
- Students should ave basic understanding of scientific principles and quantitative skills.

Course Objective:

- To provide students with a foundational understanding of fundamental biological concepts and principles.
- To familiarize students with the scientific method and its application in biology.
- To enhance written and verbal communication skills, including the ability to articulate scientific ideas, present experimental findings.

Course Outcomes:

- Students will be able to demonstrate a solid understanding of fundamental biological concepts.
- Students will be able to enhance written and verbal communication skills related to scientific topics, including the ability to write lab reports, present findings, and engage in scientific discussions.
- Students will be able to cultivate problem-solving skills related to biological issues, applying knowledge to address real-world problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**01**	**Introduction to Biology**	08
	1.1	Overview of Biology as a Science	
	1.2	Characteristics of Living Organisms	
	1.3	Biological Classification: Taxonomy and Systematics	
	1.4	Introduction to Ecology and Ecosystems; Biomes and Biodiversity	
2.0	**02**	**Micro-organisms**	08
	2.1	Classification and Nomenclature of Microorganisms	
	2.2	Overview of Microbial Diversity: Bacteria, Archaea, Viruses,	

		Fungi, Protists	
	2.3	Microbes in Industry: Fermentation, Biotechnology, Environment; Pathogenic Bacteria: Overview and Examples	
	2.4	Structure and Classification of Viruses	
3.0	**03**	**Introduction to Plant Biology**	
	3.1	Overview of Plant Biology; Importance of Plants in Ecosystems	
	3.2 3.3	Classification of Plants: Bryophytes, Pteridophytes, Gymnosperms, Angiosperms	08
	3.4	Economic Importance of Plants: Agriculture, Medicine, Industry	
4.0	**04**	**Basics of Genetics**	
	4.1	Mendelian Genetics and Inheritance Patterns	
	4.2	DNA Structure, Replication, and Repair; RNA and Protein Synthesis; Genetic Code and Translation	
	4.3	Gene Mutations: Types and Consequences; Regulation of Gene Expression	06
	4.4	Epigenetics and Genomic Imprinting; Modern Developments in Genetics	
		Total	
			30

Reference Books:

1. CAMPBELL, NEIL A., et al. "Biology: A Global Approach–10th edition."
2. Sadava, D. E., Hillis, D. M., & Heller, H. C. (2011). Life: The science of biology (Vol. 2). Macmillan.
3. Campbell, N. A. (2006). Biology concepts & connections.
4. Molles, M. C., & Tibbets, T. (2002). Ecology: concepts and applications (pp. 186-254). New York: McGraw-Hill.
5. Tortora, G. J., Funke, B. R., & Case, C. L. (2007). Microbiology: an introduction (p. 912). San Francisco, CA: Pearson Benjamin Cummings.
6. Mauseth, J. D. (2014). Botany: an introduction to plant biology. Jones & Bartlett Publishers.
7. Hartwell, L., Goldberg, M. L., Fischer, J. A., Hood, L. E., & Aquadro, C. F. (2018). Genetics: from genes to genomes (p. 960). New York, NY, USA: McGraw-Hill Education.

SBIOCP-1103: Lab Course based on Basic Concepts in Biology

B.Sc. Bioinformatics Marks: 50

Sr. No.	List of Experiments:
1	Lab Safety and Equipment: Introduction to laboratory safety rules and proper use of equipment.
2	Microscopy: Introduction to microscope usage, observing cells, and cell structures.

3	Ecosystem Sampling: Fieldwork to analyze biodiversity and interactions in local ecosystems.
4	Photosynthesis Lab: Investigating factors affecting the rate of photosynthesis.
5	Cell Staining: Staining techniques to enhance visibility of cell structures.
6	Punnett Square Exercises: Predicting genetic outcomes using Punnett squares.

Skill Enhancement Course
SBIOSC-1101: Programming Language Concept

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- Basic knowledge of computer architecture, including CPU, memory, and assembly language.
- Ability to think logically and solve problems using mathematical reasoning.
- Basic understanding of formal language concepts, regular expressions, etc.

Course Objectives:

- To introduce concepts from formal language theory, such as regular languages, context-free languages, and grammars.
- To understand the fundamental concepts that define programming languages, such as syntax, semantics, and pragmatics.
- To explore the principles of designing programming languages, considering factors like readability, writability, and reliability.

Course Outcomes: At the end of the course:

- Students will demonstrate a strong understanding of the foundational concepts of programming languages, including syntax, semantics, and pragmatics.
- Students will be able to apply language design principles to create programming constructs that prioritize readability, writability, and reliability.
- Students will demonstrate proficiency in memory management concepts, including memory allocation, deallocation, and garbage collection.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1.0**	**Foundations of Programming Languages**	08
	1.1	Introduction to Programming Languages	
	1.2	Overview of programming languages and their importance.	
	1.3	Classification of programming languages	
	1.4	high-level vs. low-level, procedural vs. declarative, etc.	
2.0	**2.0**	**Art of Programming**	08
	2.1	Individual approaches to programming	

	2.2	Programming strategies; Formal language theory basics	
	2.3	Understanding syntax and semantics in programming languages;	
	2.4	Context-free grammars; Regular expressions	
3.0	**3.0**	**Programming Paradigms**	06
	3.1	Characteristics of imperative programming. Case studies: C, Pascal.	
	3.2	Introduction to functional programming. Case studies: Lisp, Haskell.	
	3.3	Principles of object-oriented programming. Case studies: Java, Python.	
	3.4	Overview of languages that support multiple paradigms. Case studies: Scala, JavaScript.	
4.0	**4.0**	**Language Features**	08
	4.1	Analysis of language features: control structures, data types, abstraction mechanisms.	
	4.2	Overview of tools used in the implementation of programming languages.	
	4.3	Discussion on languages for specific domains (e.g., data science, web development).	
	4.4	Exploration of modern programming language trends.	
		Total	30

References:

1. Sebesta, R. W. (2016). Concepts of programming languages. Pearson Education India.
2. Alfred, V. A., Monica, S. L., & Jeffrey, D. U. (2007). Compilers Principles, Techniques & Tools. pearson Education.
3. Abelson, H., & Sussman, G. J. (1996). Structure and interpretation of computer programs (p. 688). The MIT Press.
4. Hopcroft, J. E., Motwani, R., & Ullman, J. D. (2001). Introduction to automata theory, languages, and computation. Acm Sigact News, 32(1), 60-65.
5. Scott, M. (2000). Programming language pragmatics. Morgan Kaufmann.
6. Pierce, B. C. (2002). Types and programming languages. MIT press.
7. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). Design patterns: elements of reusable object-oriented software. Pearson Deutschland GmbH.

Sr. No.	List of Experiments: Programming Language Concept
1	**Practical 1: Exploring Programming Languages** **Objective:** To introduce students to different programming languages and their classifications, and to understand their importance in various contexts. **Activities:** 1. **Language Survey:** o Have students research and present on a variety of programming languages, focusing on their history, primary use cases, and unique features. o Languages could include Python, C, Java, JavaScript, Lisp, and Prolog.
2	**Practical 2: Classification of Programming Languages** **Objective:** To classify programming languages based on different criteria such as high-level vs. low-level and procedural vs. declarative. **Activities:** 1. **Language Classification Activity:** o Provide a list of programming languages and have students classify them into high-level vs. low-level and procedural vs. declarative categories. o Example languages: Assembly, C, Python, Java, Lisp, Prolog.
3	**Practical 3: Procedural vs. Declarative Programming** **Objective:** To understand the fundamental differences between procedural and declarative programming through hands-on practice. **Activities:** 1. **Problem Solving:** o Provide a problem that can be solved using both procedural and declarative approaches (e.g., finding the factorial of a number, searching an element in a list).
4	**Practical 4: Individual Approaches to Programming** **Objective:** To explore various programming strategies and individual approaches to solving problems. **Activities:** 1. **Problem-Solving Exercise:** o Provide students with a moderately complex problem (e.g., sorting a list of numbers, solving a simple game puzzle). o Have students individually develop a strategy to solve the problem, including pseudocode and a flowchart.
5	**Practical 5: Syntax and Semantics in Programming Languages** **Objective:** To understand the basics of formal language theory, including syntax and semantics, and their importance in programming languages. **Activities:** 1. **Syntax and Semantics Analysis:** o Provide code snippets in different programming languages (e.g.,

	Python, Java, Lisp). o Students analyze the syntax and semantics of each snippet, identifying keywords, operators, data types, and control structures.
6	**Practical 6: Imperative Programming Paradigm** **Objective:** To understand the characteristics of imperative programming through practical examples in C and Pascal. **Activities:** 1. **Exploring Basic Concepts:** o Provide a brief overview of imperative programming, including concepts like variables, control structures (loops, conditionals), and functions.
7	**Practical 7: Analysis of Language Features** **Objective:** To analyze and compare control structures, data types, and abstraction mechanisms in different programming languages. Activities: **1. Control Structures Comparison:** o Provide code snippets that implement the same algorithm (e.g., a simple sorting algorithm) using different control structures (loops, conditionals) in multiple languages (e.g., Python, Java, and C++).
8	**Practical 8: Domain-Specific Languages and Modern Programming Trends** **Objective:** To explore programming languages designed for specific domains and examine modern programming language trends. **Activities:** **1. Domain-Specific Languages (DSLs):** o Provide an overview of DSLs and their uses in fields such as data science, web development, and system administration. o Students select a DSL (e.g., R for data science, HTML/CSS/JavaScript for web development, Bash for system administration) and complete a small project relevant to the domain. **2. Modern Programming Language Trends:** o Introduce trends such as concurrent and parallel programming, language interoperability, and type inference. o Students explore a modern language that embodies one of these trends (e.g., Go for concurrency, Rust for safety and performance, TypeScript for type inference in JavaScript).

SEMESTER II

SBIOCT-1151: Basics of Cell and Molecular Biology

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course Prerequisite:

- Basic understanding of biology concepts gained in high school, including cell structure, genetics, and basic molecular biology.
- Fundamental knowledge of basic chemistry concepts, especially those related to biochemistry (e.g., chemical bonding, molecular structures, chemical reactions).
- Completion of high school-level chemistry is often recommended to understand the chemical principles underlying biological processes. Familiarity with basic cell biology concepts, such as cell structure, organelles, and cellular processes, can be beneficial.

Course Objectives:

- To familiarize students with the structure and function of eukaryotic and prokaryotic cells.
- To understand key cellular processes such as cell division, cell cycle regulation, and cell signaling.
- To introduce students to the basic principles of molecular biology, including DNA structure, replication, transcription, and translation. Understand the process of transcription and translation, and the role of RNA in protein synthesis.

Course Outcomes: A the end of the course:

- Students will demonstrate a comprehensive understanding of cell structure and function, distinguishing between prokaryotic and eukaryotic cells.
- Students will explain key cellular processes, including cell division, cell cycle regulation, and cell signaling.
- Students will describe the structure of DNA, RNA, and the central dogma of molecular biology, including replication, transcription, and translation. Also illustrate the processes of transcription and translation, and describe the roles of RNA in protein synthesis.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**01**	**Introduction to Cell Biology**	08
	1.1	Overview of biology and its branches.	
	1.2	Historical development of cell biology.	
	1.3	Introduction to cell types: prokaryotic and eukaryotic cells.	
	1.4	Cellular organelles and their functions.	
2.0	**02**	**Cell Membrane, Cellular Transport and Cell Division**	08

	2.1	Structure and function of the cell membrane.	
	2.2	Mechanisms of cellular transport: diffusion, osmosis, active transport.	
	2.3	Cell Cycle and Division: Phases of the cell cycle.	
	2.4	Mitosis and meiosis.	
3.0	**03**	**Molecular Biology Fundamentals**	08
	3.1	DNA Structure: Molecular structure of DNA.	
	3.2	DNA Replication: DNA replication process.	
	3.3	RNA and Protein Synthesis: Genes, RNA; Types of RNA and their functions.	
	3.4	Transcription and translation processes.	
4.0	**04**	**Genetic Engineering and Biotechnology**	06
	4.1	Basics of genetic engineering.	
	4.2	Applications in biotechnology.	
	4.3	Emerging Topics in Cell and Molecular Biology: Exploration of recent advancements and emerging topics.	
	4.4	Molecular Biology and Bioinformatics.	
		Total	
			30

Reference Books:

1. Bruce, A. (1983). Molecular biology of the cell. Garland publishing.
2. Milo, R., & Phillips, R. (2015). Cell biology by the numbers. Garland Science.
3. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., ... & Walter, P. (2015). Essential cell biology. Garland Science.
4. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2005). Lehninger principles of biochemistry. Macmillan.
5. Hartwell, L., Goldberg, M. L., Fischer, J. A., Hood, L. E., & Aquadro, C. F. (2018). Genetics: from genes to genomes (p. 960). New York, NY, USA: McGraw-Hill Education.
6. Craig, N. L., Green, R. R., Greider, C. C., Wolberger, C., & Storz, G. G. (2021). Molecular biology: principles of genome function. Oxford University Press, USA.
7. Lodish, H. F. (2008). Molecular cell biology. Macmillan.
8. Lim, W., Mayer, B., & Pawson, T. (2014). Cell signaling. Garland Science.

SBIOCP-1151: Lab Course based on Basics of Cell and Molecular Biology

B.Sc. Bioinformatics **Marks: 50**

Sr. No.	List of Experiments: Basics of Cell and Molecular Biology
1	**Microscopy Techniques:**

	• Introduction to light microscopy and electron microscopy. • Observation of different cell types under the microscope.
2	**Cell Staining:** • Staining techniques for visualizing cellular structures. • Preparation of slides for microscopy.
3	**Cell Culture Basics:** • Introduction to cell culture techniques. • Observation and maintenance of cell cultures.
4	**DNA Extraction:** • Hands-on experience in extracting DNA from plant or animal cells. • Understanding the principles of DNA isolation.
5	**PCR (Polymerase Chain Reaction):** • Amplification of specific DNA sequences using PCR. • Gel electrophoresis to analyze PCR products.
6	**Gel Electrophoresis:** • Separation of DNA fragments using gel electrophoresis. • Visualization and analysis of DNA bands.

SBIOCT-1152: Principles of Evolution and Ecology

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- Understanding of cellular structures, functions, and processes such as cell division (mitosis and meiosis).
- Fundamental Ecology Concepts: Basic understanding of ecological principles, including ecosystems, energy flow, and nutrient cycles.
- Environmental Science: Knowledge of environmental issues and the impact of human activities on ecosystems.

Course objectives:

- To comprehend the basic principles and mechanisms of evolution, including natural selection, genetic drift, gene flow, and mutation.
- To understand ecological principles, including energy flow, nutrient cycling, population dynamics, species interactions, and ecosystem functions.
- To apply theoretical knowledge to real-world scenarios, such as understanding the evolution of antibiotic resistance, conservation strategies, and the impact of human activities on ecosystems.

Course Outcomes: After completing this course, students shall be able to

- Students will be able to explain the fundamental mechanisms of evolution, including natural selection, genetic drift, gene flow, and mutation, and how these processes contribute to genetic variation and speciation in populations.
- Students will gain a comprehensive understanding of ecological principles, including population dynamics, community interactions, and ecosystem functions. They will be able to analyze how different species interactions and environmental factors influence community structure and ecosystem stability.
- Students will be able to apply evolutionary and ecological concepts to real-world scenarios, such as conservation efforts, biodiversity management, and the study of human impacts on ecosystems. They will also develop skills in ecological modeling and data analysis, using appropriate software tools to investigate and solve ecological problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1.0**	**Fundamentals of Evolution**	08
	1.1	Introduction to Evolutionary Biology: Definition and significance of evolution; Historical perspectives (Darwin, Lamarck, Wallace); Modern synthesis of evolutionary theory	
	1.2	Mechanisms of Evolution: Natural selection, genetic drift, gene flow, and mutation; Hardy-Weinberg equilibrium and its applications; Types of selection (directional, stabilizing, disruptive)	
	1.3	Concepts of species and speciation mechanisms (allopatric, sympatric)	
	1.4	Phylogenetic trees and cladistics; Molecular evolution and evolutionary rates	
2.0	**2.0**	**Population Genetics and Ecology**	08
	2.1	Population Genetics: Gene pools and allele frequencies; Factors affecting genetic variation; Population bottlenecks and founder effects	
	2.2	Principles of Ecology: Definitions and scope of ecology; Levels of ecological organization (organism, population, community, ecosystem, biosphere)	
	2.3	Energy flow and nutrient cycling in ecosystems	
	2.4	Population Ecology: Population growth models (exponential, logistic); Life history strategies (r/K selection theory); Population dynamics and regulation	
3.0	**3.0**	**Community and Ecosystem Ecology**	08
	3.1	Community Ecology: Species interactions (competition, predation, mutualism, parasitism)	
	3.2	Community structure and biodiversity; Ecological succession and community stability	
	3.3	Ecosystem Ecology: Ecosystem structure and function; Primary and secondary productivity	
	3.4	Biogeochemical cycles (carbon, nitrogen, phosphorus)	
4.0	**4.0**	**Applied Evolutionary and Ecological Principles**	06
	4.1	Evolutionary Applications: Evolution of antibiotic resistance; Co-evolution and evolutionary arms races; Evolutionary medicine	
	4.2	Conservation Ecology: Principles of conservation biology; Human impacts on ecosystems and conservation biology	
	4.3	Biodiversity hotspots and conservation strategies; Restoration ecology and rewilding	
	4.4	**Ecological Modeling and Analysis:** Ecological data collection and analysis methods; Use of software tools in ecological research	
		Total	

			30

Reference Books

1. Molles, M. C., & Tibbets, T. (2002). Ecology: concepts and applications (pp. 186-254). New York: McGraw-Hill.
2. Zimmer, C., & Emlen, D. J. (2013). Evolution: making sense of life. Greenwood Village, CO: Roberts.
3. Darwin, C. (2010). The origin of species: A variorum text. University of Pennsylvania Press.
4. Hartl, D. L., Clark, A. G., & Clark, A. G. (1997). Principles of population genetics (Vol. 116, p. 542). Sunderland, MA: Sinauer associates.
5. Molles, M. C., & Tibbets, T. (2002). Ecology: concepts and applications (pp. 186-254). New York: McGraw-Hill.
6. Smith, R. L., Smith, R. L., Hickman, G. C., & Hickman, S. M. (1998). Elements of ecology.
7. Jablonski, D. (2000). Micro-and macroevolution: scale and hierarchy in evolutionary biology and paleobiology. Paleobiology, 26(S4), 15-52.

SBIOCP-1152: Lab Course based on Principles of Evolution and Ecology

B.Sc. Bioinformatics Marks: 50

Sr. No.	List of Experiments:
1	**Hardy-Weinberg Equilibrium:** • **Objective**: Explore the principles of Hardy-Weinberg equilibrium. • **Activities**: Calculate allele and genotype frequencies in a population and verify conditions for Hardy-Weinberg equilibrium.
2	**Simulating Natural Selection:** • **Objective**: Understand the process of natural selection through simulation. • **Activities**: Use computer simulations or hands-on activities to model how environmental factors influence allele frequencies in a population over time.
3	**Field Sampling Techniques:** • **Objective**: Learn basic field sampling methods. • **Activities**: Conduct quadrat and transect sampling to estimate population density and distribution in a local habitat.
4	**Biodiversity Assessment:**

	• **Objective**: Assess biodiversity in different ecosystems. • **Activities**: Measure species richness, evenness, and diversity indices (e.g., Shannon-Wiener Index) in various habitats.
5	**Nutrient Cycling:** • **Objective**: Study nutrient cycles in ecosystems. • **Activities**: Analyze soil and water samples for nutrient content (e.g., nitrogen, phosphorus) and understand their role in ecosystem dynamics.
6	**Co-evolution Studies:** • **Objective**: Investigate co-evolutionary relationships. • **Activities**: Study examples of co-evolution (e.g., predator-prey, host-parasite) through field observations and laboratory experiments.
7	**Adaptation Analysis:** • **Objective**: Analyze adaptations in different species. • **Activities**: Examine morphological and behavioural adaptations in various organisms and relate them to their ecological niches.
8	**Climate Change Impact:** • **Objective**: Study the effects of climate change on ecosystems. • **Activities**: Use long-term ecological data to analyze changes in species distribution, phenology, and ecosystem processes due to climate change.
9	**Invasive Species:** • **Objective**: Study the impact of invasive species on native ecosystems. • **Activities**: Conduct field surveys to identify invasive species and assess their impact on local biodiversity and ecosystem function.

SBIOCT-1153: Ethics and Data Management in Bioinformatics

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- **Basic Bioinformatics Concepts**: Understanding key concepts in bioinformatics, such as sequence alignment, genomic databases, and biological data types. Familiarity with commonly used bioinformatics tools (e.g., BLAST, ClustalW) and software platforms. Students have a basic understanding of scientific principles and quantitative skills.
- **Data Handling and Analysis**: Basic skills in data collection, preprocessing, and analysis using tools like Python, R, or Excel. Understanding of fundamental statistical concepts and techniques, such as descriptive statistics, probability, and hypothesis testing.
- **Ethical Theories and Principles**: Familiarity with fundamental ethical theories (e.g., utilitarianism, deontology) and principles (e.g., autonomy, justice, beneficence).Basic knowledge of ethical considerations in scientific research, including informed consent, privacy, and integrity. To provide students with a foundational understanding of fundamental biological concepts and principles.

Course Objectives:

- To familiarize students with the fundamental ethical principles that govern the use and management of biological data.
- To equip students with the knowledge and skills necessary for effective and responsible data management in bioinformatics.
- To critically evaluate the societal implications and impact of bioinformatics research and data practices.

Course Outcomes:

- Students will be able to explain fundamental ethical principles such as privacy, confidentiality, informed consent, and data security.
- Students will gain proficiency in best practices for managing bioinformatics data, including data collection, storage, curation, and archiving. Students will learn how to implement data management plans that ensure data integrity, reproducibility, and compliance with relevant regulations and standards.

- Students will understand and apply relevant legal and regulatory frameworks governing bioinformatics data, such as HIPAA, GDPR, and other data protection laws. Students will be able to design and conduct bioinformatics research in a manner that adheres to ethical guidelines and legal requirements, ensuring responsible conduct of research and data stewardship.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**01**	**Introduction to Bioinformatics and Ethical Issues**	08
	1.1	Overview of Bioinformatics: Definition and scope of bioinformatics;	
	1.2	Applications of bioinformatics in research and healthcare ; Importance of data management in bioinformatics	
	1.3	Ethical Principles in Bioinformatics: Key ethical principles (autonomy, beneficence, non-maleficence, justice); Importance of ethics in scientific research and bioinformatics; Case studies highlighting ethical issues in bioinformatics	
	1.4	Privacy and Confidentiality: Importance of privacy and confidentiality in handling genetic and health data; Legal frameworks and regulations (e.g., GDPR, HIPAA); Strategies for ensuring data privacy and confidentiality	
2.0	**02**	**Data Management Principles and Practices**	08
	2.1	Data Life Cycle in Bioinformatics: Stages of the data life cycle: data generation, collection, storage, processing, analysis, sharing, and archiving	
	2.2	Importance of proper data management at each stage; Best practices for data curation and metadata management	
	2.3	Data Storage and Security: Types of data storage solutions (local, cloud, hybrid); Data encryption and access control mechanisms; Backup and disaster recovery planning	
	2.4	Data Sharing and Collaboration: Benefits and challenges of data sharing in bioinformatics; Data sharing policies and repositories; Collaborative tools and platforms for data sharing	
3.0	**03**	**Data Analysis and Reproducibility**	08
	3.1	Data Quality and Integrity: Importance of data quality and integrity in bioinformatics research; Methods for assessing and ensuring data quality; Data validation and error correction techniques	
	3.2	Reproducible Research: Definition and importance of reproducibility in bioinformatics; Tools and practices for reproducible research (version control, electronic lab notebooks); Role of open science and open data in reproducibility	
	3.3	Ethical Considerations in Data Analysis: Ethical issues related	

		to data manipulation and analysis; Responsible conduct of research and data analysis	
	3.4	Case studies on ethical breaches in data analysis	
4.0	**04**	**Legal and Social Implications**	
	4.1	Intellectual Property and Data Ownership: Intellectual property rights in bioinformatics; Issues related to data ownership and authorship	06
	4.2	Licensing and data sharing agreements	
	4.3	Societal Implications of Bioinformatics Research: Impact of bioinformatics research on society and individuals: Ethical considerations in personalized medicine and genetic testing	
	4.4	Future Directions and Emerging Issues: Emerging ethical issues in bioinformatics (e.g., AI and machine learning in genomics); The role of bioethics committees and review boards	
		Total	
			30

Reference Books:

1. Buffalo, V. (2015). Bioinformatics data skills: Reproducible and robust research with open source tools. " O'Reilly Media, Inc.".
2. Goodman, K. W. (2020). Ethics in health informatics. Yearbook of medical informatics, 29(01), 026-031.
3. Beauchamp, T. L., & Childress, J. F. (2001). Principles of biomedical ethics. Oxford University Press, USA.
4. Briney, K. (2015). Data Management for Researchers: Organize, maintain and share your data for research success. Pelagic Publishing Ltd.
5. Comstock, G. (2012). Research ethics: A philosophical guide to the responsible conduct of research. Cambridge University Press.

Online References:

1. NIH Office of Data Science Strategy: Data Management & Sharing
    a. Guidelines and resources for data management and sharing in biomedical research.
    b. NIH Data Management & Sharing
2. Nature: Guidelines for Authors on Data Management and Sharing
    a. Guidelines from the journal Nature on best practices for data management and sharing in scientific research.
    b. Nature Data Policies

3. European Bioinformatics Institute (EMBL-EBI): Data Management and Sharing for Life Scientists
    a. Online resources and training materials on data management and sharing practices.
    b. EMBL-EBI Data Management
4. The National Center for Biotechnology Information (NCBI): Data Management Resources
    a. Tools and resources for managing and sharing bioinformatics data.
    b. NCBI Data Management
5. The Global Alliance for Genomics and Health (GA4GH): Framework for Responsible Sharing of Genomic and Health-Related Data
    a. Guidelines for ethical data sharing in genomics and health research.
    b. GA4GH Framework

SBIOCP-1153: Lab Course based on Ethics and Data Management in Bioinformatics

B.Sc. Bioinformatics Marks: 50

Sr. No.	List of Experiments:
1	**Case Study Analysis: Ethical Issues in Bioinformatics** • **Objective**: Analyze real-world case studies to identify and discuss ethical dilemmas in bioinformatics. • **Activities**: Group discussions, written reports, and presentations on selected case studies.
2	**Data Privacy and Confidentiality Assessment** • **Objective**: Evaluate data privacy and confidentiality measures in bioinformatics projects. • **Activities**: Review privacy policies
3	**Data Sharing and Repository Submission** • **Objective**: Learn how to prepare and submit data to public repositories. • **Activities**: Format data according to repository guidelines (e.g., NCBI, EMBL-EBI), create metadata, and submit datasets.
4	**Intellectual Property and Data Licensing** • **Objective**: Understand intellectual property rights and data licensing in bioinformatics. • **Activities**: Review different types of licenses.
5	**Impact Assessment of Bioinformatics Research** • **Objective**: Assess the societal impact of bioinformatics research. • **Activities**: Conduct a case study on a bioinformatics project, evaluate its societal implications, and present findings.

Skill Enhancement Course
SBIOSC-1151: C Programming for Bio-computing Applications

Marks: 50 **B.Sc. Bioinformatics** **Hours: 30**

Course pre-requisite:

- Proficiency in basic mathematics, including algebra and logic, as programming often involves mathematical concepts. Basic understanding of computer science fundamentals, including algorithms, data structures, and problem-solving.
- Basic knowledge of biological concepts, especially those relevant to bioinformatics and biocomputing.
- Understanding of basic statistical concepts, as statistical analysis is often used in biocomputing applications. Basic programming skills in C or another programming language. Students should be familiar with variables, loops, conditional statements, functions, and basic debugging.

Course Objectives:

- To develop a solid understanding of C programming language fundamentals, including syntax, variables, data types, loops, and functions. Integrate biological concepts with programming knowledge to understand how computational solutions are applied in bioinformatics.

- To enhance problem-solving skills by formulating and implementing algorithms for bioinformatics challenges. Acquire skills in manipulating biological data using C programming, with a focus on tasks like sequence analysis, file parsing, and data extraction.
- To design and develop simple biocomputing tools and applications in C to solve specific biological problems. Acquire skills in debugging C code and troubleshooting common programming errors, with a focus on bioinformatics-related issues.

Course Outcomes: After completing this course, students shall be able to

- Demonstrate a strong understanding of C programming language fundamentals, including syntax, data types, control structures, and functions.
- Implement and utilize essential data structures in C, such as arrays, linked lists, and trees, for effective biological data manipulation.
- Apply C programming skills to manipulate biological data, including tasks like sequence analysis, parsing file formats, and data extraction. Demonstrate proficiency in debugging C code, identifying errors, and troubleshooting common programming issues, with an emphasis on bioinformatics-related challenges.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1.0**	**Foundations of C Programming**	08
	1.1	Introduction to C Programming: Overview of the C programming language;	
	1.2	Basic syntax, data types, and control structures, Program flow control statements	
	1.3	Essential C Programming Concepts: Functions, arrays, and pointers in C.	
	1.4	Writing and executing simple C programs	
2.0	**2.0**	**Data Structures and Algorithms**	08
	2.1	Data Structures in C: Arrays, linked lists, and trees in the context of bio-computing	
	2.2	Implementation of basic data structures in C	
	2.3	Understanding memory allocation and management	
	2.4	Practical exercises for manipulating biological data structures	
3.0	**3.0**	**File Handling and Input/output Operations**	06
	3.1	File input/output operations in C	
	3.2	Reading and writing data from/to files	
	3.3	Handling different file formats in bioinformatics	
	3.4	Practice exercises for hands-on experience	
4.0	**4.0**	**Algorithmic Problem Solving**	08
	4.1	Introduction to algorithm design and analysis	
	4.2	Implementing algorithms for common bioinformatics tasks	
	4.3	Debugging and Troubleshooting: Debugging C code for common programming errors	
	4.4	Case studies highlighting the role of programming in bioinformatics; Review of key concepts and skills learned	

		throughout the course	
		Total	30

References:

1. Perry, G. M., & Miller, D. (2013). C programming: absolute beginner's guide. Pearson Education.
2. Vine, M. (2002). C Programming for the Absolute Beginner. Premier Press.
3. Tenenbaum, A. M. (1990). Data structures using C. Pearson Education India.
4. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to algorithms. MIT press. (A comprehensive textbook on algorithms, providing a solid foundation for algorithmic problem-solving.)
5. Narasimha Karumanchi, N. K. (2017). Data Structures And Algorithms Made Easy.
6. Rasmussen and Kaas Programming Skills for Bioinformatics (Covers programming skills relevant to bioinformatics, which can be applicable to C programming as well.)

Online Resources:

1. Geeks for Geeks: C Programming Language – Geeks for Geeks; Provides tutorials and examples on C programming.
2. Rosetta Code: C Programming - Rosetta Code; Offers examples of C programming tasks and solutions.
3. GitHub Guides: GitHub Guides; Tutorials on using GitHub for collaborative programming.

Sr. No.	List of Experiments: C Programming for Bio-computing Applications
1	**Practical 1: Basic Syntax, Data Types, and Control Structures in C** **Objective:** To introduce students to the basic syntax, data types, and control structures in C, and to practice writing and executing simple C programs. **Activities:** 1. **Hello World Program:** o Students write and compile a simple "Hello, World!" program to familiarize themselves with the C programming environment and basic syntax. o Discuss the structure of a C program, including the main function, printf statement, and return types
2	1. **Data Types and Variables:** o Students write a program that declares and initializes different data types

	(e.g., int, float, char, double). o Perform basic arithmetic operations and print the results to the console.
3	**Control Structures:** • Introduce control structures such as if-else statements, switch-case statements, and loops (for, while, do-while). • Students write programs to demonstrate each control structure: o **If-Else Statement:** Write a program to check if a number is even or odd. o **Switch-Case Statement:** Write a program to display the day of the week based on user input (1-7). o **For Loop:** Write a program to calculate the factorial of a number. o **While Loop:** Write a program to find the sum of the first N natural numbers.
4	**Functions:** • Introduce the concept of functions, including function declaration, definition, and calling. • Students write a program with multiple functions: o **Main Function:** Manages user input and output. o **Addition Function:** Takes two integers as parameters and returns their sum. o **Factorial Function:** Takes an integer as a parameter and returns its factorial. • Emphasize the importance of function prototypes and scope of variables.
5	**Arrays:** • Introduce arrays and their usage in C. • Students write a program to: o Declare and initialize an array of integers. o Calculate the average of elements in the array. o Find the maximum and minimum values in the array. • Discuss the concepts of array indexing and bounds.
6	**Pointers:** • Introduce pointers, pointer arithmetic, and their significance in C programming. • Students write a program to: o Declare and initialize a pointer to an integer. o Use the pointer to modify the value of a variable. o Demonstrate the use of pointers with arrays (e.g., iterating through an array using pointers). • Discuss the relationship between arrays and pointers.
7	**Arrays for Sequence Storage:** • **Activity:** Write a program that uses arrays to store and manipulate DNA sequences. • **Steps:** o Create an array to store a DNA sequence (a string of characters containing 'A', 'T', 'C', 'G'). o Implement functions to perform the following operations on the DNA sequence: ▪ Count Nucleotides: Count the occurrences of each nucleotide (A, T, C, G). ▪ Reverse Complement: Generate the reverse complement of the DNA sequence.

	○ Print the results of these operations.
8	**Memory Allocation and Management:** • **Activity:** Write a program that dynamically allocates and deallocates memory for storing genetic sequences. • **Steps:** ○ Use malloc, calloc, and free functions to manage memory for storing a variable-length DNA sequence. ○ Implement functions to perform the following operations: ▪ **Allocate Memory:** Dynamically allocate memory for a DNA sequence based on user input. ▪ **Free Memory:** Deallocate the memory once it is no longer needed. ▪ **Reallocate Memory:** Resize the allocated memory to accommodate a longer DNA sequence.

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