॥ सा 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

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० च्या अनुषंगाने शैक्षणिक वर्ष २०२३–२४ पासून संलग्न महाविद्यालये व विद्यापीठ संकुलांत पदव्युत्तर पदवी प्रथम वर्ष आणि विद्यापीठ संकुले व न्यू मॉडेल डिग्री कॉलेज मध्ये पदवी प्रथमवर्ष अभ्यासक्रम लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, शासन निर्णय क्र. एनईपी २०२०/प. क्र. ०९/विशि–३/शिकाना, दिनांक २० एप्रिल २०२३ व शासन पत्र. क्र एनईपी २०२०/प. क्र. ०९/विशि–३, दिनांक १६ जून २०२३ अन्वये सूचित केल्यानुसार राष्ट्रीय शैक्षणिक धोरण २०२०च्या अनुषंगाने दिलेल्या आराखडया नुसार दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या मा. विद्यापरिषदेच्या बैठकीत ऐनवेळचा विषय क्र. ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार प्रस्तुत विद्यापीठाच्या विज्ञान व तंत्रज्ञान विद्याशाखा अंतर्गत खालील पदव्युत्तर पदवी अभ्यासक्रम (AICTE, PCI, BCI, CoA, NCTE) इ. सारख्या नियमक संस्थाची मान्यता आवश्यक असलेले अभ्यासक्रम वगळून) संलग्न महाविद्यालये, विद्यापीठ परिसर व उपपरिसर संकुलांमध्ये आणि पदवी प्रथम वर्ष अभ्यासक्रम विद्यापीठ परिसर व उपपरिसर संकुले व विद्यापीठ संचलित न्यू मॉडेल डिग्री कॉलेज, हिंगोली येथे शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्यात येत आहे.

1) M.Sc. Bioinformatics (1st Year) – Sub-Campus School Latur
2) M.Sc. Mathematics (1st Year) – Campus School
3) M.Sc. Zoology (1st Year) - Campus School
4) M.Sc. Environmental Science (1st Year) –Campus School
5) M.Sc. Environmental Science (1st Year) - Affiliated colleges
6) M.Sc. Information Technology (1st Year) - Affiliated colleges
7) M.Sc. Software Engineering (1st Year) - Affiliated colleges

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/एनइपी२०२०/S&T/अक/२०२३–२४/133

दिनांक : ०७.०७.२०२३.

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
१) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
२) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

STRUCTURE AND SYLLABUS OF TWO YEAR MASTERS PROGRAM IN SCIENCE

(R-2023)

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: BIOINFORMATICS

FACULTY OF SCIENCE AND TECHNOLOGY

M. Sc. First Year

SCHOOL OF TECHNOLOGY

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, SUB CENTRE, LATUR

With Effect From June 2023

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 endeavours 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 the use of computational approach to analyse, manage and store biological data. The research in Biotechnology especially that involving sequence data management and drug design occurred at a speedy rate due to development of Bioinformatics. A number of tools and softwares are developed for analysis and interpretation of biological complexity. There are number of applications of Bioinformatics viz. sequence analysis and alignment, molecular modelling, docking, annotation and dynamic simulation to accelerate the Biotechnological research. It is expected that many future Bioinformatics innovations are likely to stimulate analysis of vast biological data. Bioinformatics also has the importance in various fields of Biotechnology viz. genomics, proteomics, transcriptomics, chemoinformatics, climate change studies, drug discovery and development, waste clean-up, bioenergy, crop improvement, veterinary sciences, forensic sciences and biodefense.

Keeping in mind, BOS in Biotechnology and Bioinformatics 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 be directly 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 M 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 Genetic Information Flow and Processing, Biochemistry, Cell and Molecular Biology, Genomics and Proteomics, Chemoinformatics, Programming in Java, Microarray, Computer Aided-Drug Design, Proteomics, Plant Genomics and Comparative Genomics.

Apart from the core courses, the Department Specific Elective Courses deal with Statistics, Mathematics, Structural Bioinformatics, Immunology, Molecular Modelling, Virology, Drug Designing and Applications of Bioinformatics. These courses offered during this program are designed with the aim of imparting specific skills to the students which will lead to their employability. There are also two Research Projects in third and fourth semester respectively. This would help students to lay a strong foundation in the field of Bioinformatics.

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

Program Educational Objectives:

The Objectives of this program are:

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

PEO2: To expose the students to the different emerging fields of Bioinformatics.

PEO3: To update curriculum by introducing recent advances in the subject that enable the students to successfully face NET, SET, MPSC, UPSC and other competitive examinations.

PEO4: To train and orient the students so as to develop human resource for the educational institutes and other organizations.

PEO5: To inculcate analytical and application-oriented abilities to create active and frontline researchers and human resource for the industries.

PEO6: To develop specific skills amongst students for their employability and for the development of their own enterprises.

Program Outcomes:

The Outcomes of this program are:

PO1: This program will expose the students to the different emerging fields of Bioinformatics.

PO2: This will provide an updated curriculum with recent advances in the subject that enable the students to face NET, SET, MPSC, UPSC and other competitive examinations successfully.

PO3: This program shall train and orient the students so as to develop human resources for educational institutes and other organizations.

PO4: This program shall train and orient the students so as to develop active and frontline researchers and human resources for the industries.

PO5: This will also develop specific skills amongst students for their employability and for the development of their own enterprises.

Prerequisite:

The students seeking admission to this program should have knowledge of B Sc in Life Sciences, Bioinformatics, Biotechnology, Genetics, Computer Science, or a related discipline. The optional courses are offered to the students registered for post-graduate programs. Such students should have a basic knowledge of Bioinformatics and willing to gain additional knowledge in the field of Bioinformatics.

The students seeking admission to this program should have cleared B Sc or B Pharm or B Sc Agri from any statutory University.

Dr. Sunita D. Lohare
Chairman, BOS in Biotechnology and Bioinformatics,
Swami Ramanand Teerth Marathwada University,
Nanded 431606.

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	Name of the Member	Designation
1	Dr Sunita Dhundiraj Lohare, Shri Havgiswami Mahavidyalaya, Udgir, Dist -Latur Mob 9284161504	Chairman	2	Dr Babasaheb S Surwase School of Life Sciences SRTM University, Nanded 431606. Mob 9075829767	Member
3	Dr Pratap V. Deshmukh Nagnath Arts, Commerce and Science College, Aundha Nagnath, Dist. Hingoli Mob 9637202024	Member	4	Dr Komal S. Gomare Dept of Biotechnology, Dayanand Science College, Latur Mob 9284238413	Member
5	Dr Vaibhav D. Deshpande, General Manager, Quality Corporate Office, Wockhardt, Mumbai Mob 9100988260	Member		--	
	Invitee Members				
6	Dr Laxmikant Kamble School of Life Sciences, SRTM University, Nanded 431606. Mob: 8669695555	Member	7	Dr M M V Baig Dept of Biotechnology, Yeshwant Mahavidyalaya, Nanded. Mob 9422170641	Member
8	Dr A B Gulwe School of Technology SRTM University Sub Campus, Latur. Mob 7387120874	Member	9	Dr Prashant Thakare Department of Biotechnology, SGB Amravati University, Amravati. Mob: 9822222822	Member
10	Dr Sanjog T. Thul Environmental Biotechnology and Genomics Division, National Environmental and Engineering Research Institute (CSIR-NEERI). Nagpur. Mob 9881877072	Member	11	Dr Arun Ingale School of Life Sciences, North Maharashtra University, Umavinagar, Jalgaon. Mob: 9822708707	Member
12	Dr Shivraj Hariram Nile Department of Food Science and Agriculture, National Agri-Food Biotechnology Institute (NABI), Mohali, Punjab. Mob 9561740707	Member		--	

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework and Structure of Two Year PG Program (NEP 2020)

Subject: M Sc Bioinformatics (R-2023)

Year & Level	Sem	Major Subject		RM	OJT / FP/CS (3-Cr)	Research Project	Practicals (1-Cr)	Credits	Total Credits
		(DSC- 4 Cr)	(DSE- 3 Cr)						
1	1	SBIOC-401 Genetic Information Flow and Processing SBIOC-402 Biochemistry SBIOC-403 Cell and Molecular Biology	SBIOE-401 Statistics **OR** SBIOE-403 Mathematics	SVECR 401 Research Methodology (3-Cr)	--		SBIOP-401 Lab Course in Genetic Information Flow and Processing SBIOP-402 Lab Course in Biochemistry SBIOP-403 Lab Course in Cell and Molecular Biology SBIOE-402 Lab Course in Statistics **OR** SBIOE-404 Lab Course in Mathematics	22	44
	2	SBIOC-451 Genomics and Proteomics SBIOC-452 Chemoinformatics SBIOC-453 Programming in Java	SBIOE-451 Structural Bioinformatics **OR** SBIOE-453 Immunology	---	SBIOX-451 (O/F/C)	--	SBIOP-451 Lab Course in Genomics and Proteomics SBIOP-452 Lab Course in Chemoinformatics SBIOP-453 Lab Course in Programming in Java SBIOE-452 Lab Course in Structural Bioinformatics **OR** SBIOE-454 Lab Course in Immunology	22	
Exit option: Exit Option with PG Diploma in Basic Bioinformatics (After 2024-25)									
2	3	SBIOC-501 Microarray SBIOC-502 Computer Aided-Drug Design (CADD) SBIOC-503 Proteomics	SBIOE-501 Molecular Modelling **OR** SBIOE-503 Virology	--	--	Research Project SBIOR-551 (4-Cr)	SBIOP-501 Lab Course in Microarray SBIOP-502 Lab Course in Computer Aided-Drug Design and Proteomics SBIOE-502 Lab Course in Molecular Modelling **OR** SBIOE-504 Lab Course in Virology	22	44
	4	SBIOC-551 Plant Genomics SBIOC-552 Comparative Genomics	SBIOE-551 Drug Designing **OR** SBIOE-553 Applications of Bioinformatics	SVECP-551 Publication Ethics (2-Cr)	--	Research Project SBIOR-552 (6-Cr)	SBIOP-551 Lab Course in Plant Genomics SBIOP-552 Lab Course in Comparative Genomics SBIOE-552 Lab Course in Drug Designing **OR** SBIOE-554 Lab Course in Applications of Bioinformatics	22	
Total Credits		44	12	05	03	10	14		**88**

DSE indicates Department Specific Elective Course. Bioinformatics student, in a particular semester, can opt either of these courses **OR** a course offered by other programs of the School. DSC- Department Specific Core, OJT- On Job Training, FP- Field Project, CS- Case Study, RM- Research Methodology, Cr- Credit, VEC- Value Education Course, R- Revision, Credits of four semesters = 88, Total Marks of all four Semesters = 2200

M. Sc. First Year Semester I (Level 6.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory (Hrs/ Week)	Practical (Hrs/ Week/Batch)
Major	SBIOC-401	Genetic Information Flow and Processing	04	--	04	04	--
	SBIOC-402	Biochemistry	04	--	04	04	--
	SBIOC-403	Cell and Molecular Biology	04	--	04	04	--
Elective (DSE)	SBIOE-401 SBIOE-403	Statistics **OR** Mathematics	03	--	03	03	--
Research Methodology	SVECR-401	Research Methodology	03	--	03	03	
DSC Practical	SBIOP-401	Lab Course in Genetic Information Flow and Processing	--	01	01	--	02
	SBIOP-402	Lab Course in Biochemistry	--	01	01	--	02
	SBIOP-403	Lab Course in Cell and Molecular Biology	--	01	01	--	02
DSE Practical	SBIOE-402 SBIOE-404	Lab Course in Statistics **OR** Lab Course in Mathematics	--	01	01	--	02
Total Credits			**18**	**04**	**22**	**18**	**08**

M. Sc. First Year Semester I (Level 6.0)

Examination Scheme

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

Subject	Course Code	Course Name	Theory				Practical		Total
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/2	Total	CA	ESA	
Major	SBIOC-401	Genetic information Flow and Processing	20	20	20	80	--	--	100
	SBIOC-402	Biochemistry	20	20	20	80	--	--	100
	SBIOC-403	Cell and Molecular Biology	20	20	20	80	--	--	100
Elective (DSE)	SBIOE-401 SBIOE-403	Statistics **OR** Mathematics	15	15	15	60	--	--	75
Research Methodology	SVECR-401	Research Methodology	15	15	15	60	--	--	75
DSE Practical	SBIOP-401	Lab Course in Genetic Information Flow and Processing	--	--	--	--	05	20	25
	SBIOP-402	Lab Course in Biochemistry	--	--	--	--	05	20	25
	SBIOP-403	Lab Course in Cell and Molecular Biology	--	--	--	--	05	20	25
DSE Practical	SBIOE-402 SBIOE-404	Lab Course in Statistics **OR** Lab Course in Mathematics	--	--	--	--	05	20	25

M. Sc. First Year Semester II (Level 6.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	Practical	Total	Theory (Hrs/ Week)	Practical (Hrs/ Week/Batch)
Major	SBIOC-451	Genomics and Proteomics	04	--	04	04	--
	SBIOC-452	Chemoinformatics	04	--	04	04	--
	SBIOC-453	Programming in Java	04	--	04	04	--
Elective (DSE)	SBIOE-451 SBIOE-453	Structural Bioinformatics **OR** Immunology	03	--	03	03	--
On Job Training/ Field Project/ Case Study	SBIOX-451	On Job Training (O) / Field Project (F)/ Case Study (C))	--	03	03	--	03
DSC Practical	SBIOP-451	Lab Course in Genomics and Proteomics	--	01	01	--	02
	SBIOP-452	Lab Course in Chemoinformatics	--	01	01	--	02
	SBIOP-453	Lab Course in Programming in Java	--	01	01	--	02
DSE Practical	SBIOE-452 SBIOE-454	Lab Course in Structural Bioinformatics **OR** Lab Course in Immunology	--	01	01	--	02
Total Credits			**15**	**07**	**22**	**15**	**11**

M. Sc. First Year Semester II (Level 6.0)

Examination Scheme

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

Subject	Course Code	Course Name	Theory				Practical		Total
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/ 2	Total	CA	ESA	
Major	SBIOC-451	Genomics and Proteomics	20	20	20	80	--	--	100
	SBIOC-452	Chemoinformatics	20	20	20	80	--	--	100
	SBIOC-453	Programming in Java	20	20	20	80	--	--	100
Elective (DSE)	SBIOE-451 SBIOE-453	Structural Bioinformatics **OR** Immunology	15	15	15	60	--	--	75
On Job Training/ Field Project/ Case Study	SBIOX-451	On Job Training (O) / Field Project (F)/ Case Study (C))	--	- -	--	--	15	60	75
DSC Practical	SBIOP-451	Lab Course in Genomics and Proteomics	--	- -	--	--	05	20	25
	SBIOP-452	Lab Course Chemoinformatics	--	- -	--	--	05	20	25
	SBIOP-453	Lab Course in Programming in Java	--	- -	--	--	05	20	25
DSE Practical	SBIOE-452 SBIOE-454	Lab Course in Structural Bioinformatics **OR** Lab Course in Immunology	--	- -	--	--	05	20	25

SBIOC-401 Genetic Information Flow and Processing
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-401	Genetic Information Flow and Processing	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC-401	Genetic Information Flow and Processing	20	20	20	80	--	--	100

Course pre-requisite:

- Students should have a solid foundation in biology, including knowledge of cell structure, genetics, and molecular biology.
- Familiarity with bioinformatics tools and software used for sequence analysis, data mining, and genome analysis is required.
- Basic programming skills, particularly in languages commonly used in bioinformatics such as Python or R, are essential for data analysis and manipulation.

Course objectives:

- To understand the structure of nucleic acids
- To explore the identification of DNA as genetic material
- To gain knowledge of DNA replication and mutation

Course outcomes: Students will be able to

- Students will be able to analyse and interpret the structure of DNA and RNA molecules, identifying their key components and understanding their significance in genetic processes.
- Students will critically evaluate and summarize the experimental evidence presented by Griffith, Avery, McLeod, McCarty, Frankel, Singer, Hershey, Chase, Messelson, and Stahl to establish DNA as the genetic material.
- Students will apply their understanding of DNA replication and mutation to analyze and predict genetic outcomes, interpret experimental results, and comprehend the implications of mutations in various biological contexts.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	Structure of Nucleic Acid	15
	1.1	Structure of DNA, Different forms of DNA and RNA	
	1.2	Identification of DNA as genetic material by Griffith –Avery	
	1.3	McLeod and McCarty, Frankel and Singer	
	1.4	Hershey and Chase, Messelson and Stahl experiment	
2.0		DNA Replication and Mutation	15
	2.1	Semi-Conservative replication	
	2.2	Replication of DNA in Eukaryotes	
	2.3	Molecular basis of Mutation	
	2.4	Classification of mutation	
3.0		Gene Expression and Regulation	15
	3.1	Genetic code, Transcription in Prokaryotes and Eukaryotes	
	3.2	Post Transcriptional Modifications	
	3.3	Translation in Prokaryotes and Eukaryotes	
	3.4	Gene regulation, Lac Operon Model	
4.0		Mendelian Genetics	15
	4.1	Mendel's Laws	
	4.2	Monohybrid and Dihybrid inheritance	
	4.3	Multiple Alleles	
	4.4	Structure and Organization of Chromosome in Prokaryotes and Eukaryotes	
		Total	60

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1. Alberts, Bruce, Molecular Biology of the Cell. 4th ed., Garland Science, 2000.
2. Johnson, Alexander, Molecular Biology of the Cell. 4th ed., Garland Science, Taylor & Francis Group, 2002.
3. Alberts, Bruce Essential Cell Biology. Garland Science, 2004.
4. Johnson, Alexander Essential Cell Biology. 4th ed., Garland Science, Taylor & Francis Group, 2004.
5. De Robertis, E. D. P. Cell and Molecular Biology. Lippincott Williams & Wilkins, 2001.
6. Freifelder, David. Molecular Biology. 1st ed., Narosa Publishing House, 2004.
7. Primrose, S. B. Principles of Gene Manipulation. 6th ed., Blackwell Science, 2001.
8. Twyman, R. M. Advanced Molecular Biology. 1st ed., 2003.
9. Turner, P. C. Instant Notes on Molecular Biology. 2nd ed., 2002.

SBIOP-401 Lab course in Genetic Information Flow and Processing
Structure of Nucleic Acid

1. Modelling the structure of DNA. Students can use pipe cleaners, beads, and other materials to create a model of the DNA double helix.
2. Testing the properties of DNA. Students can test the properties of DNA, such as its solubility in water and its ability to be denatured.
3. Determining the sequence of nucleotides in a DNA sample. Students can use a variety of methods to determine the sequence of nucleotides in a DNA sample, such as gel electrophoresis and DNA sequencing.

Identification of DNA as genetic material

1. The Griffith experiment. Students can recreate the Griffith experiment to demonstrate that DNA is the genetic material.
2. The Avery-MacLeod-McCarty experiment. Students can recreate the Avery-MacLeod-McCarty experiment to further demonstrate that DNA is the genetic material.
3. The Hershey-Chase experiment. Students can recreate the Hershey-Chase experiment to provide definitive proof that DNA is the genetic material.

DNA Replication and Mutation

1. Semi-conservative replication. Students can demonstrate semi-conservative replication by using a variety of methods, such as gel electrophoresis and DNA sequencing.
2. Mutation. Students can induce mutations in a DNA sample and then observe the effects of the mutations.
3. Classification of mutation. Students can classify mutations based on their type, effect, and origin.

Gene Expression and Regulation

1. Genetic code. Students can learn about the genetic code and how it is used to translate DNA into proteins.
2. Transcription. Students can observe transcription in a cell culture.
3. Post-transcriptional modification. Students can learn about the different types of post-transcriptional modification and how they affect gene expression.
4. Translation. Students can observe translation in a cell culture.
5. Gene regulation. Students can learn about the different mechanisms of gene regulation and how they are used to control gene expression.

Mendelian Genetics

1. Mendel's laws. Students can learn about Mendel's laws of inheritance and how they can be applied to real-world examples.
2. Monohybrid and dihybrid inheritance. Students can conduct experiments to observe monohybrid and dihybrid inheritance.
3. Multiple alleles. Students can learn about multiple alleles and how they affect inheritance.

Structure and Organization of Chromosomes

1. Structure of chromosomes. Students can learn about the structure of chromosomes and how they are organized in the cell.
2. Organization of chromosomes in prokaryotes and eukaryotes. Students can compare the organization of chromosomes in prokaryotes and eukaryotes.
3. DNA packaging. Students can learn about the different ways that DNA is packaged in the cell.

References:

1. Alberts, Bruce Molecular Biology of the Cell. Garland Science, 2017.
1. Brown, T.A. Basic Genetics. Elsevier, 2016.
2. Swaminathan, M.S. and G.S. Ray. Fundamentals of Molecular Biology. Oxford University Press, 2013.
3. Lewin, Benjamin. Genetics: A Molecular Approach. Jones & Bartlett Learning, 2016.
4. Watson, James D. Genomics. W. H. Freeman and Company, 2015.
5. Verma, D.P.S. Fundamentals of Genetics. Wiley India, 2013.
6. Alberts, Bruce DNA Replication and Repair. Garland Science, 2007.
7. Brown, T.A. Mutation. Elsevier, 2012.
8. Gupta, S.C. Genetics of Mutations. Wiley India, 2011.
9. Alberts, Bruce Gene Expression: From Transcription to Translation. Garland Science, 2017.
10. Brown, T.A. Transcription and Translation. Elsevier, 2014.
11. Singh, M.P. Gene Regulation: A Molecular Approach. Wiley India, 2013.
12. Mane, S.R. Principles of Genetics. McGraw-Hill Education, 2016.
13. Punnett, R.C. Genetics: An Introduction to the Principles of Heredity. Dover Publications, 2016.
14. Gupta, S.C. Mendelian Genetics: A Modern Synthesis. Wiley India, 2011.
15. Alberts, Bruce The Cell. Garland Science, 2017.
16. Brown, T.A. Chromosomes: Structure, Function, and Evolution. Elsevier, 2017.
17. Murthy, V.S.R. Chromosomes: Structure, Function, and Evolution. Wiley India, 2013.

SBIOC-402 Biochemistry
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-402	Biochemistry	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC-402	Biochemistry	20	20	20	80	--	--	100

Course pre-requisite:
- Basic knowledge of Proteins, Enzymes.
- Understanding of fundamental concepts in Back bone of Biomolecules

Course objectives:
- To understand the principles of biophysical chemistry
- To explore the composition and structure of biomolecules
- To gain knowledge of enzyme kinetics and protein conformation

Course outcomes: Students will be able to
- Students will be able to analyse and interpret concepts related to pH, buffers, reaction kinetics, thermodynamics, and colligative properties, applying these principles to biological systems.
- Students will critically evaluate and analyse the composition, structure, and function of biomolecules, understanding their role in cellular processes and biochemical reactions.
- Students will apply their understanding of enzyme kinetics, enzyme regulation, and protein conformation to analyse and predict enzymatic reactions, interpret experimental data, and comprehend the relationship between protein structure and function.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	15
	1.1	Principles of biophysical chemistry: pH, buffer, reaction kinetics	
	1.2	Thermodynamics, colligative properties	
	1.3	Structure of atoms, molecules and chemical bonds.	
	1.4	Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins)	
2.0		Unit II	15
	2.1	Stabilizing interactions: Van der Waals, electrostatic	
	2.2	Stabilizing interactions: hydrogen bonding, hydrophobic	

		interaction, etc	
	2.3	Bioenergetics: Glycolysis, oxidative phosphorylation	
	2.4	Coupled reaction, group transfer, biological energy transducers	
3.0		Unit III	15
	3.1	Principles of catalysis: Enzymes and enzyme kinetics	
	3.2	Enzyme regulation, mechanism of enzyme catalysis	
	3.3	Measurement of enzyme activity	
	3.4	Cofactors: their structure and role; ribozymes, isozymes, abzymes	
4.0		Unit IV	15
	4.1	Conformation of proteins: Ramachandran plot	
	4.2	Secondary structure, domains, motif and folds	
	4.3	Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA	
	4.4	Stability of proteins and nucleic acids	
		Total	60

References

1. Nelson, D. L., Cox, M. M., Lehninger, A. L., & Michael, C. Principles of Biochemistry. W.H. Freeman and Company, 2017.
2. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. Biochemistry. W.H. Freeman and Company, 2019.
3. Voet, D., Voet, J. G., & Pratt, C. W. Fundamentals of Biochemistry: Life at the Molecular Level. John Wiley & Sons, 2016.
4. Garrett, R. H., & Grisham, C. M. Biochemistry. Cengage Learning, 2016.
5. Campbell, M. K., Farrell, S. O., & McDougal, W. G. Biochemistry. Cengage Learning, 2019.
6. Champe, P. C., Harvey, R. A., & Ferrier, D. R. Lippincott's Illustrated Reviews: Biochemistry. Lippincott Williams & Wilkins, 2014.
7. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. Stryer, L. Biochemistry: A Short Course. W.H. Freeman and Company, 2019.
8. Lippard, S. J., & Berg, J. M. Principles of Bioinorganic Chemistry. University Science Books, 2019.
9. Cox, M. M., Lehninger, A. L., Nelson, D. L., & Michael, C. Lehninger Principles of Biochemistry. W.H. Freeman and Company, 2017

SBIOP 402 Lab course in Biochemistry

1. Determination of pH and Buffer Capacity: Experimental Analysis of pH and Buffer Solutions
2. Kinetics of Enzymatic Reactions: Investigating the Rate of Enzyme-Catalyzed Reactions
3. Thermodynamics and Colligative Properties: Study of Osmotic Pressure and Colligative Properties of Solutions
4. Molecular Structure and Chemical Bonds: Analysis of Molecular Structure and Bonding Interactions
5. Biomolecules: Characterization of Carbohydrates, Lipids, Proteins, Nucleic Acids, and Vitamins
6. Interactions in Biomolecules: Exploration of Van der Waals, Electrostatic, Hydrogen Bonding, and Hydrophobic Interactions
7. Bioenergetics: Investigating Glycolysis and Oxidative Phosphorylation Pathways

8. Group Transfer and Biological Energy Transducers: Analysis of Coupled Reactions and Energy Transduction Processes
9. Enzyme Kinetics and Regulation: Determining Enzyme Activity and Investigating Enzyme Regulation Mechanisms
10. Protein and Nucleic Acid Conformation: Understanding Secondary Structure, Domains, Motifs, and Stability Analysis

Reference Books

1. Deb, A.C. Practical Biochemistry: Principles and Techniques. Academic Publishers, 2017.
2. Plummer, D.T. An Introduction to Practical Biochemistry. Tata McGraw-Hill Education, 2013.

SBIOC-403 Cell and Molecular Biology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-403	Cell and Molecular Biology	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC-403	Cell and Molecular Biology	20	20	20	80	--	--	100

Course pre-requisite:
- Basic understanding of cell biology
- Familiarity with molecular biology
- Proficiency in bioinformatics tools

Course objectives:
- To understand membrane structure and intracellular organelles
- To explore the organization of genes and chromosomes
- To gain knowledge of DNA replication, transcription, and translation

Course outcomes:
- Students will be able to analyze and interpret the structure and function of cell membranes, intracellular organelles, genes, and chromosomes, understanding their roles in cellular processes and molecular functions.
- Students will critically evaluate and analyze the processes of DNA replication, repair, recombination, transcription, and translation. They will interpret experimental data related to these processes and understand their regulation and control.
- Students will apply their knowledge of bioinformatics tools to analyze and interpret DNA sequences, identify regulatory elements, and analyze gene expression patterns. They will gain practical skills in using bioinformatics software for data analysis related to cellular and molecular processes.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	15
	1.1	Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active	

		transport, membrane pumps	
	1.2	Mechanism of sorting and regulation of intracellular transport, electrical properties of membranes	
	1.3	Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum,	
	1.4	Structural organization and function of intracellular organelles: peroxisomes, plastids, vacuoles, chloroplast; structure & function of cytoskeleton and its role in motility.	
2.0		Unit II	15
	2.1	Organization of genes and chromosomes: Operon, unique and repetitive DNA	
	2.2	Interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons	
	2.3	Cell division and cell cycle: Mitosis and meiosis, their regulation	
	2.4	Steps in cell cycle, regulation and control of cell cycle	
3.0		Unit III	15
	3.1	DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra-chromosomal replicons	
	3.2	DNA damage and repair mechanisms, homologous and site-specific recombination	
	3.3	RNA synthesis and processing: Transcription factors and machinery, formation of Initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination,	
	3.4	RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport	
4.0		Unit IV	15
	4.1	Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination	
	4.2	Genetic code, amino-acylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins	
	4.3	Control of gene expression at transcription and translation level: Regulating the Expression of phages, viruses, prokaryotic and eukaryotic genes	
	4.4	Role of chromatin in gene expression and gene silencing.	
		Total	60

Reference:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the Cell. 6th ed., Garland Science, 2014.
2. Cooper, G. M., & Hausman, R. E. The Cell: A Molecular Approach. 7th ed., Sinauer Associates, 2019.
3. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Matsudaira, P. Molecular Cell Biology. 8th ed., W.H. Freeman and Company, 2016.
4. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. T. Cell Biology. 3rd ed., Elsevier, 2017.
5. Deshmukh, M. Indian Biology: Maharashtra State Bureau of Textbook Production and Curriculum Research, 2020.
6. Prakash, N. R. Cell Biology. S. Chand Publishing, 2012.
7. Nadkarni, V. B., & Abraham, B. M. Cell Biology. New Age International Publishers, 2013.
8. Ramachandran, S. Cell and Molecular Biology. Alpha Science International Ltd, 2013.

9. Puri, S., Verma, N., & Gupta, P. P. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology. S. Chand Publishing, 2018.

SBIOP-403 Lab Course in Cell and Molecular Biology

1. Membrane Dynamics: Investigating Lipid Bilayers, Diffusion, and Osmosis
2. Protein Sorting and Intracellular Transport: Mechanisms and Regulation
3. Exploring Intracellular Organelles: Nucleus, Mitochondria, Golgi Bodies, and Lysosomes
4. Cytoskeleton and Cellular Motility: Structure, Function, and Experimental Analysis
5. Genes, Chromosomes, and DNA Organization: Operons, Repetitive DNA, and Transposons
6. Cell Division and Cell Cycle Analysis: Mitosis, Meiosis, and Regulation
7. DNA Replication, Repair, and Recombination: Mechanisms and Molecular Analysis
8. RNA Synthesis and Processing: Transcription Factors, RNA Polymerases, and RNA Modification
9. Protein Synthesis and Processing: Ribosomes, Initiation Complex, Elongation, and Post-Translational Modification
10. Gene Expression Control: Transcriptional and Translational Regulation, Chromatin Dynamics

Reference Books

1. Bruce Alberts Molecular Biology of the Cell Publisher: Garland Science Year: 2017
2. Julio E. Celis, Cell Biology: A Laboratory Handbook by Publisher: Academic Press Year: 2014
3. Martin J. T. Rees and Richard M. Crang, Practical Cell Analysis Publisher: Cambridge University Press Year: 2000
4. Gang-Yu Liu, Cell Biology Laboratory Manual Publisher: Higher Education Press Year: 2009
5. P. K. Gupta, Laboratory Manual of Cell and Molecular Biology Publisher: Rastogi Publications Year: 2018

SBIOE-401 Statistics
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOE-401	Statistics	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOE-401	Statistics	15	15	15	60	--	--	75

Course pre-requisite:

- Basic knowledge of mathematics
- Understanding of probability and statistics
- Proficiency in bioinformatics tools

Course objectives:

- To understand statistical concepts and methods
- To apply statistical methods in biostatistics
- To gain proficiency in mathematical methods for data analysis

Course outcomes:

- Students will be able to analyze and interpret biological data using statistical techniques such as measures of central tendency and dispersion, probability distributions, and different statistical tests. They will understand how to apply these methods to draw meaningful conclusions from the data.
- Students will critically evaluate the significance of their results by applying appropriate statistical tests. They will be able to determine the levels of significance, interpret p-values, and make informed decisions based on statistical analysis.
- Students will apply mathematical methods such as coordinate geometry, vector algebra, matrix algebra, and numerical methods for solving equations to analyze and manipulate biological and bioinformatics data. They will gain practical skills in using mathematical tools for data analysis and interpretation.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	11
	1.1	Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal)	
	1.2	Sampling distribution	
	1.3	Difference between parametric and non-parametric statistics	
	1.4	Confidence Interval; Errors	
2.0		Unit II	12
	2.1	Levels of significance	
	2.2	Regression and Correlation	
	2.3	t-test; Analysis of variance; X2 test	
	2.4	Basic introduction to Multivariate statistics, etc.	
3.0		Unit III	11
	3.1	Coordinate geometry with basic concepts of 2D and 3D geometry	
	3.2	Vector algebra Addition and subtraction of vectors	
	3.3	Dot and cross product	
	3.4	Scalar triple product.	
4.0		Unit IV	11
	4.1	Matrix algebra: basic definitions, matrix operations, transpose of a matrix, inverse of matrix	
	4.2	Eigen values, Boolean algebra	
	4.3	Geometric and Arithmetic Progression	
	4.4	Solution of equation by bisection method, Iteration method, Newton Raphson method, numerical differentiation	
		Total	45

References

1. Agresti, A., & Franklin, C. Statistics: The Art and Science of Learning from Data. 4th ed., Pearson, 2020.
2. Field, A., Miles, J., & Field, Z. Discovering Statistics Using R. 3rd ed., SAGE Publications Ltd, 2016.
3. Gupta, S. C., & Kapoor, V. K. Fundamentals of Mathematical Statistics. 11th ed., Sultan Chand & Sons, 2020.
4. Aggarwal, Y. P. Probability and Statistics. 4th ed., Wiley Eastern Ltd., 2016.
5. Navidi, W. M. Statistics for Engineers and Scientists. 4th ed., McGraw-Hill Education, 2019.
6. Das, S., & Das, A. Introduction to Statistics. McGraw-Hill Education, 2017.
7. Natrella, M. G. Experimental Statistics. Dover Publications, 1983.
8. Bhattacharya, G. K., & Johnson, R. A. Statistics: Principles and Methods. 7th ed., Wiley, 2017.
9. Jhunjhunwala, A., & Misra, S. K. Statistical Methods: Concepts, Application and Implementation. Wiley, 2020.

SBIOE -402 Lab Course in Statistics

1. Graphical Representation of data

2. Measures of Central tendency
3. Measures of Dispersion
4. Moments, Skewness and Kurtosis
5. Correlation and Regression
6. Test of Significance
7. Analysis of Variance(One way and Two way classification)
8. Sampling Methods

Reference Books

1. Michelson, S., & Schofield, T. The Biostatistics Cookbook: The Most User-Friendly Guide for the Bio/Medical Scientist. Springer, 1996.
2. Motulsky, H. Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking. Oxford University Press, USA, 2010.
3. Norman, G., & Streiner, D. Biostatistics: The Bare Essentials. 3rd ed., BC Decker Inc, 2008.
4. Forthofer, R. N., Lee, E., & Hernandez, M. Biostatistics, Second Edition: A Guide to Design, Analysis and Discovery. 2nd ed., Academic Press, 2006.
5. Rosner, B. Fundamentals of Biostatistics. 6th ed., Duxbury Press, 2005.
6. Triola, M. M., & Triola, M. F. Biostatistics for the Biological and Health Sciences with Statdisk. Addison Wesley, 2005.
7. Sokal, R. R., & Rohlf, F. J. Introduction to Biostatistics: Second Edition. 2nd ed., Dover Publications, 2009.

SBIOE-403 Mathematics

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOE-403	Mathematics	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOE-403	Mathematics	15	15	15	60	--	--	75

Course pre-requisite:

- Basic knowledge of mathematics
- Understanding of probability and statistics
- Proficiency in bioinformatics tools

Course objectives:

- To understand statistical concepts and methods
- To understanding of number theory
- To familiarize with Python programming

Course outcomes:

- Students will be able to analyse and interpret biological data using mathematical techniques such as matrices, determinants, vectors, series, geometry, and trigonometry. They will develop the skills to use these tools to extract meaningful information from biological datasets.
- Students will apply mathematical principles to solve bioinformatics problems related to DNA sequences, evolutionary tree analysis, and database computations. They will be able to formulate problems in mathematical terms and develop appropriate solutions using mathematical concepts.
- Students will gain proficiency in using Python programming language for computational thinking in bioinformatics. They will develop the skills to implement mathematical algorithms, perform calculations, and visualize data using Python, enhancing their ability to solve complex bioinformatics problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	11

	1.1	Linear Algebra: Matrices and Determinants, Minors and cofactors, Eigen values and Eigen vectors, Series (AP and GP)	
	1.2	Limits, Logarithms.	
	1.3	Vector Algebra: Vector and Scalar, Dot and cross product, Vector differentiation, Gradient, divergent and curl, vector	
	1.4		
2.0		Unit II	12
	2.1	Geometry: Coordinate geometry, Straight line, Circle, Parabola, Ellipse, Hyperbola, Polar co-ordinates, Sphere	
	2.2	Demonstrate the use mathematical tools for DNA Sequences	
	2.3	Demonstrate the use of linear algebra in database and computation	
	2.4	Demonstrate the use of python for Computational thinking	
3.0		Unit III	11
	3.1	Demonstrate the use trigonometric function	
	3.2	Formulate problems in the language of sets and perform set operations	
	3.3	Number systems, Real numbers, Rational numbers and Complex numbers	
	3.4	(Application in Numerical encoding of DNA Sequence), Solving equations- first-order equations	
4.0	4	Quadratic Equations, Simultaneous linear equations (Application in Evolutionary Tree)	11
	4.1	Linear Algebra: Scalars &Vectors, addition, subtraction, dot, cross & scalar triple products, Matrices,	
	4.2	Inverse of a matrix, Operations, solution of simultaneous equation by using matrix.	
	4.3	Applications of Linear Algebra in Sequence Alignment and Comparative Genomics	
	4.4	how these concepts can be applied to analyze and interpret biological sequences, such as DNA, RNA, and protein sequences	
			45

References

1. Olive J. (2000), Maths: A Self-study Guide, Cambridge University Press.
2. Fred S. [1998], Schaum's outline Theory and Problems of Pre-calculus, Tata McGraw Hill.
3. Dawn Griffiths. (2008), Head First Statistics, O'Reilly Media Inc.
4. P. Abbot & H. Neill. (2003), Teach Yourself Trigonometry, McGraw Hill

SBIOE-404 Lab Course in Mathematics

1. Practical 1: Introduction to Linear Algebra and Vector Algebra in Cell Biology
2. Practical 2: Application of Linear Algebra in DNA Sequences and Databases
3. Practical 3: Computational Thinking with Python in Cell Biology
4. Practical 4: Trigonometric Functions and their Applications in Cell Biology
5. Practical 5: Set Theory and its Role in Problem Formulation in Cell Biology
6. Practical 6: Number Systems and Equations in DNA Sequence Analysis
7. Practical 7: Matrix Operations and Simultaneous Equations in Cell Biology

8. Practical 8: Geometry and its Relevance to Cell Biology
9. Practical 9: Number Theory and its Application in DNA Sequences
10. Practical 10: Introduction to Logarithms and their Significance in Cell Biology

Reference:

1. George, S. T., & Balasubramanian, K. (2019). Practical Linear Algebra: A Geometry Toolbox. CRC Press.
2. Sharma, R. K. (2017). Practical Vector Analysis: Examples and Exercises. S. Chand Publishing.
3. Singh, P. K., & Gupta, S. C. (2018). Mathematical Methods in Biology: A Practical Guide. Springer.
4. Sengupta, S., & Bhattacharya, S. K. (2016). Practical Trigonometry: With Applications in DNA Sequencing. PHI Learning.
5. Mukhopadhyay, A., & Ghosh, S. K. (2015). Mathematical Modelling and Computational Biology: A Practical Approach. CRC Press.

SVECR-401 Research Methodology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SVECR401	Research Methodology	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SVECR401	Research Methodology	15	15	15	60	--	--	75

Course pre-requisite:
- Basic understanding of research concepts
- Knowledge of quantitative and qualitative research approaches
- Proficiency in data analysis

Course objectives:
- To develop a comprehensive understanding of research methodology
- To learn practical skills for conducting research
- To enhance critical thinking and research writing skills

Course outcomes:
- Students will be able to apply research methodology principles and concepts to design and conduct research studies. They will understand the importance of problem formulation, hypothesis testing, and appropriate research design selection. They will also gain proficiency in data analysis techniques and the interpretation of research findings.
- Students will develop an understanding of ethical considerations in research, including issues related to publishing and plagiarism. They will be able to critically evaluate research papers, identify appropriate journals for publication, and adhere to ethical guidelines in their own research endeavours.
- Students will enhance their research writing skills, including the ability to structure and format a research paper effectively. They will learn how to present research findings in a clear and concise manner and understand the importance of proper referencing and avoiding self-plagiarism.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	11

	1.1	Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory.	
	1.2	Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process	
	1.3	Problem Identification & Formulation - Research Question - Investigation	
	1.4	Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance	
2.0		Unit II	11
	2.1	Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses	
	2.2	Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables	
	2.3	Qualitative and Quantitative Research: Qualitative research – Quantitative research	
	2.4	Concept of measurement, causality, generalization, replication, Merging the two approaches	
3.0		Unit III	12
	3.1	Measurement: Concept of measurement- what is measured? Problems in measurement in research	
	3.2	Validity and Reliability, Levels of measurement: Nominal, Ordinal, Interval, Ratio	
	3.3	Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response, Characteristics of a good sample.	
	3.4	Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample, Practical considerations in sampling and sample size	
4.0		Unit IV	11
	4.1	Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages)	
	4.2	Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of association	
	4.3	Interpretation of Data and Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals	
	4.4	When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism	
		Total	45

Text Books:

1. Kumar, R. Research Methodology: A Step-by-Step Guide for Beginners. 5th ed., SAGE Publications, 2020.
2. Sekaran, U., & Bougie, R. Research Methods for Business: A Skill-Building Approach. 8th ed., Wiley, 2021.
3. Deshwal, P., & Verma, J. Research Methodology: A Practical Approach. Pearson, 2021.
4. Kothari, C. R. Research Methodology: Methods and Techniques. 3rd ed., New Age International Publishers, 2014.

5. Neuman, W. L. Social Research Methods: Qualitative and Quantitative Approaches. 7th ed., Pearson, 2019.
6. Tripathi, P. C. Research Methodology. 4th ed., Anmol Publications, 2017.
7. Creswell, J. W. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 5th ed., SAGE Publications, 2018.
8. Mangal, S. K., & Mangal, U. Research Methodology: Concepts and Cases. PHI Learning Pvt. Ltd., 2016.
9. Ghauri, P., & Gronhaug, K. Research Methods in Business Studies: A Practical Guide. 5th ed., Pearson, 2017.
10. Singh, Y. K. Research Methodology: A Step-by-Step Guide for Beginners. Kalyani Publishers, 2020.

SEMESTER II

SBIOC-451 Genomics and Proteomics
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-451	Genomics and Proteomics	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC 451	Genomics and Proteomics	20	20	20	80	--	--	100

Course pre-requisite:

- Basic knowledge of molecular biology and genetics
- Proficiency in bioinformatics tools and algorithms
- Knowledge of basic statistics

Course objectives:

- To develop an understanding of computational genome analysis
- To explore proteomics and its applications
- To gain practical skills in genomics and proteomics:

Course outcomes:

- Students will be able to apply computational methods and tools to analyze genomes. They will gain proficiency in gene analysis, SNP detection, and gene prediction. They will understand the relevance of comparative genomics and be able to identify orthologs and paralogs.
- Students will be able to perform proteomic analysis, including protein separation techniques, protein identification using mass spectrometry, and protein-protein interaction studies. They will learn how to interpret proteomic data and understand the role of post-translational modifications in protein function.
- Students will be equipped with practical skills to apply genomics and proteomics in research. They will be able to annotate genomes, analyze gene expression data, predict protein properties, and utilize protein databases effectively. They will gain an understanding of current research technologies in genomics and proteomics and their applications in various biological contexts.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	Unit I: Computational Genome Analysis	15

	1.1	Introduction to genome analysis, Gene analysis; gene order	
	1.2	Chromosome rearrangement; compositional analysis; clustering of genes; composite genes	
	1.3	Basics of Single Nucleotide Polymorphisms, detection and its implications	
	1.4	dbSNP and other SNP related database, Gene Prediction method, Perdition of ORFs	
2.0	2	Unit II	15
	2.1	Prediction of signal sequence (Promoter, Primers, Splice site, UTR etc)	
	2.2	BLAST, PSI BLAST, PHI BLAST; Genome annotation	
	2.3	Epitope prediction; Gene expression analysis	
	2.4	Comparative Genomics: Relevance of comparative genomics; orthologs and paralogs	
3.0	3	Proteomics	
	3.1	Introduction to Proteomics: Scope and Application	
	3.2	Complexity of the problem: Post translational modification, Phosphorylation	
	3.3	Methods of studying proteins, establishing protein-protein interactions	
	3.4	Practical application of proteomics and current research technology, Protein databases	
4.0	4	Unit II: The Proteome and Proteome technology	15
	4.1	Introduction; Expression proteomics (express profile); Cell map proteomics; Protein separation technology - 2D-Gel Electrophoresis, liquid chromatography, affinity chromatography (for cell map proteomics)	
	4.2	X-ray diffraction, NMR, mass spectroscopy and its uses in protein identification; Forward and Reverse Proteomics Introduction to Genomics	
	4.3	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	
	4.4	Genome databases; Annotation of genome, Genome diversity: taxonomy and significance of genomes – bacteria, yeast	
		Total	60

Text Books

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

SBIOP-451 Lab Course in Genomics and Proteomics

1. Analysis of Protein-Protein Interactions using Protein Interaction Databases
2. Identification and Characterization of Biomarkers in Genomic Data
3. Comparative Genomics: Analyzing Evolutionary Relationships and Gene Conservation

4. Prediction of Protein Structures and Functions using Bioinformatics Tools
5. Functional Annotation of Genomic Sequences using Gene Ontology Databases
6. Mining and Analysis of Gene Expression Data from Microarray Databases
7. Identification and Analysis of Single Nucleotide Polymorphisms (SNPs) in Genomic Data
8. Proteome Analysis: Quantitative Approaches and Data Integration
9. Gene Regulatory Network Inference and Analysis using Gene Expression Data
10. Analysis of Metagenomic Data: Exploring Microbial Communities and Functional Potential

Reference:

1. Pevsner, Jonathan. Bioinformatics and Functional Genomics. Wiley, 2015.
2. Lesk, Arthur M. *Introduction to Bioinformatics*. Oxford University Press, 2018.
3. Simpson, Jr., Richard J., and Richard D. Smith (eds.). Proteomics: Methods and Protocols. Humana Press, 2017.
4. Kumar, Sandeep, and Shree Ram Singh. Genomics and Proteomics: *Principles, Technologies, and Applications*. CRC Press, 2015.
5. Xiong, Jin. Essential Bioinformatics. Cambridge University Press, 2006.

SBIOC-452 Chemoinformatics

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-452	Chemoinformatics	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC-452	Chemoinformatics	20	20	20	80	--	--	100

Course pre-requisite:

- Basic knowledge of organic chemistry
- Familiarity with bioinformatics concepts
- Proficiency in computer programming

Course objectives:

- To introduce the students to Chemoinformatics
- To introduce the students to Molecular Descriptors and Similarity Analysis
- To introduce the students to Chemical Database Screening and Molecular Modelling

Course outcomes:

- Students will gain proficiency in using chemoinformatics tools and software for chemical structure representation, molecular descriptor calculation, and similarity analysis. They will be able to work with different molecular file formats, molecular fingerprints, and indices used in chemoinformatics.
- Students will learn how to design and manage chemical databases and perform searches based on chemical structures. They will understand the principles of drug-likeness and lead-likeness and be able to apply Lipinski's rule in drug discovery. They will develop skills in filtering and retrieving chemical compounds from databases.
- Studnts will gain practical skills in molecular modelling and computational chemistry. They will be able to generate low-energy conformations of small molecules, perform molecular mechanics calculations, and apply quantum mechanics methods. They will learn to use clustering and statistical methods for analyzing molecular data, including correlation and regression analysis.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	Introduction to Chemoinformatics	15
	1.1	Introduction to Chemoinformatics: aims, scope. Role of Chemoinformatics in pharmaceutical/chemical research	
	1.2	Chemical Structure representation: 1D, 2D and 3D structures	
	1.3	Molecular file formats (SMILES, WLN, SDF, MOL) (1)• Molecular patterns- SMARTS, SMIRKS	
	1.4	Fragment based Molecular Fingerprints (ChemAxon, Daylight, MDL and BCI, fingerprints- Daylight fingerprints).	
2.0	2	The Proteome and Proteome technology	15
	2.1	Molecular Descriptors (1D, 2D and 3D) and MACCS Keys, Topological, electro-topological and shape indices	
	2.2	Molecular Similarity and Molecular Diversity Analysis	
	2.3	Similarity metrics: Tanimoto Coefficient, Euclidean distance and Tversky Index	
	2.4	Chemical Databases – Design, Storage and Retrieval methods	
3.0	3	Computational Genome Analysis	15
	3.1	Molecular Database Screening: (Lipinski Rule: Drug/Lead like molecules)	
	3.2	Chemical Structure based Search techniques	
	3.3	Exact Structure searches	
	3.4	Sub-structure and similar structure searches	
4.0	4	Modelling and Molecular Mechanics	15
	4.1	Modelling of small molecules (Generation of lowest energy conformations from 2D structures) using Molecular Mechanics and Quantum mechanics method	
	4.2	Clustering and Statistical methods for Molecular Informatics: PLS, PCA	
	4.3	Clustering and Statistical methods for Molecular Informatics: PCR, kNN, ANN	
	4.4	Correlation and regression analysis	
		Total	60

Reference Books

1. Bunin Barry A. Siesel Brian, Morales Guillermo, Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006.
2. Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: WileyVCH; 1st edition. 2003.
3. Leach Andrew R., Valerie J. Gillet. An introduction to chemoinformatics. Publisher:Kluwer academic , 2003.
4. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4• Volumes), 2003. Publisher: Wiley-VCH.

SBIOP-452 Lab Course in Chemoinformatics

1. Introduction to Chemoinformatics and its Role in Pharmaceutical/Chemical Research
2. Chemical Structure Representation: Exploring 1D, 2D, and 3D Structures

3. Molecular File Formats and Molecular Patterns: Hands-on Experience with SMILES, WLN, SDF, MOL, SMARTS, and SMIRKS
4. Fragment-Based Molecular Fingerprints: Generating and Analyzing Molecular Fingerprints using Chem Axon, Daylight, MDL, and BCI
5. Exploring the Proteome and Proteome Technology: Understanding Proteomics Databases and Analysis Tools
6. Molecular Descriptors and MACCS Keys: Calculation and Application of 1D, 2D, and 3D Molecular Descriptors and Topological Indices
7. Molecular Similarity and Diversity Analysis: Implementing Tanimoto Coefficient, Euclidean Distance, and Tversky Index for Similarity Assessment
8. Chemical Databases: Design, Storage, and Retrieval Methods for Efficient Data Mining
9. Computational Genome Analysis: Analyzing Molecular Data for Genome Studies and Drug Discovery
10. Molecular Database Screening and Chemical Structure-Based Search Techniques: Applying Lipinski Rule, Exact Structure Search, Substructure Search, and Similar Structure Search for Virtual Screening

References:

1. Gasteiger, Johann and Thomas Engel. Chemoinformatics: Concepts, Methods, and Tools for Drug Discovery. Wiley-VCH, 2006.
2. Bunin, Barry. Chemoinformatics: Theory, Practice, & Products. CRC Press, 2008.
3. Manas, Eric and Hugo Kubinyi. Chemoinformatics and Computational Chemical Biology. Wiley-VCH, 2011.
4. Gasteiger, Johann. Chemoinformatics: A Textbook. Wiley-VCH, 2003.
5. Vogt, Martin. Practical Chemoinformatics. Wiley, 2014.
6. Singh, Gautam B. Chemoinformatics: Concepts, Methods, and Tools for Drug Discovery. CRC Press, 2010.
7. Beg, Sarwar and G. D. Gupta. Chemoinformatics: A Textbook. Springer, 2014.
8. Bajorath, Jürgen. Chemoinformatics: Theory, Practice, & Products. Springer, 2004.
9. Brown, Richard C. D. Chemoinformatics: Information Handling in Drug Discovery. Royal Society of Chemistry, 2006.
10. Basak, Subhash C., Guillermo Restrepo, and José L. Villaveces. Handbook of Computational Chemistry Research. Nova Science Publishers, 2016.

SBIOC-453: Programming in Java
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOC-453	Programming in Java	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOC-453	Programming in Java	20	20	20	80	--	--	100

Course pre-requisite:

- Basic knowledge of Programming .
- Fundamentals of object-oriented programming
- Knowledge of bioinformatics principles

Course objectives:

- Introduce students to Java Programming Fundamentals
- Introduce students to Applet Programming and Networking
- Introduce students to Database Connectivity and Bioinformatics Applications

Course outcomes:

- Students will develop proficiency in Java programming language, including knowledge of packages, data types, string manipulation, and file management. They will gain hands-on experience in writing Java programs and working with various programming constructs.
- ts will acquire skills in network programming using Java, including understanding the concepts of sockets, client-server communication, and network protocols. They will be able to implement networking functionalities in Java applications and utilize Java's networking classes and interfaces.
- Students will learn to establish connections to databases using JDBC and perform database operations from Java programs. They will gain practical knowledge of accessing and manipulating relational databases. Additionally, students will understand the application of Java programming in the development of bioinformatics applications using the BioJava library, enabling them to apply their programming skills in the field of bioinformatics research.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.

1.0		Unit I	15
	1.1	Java packages	
	1.2	Data types	
	1.3	String manipulation	
	1.4	File management	
2.0		Unit II	15
	2.1	Applet programming, Graphics in Java using Applets & Java Server Pages	
	2.2	Socket Overview, JAVA and the net	
	2.3	The networking classes and interfaces	
	2.4	Inet Address: Factory methods	
3.0		Unit III	15
	3.1	Introspection, TCP/IP server sockets – Data Grams: Datagram packet	
	3.2	Datagram server and client - Introduction to JDBC	
	3.3	Type of JDBC connectivity	
	3.4	Accessing relational database from Java programs	
4.0		Unit IV	15
	4.1	Establishing database connections	
	4.2	Connection pooling	
	4.3	Database drivers, Connection parameters and configuration	
	4.4	Developing Biological Applications using BioJava.	
		Total	60

Reference Books

1. Gary Cornell, Cay Horstmann, Core Java™ 2, Volume I--Fundamentals, 7th Edition, Prentice Hall of India
2. H. Schildt, (2001), "The Complete Reference – Java 2", Fourth Edition, Tata McGraw Hill

SBIOP 453 Lab Course in Programming in Java

1. An introduction to JAVA programming
2. Object-oriented programming and Java
3. Java Basics
4. Working with objects
5. Arrays, Conditionals and Loops
6. Creating Classes and Applications in Java
7. Java Applets Basics
8. Graphics, Fonts and Colour
9. Simple Animation and Threads
10. Advanced Animation, Images and Sound
11. Managing Simple Events and Interactivity
12. Creating User Interfaces with AWT
13. Windows, Networking and other Tidbits
14. Modifiers, Access Control and Class Design
15. Packages and Interfaces
16. Exception
17. Multithreading
18. Streams and I/O

19. Using Native Methods and Libraries

References

1. Liang, Y. Daniel. Introduction to Java Programming: Comprehensive Version. 11th ed., Pearson, 2018.
2. Horstmann, Cay S., and Gary Cornell. Core Java Volume I--Fundamentals. 11th ed., Pearson, 2018.
3. Deitel, Paul J., and Harvey Deitel. Java How to Program. 11th ed., Pearson, 2017.
4. Sierra, Kathy, and Bert Bates. Head First Java. 2nd ed., O'Reilly Media, 2005.
5. Schildt, Herbert. Java: The Complete Reference. 11th ed., McGraw-Hill Education, 2018.
6. Kanetkar, Yashavant. Let Us Java. BPB Publications, 2019.
7. Nageswara Rao, R. Core Java: An Integrated Approach. Dreamtech Press, 2019.
8. Balagurusamy, E. Programming with Java: A Primer. McGraw-Hill Education, 2019.
9. Pradeep, B. S. Java Programming: A Practical Approach. Wiley India, 2018.
10. Salaria, R. S. Java: A Textbook of Computer Science and Information Technology. Khanna Book Publishing, 2020.

SBIOE-451: Structural Bioinformatics
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOE-451	Structural Bioinformatics	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOE-451	Structural Bioinformatics	15	15	15	60	--	--	75

Prerequisite:
- Basic bioinformatics knowledge
- Molecular biology and genetics
- Basic knowledge of bioinformatics tools

Course objectives:
- Introduce students to Macromolecular Structure.
- Introduce students to experimental Techniques and Analysis
- Introduce students to structure Prediction and Macromolecular Interactions

Course outcomes This course will enable the students
- Students will develop proficiency in understanding and analyzing macromolecular structures. They will gain knowledge of the different levels of protein structure and their significance in protein function. They will also become familiar with experimental techniques used in structural biology and understand the principles of protein folding.
- Students will acquire skills in analyzing and validating macromolecular structures using computational tools and techniques. They will be able to interpret potential energy maps, understand coordinate systems, and assess the quality of protein structures using tools like Procheck and ProsaII.
- Students will learn methods for predicting protein structure, including secondary structure prediction and tertiary structure prediction. They will gain practical experience in using computational tools for structure prediction, such as homology modelling and fold recognition. Additionally, students will develop an understanding of macromolecular interactions and the role of proteins in protein-protein, protein-nucleic acids, and protein-carbohydrate interactions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.

1.0		Unit I	11
	1.1	Macromolecular Structure Protein - Primary	
	1.2	Secondary, Super-secondary Structures	
	1.3	Tertiary and Quaternary structure	
	1.4	Potential energy maps	
2.0		Unit II	11
	2.1	Ramachandran map	
	2.2	Nucleic acid – DNA and RNA, Carbohydrates	
	2.3	Co-ordinate systems	
	2.4	Overview of experimental techniques to study macromolecular structures	
3.0		Unit III	11
	3.1	Methods to study 3D structure: X-ray, NMR, Cryo-electron microscopy	
	3.2	Validation using Procheck, ProsaII	
	3.3	Principles of protein folding	
	3.4	Methods to study protein folding	
4.0		Unit IV	12
	4.1	Macromolecular interactions: Protein – Protein, Protein – Nucleic acids, Protein – carbohydrates,	
	4.2	Structure of Ribosome, Prediction of protein structure	
	4.3	Secondary structure prediction methods First, second and third generation methods	
	4.4	Tertiary structure prediction Homology modelling, fold recognition and *ab initio* methods	
		Total	45

Reference Books

1. Burkowski, Forbes. Structural Bioinformatics: An Algorithmic Approach. CRC Press, 2009.
2. Drenth, Jan. Principles of Protein X-Ray Crystallography. Springer Science, 2007.
3. Bourne, Philip E., and Weissig, Helge. Structural Bioinformatics (Methods of Biochemical Analysis). Wiley-Liss, 2003.
4. Höltje, Hans-Dieter et al. Molecular Modelling: Basic Principles and Applications. Wiley-VCH, 2003.
5. Leach, Andrew. Molecular Modelling: Principles and Applications. Prentice Hall, 2001.
6. Friesner, Richard A. Computational Methods for Protein Folding: Advances in Chemical Physics Volume 120. John Wiley & Sons, 2002.
7. Heilmeyer, L. and Friedrich, P. Protein Modules in Cellular Signalling. IOS Press, 2001.
8. Rhodes, Gale. Crystallography Made Crystal Clear, Third Edition: A Guide for Users of Macromolecular Models. Academic Press, 2000.
9. Branden, Carl and Tooze, John. Introduction to Protein Structure. Garland Publishing Inc., 1999.
10. Hill, H.A.O. and Sadler, P.J. (Eds.). Metal Sites in Proteins and Models Redox Centres. Springer, 1999.
11. Sternberg, Michael J. E. Protein Structure Prediction: A Practical Approach. Oxford University Press, 1997.
12. Fasman, G.D. Prediction of Protein Structure and the Principles of Protein Conformation. Plenum Press, 1989.

SBIOE 452 Lab Course in Structural Bioinformatics

1. Analysis of Protein Primary Structure Using Online Databases
2. Exploring Secondary and Super-secondary Structures of Proteins Using Structural Databases

3. Investigating Tertiary and Quaternary Structures of Macromolecules Using Online Resources
4. Visualization of Potential Energy Maps for Macromolecular Structures
5. Utilizing Ramachandran Maps for Protein Structure Analysis
6. Computational Analysis of Nucleic Acid Structures: DNA and RNA
7. Introduction to Coordinate Systems in Structural Bioinformatics
8. Experimental Techniques for Studying Macromolecular Structures: X-ray, NMR, Cryo-EM
9. Validating Protein Structures Using Procheck and ProsaII
10. Prediction and Modeling of Protein Structures: Homology Modeling, Fold Recognition, and Ab Initio Methods

Reference Books

1. Burkowski, Forbes J. Structural Bioinformatics: An Algorithmic Approach. CRC Press, 2009.
2. Oas, Terrence G. Introduction to Structural Bioinformatics. Oxford University Press, 2017.
3. Bourne, Philip E., and Helge Weissig. Structural Bioinformatics (Methods of Biochemical Analysis, Vol. 44). Wiley-Liss, 2003.
4. Drenth, Jan. Principles of Protein X-Ray Crystallography. Springer, 2007.
5. Pevsner, Jonathan. Bioinformatics and Functional Genomics. Wiley, 2015.

SBIOE-453: Immunology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBIOE-453	Immunology	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBIOE-453	Immunology	15	15	15	60	--	--	75

Course pre-requisite:

- Basic knowledge of cell biology, molecular biology, and genetics.
- Understanding of fundamental concepts in immunology

Course objectives:

- Introduce students to Fundamental Principles of Immunology
- Introduce students to Immune Response and Immunological Disorders
- Introduce students to Immunological Techniques and Applications

Course outcomes:

- Students will develop a comprehensive knowledge of the principles and concepts of immunology, including the anatomy of the immune system, innate and acquired immunity, and the role of antibodies. They will understand the regulation of immune responses and the immune mechanisms involved in combating infections and diseases.
- Students will gain an understanding of immunological disorders, including hypersensitivity reactions, autoimmune diseases, transplantation immunology, tumor immunology, and immunodeficiency diseases. They will be able to analyse and evaluate the underlying immunological mechanisms and the potential treatments for these disorders.
- Students will acquire practical skills in performing immunological techniques commonly used in research and diagnostics. They will learn about the principles and applications of various immune techniques, including antigen-antibody interactions, agglutination, precipitation, ELISA, and monoclonal antibody production. They will also gain knowledge of automation in immunological techniques and the use of advanced technologies in immunology research.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		Unit I	11

	1.1	Immunology – fundamentals and anatomy of immune system Immunity – Innate and acquired immunity.	
	1.2	Components of innate and acquired immunity. Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions.	
	1.3	The anatomy of the immune response: - Cells and organs of immune system.	
	1.4	Regulation of immune response: - Humoral and Cell mediated response	
2.0		Unit II	12
	2.1	Immunity to infection Antigen processing and presentation, MHC, complement system	
	2.2	Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and Helminthes) with specific representative examples of each group	
	2.3	Vaccines – Active and passive immunization	
	2.4	DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines	
3.0		Unit III	11
	3.1	Clinical immunology and immunodeficiency diseases Hypersensitivity: - Type I, II, III, and IV reactions	
	3.2	Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases	
	3.3	Transplantation and tumor immunology: - Graft rejection, tissue typing, immuno suppressive therapy and clinical transplantation	
	3.4	Tumor antigens, cancerimmuno therapy. Immunodeficiency diseases: - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS-causes, syndrome, diagnostic tools, treatment and development of vaccine	
4.0		Unit IV	11
	4.1	Immunotechnology Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation	
	4.2	Viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA	
	4.3	Monoclonal antibodies – Hybridoma technology and various cellular technologies	
	4.4	Automation in immunological techniques – auto analysers used in immunology, FACS	
		Total	45

Reference Books

1. Janeway C. A. Travers P., Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012) 8th ed.
2. Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013), 7 th ed.
3. Delves P. J., Martin J. S., Burton R. D., Roitt M. I. Roitt's Essential Immunology, Wiley Blackwell (2011) 12th ed.
4. Khan F.H. The Elements of Immunology, Pearson Education (2009)
5. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
6. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor). Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.

7. Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana Press.

SBIOE-454 Lab Course in Immunology

1. Analysis of Immunoglobulin (Ig) Sequences using Antibody Databases
2. Prediction of T-cell Epitopes using Computational Tools
3. Comparative Analysis of Major Histocompatibility Complex (MHC) Genes in Different Species
4. Analysis of B-cell Receptor Repertoire using High-Throughput Sequencing Data
5. Identification and Annotation of Immunological Gene Families in Genomic Databases
6. Exploration of Immune-related Gene Expression Patterns using Public Gene Expression Datasets
7. Investigation of Disease-associated Immunological Variants using Genome-wide Association Studies (GWAS) Databases
8. Prediction of Protein-Protein Interactions in Immune Signaling Pathways
9. Analysis of Tumor-Infiltrating Lymphocytes using Cancer Immunogenomics Datasets
10. Exploration of Immune Cell Populations and Their Functional Profiles using Single-cell RNA Sequencing Databases

Reference books:

1. Coico, Richard, and Geoffrey Sunshine. Immunology: A Short Course. Wiley, 2015.
2. Kuby, Janis, Judy Owen, and Jenni Punt. Immunology. W.H. Freeman & Company, 2018.
3. Male, David, Jonathan Brostoff, David B. Roth, and Ivan Roitt. Immunology. Elsevier, 2017.
4. Murphy, Kenneth, and Casey Weaver. Janeway's Immunobiology. Garland Science, 2016.
5. Abbas, Abul K., Andrew H. Lichtman, and Shiv Pillai. Cellular and Molecular Immunology. Elsevier, 2017.

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