॥ 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, PCL, 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. Biotechnology (1st Year) - Campus School
2) M.Sc. Biotechnology (1st Year) – Affiliated colleges
3) B.Sc. Biotechnology (1st Year) – New Model Degree College, Hingoli
4) M.Sc. Botany (1st Year) - Campus School
5) M.Sc. Botany (1st Year) – Affiliated colleges
6) M.Sc. Herbal Medicine (1st Year) - Affiliated colleges
7) M.Sc. Chemistry (1st Year) - Campus School
8) M.Sc. Chemistry (1st Year) - Affiliated colleges
9) M.Sc. Computer Science / Computer Network / Computer Applications (1st Year) University campus, sub campus Latur
10) M.Sc. System Administration & Networking (1st Year) – Affiliated colleges
11) M.Sc. Computer Management (1st Year) – Affiliated Colleges
12) M.Sc. Computer Science (1st Year) – Affiliated Colleges
13) M.Sc. Dairy Science (1st Year) - Affiliated colleges
14) M.Sc. Electronic (1st Year) - Affiliated colleges
15) M.Sc. Geology (1st Year) – University Campus
16) M.Sc. Geography (1st Year) – University Campus
17) M.Sc. Applied Mathematics (1st Year) – Affiliated Colleges
18) M.Sc. Mathematics (1st Year) – Affiliated Colleges
19) M.Sc. Microbiology (1st Year) - University Campus
20) M.Sc. Microbiology (1st Year) – Affiliated colleges

21) M.Sc. Physics (1st Year) - University Campus
22) M.Sc. Physics (1st Year) – Affiliated Colleges
23) M.Sc. Statistics (1st Year) - University Campus
24) M.Sc. Statistics (1st Year) – Affiliated colleges
25) M.Sc. Biochemistry (1st Year) – Affiliated Colleges
26) M.Sc. Zoology (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/ 130

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

दिनांक : ३०.०६.२०२३.

प्रत : १) मा. प्राचार्य, सर्व संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
२) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
३) मा. प्राचार्य, न्यु मॉडेल डिग्री कॉलेज हिंगोली.
४) मा. समन्यवक, कै. श्री उत्तमराव राठोड आदिवासी विकास व संशोधन केंद्र, किनवट.

प्रत माहितीस्तव :
१) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. कुलसचिव, प्रस्तुत विद्यापीठ.
३) मा. सर्व आधिष्ठाता, प्रस्तुत विद्यापीठ.
४) सर्व प्रशासकीय विभाग प्रमुख साहाय्यक, प्रस्तुत विद्यापीठ.
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

STRUCTURE AND SYLLABUS OF TWO-YEAR MASTERS

PROGRAM IN SCIENCE

(R-2023)

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

M. Sc. First Year

SUBJECT: BIOTECHNOLOGY
(Affiliated Colleges)

FACULTY OF SCIENCE AND TECHNOLOGY

With Effect From June 2023

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 first-hand 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. L. M. Waghmare, *Dean,* *Faculty of Science and Technology*

Dr. M. K. Patil, *Associate 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.

Biotechnology is often considered as the technology of hope for meeting future challenges like feeding our increasing population, cleaning dangerously polluted environments and potentiating healthcare sector etc. Establishment of new IISERs, Central Universities and IITs indicate that we are already on the track of developing infrastructure and human resource. Our dream of becoming future ‘superpower’ will not be possible without Biotechnology and inclusive efforts. Therefore, it is necessary to attract young and bright students and train them in the field of Biotechnology.

Keeping in mind, BOS in Biotechnology and Bioinformatics prepared the curriculum to ensure up-to-date level of understanding of Biotechnology. Studying Biotechnology 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 and 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 Biotechnology 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 Biotechnology.

The Core Courses deal with Biochemistry, Cell and Developmental Biology, Microbiology and Virology, Immunotechnology, Molecular Genetics, Industrial Biotechnology, Process Biotechnology, Pharmaceutical Biotechnology, Genetic Engineering, Plant Biotechnology and Computational Biology.

Apart from the core courses, the Department Specific Elective Courses deal with Enzymology, Environmental Biotechnology, Plant Metabolism and Development, Animal Biotechnology, Nanobiotechnology, IPR and Techniques in Biotechnology. These courses offered during this program are designed with the aim of imparting specific skills to the students which will lead to the employability of the students. 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 Biotechnology.

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

Program Educational Objectives:

The Objectives of this program are:

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

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

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

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 Biotechnology program shall promote and popularize Biotechnology 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 Biotechnology.

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 resources 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 B.Sc. level. The optional courses are offered to the students registered for post-graduate programs. Such students should have the basic knowledge of Biotechnology and willing to gain additional knowledge in the field of Biotechnology.

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 of 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 Biotechnology (Affiliated Colleges) (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	SBTTC-401 Cell and Developmental Biology SBTTC-402 Microbiology and Virology SBTTC-403 Biochemistry	SBTTE-401 Techniques in Biotechnology **OR** SBTTE-403 Plant Metabolism and Development	SVECR 401 Research Methodology (3-Cr)	--		SBTTP-401 Lab Course in Cell and Developmental Biology SBTTP-402 Lab Course in Microbiology and Virology SBTTP-403 Lab Course in Biochemistry SBTTE-402 Lab Course in Techniques in Biotechnology **OR** SBTTE-404 Lab Course in Plant Metabolism and Development	22	44
	2	SBTTC-451 Molecular Genetics SBTTC-452 Immunotechnology SBTTC-453 Process Biotechnology	SBTTE-451 Enzymology **OR** SBTTE-453 Nanobiotechnology	---	SBTTX-451 (O/F/C)	--	SBTTP-451 Lab Course in Molecular Genetics SBTTP-452 Lab Course in Immunotechnology SBTTP-453 Lab Course in Process Biotechnology SBTTE-452 Lab Course in Enzymology **OR** SBTTE-454 Lab Course in Nanobiotechnology	22	
Exit option: Exit Option with PG Diploma in Basic Biotechnology (After 2024-25)									
2	3	SBTTC-501 Genetic Engineering SBTTC-502 Industrial Biotechnology SBTTC-503- Plant Biotechnology	SBTTE-501 English and Science Communication Skills **OR** SBTTE-502 Intellectual Property Rights /Online Certification Course NPTEL /SWAYM /MOOC of equivalent credits	--	--	Research Project SBTTR-551 (4-Cr)	SBTTP-501 Lab Course in Genetic Engineering SBTTP-502 Lab Course in Industrial Biotechnology SBTTP-503 Lab Course in Plant Biotechnology	22	44
	4	SBTTC-551 Computational Biology SBTTC-552 Pharmaceutical Biotechnology	SBTTE-551 Environmental Biotechnology **OR** SBTTE-553 Animal Biotechnology	SVECP-551 Publication Ethics (2-Cr)	--	Research Project SBTTR-552 (6-Cr)	SBTTP-551 Lab Course in Computational Biology SBTTP-552 Lab Course Pharmaceutical Biotechnology SBTTE-552 Lab Course in Environmental Biotechnology **OR** SBTTE-554 Lab Course in Animal Biotechnology	22	
Total Credits		44	12	05	03	10	14		**88**

DSE indicates Department Specific Elective Course. Biotechnology student, in particular semester, can opt either of these courses OR a course offered by other Departments. 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	
			Theory	Practical	Total	Theory (Hrs/ Week)	Practical (Hrs/ Week/Batch)
Major	SBTTC-401	Cell and Developmental Biology	04	--	04	04	--
	SBTTC-402	Microbiology and Virology	04	--	04	04	--
	SBTTC-403	Biochemistry	04	--	04	04	--
Elective (DSE)	SBTTE-401 SBTTE-403	Techniques in Biotechnology **OR** Plant Metabolism and Development	03	--	03	03	--
Research Methodology	SVECR-401	Research Methodology	03	--	03	03	--
DSC Practical	SBTTP-401	Lab Course in Cell and Developmental Biology	--	01	01	--	02
	SBTTP-402	Lab Course in Microbiology and Virology	--	01	01	--	02
	SBTTP-403	Lab Course in Biochemistry	--	01	01	--	02
DSE Practical	SBTTE-402 SBTTE-404	Lab Course in Techniques in Biotechnology **OR** Lab Course in Plant Metabolism and Development	--	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	SBTTC-401	Cell and Developmental Biology	20	20	20	80	--	--	100
	SBTTC-402	Microbiology and Virology	20	20	20	80	--	--	100
	SBTTC-403	Biochemistry	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-401 BTTE-403	Techniques in Biotechnology **OR** Plant Metabolism and Development	15	15	15	60	--	--	75
Research Methodology	SVECR-401	Research Methodology	15	15	15	60	--	--	75
DSE Practical	SBTTP-401	Lab Course in Cell and Developmental Biology	--	--	--	--	05	20	25
	SBTTP-402	Lab Course in Microbiology and Virology	--	--	--	--	05	20	25
	SBTTP-403	Lab Course in Biochemistry	--	--	--	--	05	20	25
DSE Practical	SBTTE-402 SBTTE-404	Lab Course in Techniques in Biotechnology OR Plant Metabolism and Development	--	--	--	--	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	SBTTC-451	Molecular Genetics	04	--	04	04	--
	SBTTC-452	Immunotechnology	04	--	04	04	--
	SBTTC-453	Process Biotechnology	04	--	04	04	--
Elective (DSE)	SBTTE-451 **OR** SBTTE-453	Enzymology **OR** Nanobiotechnology	03	--	03	03	--
On Job Training / Field Project/ Case Study	SBTTX-451	On Job Training (O) / Field Project (F)/ Case Study (C))	--	03	03	--	03
DSC Practical	SBTTP-451	Lab Course in Molecular Genetics	--	01	01	--	02
	SBTTP-452	Lab Course in Immunotechnology	--	01	01	--	02
	SBTTP-453	Lab Course in Process Bio Technology	--	01	01	--	02
DSE Practical	SBTTE-452 **OR** SBTTE-454	Lab Course in Enzymology **OR** Lab Course in Nanobiotechnology	--	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	SBTTC-451	Molecular Genetics	20	20	20	80	--	--	100
	SBTTC-452	Immunotechnology	20	20	20	80	--	--	100
	SBTTC-453	Process Biotechnology	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-451 **OR** SBTTE-453	Enzymology **OR** Nanobiotechnology	15	15	15	60	--	--	75
On Job Training/ Field Project/ Case Study	SBTTX-451	On Job Training (O) / Field Project (F)/ Case Study (C))	--	--	--	--	15	60	75
DSC Practical	SBTTP-451	Lab Course in Molecular Genetics	--	--	--	--	05	20	25
	SBTTP-452	Lab Course in Immunotechnology	--	--	--	--	05	20	25
	SBTTP-453	Lab Course in Process Bio Technology	--	--	--	--	05	20	25
DSE Practical	SBTEP-452 **OR** SBTEP-454	Lab Course in Enzymology **OR** Lab Course in Nanobiotechnology	--	--	--	--	05	20	25

SBTTC-401 CELL AND DEVELOPMENTAL BIOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-401	Cell and Developmental Biology	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA						
		Test I	Test II	Avg of (T1+T2)/2	ESA	CA	ESA	
SBTTC-401	Cell and Developmental Biology	20	20	20	80	--	--	100

Course pre-requisite:

A prerequisite for a Cell and Developmental Biology course will be knowledge of basic biology with a foundational course in general biology with essential knowledge of basic biological concepts, such as cell structure and function, genetics, and molecular biology.

Course Objectives:

- To understand the basics of cell biology and developmental biology.
- To know the communication as well as transportation in cells.
- To become aware of stem cell technology

Course Outcomes:

- The students will understand the basics of cell biology, developmental biology, and the fundamentals of cancer.
- The students will identify the characteristics and basic needs of living organisms and ecosystems.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs.
1		**Study of Cell & its architecture**	**15**
	1.1	Cell size and shape, History & Evolution, Cell as the basic unit of life, cell theory, Structural organization of prokaryotes and eukaryotes.	
	1.2	Biogenesis of Mitochondria, Chloroplast. Structure of model membrane, lipid bilayer and membrane	
	1.3	Protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.	
	1.4	Structure and function of Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility	
2		**Cell-Cell interactions**	**15**
	2.1	General principles of cell communication cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix,	

		integrin's.	
	2.2	Neurotransmission and its regulation. Hormones and their receptors, cell surface receptor, signaling through G- protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways	
	2.3	Bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing. Regulation of hematopoiesis,	
3		**Cell division & Cancer genetics**	**15**
	3.1	Mechanism of cell division mitosis, meiosis and genetic recombination; regulation of cell cycle; factors and genes regulating cell cycle.	
	3.2	Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle,	
	3.3	Virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth	
4		**Developmental Biology and Gene Patterning**	**15**
	4.1	Gametogenesis, Fertilization, cleavage, blastulation, Gastrulation & formation of germ layers in animals,	
	4.2	Concepts of competence, determination, commitment and differentiation (dedifferentiation, re-differentiation, trans-differentiation) developmental plasticity in plant. Sex determination in plants & animals.	
	4.3	Role of gene/s in patterning and development e.g. Arabidopsis thaliana (root, shoot, leaf & flower) & Drosophila melanogaster (maternal genes, bicoid, gap genes), Stem cells.	
			60

Text and Reference Books:

1. David Sadava., Cell biology. Jones & Bartlett Publishers. 1993.
2. Karp, G., Cell and molecular biology. John Wiley & Sons. 2009.
3. Gilbert, S.F., Developmental biology. Sinauer associates. 2011.
4. Brown, T.A., Genomes, Garland Science. 2006.
5. Bruce Alberts · Molecular Biology of the Cell. Garland Science. 2002.
6. J. Darnell, H. Lodish, and D. Baltimore. T., Molecular cell biology: WH Freeman and Co. 1986.
7. D.M Prescott, Reproduction in Eukaryotic cells, Academic Press. 2012.
8. EB Wilson, Cell in Developmental and Inheritance-, Macmillan New York. 2018.
9. Longo, F. Fertilization. Chapman and Hall, London.1987.
10. LP Freedman, Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhäuser. 2012.
11. J. Sambrook, Molecular Cloning: a Laboratory Manual, CSHL Press, 2003.

SBTTP-401 LAB COURSE IN CELL AND DEVELOPMENTAL BIOLOGY

1. Microscopy: Bright field & phase contrast & fluorescence microscopy
2. Cell types of plants- Microtomy/ maceration of various tissue explants and identification
3. Study of Mitosis and Meiosis (root tips and anthers)
4. Study of karyotypes of genetic disorders and normal
5. Cell fractionation and separation at cell organelles chloroplast and Mitochondria

6. Pigment separation by TLC & Chromatography.
7. Analysis of chlorophyll amount by Spectrophotometer.
8. Drosophila culture: Cultivation, maintenance and *Drosophila* genetics study
9. Study of chick/ Frog/ Plant embryo for developmental study.

SBTTC-402 MICROBIOLOGY AND VIROLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-402	Microbiology and Virology	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	
SBTTC-402	Microbiology and Virology	20	20	20	80	--	--	100

Course pre-requisite:

A foundational course in microbiology will provide a comprehensive understanding of microorganisms, including bacteria, fungi, protozoa, and viruses. Earlier knowledge of topics such as microbial structure, physiology, genetics, and interactions with their environment will enable the students to learn about the different types of microorganisms and their functions.

Course Objectives:

- To understand the basic principles of microbiology and virology.
- To learn the cultivation methods of microorganisms.

Course Outcomes:

- Students will understand the development of microbiology and virology.
- Students will learn about the growth pattern of microorganisms.
- Students will know the methods of cultivation of bacteria and viruses for industrial and human use.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**The Beginning of Microbiology**	**15**
	1.1	Controversy over spontaneous generation, Development of pure culture methods.	
	1.2	**Bacteria:** Purple and green bacteria, Cyanobacteria, Homoacetogenic bacteria. Budding and appendaged bacteria, Spirilla, Spirochetes, Gliding and sheathed bacteria, Pseudomonades; Lactic and propionic acid bacteria, Endospore forming rods and cocci, Mycobacterium, Rickettsia's, Chlamydia's and Mycoplasmas.	
	1.3	**Archaea:** Archaea as earliest life forms, Halophiles, Methanogens, Hyper-thermophilic archaea.	
2		**Methods in Microbiology**	**15**
	2.1	Theory and practice of sterilization,	
	2.2	Principles of microbial Nutrition, Construction of culture media. Microbial Evolution, Systematics and Taxonomy Evolution of earth and earliest life forms: Primitive organisms and their metabolic strategies and molecular	

		coding;	
	2.3	New approaches to bacterial taxonomy classification including Ribotyping; Ribosomal RNA sequencing;	
	2.4	Characteristics of primary domains; Taxonomy, Nomenclature and Bergey's Manual.	
3		**Microbial Growth**	**15**
	3.1	The definition of growth, mathematical expression of growth, growth curve,	
	3.2	measurement of Growth and growth yields; Synchronous growth: Continuous culture;	
	3.3	Growth as affected by Environmental factors like temperature, acidity, alkalinity, water availability and oxygen.	
4		**Virology**	**15**
	4.1	Discovery of viruses, Nomenclature, Classification, Structure of viruses, morphology and ultra structure.	
	4.2	Virus receptors & entry into cell, Virus related agents Overview of viral replication; Assembly, Maturation & release from cell,	
	4.3	Diagnostic Virology; Cultivation of viruses in embryonated eggs, animal cells and experimental animals, transgenic systems, Virus infectivity Assay (chemical and physical methods), PCR based diagnosis of viruses.	
	4.4	Life cycle of – Bacterial viruses (Lambda, M13), Plant viruses (TMV, and CMV) Animal viruses (Herpes and Retro)	**60**

Text and Reference Books:

1. RY Stainer, General Microbiology, MacMillan Press Ltd. 1987.
2. Madigan, M.T, Brock Biology of Microorganisms, Pearson. 2018.
3. Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. Microbiology, Tata McGraw Hill. 1986.
4. Freifelder, D. Microbial Genetics, Jones, Bartlett Publishers. 1987.
5. Cappuccino, J.G. and Sherman, N. Microbiology - A Laboratory Manual, Addison Wesley. 2014.
6. Edward Birge, Bacterial and Bacteriophage Genetics, Springer. 2013.
7. RE Ford Matthews, Roger Hull, Mathews Plant Virology, Academic Press. 2002.
8. John Carter, Venetia A. Saunders, Virology Principles and Applications, Wiley. 2014.
9. S. B. Primrose, N. J. Dimmock. Introduction to Modern Virology, Blackwell Scientific. 1980.
10. M.V. Nayudu, Plant Virus, Tata McGraw Hill. 2008

SBTTP-402 LAB COURSE IN MICROBIOLOGY AND VIROLOGY

1. Preparation of liquid and solid media for growth of microorganisms.
1. Isolation and maintenance of organisms from soil and water by plating, streaking and serial dilution
2. Plate, Slants and stab cultures, Storage of microorganisms.
3. Study of microbial growth and factors affecting on growth temperature, pH, carbon and nitrogen.
4. Staining and Microscopic examination of bacteria, yeast and molds.
5. Assay of antibiotics and demonstration of antibiotic resistance.
6. Analysis of potable water and determination of MPN.
7. Biochemical characterization of selected microbes.
8. Measurement of Size of microorganism by Micrometry.
9. Cultivation and study of Coli phage and one step growth curve of coli phage.
10. Cultivation study of virus in embryonated chicken eggs, Hemagglutination assay.

SBTTC-403 BIOCHEMISTRY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-403	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	
SBTTC-403	Biochemistry	20	20	20	80	--	--	100

Course pre-requisite:
Basic concepts of general chemistry, with an understanding of the principles of chemistry, chemical bonding, and chemical reactions, is crucial for comprehending the biochemical processes occurring within cells. Biochemistry explores the chemical processes and compounds occurring in living organisms. It provides an understanding of cellular metabolism, enzymatic reactions, and the role of biomolecules in cellular processes.

Course Objectives: To familiarize the students

- Structure, classification, and the properties of biomolecules
- Functions of biomolecules in human health
- Laboratory skills for the study of biomolecules

Course Outcomes:

- Students will understand the structure, classification, and properties of biomolecules.
- Students will acquire the basic laboratory skills for the isolation and separation of biomolecules.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Chemical foundations of Biology**	**15**
	1.1	Structure of atoms, molecules and chemical bonds; Ionization of water, properties of water,	
	1.2	The pH scale, concept of acids and bases, Henderson- Hasselbach equation, biological buffer systems.	
	1.3	Thermodynamic principles in biology, Concept of free Energy and redox potential	
2		**Biomolecules I**	**15**
	2.1	Carbohydrates: Classification occurrence, structure, function and properties of monosaccharide, oligosaccharide and polysaccharides.	
	2.2	Lipids: Classification, structure and functions of major lipids, Triglycerides, Phospholipids, Steroids and terpenes. Glycolipids and lipoproteins-structure and function. Role of lipids.	

	2.3	Hormones: Structure and function; Vitamins: Types, structure and functions; Prostaglandins; Silk fibroin, coiled coils, collagen triple helix and hemoglobin.	
3		**Biomolecules II**	**15**
	3.1	Amino acids: Classification and chemical reactions and physical properties. Peptide bond, peptide classification, biologically important peptides.	
	3.2	**Proteins:** Properties and classification, primary, secondary, tertiary and quaternary structure of proteins with example, structural comparison at secondary and tertiary levels. Ramachandran plot.	
	3.3	**Enzymes:** Historical perspectives, general characteristics, nomenclature and classification. Methods of isolation, purification and characterization of enzymes. Concept of enzyme assay, enzyme activity, coenzymes and isoenzymes.	
4		**Biomolecules III**	**15**
	4.1	Nucleic acids: Primary, secondary and tertiary structure of nucleic acids, double stranded DNA and biological significance,	
	4.2	forms of DNA, Physical properties of double stranded DNA,	
	4.3	Types of RNAs and their biological significance. DNA Supercoiling.	**60**

Text and Reference Books:

1. Lehninger, A.L. Nelson, DL., Cox, MM.· Principles of Biochemistry - CBS publishers. 2008.
2. D. Voet, J.G. Voet, C. W. Pratt. Fundamentals of Biochemistry, John Wiley, and Sons. 2013.
3. G. L. Zubay, W. W. Parson, D. E. Vance., Biochemistry, WCB publishers. 1995.
4. R. K. Murray, D. K. Granner, P. A. Mayes, Harper's Biochemistry, McGraw Hill. 2009.
5. J.M. Berg, J. L. Tymoczko, G. J. Gatto, Jr., Lubert Stryer. Biochemistry, W.H. Freeman. 2015.
6. J. David Rawn. Biochemistry, Neil Patterson Publishers. 1989.
7. U Satyanarayana, U Chakrapani. Biochemistry, Elsevier Health Sciences. 2020.

SBTTP-403 LAB COURSE IN BIOCHEMISTRY

1. Study of General and Safety Rules of Biotechnology Laboratory
2. Concept of Buffers, pH, Morality and Normality (Problem solving and preparation)
3. Reaction of amino acids, sugars, lipids
4. Estimations of Carbohydrates and Sugars
5. Estimation of amino acids, proteins
6. Titration of amino acids and determination of pKa
7. Estimations of DNA & RNA
8. Analysis of oils, iodine number, saponification value, acid number
9. Cholesterol estimation
10. UV visible fluorescence & IR spectroscopy absorption spectra
11. Enzyme assay

SBTTE-401 TECHNIQUES IN BIOTECHNOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-401	Techniques in Biotechnology	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	
SBTTE-401	Techniques in Biotechnology	15	15	15	60	--	--	75

Course pre-requisite:

The course requirements for a course in techniques in biotechnology include knowledge of all branches of biological science, such as biology, microbiology, or biochemistry, with a strong foundation in cell biology, genetics, and biochemistry and a good understanding of scientific research methods and techniques. Excellent written and verbal communication skills.

Course Objectives:

To know the basic principles, workings and applications of biological techniques in microscopy, electrophoresis, chromatography and spectroscopy.

Course Outcomes:

Students will learn the working principles of biological techniques in microscopy, electrophoresis, chromatography and spectroscopy.

They will use these biological techniques in research and development.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Microscopy and Electrochemical techniques**	**11**
	1.1	Light microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope.	
	1.2	Centrifugation: Principles, RCF and Types of centrifuges, types of rotors, preparative and analytical ultra-centrifuge.	
	1.3	Principles of electrochemical techniques, redox reactions, the pH electrode, ion-sensitive and gas-sensitive electrodes, The Clark oxygen electrode.	
2		**Chromatography and Electrophoresis**	**12**
	2.1	Principles of chromatography, lon-exchange and affinity chromatography. High performance liquid chromatography (HPLC), Gas liquid chromatography (GLC),	
	2.2	Thin layer chromatography (TLC), Paper chromatography, GC-MS, LC-MS, Maldi ToF.	
	2.3	Electrophoresis: General principles, SDS-PAGE , Native gels, Gradient gel, Iso electricfocusing, 2-D gel electrophoresis (2-D PAGE), Detection,	

		estimation and recovery of proteins, Western blotting.	
	2.4	Electrophoresis of nucleic acids: agarose gel electrophoresis of DNA, DNA sequencing gels, Pulse field gel electrophoresis, Capillary electrophoresis.	
3		**Spectroscopic techniques:**	**11**
	3.1	Properties of electromagnetic radiation, interaction with matter. Gamma ray spectroscopy, Xray spectroscopy,	
	3.2	UV and Visible spectroscopy, Infrared and Raman spectroscopy, Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy,	
	3.3	Circular dichroism spectroscopy, Atomic spectroscopy, x-ray diffraction, x-ray crystallography. Spectrofluorimetry, turbidometry and nephelometry.	
4		**Radio isotope techniques and Biosensor**	**11**
	4.1	The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller counter- principles and applications.	
	4.2	Detection based on excitation- Liquid Scintillation counter-principle and applications. Supply, storage and purity of radiolabelled compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications- of radio isotopes in biological sciences. Flowcytometry, ELISA, immunoblotting.	
	4.3	Biosensors: Principle, construction, mechanism and applications of biosensor with one example. (Enzyme and cell based)	
			45

Text and Reference Books:

1. D. Freifelder, Physical Biochemistry, W. H. Freeman. 1982
2. A. Hofmann, J. M. Walker, K. Wilson, S, Clokie, Principles and Techniques of Biochemistry and Molecular Biology; Cambridge Press. 2018.
3. David T Plummer, Practical Biochemistry, Tata McGraw- Hill. 2001.
4. B. K. Sharma. Instrumental methods of chemical analysis, Krishna Prakashan. 1981.
5. Upadhyay, A., Upadhyay, K., and Nath, N. Biophysical chemistry, Himalaya Publishing House, 2009.
6. R.S. Khandpur. Handbook of Biomedical Instrumentation, Tata McGraw Hill. 1987.
7. Van Holde, K. E., W. Johnson, and P. Shing Ho. Principles of Physical Biochemistry. Prentice Hall. 1998.
8. A. Cass, J. Cooper, Biosensors, Oxford University Press. 2012.

SBTTE-402 LAB COURSE IN TECHNIQUES IN BIOTECHNOLOGY

1. Study of standard operating protocols, validation, and calibrations of instruments
2. Electrophoresis of proteins under native and denaturing conditions (PAGE)
3. Separation of proteins / pigments using column chromatography
4. Demonstration of techniques: GC, HPLC and atomic absorption spectroscopy AAS
5. Theory & Principal, operation of microscopes centrifuges, spectrophotometers, chromatographic techniques, electrophoresis, radio isotopic techniques
6. Methods based on centrifugation, electrochemical techniques, spectrophotometer.
7. Methods on TLC, Paper Chromatography
8. SDS PAGE, 2D Gel electrophoresis capillary, electrophoresis western blotting,
9. ELISA, Immunoblotting
10. Demonstration of flowcytometry liquid scintillation counter, Geiger Muller counter

SBTTE-403 PLANT METABOLISM AND DEVELOPMENT

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-403	Plant Metabolism and Development	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	
SBTTE-403	Plant Metabolism and Development	15	15	15	15	--	--	75

Course pre-requisite:

Students taking Plant Metabolism and Development are likely to have basic knowledge of botany, cell biology, and fundamental physiology. This course needs an essential background for the more specialized options in plant sciences, as well as a strong scientific basis for topics in biochemistry, genetics, and ecology. Students need to have a range of experimental techniques used in modern plant biology in the laboratory and in the field.

Course Objectives:

To learn the fundamental processes in plant systems. To understand the basic aspects of plant physiology.

Course Outcomes:

Students will learn about the plant-water relationship, the mechanism of photosynthesis, and respiration.
They will be able to explain the mechanisms of physiological processes in plants.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Plant Water Relationship**	**11**
	1.1	Physical and chemical properties of water, diffusion, osmosis, plasmolysis, stress physiology,	
	1.2	Whole Plants and Inorganic Nutrients, theories of absorption of mineral salt ions – contact exchange theory, carbonic acid exchange theory, mechanism of active absorption,	
	1.3	Nutrient Uptake –Transport Systems - Translocation in the Phloem,	
2		**Photosynthesis and Respiration**	**12**
	2.1	The Light Reactions - Mode of Action of Some Herbicides - Dark Reactions - Oxidative Photosynthetic	
	2.2	Carbon Cycle –C3, C4 and CAM pathway, Respiration: Mitochondrial electron transport; Glycolysis; synthesis of ATP,	
	2.3	Respiratory pathways- PPP; regulation of Respiration; Photorespiration: Glyoxylate pathway.	
3		**Light and Hormonal Control of Plant Growth**	11
	3.1	Photoperiodism - Phytochrome Regulation of Gene Expression - Blue-Light	

		Responses - Guard Cell Osmoregulation	
	3.2	Auxin - Growth Hormone – Gibberellins - Regulators of Plant Height – Cytokinins	
	3.3	Regulators of Cell Division – Ethylene - Gaseous Hormone - Abscisic Acid - A Seed Maturation and Anti stress Signal - Circadian Rhythms.	
4		**Plant Development**	**11**
	4.1	Stamen and Androecium - Pollen Development - Carpel and Gynoecium - Ovule and Embryo Sac –	
	4.2	Pollination and Pollen-Stigma Interaction – Pollen tube germination, growth and Fertilization –	
	4.3	Endosperm- Embryo	
			45

Text and Reference Books:

1. Heldt, H.-W., & Piechulla, B. Plant Biochemistry. Academic Press. 2011.
2. Taiz, L., & Zeiger, E. Plant Physiology and Development. Sinauer Associates, Inc. 2014.
3. Dennis, D. T., & Turpin, D. H. Plant Metabolism. Longman. 2002.
4. Plaxton, W. C., & McManus, M. T. Plant Metabolism: Methods and Protocols. Humana Press. 2006.
5. Davies, P. J. Ed.. Plant Hormones: Biosynthesis, Signal Transduction, Action! Kluwer Academic Publishers. 2004.
6. Ambrose, M. J., & Purugganan, M. D. Plant Developmental Biology. Springer. 2013.
7. Salisbury, F. B., & Ross, C. W. Plant Physiology. Cengage Learning. 2019.
8. Srivastava, L. M. Plant Growth and Development: Hormones and Environment. Academic Press. 2002.
9. Stitt, M., & Francey, R. G. H. Plant Metabolism: Methods and Applications. Wiley-Blackwell. 2002.
10. Ashihara, H., Crozier, A., & Komamine, A. Eds. Plant Metabolism and Biotechnology. Wiley-Blackwell. 2004.

SBTTE-404 LAB COURSE IN PLANT METABOLISM AND DEVELOPMENT

1. Experiment based on osmosis
2. Experiment based on plasmolysis
3. Effect of time on the rate of reaction of enzyme
4. Estimations of proteins
5. Study of pollen germination by hanging/seating drop method
6. Estimation of different plant hormones from plants
7. Study of different Photosynthetic Inhibitors
8. Study of Pollen viability
9. Study of different types of Ovules
10. Separations of photosynthetic pigments
11. Study of Respiratory Quotient (R.Q,)

SEMESTER II

SBTTC-451 MOLECULAR GENETICS

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-451	Molecular Genetics	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	
SBTTC-451	Molecular Genetics	20	20	20	80	--	--	100

Course pre-requisite:
This course in molecular genetics explores the principles of gene expression, and genetic variation. This knowledge is important for understanding the mechanisms underlying molecular processes occurring within cells, including DNA replication, transcription, and translation. A prerequisite for a Molecular Genetics course includes knowledge of molecular biology. This course provides a foundation for understanding the molecular basis of cells and developmental biology.

Course Objectives:
To learn the principles of mendelian inheritance.
To understand the genome organization and gene regulation of prokaryotes and eukaryotes.

Course Outcomes:
Students will acquire laboratory skills for the isolation of genetic material.
They will learn the biochemistry of DNA and RNA.
Students will be able to analyze the gene interactions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Fundamentals of genetics**	**15**
	1.1	Principles of Mendelian inheritance and Gene interactions: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes, lethal genes.	
	1.2	Population and gene frequencies; The Hardy Weinberg Law. Genetic diseases due to defects in Autosome and Sex chromosomes.	
	1.3	Gene transfer in Prokaryotes, Recombination.	
2		**Genome organization**	**15**
	2.1	Genome organization of Prokaryotes-Bacteria and virus system.	
	2.2	Genome organization of Eukaryotes- Structure and types of chromosome, heterochromatin, eu-chromatin, nucleosome. Variation in chromosome number, chromosome structure.	
	2.3	Denaturation and Renaturation DNA, C-value paradox, Cot curve.	
3		**DNA and RNA**	**15**
	3.1	DNA as genetic material, Genome Replication in prokaryote & eukaryotes,	

		enzymes involved, replication origin and replication fork, mechanism of replication, elongation and termination.	
	3.2	DNA damage and repair mechanisms. Homologous and site-specific recombination, transposition.	
	3.3	RNA synthesis and processing, transcription factors and machinery, RNA polymerases, co and post transcriptional RNA processing. RNA transport, RNA Stability and Half-life period.	
4		**RNA and Protein synthesis and Gene regulation**	**15**
	4.1	Protein synthesis- Ribosome, Genetic code, t-RNA, initiation, elongation, termination of translation. Post translational modification of proteins.	
	4.2	Gene regulation in prokaryotes-operon concept, Lactose, Tryptophan and Arabinose. Role of cAMP and CRP in lac operon, trp operon. Catabolite repression.	
	4.3	Gene regulation in eukaryotes at transcription and translation level. Regulation of gene expression in phages, viruses, role of chromatin in gene expression and gene silencing.	
			60

Text and Reference Books:

1. Calladine, C. R. Understanding DNA: The Molecule and How It Works. Elsevier. 2004.
2. Lewin, B. Gene IX. Jones and Bartlett Publishers. 2007.
3. Simmons, M. J., & Snustad, D. P. Principles of Genetics. Wiley. 2016.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Molecular Biology of the Gene. Pearson. 2013.
5. Adams, A., Knowler, J. T., & Leader, D. P. The Biochemistry of Nucleic Acids. Chapman and Hall. 2004.
6. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. Molecular Biology of the Cell. W. H. Freeman. 2016.
7. Miglani, G. S. Developmental Genetics. I.K. International Publishing House. 2009.
8. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. Molecular Biology of the Cell. Garland Science. 2014.
9. Brown, T. A. Genome. Wiley. 2007.
10. Baig, M.M.V., Telang, S.M., & Ingle, S.S. Fundamentals of Cell and Molecular Biology. Amruta. 2018.
11. Brown, T. A. Genetics: A Molecular Approach. John Wiley & Sons. 2019.

SBTTP-451 LAB COURSE IN MOLECULAR GENETICS

1. Problems based on Gene linkage, Sex linked inheritance and Crossing over.
2. Genetic recombination (conjugation, transformation, transduction) in bacteria
3. Study of mutations, Ames test
4. Study and isolation of mutants by Replica plate technique
5. Isolation of antibiotic resistant bacteria by gradient plate method
6. Study to mutation and repair in bacteria /yeast
7. Study of spontaneous mutation by Fluctuation test
8. Isolation of genomic DNA/RNA from bacteria, animal and plant cells.
9. Isolation of plasmid DNA /Phage DNA.
10. Spectroscopic analysis of DNA/ RNA
11. Agarose gel electrophoresis.
12. Study of in vitro transcription and translation

SBTTC-452 IMMUNOTECHNOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-452	Immunotechnology	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	
SBTTC-452	Immunotechnology	20	20	20	80	--	--	100

Course pre-requisite:

Immunotechnology is a rapidly growing field that combines the principles of immunology and biotechnology to develop new treatments for diseases. Immunotechnology course requires a strong foundation in biology, chemistry, cell biology, genetics, and biochemistry.

Course Objectives:

To understand the basic concepts of the immune system and components of immune system.
To learn about vaccines and the development of vaccine technology

Course Outcomes:

Students will learn about the various components and workings of immune system.
They will acquire the techniques for the development of vaccines.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Basic Concepts**	**15**
	1.1	Basic concepts of Immune System Cells and organs of immune system, Immunity Humoral and cell mediated, Hematopoiesis and differentiation.	
	1.2	Antigens- General properties, types, epitope, hapten, adjuvant.	
	1.3	Antibodies- Types, biological functions. Biology of Superantigen. BCR & TCR (structure & properties), MHC Antigen processing and presentation Maturation and Activation of B-cells Maturation and Activation of T-cells	
2		**Complement system and Vaccine**	**15**
	2.1	Complement system; complement activation pathways, biological consequences of complement activation.	
	2.2	Hypersensitivity: Components, Mechanisms of degranulation, Mediators, Consequences, Transfusion reactions, Localized reactions, generalized reactions, Delayed type hypersensitivity	
	2.3	**Vaccine** technology and recombinant vaccines, Identifications of B and T epitopes for vaccine development. *in situ* characterization of cells in tissues. Hybridoma technology, monoclonal antibody production and applications. Catalytic antibodies, FACS.	

3		**Autoimmunity**	**15**
	3.1	Autoimmunity: Organ specific autoimmune diseases (Hashimoto's thyroiditis, Autoimmune anemia, Insulin dependent diabetes mellitus)	
	3.2	Systemic autoimmune diseases (SLE, Multiple sclerosis, Rheumatoid arthritis) Treatment of autoimmune diseases	
	3.3	Transplantation Immunology: Types of graft, Specificity and memory of rejection response, Mechanisms involved in graft rejection, Clinical manifestations of graft rejection Immunity to infectious diseases, Tumor Immunology	
4		**Immunodeficiency**	**15**
	4.1	Immunodeficiency: Primary immunodeficiency (SCID, X-linked agammaglobulinemia, Defects in complement system),	
	4.2	Secondary immunodeficiency (AIDS), Treatment of immunodeficiency diseases. Immunity to Infectious Agents Bacteria Viruses Malaria Anthrax and Helminthes.	
	4.3	Immunological reactions: Precipitation. Agglutination, Radioimmunoassay, ELISA, Western Blotting, Flow cytometry and Fluorescence. Immunoelectron microscopy, RIA	
			60

Text and Reference Books:

1. Goldsby, R. A., Kindt, T. J., & Osborne, B. A. Kuby Immunology. W. H. Freeman. 2012.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. Cellular and Molecular Immunology. Elsevier. 2017.
3. Deves, R., Martin, B., Burton, D., & Roitt, I. Roitt's Essential Immunology. Wiley-Blackwell. 2017.
4. Buttarworth, C. E., & Heinemann, M. Cellular Interactions and Immunobiology. Boston Publisher. 1993.
5. Levinson, W. Review of Medical Microbiology and Immunology. McGraw Hill. 2018.
6. Tizard, I. R. Immunology: An Introduction. Saunders. 2013.
7. Hannigan, B. Immunology B. Viva Books Pvt. Ltd. 2009.
8. Joshi, K. R., & Osamo, N. O. Immunology and Serology. Student edition. Agro Botanical. 1998.

SBTTP-452 LAB COURSE IN IMMUNOTECHNOLOGY

1. Determination of ABO Blood group
2. Determination of total leukocyte count
3. Determination of differential leukocyte count
4. Determination of bleeding time & clotting time of blood.
5. Dissection and identification of thymus, spleen & lymph nodes
6. Radial immunodiffusion, double diffusion
7. Study of Ag-Ab reactions Widal, VDRL
8. Immuno electrophoresis
9. Latex agglutination
10. ELISA, Western Blotting
11. Rocket immuno electrophoresis
12. Radioimmunoassay

SBTTC-453 PROCESS BIOTECHNOLOGY

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-453	Process Biotechnology	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	
SBTTC-453	Process Biotechnology	20	20	20	80	--	--	100

Course pre-requisite:

The requirements for a course in bioprocess technology are a strong foundation in basic biology, including courses in cell biology, microbiology, genetics, and biochemistry. The course also requires basic knowledge of fermentation, cell culture, and protein purification.

Course Objectives:

To learn the microbial techniques for the isolation, screening, preservations and maintenance of microorganisms. To become aware of the designs and types of bioreactors.

Course Outcomes:

Students will understand the various laboratory methods for the isolation and preservation of microorganisms. They will learn about the industrial use of bioreactors and also become aware of the media optimization.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		Inoculum development and Media	**15**
	1.1	Isolation, Screening, Preservations and maintenance of Microorganisms, Strain improvement, Mutagenesis, Genetic Engineering for Strain Improvement. Selection of Mutants producing improved level of Primary Metabolites with suitable Example.	
	1.2	Isolation of mutants which do not produce feedback inhibitors or repressors. Isolation of mutants which do not recognize presence of inhibitors or repressors. Modification of Permeability.	
	1.3	Media formulation & optimization its need and significance, Sterilization of media and air, exhaust air, Batch sterilization; Del factor D and Z value, Continuous Sterilization: Design and Methods, sterilization kinetics, inoculum development.	
2		**Bioreactor**	**15**
	2.1	Basic aspect of Bioreactor Designing, Types of Bioreactors, Ideal Properties of Bioreactor,	
	2.2	Body Construction, Agitator, Impeller, Baffles, etc.	

	2.3	Packed-bed reactor, Air –lift, Trickle bed, Photo bioreactors, Rotating Biological Reactors	
3		Instrumentation and Control	15
	3.1	Fluid flow and mixing, Classification of fluids, concept of Reynolds's number, Rheological properties of fermentation process (Viscosity, cell concentration, product concentration etc.)	
	3.2	Mass transfer in bioreactors (Oxygen and heat transfer). Measurement and control of Bioprocess parameters, Automation for monitoring and Control (online and offline sensors, Biosensors)	
	3.3	Use of Computers: Data logging, data analysis, and process control, Process scale up: factors involved, steps involved, Immobilization techniques for cell and enzyme	
4		**Microbial Growth Kinetics**	**15**
	4.1	Microbial growth and its kinetics (Batch & Continuous) Types of Processes- Batch, fed batch, continuous,	
	4.2	Concept of scale up of fermentation. Comparative account of batch and continuous sterilization.	
	4.3	Types of fermentation processes, Comparison between SSC and SLC, Factors affecting solid-state fermentations, Economic Applications.	
			60

Text and Reference Books:

1. Rutledge, C. R. Basic Biotechnology. Cambridge University Press. 2019.
2. Bailay, S. M., & Ollis, D. F. Fundamentals of Biochemical Engineering. Tata McGraw Hill. 2010.
3. Doran, P. M. Principles of Bioprocess Engineering. Elsevier. 2011.
4. Shuler, M. L., & Kargi, F. Basic of Bioprocess Engineering. Prentice Hall. 2001.
5. Moo-Young, M. Ed.. Comprehensive Biotechnology, Volume III. Elsevier. 2011.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. Elsevier. 2016.
7. Crueger, W., & Crueger, A. Introduction to Industrial Microbiology. Springer. 2005.
8. Casida, L. E. Industrial Microbiology. American Society for Microbiology. 2005.

SBTTP-453 LAB COURSE IN PROCESS BIO TECHNOLOGY

1. Media formulation and optimization
2. Study of Growth Kinetics of Bacteria and Yeast by turbidometry & SCP
3. Screening of industrially important microorganism- Acids, Antibiotics, Enzymes
4. Study of scale up of fermentation
5. Study of design of bioreactor
6. Determination of TDP
7. Determination of TDT and design of sterilizer
8. Study of types of fermentation process (Surface and submerged)
9. Problems based on: - Growth kinetics, fluid flow, Reynolds's number
10. Visit to fermentation Industry

SBTTE-451 ENZYMOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-451	Enzymology	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	
SBTTE-451	Enzymology	15	15	15	60	--	--	75

Course pre-requisite:
Enzymology courses are a great way to learn about the fascinating world of enzymology, which leads to careers in a variety of fields, such as medicine, research, and industry. A strong foundation in basic biology, including courses in cell biology, genetics, microbiology, and biochemistry.

Course Objectives:
To know the fundamental details of enzymes.
To learn the various methods of enzyme immobilization and enzyme kinetics.

Course Outcomes:
Students will learn about the role of enzymes in human health and their industrial applications.
They will acquire laboratory knowledge for industrial enzyme products.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Basic Concepts**	**11**
	1.1	Enzyme Classification, Characteristics of enzymes, enzyme substrate complex.	
	1.2	Concept of active centre, binding sites, stereo specificity. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory.	
	1.3	Enzyme catalysis. Factors affecting catalytic efficiency proximity and orientation	
2		**Enzyme kinetics**	**12**
	2.1	Enzyme kinetics: Michaelis – Menten Equation – form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Allosteric Reactions and regulation:	
	2.2	Protein ligand binding including measurements, analysis of binding isotherms, Cooperativity, Hill and Scatchard plots and kinetics of allosteric enzymes.	
	2.3	Enzyme regulation: Product inhibition, feedback control, enzyme induction and repression and covalent modification.	

3		**Enzyme Interactions**	**11**
	3.1	Enzyme inhibition – types of inhibitors – competitive, non-competitive and uncompetitive, their mode of action and experimental determination.	
	3.2	Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.	
	3.3	Multi-enzyme system: Occurrence, isolation and their properties: Mechanism of action and regulation of pyruvate dehydrogenase complex.	
	3.4	Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase	
4		**Enzymes Immobilization**	**11**
	4.1	Immobilized Enzymes: Relative practical and economic advantage for industrial use,	
	4.2	effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km).	
	4.3	Various methods of immobilization ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment.	
			45

Text and Reference Books:

1. Price, N. C., & Stevens, L. Fundamentals of Enzymology. Oxford University Press. 1999.
2. Dixon, M., & Webb, E. C. Enzymes. Academic Press. 1979.
3. Cornish-Bowden, A. Fundamentals of Enzyme Kinetics. Wiley-Blackwell. 2012.
4. Bisswanger, H. Enzyme Kinetics: Principles and Methods. Wiley. 2008.
5. Cook, P. F., & Cleland, W. W. Enzymes. Taylor & Francis. 2007.
6. Palmer, T., & Bonner, P. Enzymes. Woodhead Publishing. 2010.
7. Moss, D. W. Isoenzymes. Wiley-Blackwell. 2010.
8. Nelson, D. L., Cox, M. M. Lehninger Principles of Biochemistry. W.H. Freeman. 2017.
9. Alexander, R. R., & Griffith, J. M. Basic Biochemical Methods 2nd ed.. John Wiley & Sons. 1994.
10. Oser, B. L. Hawk's Physiological Chemistry. Pearson. 1983.
11. Plummer, D. T. A Textbook of Practical Biochemistry. McGraw-Hill Education. 1991.
12. Cohn and stumpt- Outline of Biochemistry- Wiley India. 2006.

SBTTE-452 LAB COURSE IN ENZYMOLOGY

1. Identification and quantitation of activity of Amylase, cellulose, invertase
2. Alkaline phosphatase (salivary/microbial/animal/plant source).
3. Determination of specific activity, in presence of activators/ inhibitors.
4. Study of effect of pH/ temperature /inhibitor on enzyme activity.
5. Separation and identification of amino acid mixture by chromatography technique.
6. Separation and identification of serum proteins by PAGE
7. Separation of proteins (hemoglobin & cytochrome c) chromatography
8. Study of Immobilization of enzymes
9. Purification of protein by ion exchange chromatography. [DEAE cellulose chromatography]
10. Determination of activity of invertase from immobilized cells of Saccharomyces cerevisiae.

SBTTE-453 NANOBIOTECHNOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-453	Nanobiotechnology	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	
SBTTE-453	Nanobiotechnology	15	15	15	60	--	--	75

Course pre-requisite:
Nanobiotechnology is a rapidly growing field that combines the principles of nanotechnology and biotechnology to develop new treatments for diseases, create new materials, and improve our understanding of the biological world. Nanobiotechnology course requires a strong foundation in biology, chemistry, and physics.

Course Objectives:
To know the use of biotechnology at nanoscale and learn the various methods for the development of nanoparticles.

Course Outcomes:
Students will understand the use of nanobiotechnology in various areas like agriculture, medicine, and the environment.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Introduction to Nano-Biotechnology**	**11**
	1.1	Introduction, The nanoscale dimension and paradigm. Types of nanomaterials and their classifications. D, 2D and 3D etc.	
	1.2	Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc.	
	1.3	Polymer, Carbon, Inorganic, Organic and Biomaterials – Structures and characteristics. Physical and Chemical Fundamentals of Nanomaterial	
2		**Nano-Biotechnology Applications**	**11**
	2.1	Proteins - Lipids - RNA and DNA Protein Targeting – Small molecule/Nanomaterial – Protein Interactions Nanomaterial-Cell interactions-	
	2.2	Manifestations of Surface Modification (Polyvalency) MRI, Imaging Surface Modified	
	2.3	Nanoparticles MEMS/NEMS based on Nanomaterials.	
3		**Biological Nanoparticles**	**12**
	3.1	Lipid Nanoparticles for Drug Delivery. Peptide/DNA Coupled Nanoparticles.	
	3.2	Inorganic Nanoparticles for Drug Delivery	
	3.3	Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/anti viral) Anisotropic and Magnetic Particles (Hyperthermia)	

4		**Applications of Nanomaterial**	**11**
	4.1	Applications of Nanomaterial in medicine	
	4.2	Applications of Nanomaterial in agriculture,	
	4.3	Applications of Nanomaterial in environment	
			45

Text and Reference Books:

1. Sheron, M., & Pande, S. Bio-Nano Technology: Concept and Applications. Ane Books, New Delhi. 2012.
2. Ratner, M., & Ratner, D. Nanotechnology. Pearson. 2010.
3. Ramsden, J. J. Nanotechnology: An Introduction. Elsevier. 2016.
4. Rotello, V. Ed.. Nanoparticles. Springer. 2013.
5. Niemeyer, C. M., & Mirkin, C. A. Nano-Biotechnology. Wiley-VCH. 2004.
6. Pradeep, T. Nano: The Essentials. McGraw-Hill Education. 2007.
7. Boisseau, P., Houdy, P., & Lahmani, M. Nanoscience: Nano-biotechnology and Nano-biology. Springer. 2007.
8. Lindsay, S. M. Introduction to Nanoscience. Oxford University Press. 2009.
9. Krueger, A. Carbon Materials and Nanotechnology. Wiley-VCH. 2012.
10. Kulkarni, S. K. Nanotechnology 3rd Edition. 2019.
11. Fulekar, M. H. Nanotechnology: Importance and Applications. IK International Publishing. 2010.

SBTTE-454 LAB COURSE IN NANOBIOTECHNOLOGY

1. Demonstration of techniques for isolation and synthesis of nanoparticles
2. Isolation and detection of nano particles from plant extract (silver nano particles)
3. To study antibacterial/antifungal activity of nanomaterial
4. Extraction and estimation of protein
5. Isolation of DNA from Bacteria/Plant/Animal material.
6. Spectrophotometric analysis (UV/IR) of nano particles
7. Study of IPR, Patent applications process in concern with nano materials derived from living system

SVECR-401 RESEARCH METHODOLOGY

Teaching Scheme

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SVECR-401	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	
SVECR-401	Research Methodology	15	15	15	60	--	--	75

Course pre-requisite:

The course requires prior knowledge, and a foundational understanding of biotechnology are essential to contextualizing their research and formulating relevant research questions. Basic knowledge and understanding of statistics, communicative English, and computer awareness are essential.

Course Objectives:

To familiarize the students with fundamental research concepts, such as hypothesis formulation, data collection, and data analysis. To inculcate, understand, and apply principles of research methodology learning the necessary skills to conduct rigorous and effective research in their respective fields..

Course Outcomes:

Students will develop critical thinking abilities, learn various research methods, and acquire the tools required to design and execute research projects.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1		**Introduction to Research**	**12**
	1.1	Introduction and definition of research	
	1.2	General characteristic and functions of research	
	1.3	Objectives and types of research	
	1.4	Scientific and reflective thinking	
2		**The Research Problem**	**13**
	2.1	Identification, source, and criteria for selection, characteristics of problem	
	2.2	Hypothesis: meaning. nature, function, formulation, and testing	
	2.3	Research proposal or synopsis	
	2.4	Literature review: objectives, principles, procedure, and sources	
3		**Collection and Analysis of Data**	**10**
	3.1	Data: methods of Collection and techniques	
	3.2	Qualitative and quantitative data analysis	
	3.3	Experimental data and regression analysis	
4		**The Research Report**	**10**
	4.1	Format, Process, Style, Form	
	4.2	Contents of Research Paper, Reports, and Theses	
	4.3	Ethics in publication and plagiarism	
			45

Text and Reference Books:

1. Creswell, J. W., & Creswell, J. D. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications. 2017.
2. Kumar, R. Research Methodology: A Step-by-Step Guide for Beginners. SAGE Publications.
3. Booth, W. C., Colomb, G. G., & Williams, J. M. 2008. The Craft of Research. University of Chicago Press. 2021.
4. Comstock, G. Research Ethics: A Philosophical Guide to the Responsible Conduct of Research. Routledge. 2017.
5. Alley, M. The Craft of Scientific Writing. Springer. 2019.
6. American Psychological Association APA. Publication Manual of the American Psychological Association. American Psychological Association. 2020.
7. Laake, P., Benestad, H. B., & Olsen, B. R. Research Methodology in the Medical and Biological Sciences [1st ed.]. Academic Press. 2007.
8. Kothari, C. R. Research Methodology: Methods and Techniques. New Age International. 2004.
9. Bickel, R. Methodology In The Social Sciences Multilevel Analysis for Applied Research: It's Just Regression. Guilford Press. 2007.

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