॥ 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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Academic-1 (BOS) Section

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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)

स्वामी रामानंद तीर्थ
मराठवाडा विद्यापीठ, नांदेड.

M. Sc. First Year

SUBJECT: BOTANY

(Campus School)

(As Per NEP 2020)

FACULTY OF SCIENCE AND TECHNOLOGY

Program Code: SLS-S-BOT-PG

SCHOOL OF LIFE SCIENCES
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 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.

Keeping in mind, BOS in Botany prepared the curriculum to ensure up-to-date level of understanding of plant science. Studying plant science 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 PG level, curriculum of different Indian Universities, syllabus of NET, SET, MPSC, UPSC, Forest Services 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 Botany 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 Botany.

Apart from the Fundamental and applied Core Courses, the Department Specific Elective Courses deal with Pharmacognosy, Phytochemistry and Phytotherapy, Biodiversity and Conservation, Herbal Drug Technology and Fungal Biotechnology.

The Department Specific Elective Courses which include Skill Enhancement Courses like Technology of Fruit and Vegetable Processing and Technology of Biofertilizer Production offered during this program are designed with the aim of imparting specific skills to the students which will lead to the self-employability through development of their own enterprises.

This would help students to lay a strong foundation in the field of Botany.

The courses which deal with the environment, sustainability and ethics are Biodiversity and Conservation, Taxonomy of Angiosperms and Systematics, Ecology, Plant Development and Reproduction and Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms. These courses create awareness about conservation of biodiversity and its relevance with the socio-economic and environmental aspects. It also aims to make the students aware of bioethics, legislations and acts prevalent to control the degradation of our environment.

Overall after completion of this program, students will acquire fundamental knowledge of applications in Botany and also understand that Botany is an integral part of the human life and developments.

Program Educational Objectives:

The Objectives of this program are:

PEO1: To expose the students to the diversity amongst life forms.

PEO2: To make aware of natural resources and environment and the importance of conserving the same.

PEO3: 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.

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

PEO5: To develop specific skills amongst students for self-employability and also for the development of their own enterprises.

PEO6: To develop ability for the application of the acquired knowledge in the fields of life so as to make our country self-reliant and self-sufficient.

Program Outcomes:

The Outcomes of this program are:

PO1: This program will expose the students to the diversity amongst different life forms.

PO2: This program shall also make aware the students about natural resources and environment and the importance of conserving the same.

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, industries and other organizations.

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

PO6: This shall develop ability in the students for the application of the acquired knowledge in the fields of life so as to make our country self-reliant and self-sufficient.

Program Specific Outcomes:

PSO1: This program will train and orient the students for job opportunities in Plant Biotechnology

PSO2: This program will also generate human resource for Phytochemical and Herbal Drug Industries.

Prerequisite:

Basic knowledge of B. Sc. with Botany as one of the optional subjects. The optional courses of this program are offered to the students registered for post-graduate programs. Such students should have the basic knowledge of Botany and willing to gain additional knowledge in the field of Botany.

The students seeking admission to this program should have cleared B Sc in Botany (Hons) or B Sc with Botany as one of the optional subjects with 24 credits.

Dr Saheb L Shinde

Chairman, BOS in Botany and Herbal Medicine

Swami Ramanand Teerth Marathwada University, Nanded.

Details of the Board of Studies Members in the subject Botany and Herbal Medicine 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 Saheb L Shinde Department of Botany,	Chairman	2	Dr Babasaheb S Surwase Department of Botany,	Member

	Yeshwant Mahavidyalaya, Nanded Mob 7588151967			School of Life Sciences SRTM University, Nanded Mob 9075829767	
3	Dr B D Gachande Department of Botany, Science College, Nanded Mob 8788727840	Member	4	Dr Vijay T Gorgile Department of Botany, Shahir Annabhau Sathe Mahavidyalaya, Mukhed, Dist -Nanded. Mob 9421762073	Member
5	Dr Sudhakar V Chate Department of Botany, Shivaji Mahavidyalaya, Udgir, Dist Latur. Mob 8421241300	Member	6	Dr Suresh M Telang Department of Botany, Yeshwant Mahavidyalaya, Nanded. Mob 9822174684	Member
7	Dr R M Kadam Department of Botany, Mahatma Gandhi Mahavidyalaya, Ahmedpur, Dist Latur. Mob 9422657976	Member	8	Dr Sopan D Dhavale Department of Botany, Shahir Annabhau Sathe Mahavidyalaya, Mukhed, Dist Nanded. Mob 9423614703	Member
9	Dr Sanjay M Dalvi Department of Botany, Shri Guru Buddhiswami Mahavidyalaya, Purna, Dist Parbhani. Mob 9921101210	Member	10	Dr Prashant Gawande, Department of Botany, SGB Amravati University, Amravati. Mob 9403622568	Member
11	Dr Bindu Maurya 07, Mangal Pravesh Building, Plot C 16, Sector 3, Airoli, Navi Mumbai. Mob 9987591561	Member	12	Dr Ambadas S Kadam, Department of Botany, DSM College, Parbhani. Mob 8329151172	Member
13	Bhanudas B Pendkar K Fertz Lab, W-4, MIDC Industrial Area, Nanded Mob 8888896710	Member	14	Dr Kanhaiya Kadam, KK Herbal Industries, Gut 252, Naleshwar Road, Limbgaon, Nanded. Mob 9420261080	Member
Invitee Members					
15	Dr V N Nathar, Department of Botany, SGB Amravati University, Amravati Mob 942262887	Member	16	Dr G B Zore Dept of Biotechnology, Central University of Rajesthan, Sindri, Rajasthan. Mob 8605632007	Member
17	Dr D P Gogle Dept of Botany, RTM Nagpur University, Nagpur Mob 8087458874	Member	18	Dr M M V Baig Dept of Botany, Yeshwant Mahavidyalaya, Nanded. Mob 9422170641	Member
19	Tamkinat Begum Mirza Saleem (UG Student), c/o Yeshwant Mahavidyalaya, Nanded Mob 9403951262	Member	20	Narlawar Shivani Sanjay c/o Science College, Nanded Mob 9146042070	Member

Swami Ramanand Teerth Marathwada University, Nanded-431606

Faculty of Science & Technology

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

Subject: M Sc Botany (Campus School of Life Sciences) (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	SBOTC-401 Biochemistry SBOTC -402 Cell and Developmental Biology SBOTC -403 Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms	SBOTE-401 Technology of Fruit and Vegetable Processing **OR** SBOTE -403Technology of Biofertilizer Production	SVECR-401 Research Methodology (3-Cr)	--		SBOTP-401 Lab Course in Biochemistry SBOTP-402 Lab Course in Cell and Developmental Biology SBOTP-403 Lab Course in Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms SBOTE-402 Lab Course in Technology of Fruit and Vegetable Processing **OR** SBOTE-404 Lab Course in Technology of Biofertilizer Production	22	44
	2	SBOTC -451 Genetics and Molecular Biology SBOTC -452 Bioanalytical Techniques SBOTC -453 Ecology, Plant Development and Reproduction	SBOTE-451 Pharmacognosy **OR** SBOTE-453 Mycology and Plant Pathology	---	SBOTX-451 (O/F/C)	--	SBOTP-451 Lab Course in Genetics and Molecular Biology SBOTP-452 Lab Course in Bioanalytical Techniques SBOTP-453 Lab Course in Ecology, Plant Development and Reproduction SBOTE-452 Lab Course in Pharmacognosy **OR** SBOTE-454 Lab Course in Mycology and Plant Pathology	22	
Exit option: Exit Option with PG Diploma in Basic Botany *(After 2024-25)*									
2	3	SBOTC -501 r DNA Technology SBOTC -502 Plant Physiology and Metabolism SBOTC -503 Taxonomy of Angiosperms and Systematics	SBOTE-501 Biodiversity and Conservation **OR** SBOTE-503 Fungal Biotechnology	--	--	Research Project SBOTR-551 (4-Cr)	SBOTP-501 Lab Course in rDNA Technology and Plant Physiology and Metabolism SBOTP-502 Lab Course in Taxonomy of Angiosperms and Systematics SBOTE-502 Lab Course in Biodiversity and Conservation **OR** SBOTE-504 Lab Course in Fungal Biotechnology	22	44
	4	SBOTC -551 Plant Biotechnology SBOTC -552 Biostatistics and Bioinformatics	SBOTE-551 Phytochemistry and Phytotherapy **OR** SBOTE-553 Herbal Drug Technology	SVECP-551 Publication Ethics (2-Cr)	--	Research Project SBOTR-552 (6-Cr)	SBOTP-551 Lab Course in Plant Biotechnology SBOTP-552 Lab Course in Biostatistics and Bioinformatics SBOTE-552 Lab Course in Phytochemistry and Phytotherapy OR SBOTE-554 Lab Course in Herbal Drug Technology	22	
Total Credits		44	12	05	03	10	14	**Total Credits 88**	

DSE indicates Department Specific Elective Course. Botany student ,in 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	
			Theory	**Practical**	**Total**	**Theory** (Hrs/Week)	**Practical** (Hrs/Week/Batch)
Major	SBOTC-401	Biochemistry	04	--	**04**	04	--
	SBOTC-402	Cell and Developmental Biology	04	--	**04**	04	--
	SBOTC-403	Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms	04	--	**04**	04	--
Elective (DSE)	SBOTE-401 SBOTE-403	Technology of Fruit and Vegetable Processing **OR** Technology of Biofertilizer Production	03	--	**03**	03	--
Research Methodology	SVECR-401	Research Methodology	03	--	**03**	03	
DSC Practical	SBOTP-401	Lab Course in Biochemistry	--	01	**01**	--	02
	SBOTP-402	Lab Course in Cell and Developmental Biology	--	01	**01**	--	02
	SBOTP-403	Lab Course in Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms	--	01	**01**	--	02
DSE Practical	SBOTE-402 SBOTE-404	Lab Course in Technology of Fruit and Vegetable Processing **OR** Lab Course in Technology of Biofertilizer Production	--	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 Marks
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/2	Total	CA	ESA	
Major	SBOTC-401	Biochemistry	20	20	20	80	--	--	100
	SBOTC-402	Cell and Developmental Biology	20	20	20	80	--	--	100
	SBOTC-403	Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms	20	20	20	80	--	--	100
Elective (DSE)	SBOTE-401 **OR** SBOTE-403	Technology of Fruit and Vegetable Processing **OR** Technology of Biofertilizer Production	15	15	15	60	--	--	75
Research Methodology	SVECR-401	Research Methodology	15	15	15	60	--	--	75
DSC Practical	SBOTP-401	Lab Course in Biochemistry	--	--	--	--	05	20	25
	SBOTP-402	Lab Course in Cell and Developmental Biology	--	--	--	--	05	20	25
	SBOTP-403	Lab Course in Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms	--	--	--	--	05	20	25
DSE Practical	SBOTE-402 **OR** SBOTE-404	Lab Course in Technology of Fruit and Vegetable Processing **OR** Lab Course in Technology of Biofertilizer Production	--	--	--	--	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	SBOTC-451	Genetics and Molecular Biology	04	--	**04**	04	--
	SBOTC-452	Bioanalytical Techniques	04	--	**04**	04	--
	SBOTC-453	Ecology, Plant Development and Reproduction	04	--	**04**	04	--
Elective (DSE)	SBOTE-451 SBOTE-453	Pharmacognosy **OR** Mycology and Plant Pathology	03	--	**03**	03	--
On Job Training / Field Project / Case Study	SBOTX-451	On Job Training (O) / Field Project (F) / Case Study (C)	--	03	**03**	--	03
DSC Practical	SBOTP-451	Lab Course in Genetics and Molecular Biology	--	01	**01**	--	02
	SBOTP-452	Lab Course in Bioanalytical Techniques	--	01	**01**	--	02
	SBOTP-453	Lab Course in Ecology, Plant Development and Reproduction	--	01	**01**	--	02
DSE Practical	SBOTE-452 SBOTE-454	Lab Course in Pharmacognosy **OR** Lab Course in Mycology and Plant Pathology	--	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 Marks
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/2	Total	CA	ESA	
Major	SBOTC-451	Genetics and Molecular Biology	20	20	20	80	--	--	100
	SBOTC-452	Bioanalytical Techniques	20	20	20	80	--	--	100
	SBOTC-453	Ecology, Plant Development and Reproduction	20	20	20	80	--	--	100
Elective (DSE)	SBOTE-451 SBOTE-453	Pharmacognosy **OR** Mycology and Plant Pathology	15	15	15	60	--	--	75
On Job Training / Field Project / Case Study	SBOTX-451	On Job Training (O) / Field Project (F) / Case Study (C)	--	--	--	--	15	60	75
DSC Practical	SBOTP-451	Lab Course in Genetics and Molecular Biology	--	--	--	--	05	20	25
	SBOTP-452	Lab Course in Bioanalytical Techniques	--	--	--	--	05	20	25
	SBOTP-453	Lab Course in Ecology, Plant Development and Reproduction	--	--	--	--	05	20	25
DSE Practical	SBOTE-452 SBOTE-454	Lab Course in Pharmacognosy **OR** Lab Course in Mycology and Plant Pathology	--	--	--	--	05	20	25

SBOTC-401: Biochemistry
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-401	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	
SBOTC-401	Biochemistry	20	20	20	80	--	--	100

Course pre-requisite:

- Students should be aware of the basics of different types of Biomolecules, their functions and interactions.

Course objectives:

- To make students aware how the collection of thousands of inanimate molecules that constitute living organisms interact each other to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the non-living things.

Course outcomes: Students will be able to

1. Know the chemical constituents of cells, the basic units of living organisms.
2. Explain various types of weak interactions between the biomolecules.
3. Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids and nucleic acids.
4. Correlate the structure-function relationship in various biomolecules
5. Know the role of biomolecules for orderly structures of the cells/tissues.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Chemical Foundations of Living Systems:**	15
	1.1	Molecular basis of life, Biological chemistry–Biomolecules, Bioenergetics- Entropy, Biochemical equilibria	
	1.2	Dissociation and association constants, pH and buffers	
	1.3	Interactions in biological systems: Intra and intermolecular forces, Electrostatic and hydrogen bonds, Disulfide bridges	
	1.4	Hydrophobic and hydrophilic molecules and forces, Water and weak interactions	
2.0		**Amino Acids and Proteins**	15
	2.1	Amino acids as building blocks of proteins, their structure, classification and chemical properties	
	2.2	Non- protein organic amino acids	

	2.3	Structure of peptide bond	
	2.4	Organizational levels of protein structure; alpha- helix, beta pleated sheet, Ramachandran Plot.	
3.0		**Nucleic Acids and Porphyrins**	15
	3.1	Structure and properties of nucleic acid bases, nucleosides and nucleotides	
	3.2	Biologically important nucleotides	
	3.3	Physical and chemical properties of RNA/DNA	
	3.4	Hydrolysis of nucleic acids. Structure, properties and classification of porphyrins	
4.0		**Carbohydrates and Lipids**	15
	4.1	Carbohydrates: Classification, monosaccharide – structures and function; reactions of monosaccharides- mutarotation, glycoside formation, reduction and oxidation, epimerization and Esterification, important monosaccharides and disaccharide	
	4.2	Polysaccharides-Overview, structure; important polysaccharides; plant polysaccharides; Glycosaminoglycans and Glycoproteins.	
	4.3	Lipids: Fatty acids as building blocks of most lipids, their structure and properties, classification of lipids	
	4.4	General structure and function of major lipid subclasses: Acylglycerols, Phosphoglyceride, Sphingolipids, glycosphingolipids, terpenes, steroids, Prostaglandins	
		Total	60

References:

1. Nelson, D.L., Cox, M. M. and Lehninger A L (2008) Principles of Biochemistry, 5th ed. WH Freeman
2. David, E. M. (2003) Biochemistry, The Chemical reactions of Living Cells Vol. 1. 2nd Edition, Elsevier Academic Press.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2005) Biochemistry, 5th Edition, WH Freeman and Company.
4. Koolman, J. and Roehm, K. H. (2005) Color Atlas of Biochemistry, 2nd Edition, Georg Thieme Verlag, Publishers.
5. Jain, J. L., Jain, S. and Jain, N. (2005) Fundamentals of Biochemistry, S. Chand and Company Ltd.
6. Plummer, D. T. (1988) An Introduction to Practical Biochemistry, Tata McGraw-Hill Publishing Company Limited.

SBOTP-401 Laboratory course in Biochemistry

1. Calibration of instruments and verification of Beer-Lambert's Law
2. Preparation of buffer solutions
3. Determination of pK values of amino acids
4. Estimation of reducing sugars
5. Estimation of total carbohydrates, amino acids and proteins
6. Estimation of amino acids
7. Estimation of proteins
8. Qualitative tests of carbohydrates
9. Quantitative analysis of lipids
10. Quantitative analysis of nucleic acids
11. Iodine number of given oil
12. Isolation of proteins from seeds
13. Determination of Achromatic point

SBOTC-402: Cell and Developmental Biology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-402	Cell and Developmental 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	
SBOTC-402	Cell and Developmental Biology	20	20	20	80	--	--	100

Course pre-requisite:

- The students should be aware of the basics of cell and its interactions, cellular organelles and their functions. They should also be familiar with biological developmental processes and microscopy.

Course objectives:

- To provide understanding of the different microscopic techniques used to study the biology of cell.
- To understand the structure and role of various cell organelles.
- Acquire in-depth knowledge of the cellular components underlying mitotic and meiotic cell division and regulation of cell cycle.
- To have a concrete knowledge about transport and cell to cell communication in animals as well as plants.
- To provide wider perspective of cancer and its control and also developmental biology .

Course outcomes: On completion of this course, the students shall:

- Understand the structure and function of cell and its organelles. Also. acquire knowledge on cell cycle and its regulation
- Acquire the knowledge about transport and cell to cell communication in animals as well as plants.
- Acquire knowledge about causes of cancer, tumour suppressor genes and control of cancer.
- Acquire the knowledge about the developmental processes in plants and animals.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0	1	**Investigation of the Cell and Cell Organelles**	15
	1.1	**Investigating the Cell:** Cell theory, Microscope and its modifications: light, phase contrast, fluorescence, scanning and transmission electron microscopy.	
	1.2	**Cell Organelles:** Cell wall: Structure and functions; Plasma membrane: Molecular organization and functions; Vacuole: Tonoplast membrane, transporters, storage organelle; Glyoxysomes and peroxisomes: Structure, enzymes and functions	
	1.3	Golgi complex: Organization, role in storage and secretion; Cytoskeleton: Composition and organization of microtubules and microfilaments, role in cell division and mobility, intracellular motility; Lysozymes: Enzymes and role	
	1.4	Nucleus: structure, organization and regulation of nuclear pore complex, Role of Sarcoplasmic Reticulum in muscle contraction; Melanosomes, E/R etc.	
2.0		**Transport across membranes, Cell interactions and Energy transactions**	15
	2.1	Transport across membrane:Cell and transport processes, simple diffusion, facilitated diffusion	
	2.2	Active transport, Sodium-potassium pump, proton pump, transport into prokaryotic cells, endocytosis and exocytosis.	
	2.3	Cell Interactions: Extracellular matrix of animal cells, cell-cell recognition and adhesion, cell junctions.	
	2.4	Energy transaction: Role of mitochondria and chloroplast in energy transaction.	
3.0		**Cell Signalling, Cell division, Cell cycle and Cancer Biology**	15
	3.1	**Cell Signalling:** Hormones and their receptors, Cell surface receptors, Signalling through G-protein coupled and protein kinase associated receptors	
	3.2	Signal transduction pathways, Second messengers, Bacterial and plant two component signalling systems, Bacterial chemotaxis and quorum sensing, Signal transduction induced by auxins and GA in plants.	
	3.3	**Cell division and cell cycle:** Mitosis, meiosis, their regulation, steps in cell cycle and control of cell cycle.	
	3.4	**Cancer:** Normal cells and cancer cells, Causes, Genetic arrangements in progenitor cells, Oncogenes, Tumour suppressor genes, Cancer and cell cycle, virus induced cancer, Metastasis, interaction of cancer cells with normal cells, Therapeutic interventions of uncontrolled cell growth.	
4.0		**Apoptosis, Morgphogenesis and Organogenesis in Plants and Animals**	15
	4.1	**Apoptosis:** Role of different genes, Cell organelles during apoptosis, Genetic control of apoptosis.	
	4.2	**Morphogenesis and Organogenesis in Plants:** Organization of shoot and root apical meristem, shoot and root development, Flower induction, development and its regulation in *Arabidopsis.*	
	4.3	**Morphogenesis and Organogenesis in Animals:** Determination and differentiation of cells, axes and pattern formation in *Drosophila*	
	4.4	Organogenesis: Limb development and regeneration in vertebrates.	

		Differentiation of neurons.	
		Total	60

References:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. (1994) Molecular Biology of Cell, Garland Publishing Company, New York and London.
2. Darnell, J., Lodish, H. and Baltimore, D. (1990) Molecular Cell Biology by Scientific American Books, New York.
3. Backer, W. M., Kleinsmith, L. J. and Hardin, J. (2004) The World of the Cell by Pearson Education, Menlo Park, CA: Benjamin/Cummings.
4. Gerald Karp (1996) Cell and Molecular Biology by McGraw Hill Publishing Company, New York.
5. David, E. and Sadava (1992) Cell Biology – Organelle Structure and Function by Bostan and Bartlett publisher.
6. Loewy, A. G., Siekevitz, P., Manniger, J. R. and Gallant, J. (1991) Cell Structure and Function (An integrated Approach), Saunders college Publishing house.
7. Kleinsmith, L. J. (1995) Principles of Cell and Molecular Biology, Harper Collins College publishers, New York.
8. Philip, S. and Donald, B. (1997) Cell and Molecular Biology, John Wiley and Sons.
9. Harrmann, R. G. and Wien (1992) Cell Organells by Springer Verlag.
10. Gilbert S F (2000) Developmental Biology, Sinauer Associates Inc.

SBOTP-402 Lab Course in Cell and Developmental Biology

1. Microscopy
2. Demonstration of phenomenon of osmosis through a cell membrane.
3. Isolation of chloroplasts from spinach leaves.
4. Demonstration of Hill reaction to measure intactness of chloroplasts.
5. Isolation of mitochondria and mitochondrial swelling.
6. Isolation of mitochondria and activity of its marker enzyme, succinate dehydrogenase (SDH).
7. Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
8. Study of mitosis.
9. Study of meiosis.
10. Induction of polyploidy using colchicine treatment.
11. Isolation of lysosomal fraction and estimation of acid phosphatase activity.
12. Study of Karyotyping and ideogram.
13. Orcein and feulgen staining of salivary gland chromosomes of chironomas and *Drosophila.*
14. WBC count.
15. Sub-cellular fractionation and marker enzymes.
16. Microtomy
17. Visit to National Level institutes undertaking studies in cell and molecular biology.

SBOTC-403: Biology and Diversity of Algae, Bryophytes, Petridophytes and Gymnosperms
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-403	Biology and Diversity of Algae, Bryophytes, Petridophytes and Gymnosperms	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	
SBOTC-403	Biology and Diversity of Algae, Bryophytes, Petridophytes and Gymnosperms	20	20	20	80	--	--	100

Course pre-requisite:

- The students should possess the knowledge of morphological features and diversity in Algae, Bryophytes, Pteridophytes and Gymnosperms.

Course objectives:

- To understand diverse groups of organisms such as Algae, Bryophytes, Pteridophytes and Gymnosperms.
- To impart detailed knowledge of diverse groups of organisms in the form of their habits and habitats, characters, classification and Economic/ Ecological importance.

Course outcomes: Students will be able to

- This paper introduces several key markers to identify the Algae, Bryophytes, Pteridophytes and Gymnosperms.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Algae**	15
	1.1	Algae in diversified habitats (Terrestrial, freshwater, marine), thallus organization, cell structure, reproduction (Vegetative, asexual, sexual), pigments, reserve food, flagella	
	1.2	Classification of Algae, salient features of Protochlorophyta, Chlorophyta, Charophyta	

	1.3	Salient features of Xanthophyta, Bacillariophyta, Pheophyta and Rhodophyta	
	1.4	Algal blooms, Economic importance of algae- Algal biofertilizers, algae as food, feed and uses in industry	
2.0		**Bryophytes**	15
	2.1	Distribution, morphology, structure, reproduction, life cycle of Bryophytes	
	2.2	Classification, Phylogeny, economic and ecological importance of Bryophytes	
	2.3	General account of Marchantials, Junger-manials, Anthocerotales	
	2.4	General account of Sphagnales, Funariales and Polytrichales	
3.0		**Pteridophytes**	15
	3.1	Morphology, anatomy, reproduction, classification of Pteridophytes	
	3.2	Evolution of Stele, heterospory and origin of seed habit in Pteridophytes	
	3.3	General account of fossil pteridophytes, Introduction of Psilopsida	
	3.4	Introduction of Lycopsida, Sphenopsida and Pteropsida.	
4.0		**Gymnosperms**	15
	4.1	General characters, distribution, classification of Gymnosperms	
	4.2	Brief account of Pterdospermales, general account of cycadeoidales and corditales	
	4.3	Structure, reproduction and phylogeny in Cycadales, Ginkgoales, and Coniferales	
	4.4	Structure, reproduction and phylogeny in Ephedrales and Gnetales, Affinities with angiosperms, Applied aspects of Gymnosperms.	
		Total	60

References:

1. Kumar, H. D. (1988) Introduction phycology, Affiliated East West press Ltd., New Delhi.
2. Morris, I. (1986) An Introduction to the algae, Cambridge University Press, U. K.
3. Parihar, N. S. (1991) Bryophyta, Central Book Depot, Allahabad.
4. Puri, P. (1980) Bryophytes, Atmaram and Sons, Delhi.
5. Round, F. E. (1986) The biology of algae, Cambridge University Press, Cambridge.
6. Sporne, K. K. (1991) The Morphology of pteridophytes, B. I. Publishing Pvt. Ltd. Bombay.
7. Stewart, W. N. and Rathwell, G. W. (1993) Paleobotany and evolution of Plants, Cambridge university press, Cambridge.
8. Bhatnagar, S. P. and Moitra, A. (1996) Gymnosperms, New Age International Pvt. Ltd., New Delhi.

SBOTP-403 Lab Course in Biology and Diversity of Algae, Bryophytes, Pteridophytes & Gymnosperms

1. Microscopic and macroscopic observations with labelled sketches of the following types.

a) Algae:-i) Cholorophyta:- *Volvox, Chlorella, Oedogonium, Spirogyra, Zygnema* etc. ii) Charophyta:- *Chara, Nitella* etc. iii) Cyanophyta:- *Nostoc, Anabaen*a etc. iv) Pheophyta:- *Ectocarpus* v) Xanthophyta:- *Voucheria* vi) Rhodophyta:- *Batrachospermum, Polysiphonia* etc.

b) Bryophyta:- *Riccia, Marchantia, Anthoceros* etc.

c) Pteridophyta:- *Psilotum, Lycopodium, Equisetum, Selaginella* etc.

d) Gymnosperm:- *Cycus ,Pinus, Gnetum, Araucaria , Ephedra* etc.

2. Study of fossil specimens:-Compression, Impressions, Petrification.
3. Separation of algal Pigments by chromatography.
4. Microscopic measurement of the algae.
5. Camera lucida drawings of some microscopic plants.
6. Collection, Preservation and Submission of material along with excursion/ field report.

SBOTE-401: Technology of Fruit and Vegetable Processing
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTE-401	Technology of Fruit and Vegetable Processing	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	
SBOTE-401	Technology of Fruit and Vegetable Processing	15	15	15	60	--	--	75

Course pre-requisite:

- The students opting for Technology of Fruit and Vegetable Processing should be familiar with different types of edible fruits and vegetables and their processed products

Course objectives:

- To impart knowledge of basic principles in fruit and vegetable processing.
- To impart knowledge of different methods of fruits and vegetable processing.
- To impart the knowledge about Food safety regulations like National Food Law (FSSA) and Other Food Laws.
-

Course outcomes: On completion of this course-

- Students shall acquire training in processing technology of fruit and vegetable based products. Students shall also acquire knowledge about Food Safety Regulations. Over all, they will get opportunities in Food Technological Industries as well as they shall be able to start their own enterprises for self-employment.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Introduction**	11
	1.1	Importance of fruits and vegetables, Production and processing scenario of Fruits and vegetables in India and world.	
	1.2	Scope of fruit and vegetable processing industry in India- present status, constraints and prospective.	

	1.3	Principles and Methods of Preservation: Low temperature, High Temperature	
	1.4	Use of chemical preservatives, Irradiation, Drying/Dehydration, Removal of air etc	
2.0		**Fruits beverages, jams, jellies marmalades, candies, toffee and bars**	12
	2.1	Fruits beverages: Introduction, Processing of fruit juices (selection, juice extraction, deaeration, straining, filtration and clarification)	
	2.2	Fruits beverages: preservation of fruit juices (pasteurization, chemically preserved with sugars, freezing, drying, carbonation), processing of squashes, cordials, nectars, concentrates and powder.	
	2.3	Jams and jellies: Jam: Introduction, constituents, selection of fruits, processing & technology, Jelly: Essential Constituents (Role of pectin, ratio), Processing & technology, defects in jelly	
	2.4	Marmalades, candies, toffee and bars: Marmalade: Types, processing & technology, defects. Candy: Processing and Technology. Fruit Toffee and Bars: Processing & technology.	
3.0		**Pickles, chutneys and sauces and dehydration**	11
	3.1	Pickles: Processing, Types, Causes of spoilage in pickling.	
	3.2	Tomato products: Selection of tomatoes, pulping & processing of tomato juice, tomato puree.	
	3.3	Tomato products: Processing of paste, ketchup, sauce and soup.	
	3.4	Dehydration of foods and vegetables : Sun drying & mechanical dehydration, process variation for fruits and vegetables, packing and Storage	
4.0		**Food safety regulations**	11
	4.1	National food law (FSSA), standards and regulations • Global Scenario • Other laws and standards related to food	
	4.2	Food additives and contaminants	
	4.3	Hygiene and sanitation	
	4.4	HACCP	
		Total	45

References:

1. Girdharilal, Siddappaa, G. S. and Tandon, G.L. (1998) Preservation of fruits & Vegetables, ICAR, New Delhi.
2. Crusess, W. B. (2004) Commercial Unit and Vegetable Products, W.V. Special Indian Edition, Pub: Agrobios India.
3. Manay, S. and Shadaksharaswami, M. (2004) Foods: Facts and Principles, New Age Publishers.
4. Ranganna, S. (1986) Handbook of analysis and quality control for fruits and vegetable products, NTS.
5. Srivastava, R. P. and Kumar, S. (2005) Fruit and Vegetable Preservation Principles and Practices International Book Distributing Company, New Delhi.
6. Khader (2000) Preservation of Fruits and Vegetables. Indus Publishing, New Delhi
7. Lal, G. S., Siddappa, G. S. and Tandan, G. L. (1996) Preservation of Fruits and Vegetable, ICAR Publication, New Delhi.
8. Sinha, N. and Hui, Y. H. (2010) Handbook of Fruit and Vegetable Processing, John Wiley and Sons,
9. M.G. Danthy (2000) Fruit and Vegetable Processing .FAO, Rome
10. Singh, I. S. (2000)Post harvest Handling and Processing of Fruit and Vegetable.

11. Salunkhe, D. K. and Kadam, S. S. (1995) Handbook of Fruit Science &Technology: Production, Composition and Processing, Marcel Dekker.

SBOTE-402 Lab Course in Technology of Fruit and Vegetable Processing

1. Preparation of RTS beverage e.g. Amala, Mango and Pineapple etc
2. Preparation of jam/ jelly from selected fruit
3. Preparation of squash
4. Preparation of fruit candy
5. Preparation of fruit leather
6. Preparation of fruit toffee
7. Preparation of pickle
8. Preparation of banana and potato wafers
9. Estimation of total soluble solids (TSS).
10. Estimation of pH and acidity of products.
11. Estimation of Brix: acidity ratio
12. Estimation of ascorbic acid and effect of heat treatment on it.
13. Dehydration of fruits and vegetables.
14. Visit to fruit and vegetable processing units

SBOTE-403: Technology of Biofertilizer Production
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTE-403	Technology of Biofertilizer Production	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	
SBOTE-403	Technology of Biofertilizer Production	15	15	15	60	--	--	75

Course pre-requisite:

- The students opting for Technology of Bio-fertilizer Production should be familiar with different types of beneficial microorganisms and their role in enhancing plant productivity.

Course objectives:

- To impart knowledge about basic principles of Biofertilizer production.
- To acquaint the students with knowledge on various methods of Biofertilizer application.

Course outcomes:

- On completion of this course, the students shall acquire knowledge in Biofertilizer production. They shall develop scientific skills in the field of Biofertilizers. Over all, they will get opportunities in Biofertilizer Industries as well as they shall be able to start their own enterprises for self employment.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0			11
	1.1	Biofertilizer Types: Introduction, Commercial history-*Rhizobium, Azotobacter*	
	1.2	*Azospirillum,* Cyanobacteria, Azolla, PSM, AM fungi.	
	1.3	Silicate solubilizing bacteria (SSB), Plant Growth Promoting Rhizobacteria (PGPR)	
	1.4	Constraints in Biofertilizer technology, Cost and availability of Biofertilizers, Benefits and Characteristics of Liquid biofertilizers.	

2.0			12
	2.1	Maintenance and Preparation of Biofertilizer: Culturing of microbes, preparation of inoculums, processing and preparation of carrier material, mass production, packaging and storage, Concept & its need in organic farming , treatment.	
	2.2	*Rhizobium* Biofertilizer : Characteristics, Host-Rhizobium interactions, N2-fixation in root-nodules, Production , Methods of application.	
	2.3	*Azotobacter* Biofertilizer : Characteristics, N2-fixation process, Production, Methods of application	
	2.4	*Azospirillum* Biofertilizer: Characteristics, Association with plants, Production, Methods of application.	
3.0			11
	3.1	Azolla Bio fertilizers: Azolla: Characteristics , Production , Methods of application	
	3.2	BGA: Characteristics, N2-fixation process, Production , Methods of application	
	3.3	AM Biofertilizer: Characteristics & types of association	
	3.4	Production and Methods of application of AM Biofertilizers	
4.0			11
	4.1	PSB Biofertilizer (Phosphate solubilizing Bacteria) : Mechanism of phosphate solubilization,	
	4.2	Production and Methods of application of PSB	
	4.3	Quality control of Biofertilizers as per FCO (Fertilizer Control Order) : Introduction of FCO specifications for bio fertilizers , Sampling procedure, Methods of analysis,	
	4.4	Standards of biofertilizers , Biostability of Biofertilizers.	
		Total	45

References:

1. SubbaRao NS (1982) Advance in Agriculture Microbiology, Mohan Primlani, Oxford and IBH Publishing Co., 66 Janpeth, New Delhi 110001.
2. Rangaswami G, Bagyaraj DJ (2005) Agricultural Microbiology, Prentice-Hall of India Private Limited, New Delhi 110001.
3. Kannaiyan S, Kumar K, Govindarajan K (2010) Biofertilizer Technology, Scientific Publishers, India.
4. Sharma AK (2002) Biofertilizers for Sustainable Agriculture, Published by Agrobios (India), New Delhi.
5. Fertilizer Control Order(1985) amended up to June, 2011, Ministry of Agriculture, New Delhi.

SBOTE-404 Lab Course in Technology of Biofertilizer Production

1. Isolation & preparation of bacterial fertilizer
   a) *Azotobacter*
   b) *Azospirillum*
2. Isolation and preparation of symbiotic biofertilizer: *Rhizobium*
3. Isolation of Phosphate solubilizing bacteria from soil.

4. Isolation and identification of AM fungi from soil and preparation of biofertilizer.
5. Determination of heterocyst frequency of blue-green bacteria.
6. Quality control of microbial inoculants
7. Estimation of total nitrogen by Kjeldahl digestion method/ Determination of N concentration by indophenol method.
8. Determination of total nutrient content by spectrophotometric method
9. Evaluation of the P-solubilising capability of microorganisms
10. Estimation of Nitrogenase activity by acetylene reduction assay
11. Colorimetric estimation of amino-N and nitrate-N.
12. Preparation of biofertilizer carrier materials a. Preparation of materials, b. Irradiation (sterilization), c. Confirmation of sterilization effect, d. Inoculation of microorganisms to carrier.
13. Collection and preservation of root nodules in field trips

SVECR-401 Research Methodology
Teaching Scheme

Course Code	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:

- Basic knowledge of Biology and a strong foundation in biological sciences, including Molecular Biology, Genetics, and Biochemistry.

Course objectives:

- To familiarize students with the principles and concepts of research methodology in the field of Botany and other Biological Sciences.
- To develop critical thinking and analytical skills necessary for designing research experiments, formulating research questions, and selecting appropriate methodologies.
- To enhance students' understanding of various research methodologies, including experimental design, data collection and analysis, statistical methods, and literature review.
- To equip students with the necessary skills to plan and execute research projects, including ethical considerations, data interpretation, and effective communication of research findings.

Course outcomes: Students will be able to

- Demonstrate a comprehensive understanding of the principles and significance of research methodology in Botany and other Biological Sciences, including the ability to critically evaluate scientific literature and identify research gaps.
- Apply appropriate experimental design and statistical methods for data collection and analysis, and effectively interpret research results.
- Develop skills in planning and executing research projects, including the ability to formulate research questions, select and apply appropriate research methodologies, and manage research timelines and resources.
- Communicate research findings effectively through written reports, presentations, and scientific discussions, demonstrating proficiency in scientific writing and oral communication skills.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0	1	**Introduction to Research Methodology**	11
	1.1	Definition and nature of research	
	1.2	Types of research (basic, applied, quantitative, qualitative, mixed-methods)	
	1.3	Research process (problem identification, research design, data collection, data analysis, interpretation, and reporting)	
	1.4	Research ethics and Plagiarism, Literature review and referencing	
2.0	2	**Research Design and Data Collection**	11
	2.1	Research problem and hypothesis formulation	
	2.2	Sampling techniques and sample size determination	
	2.3	Data collection methods (observation, interview, questionnaire, survey, case study, experimental, and archival research)	
	2.4	Research instruments (questionnaire, interview schedule, observation checklist), Reliability and validity of research instruments	
3.0	3	**Data Analysis and Interpretation**	12
	3.1	Data editing, coding, and entry	
	3.2	Descriptive statistics (measures of central tendency, variability, and correlation)	
	3.3	Inferential statistics (hypothesis testing, t-test, ANOVA, regression analysis, chi-square test)	
	3.4	Qualitative data analysis (content analysis, thematic analysis, discourse analysis), Interpretation of research findings	
4.0	4	**Scientific Writing and Communication**	11
	4.1	Research report writing (structure, format, and style)	
	4.2	Citation and referencing (APA, MLA, Harvard, etc.)	
	4.3	Writing research proposals and abstracts	
	4.4	Presentation skills (oral and poster presentations), Publication ethics and peer review	
		Total	45

1. Kumar R (2018) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Publication, California, USA.
2. Kothari CR, Garg G (2019) Research Methodology: Methods and Techniques, New Age International Publishers, India.
3. Kumar U, Dubey B, Kothari DP (2022) Research Methodology, Techniques and Trends, Chapman and Hall/CRC, New York.
4. Frankfort-Nachmias C, Nachmias, D (1996) Research Methods in the Social Sciences. St. Martin's Press, New York.
5. Creswell JD, Creswell JW (2017) Research Design: Qualitative, Quantitative and Mixed Methods Approaches, SAGE Publication, California.

SEMESTER II

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-451	Genetics and Molecular Biology	04	--	04	--	04

SBOTC-451: Genetics and Molecular Biology
Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBOTC-451	Genetics and Molecular Biology	20	20	20	80	--	--	100

Course pre-requisite:
- The students should be familiar with the fundamentals of Genetics and Nucleic acids

Course objectives:
- To understand concept of Mendelian and post Mendelian of Genetics.
- To understand genome organization, genome duplication and genome function in Viruses, Prokaryotes and Eukaryotes.

Course outcomes: Students will know the
- Fundamentals of Mendelian and post-Mendelian Genetics.
- Genome (viral, prokaryotic and eukaryotic) organization, duplication and function.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Fundamentals of Genetics**	15
	1.1	Review of basic terminologies (Allele, multiple alleles, pseudoallele, complementation tests) and principles of Mendelian (Dominance, segregation, independent assortment) and post Mendelian genetics (Codominance, incomplete dominance, gene interactions, pleiotropy), genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Maternal inheritance.	
	1.2	Overview of human genetics (Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders). Quantitative genetics. Population genetics.	

	1.3	Structural and numerical aberrations of chromosomes, linkage maps, tetrad analysis, recombination, sex determination.	
	1.4	Introduction to Microbial genetics (Transformation, Conjugation, Transduction), Mutation, Focus of genetic studies as a platform for advances in molecular biology.	
2.0		**DNA Structure and Genome Organization**	15
	2.1	DNA structure and topology. Physical properties of DNA : Tm, hypo and hyper chromicity, solubility, mutarotation and buoyancy.	
	2.2	Organization of Viral, Prokaryotic and Eukaryotic genome (Structure of chromatin, nucleosome, chromatin organization, chromosome, centromere, telomere. General organization (size, banding, microsatellites, Gene distribution and density) of plant (rice) and animal (human) genome including their organelle genomes,	
	2.3	Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes. Overlapping genes, genes within genes, gene families, pseudo genes, truncated genes and gene fragments. Operon, Fine structure of gene (r-II locus), fine structure analysis of gene (complementation and recombination).	
	2.4	Techniques and Technology involved in genome mapping low and high resolution mapping; Strategies and milestones in mapping and sequencing of human genome approaches to physical and genetic mapping. Next generation sequencing: principles and platforms. Principles and strategies for identifying unknown disease or susceptibility genes. Major genomic databases, Glimpses and significance of the recently sequenced genomes of organisms.	
3.0		**DNA Replication and Repair**	15
	3.1	DNA Replication models, DNA replication mechanism (Prokaryotes/eukaryotes). RNA world and RNA Replication.	
	3.2	DNA modifying enzymes: DNA polymerases: types and mechanism of action.	
	3.3	DNA damage and repair and recombination: mechanisms and structure and functions of enzymes involved. RNA Polymerases and reverse transcriptase: structure and mechanisms of action.	
	3.4	DNA methyl transferases, Topoisomerase, Gyrase, Nucleases etc. Types, mechanisms, and significance of mutations.	
4.0		**Regulation of Gene Expression**	15
	4.1	Chromatin structure and remodeling. Regulation of gene expression at chromatin level. Epigenetics: Genome imprinting, DNA methylation, Acetylation, Chromosome inactivation and sex determination.	
	4.2	Gene silencing, RNA interference. Homeotic gene expression and pattern formation in plants and animals. Oncogenes and proto oncogenes.	
	4.3	Transcription in pro and eukaryotic organisms and transcription factors. Regulation of gene expression at transcriptional level (Phages, viruses, prokaryotic and eukaryotic genes). RNA processing: capping, polyadenylation, splicing, editing and transport of RNA.	
	4.4	Structure and functions of ribonucleoproteins. Translation in pro and eukaryotic organisms and its regulation. Genetic code and factors. Translational proofreading, translational inhibitors. Post translational modifications.	
		Total	60

References:

1. Birge, E. A. (2006) Bacterial and Bacteriophage Genetics. 5th Edition. Sriger Publications
2. Klug, W. S., Spencer, C. A. and Palladino, M. A. (2009) Concepts of Genetics, 9th edition, Pearson.
3. Dale, J. W. and Park, S. F. (2005) Molecular Genetics of Bacteria 4th Edition Wiley and Sons Inc.
4. Freifelder, D. (2005) Moleular Biology. 2nd Edition. Narosa Pub. House.
5. Lewin, B. (2008)- Genes IX. Jones and Barlettle Publications.
6. Griffiths AJF, Wessler SR, Lewontin RC, Carroll SB (2008) Introduction to Genetic Analysis, 9thEdition , WH Freeman Company, New York.
7. Weaver RF (2012) Molecular Biology, 5th Edition, The McGraw-Hill Companies, USA.
8. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2002) Molecular Biology of the Cell, 4th edition, Garland Science, New York.
9. Watson JD, Tania AB, Stephen PB, Alexander G, Michael L, Richard L (2017) Molecular Biology of the Gene, Pearson Education, California.
10. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2002) Molecular Biology of the Cell, 4th edition, Garland Science, New York.
11. Snustad DP, Simmons MJ (2015) Principles of Genetics, 7th Edition, published by Wiley.
12. Speicher M, Antonarakis SE, Motulsky AG (2009) Vogel and Motulsky's Human Genetics: Problems and Approaches, Springer, Germany.
13. Speicher, M., Antonarakis, S. E., Motulsky, A. G. (1997) Problems and Approaches 3rd edition and 4th edition (revised2009).
14. Read, A. and Donnai, D. (2007) New Clinical Genetics, Scion Publishing Ltd, UK.
15. Strachan, T. and Read, A. P. (2004) Human Molecular Genetics , 3rd Edition, Garland Science (Taylor and Francis Group), London and New York.
16. Synder, L., Champness, W. (1997) Molecular Genetics of Bacteria. ASM Press.
17. Turn, N., Trempy, J. (2006) Fundamental Bacterial Genetics. Blackwell Publishers.

SBOTP-451 Laboratory Course in Genetics and Molecular Biology

1. Use of drosophila as a model system in genetics: Life history, morphology, mutants, culture, sexing pupae for setting up crosses etc.
2. Gene interactions
3. Mutants of *Drosophila* Mono and Di-hybrid crosses in *Drosophila.*
4. Sex linked lethal genes in *Drosophila.*
5. Estimating gene frequencies in population, estimation of heterozygote frequencies, pedigree analysis.

6. Human karyotype and chromosomal aberrations.
7. Ames test for genotoxins.
8. UV mutagenesis.
9. Bacteriophage titration.
10. Bacterial transformation.
11. Bacterial conjugation.
12. Bacterial transduction.
13. Isolation of nuclei and chromatin. Determination of mononucleosomal size.
14. Chromatin gel electrophoresis.
15. Isolation of genomic DNA from different sources viz. plant, animal, yeast and bacteria.
16. Restriction digestion of genomic DNA and analysis.
17. Thermal melting of DNA.
18. Agarose gel electrophoresis of DNA.
19. Isolation of organelle genome and restriction digestion.

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-452	Bioanalytical techniques	04	--	04	--	04

SBOTC-452: Bioanalytical techniques
Teaching Scheme
Assessment Scheme

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

Course pre-requisite:
- The students should be familiar with the Instrumentation and its applications in Biology.

Course objectives:
- To impart knowledge about basic principles of Bioinstrumentation.
- To acquaint the students with knowledge on various techniques and methods of biochemical analysis.

Course outcomes: On completion of this course, the students shall:
- Demonstrate the knowledge about the techniques of Bioinstrumentation.
- Acquire knowledge in biochemical analysis.
- Shall develop scientific skills to analyse the structure of biomolecules and their functions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Separation Techniques, Chromatography and Centrifugation**	15
	1.1	Methods of separations, General principles and classification	
	1.2	Thin layer, Paper, affinity, gel permeation, ion exchange chromatography	
	1.3	GLC, HPLC, HPTLC	
	1.4	Preparative and analytical centrifugations and their applications	
2.0		**Electrophoretic techniques**	15
	2.1	Basic principles of electrophoresis, factors affecting electrophoresis, Electrophoretic mobility	
	2.2	Paper and gel electrophoresis	

	2.3	Native and denaturing PAGE	
	2.4	Iso-electric focusing, pulse field gel electrophoresis	
3.0		**Special techniques**	15
	3.1	Theory and applications of ultra violet and visible spectroscopy	
	3.2	Infrared (IR) Spectroscopy, Nuclear magnetic resonance (NMR) and applications	
	3.3	AAS, Mass (MS) Raman Spectroscopy and applications	
	3.4	Fluorescence and X-ray spectroscopy and applications.	
4.0		**Radiation and Non-Radioactive Techniques**	15
	4.1	Tracer Technology, dose response relationship, radioisotopes in diagnostic Biotechnology.	
	4.2	Geiger Muller Counter, Scintillation counter	
	4.3	Metabolic tracer techniques	
	4.4	Non-radioactive labels, labeling and detection methods using florescent molecules.	
		Total	60

References:

1. Willard,H. H., Merrit, L. L. Jr. and others (1986) Instrumental methods of Analysis 6th edition - CBS Publishers and Distributors.
2. Chatwal, G. and Anand, S. (1989) Instrumental Methods of Chemical Analysis., Himalaya Publishing House, Mumbai.
3. Williams, B. L. and Wilson, K. A (1975) Biologist's Guide to Principles and Techniques of Practical Biochemistry.
4. Straughan, B. B. and Walker Spectroscopy Volume I –, Chapman and Hall Ltd.
5. Hames BD (1998) Gel Electrophoresis of Proteins: A Practical Approach (Practical Approach Series, 197) 3rd Edition, Oxford University Press.
6. Jaines M (1988) Chromatography: Concepts and Contrasts, John Wiley and Sons Inc. Hoboken, New Jersey, USA.
7. Holme D, Peck H (1998) Analytical Biochemistry, Prentice Hall, Hoboken, New Jersey, U.S.
8. Straughan BP, Walker SD (1976) Spectroscopy, Chapman & Hall, London.
9. Gordon (1984)Practical Aspects of Gas Chromatography and Mass Spectrometry. M. Message, John, Wiley and Sons New York.
10. Tibor Kremmery -Gel Chromatography, Wiley Publications
11. Thornburn, C. C. Isotopes and Radiations in Biology. Butterworth and Co. Ltd. London
12. Chapman,J. M. and Ayrey The Use of Radioactive isotopes in the Life Sciences. George Allen and Unwin Ltd. London.

SBOTP-452 Lab Course in Bioanalytical Techniques

1. Separation of Lipids by thin layer chromatography
2. Gel filtration (Size exclusion Chromatography)
3. Separation of blue dextran and cobalt chloride on Sephadex G25
4. The separation of proteins by ion exchange chromatography
5. The separation of serum proteins by electrophoresis on cellulose acetate paper

6. Separation of sub cellular organelles by differential centrifugation
7. Separation of amino acids by paper chromatography.
8. Separation and identification of plant pigments by Thin Layer Chromatography.
9. Demonstration of HPTLC
10. Determination of absorption maxima of proteins and nucleic acids.
11. Demonstration of Giger Muller Counter (GMC)
12. Separation and identification of plant pigments by Radial Chromatography.

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTC-453	Ecology, Plant Development and Reproduction	04	--	04	--	04

SBOTC-453: Ecology, Plant Development and Reproduction

Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBOTC-453	Ecology, Plant Development and Reproduction	20	20	20	80	--	--	100

Course pre-requisite:

- Basic knowledge about living and non living components of environment and their interactions, climatic conditions and flora and fauna. The students should also know the methods of reproduction and general development in plants.

Course objectives:

- To asquint the students with various aspects of Ecology
- To understand the various aspects of plant development.
- To understand sexual incompatibility and types of endosperms

Course outcomes: After completion of this course, students shall be able:

- To understand the aspect of ecology and each phase of development of seeds and different plant parts.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Principals of ecology**	15
	1.1	Habitat and niche: Concept of Habitat and niche. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, S and P); primary production and decomposition	
	1.2	Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography;	

		bio-geographical zones of India.	
	1.3	Population Ecology: Population growth curves (r and k selection). Ecological Succession: Types and mechanisms.	
	1.4	Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches	
2.0		**Fundamentals of development:**	15
	2.1	Potency, competence, determination, commitment, specification, induction.	
	2.2	Morphogenetic gradients, cell fate and cell lineages, Formation of symmetry in plants, Juvenility and transition to adult phase, types of meristem and activities of meristem, Regulation of meristem size, lateral organ initiation from root and shoot meristems.	
	2.3	Secondary growth – cambium, gross structure of wood. Secretary tissues – Nectaries, laticifers, resin ducts.	
	2.4	Conversion from vegetative to reproductive phase– induction, morphological and histo-chemical changes in shoot apex, floral meristems.	
3.0		**Development and Pollination**	15
	3.1	Shoot Development: Organization of shoot apical meristem, tissue differentiation (Xylem and Phloem) Root development: Organization of root apical meristem, vascular tissue differentiation. Floral Development: Floral development in *Antirrhinum*	
	3.2	Development of male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen tube development and guidance.	
	3.3	Development of female gametophyte: Ovule development, megasporogenesis, organization of embryo sac and its types (mono, bi, tetra etc.)	
	3.4	Pollination and seed development: Pollination mechanism and vectors, Mechanism of pollen stigma interactions (self-incompatibility)	
4.0		**Fertilization and Embryogenesis**	15
	4.1	Double fertilization and triple fusion, role of synergids, endosperm development and imprinting	
	4.2	Seed formation and germination: Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, seedling development	
	4.3	Embryogenesis: Basic layout of dicot and monocot embryos, stages of embryo development, embryonic axis, cell division and pattern formation in embryo	
	4.4	Genetic and hormonal regulation of embryo development, cell polarity in embryo, Embryogenesis mutants.	
		Total	60

References:

1. Bhojwani, S. S., Dantu, P. K. and Bhatnagar, S. P. (2014) The Embryology of Angiosperms. (6th Edition) Vikas Pub. House. Paperback edition.
2. Bhojwani, S. S. and Soh, W. Y. (2001) Current Trends in Embryology of Angiosperms, Kluwer Academic Publishers.

3. Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015) Biochemistry and Molecular Biology of Plants. Second Edition. Wiley Blackwell.
4. Burgess, J. (1985) An Introduction to Plant Cell Development, Cambridge UniversityPress.
5. Davies, P. J. (2004) Plant Hormones, Biosynthesis, Signal Transduction, Action Springer Publications.
6. Fahn, A. (1990) Plant Anatomy (4th Edition) Pergamon Press, London, New York.
7. Gilbert, S. F. (2013) Developmental Biology (10th Edition). Sinauer Associates, Inc., Massachusetts, USA.
8. Graham, C. F. and Wareing, P. F. (1984) Developmental Control in Animals and Plants, Blackwell Scientific Publications, UK.
9. Johri, B. M. and Srivastava, P. S. (2001) Reproductive Biology of Plants. Narosa Publishing House, New Delhi.
10. Jones R., Ougham, H., Thomas, H. and Waaland, S. (2013) The Molecular Life of Plants.
11. Krishnamurthy, K. V. (1988) Methods in Plant Histochemistry, S. Viswanathan Printers & Publishers.
12. Lyndon, R. F. (1990) Plant Development The Cellular Basis. (Topics in Plant Physiology, Vol. 3) Springer Publications.
13. Leyser, O. and Day, S. (2009) Mechansims in Plant Dvelopment, Wiley Blackwell.
14. Raghavan, V. (2000) Developmental Biology of Flowering Plants, Springer Verlag.
15. Wada, M., Shimazaki, K. and Iino M. (2005) Light sensing in plants, Springer.
16. Wareing, P. F. and Philips, I. D. J. (1981) Growth and Differentiation in plants, Pergamon Press.
17. Wolpert, L., Tickle, C. and Arias, A. M. (2015) Principles of Development (5th Edition) Oxford University Press.
18. Taiz and Zeiger (1998) Plant Physiology by, Sinauer Associate Inc. Publishers.
19. Fegeri, K. and Van Der Piji L. (1979) The Principles of pollination Ecology, Pergamon Press, Oxford.
20. Fosket, D. E. (1994) Plant growth and development, A Molecular Approach academic Press, San Diego.
21. Salibury, F. B. and Ross, C. W. (1992) Plant Physiology (4th edition) Wadsworth publishing Belmont, California.
22. Sedgely, M. and Griffin, A. R. (1989) Sexual reproduction of Tree crops, Academic Press London.
23. Rana SVS (2013) Essentials of Ecology and Environmental Science, Prentice Hall India Learning Private Limited.
24. Subrahmanyam NS, Sambamurty AVSS (2006) Ecology, Alpha Science International Ltd. London.

SBOTP-453 Lab Course in Ecology, Plant Development and Reproduction

1. Random sampling to measure the abundance of various different species on an area of grassland.
2. To study communities by quadrat method and to determine % Frequency, Density and Abundance.
3. To determine the basal cover or vegetational cover of one herbaceous community by quadrate method.
4. To determine diversity indices (richness, Simpson, Shannon-Wiener) in grazed and protected grassland.

5. To determine transparency or turbidity of different water bodies.
6. To measure amount of dissolved oxygen content in polluted and unpolluted water bodies
7. Study of vascular tissues.
8. Comparative anatomy of dicot and monocot stem.
9. Study of types of trichomes, stomata and hairs.
10. Microtomy.
11. Study of T.S of anther.
12. *In vivo* germination of pollen grains on stigma.
13. Study and types of pollen grains
14. Pollen viability(Tetrazolium test) and Germination: Calculation of percentage germination in different media using hanging drop method
15. Study and types of Embryo sacs
16. Study of types of Ovules.
17. Megasporogenesis
18. Development of female gametophyte.
19. Educational tour to Sanctuaries and National park.

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTE-451	Pharmacognosy	03	--	03	--	03

SBOTE-451: Pharmacognosy
Teaching Scheme

Assessment Scheme

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

Course pre-requisite:
- The students should be familiar with the general medicinal plants and their uses.

Course objectives:
- To know the crude drugs and their chemical nature
- To carry out the pharmacognostic evaluation of crude drugs
- To know the cultivation and marketing of crude drugs.

Course outcomes: Upon completion of the course, the student shall be able
- To know different crude drugs, their evaluation, cultivation techniques, production and regulation of crude drugs.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0		**Pharmacognosy I**	11
	1.1	Definition, scope and development of Pharmacognosy, classification of drugs	
	1.2	Sources of Drugs – Plants and Animals.	
	1.3	Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilage, oleoresins and oleo- gum -resins).	
	1.4	Comparative study of IP, European Pharmacopoeia, BP/Ayurvedic Pharmacopoeia of India	
2.0		**Pharmacognosy II**	12
	2.1	Medicinal plants of Marathwada and Maharashtra: morphology,	

		distribution, characteristics of powder constituents, chemical tests and uses of following drugs.	
	2.2	Root drugs: *Asperagus, Withania.* Rhizome drugs: *Zingiber, Curcuma*	
	2.3	Stem/ Bark drugs: *Tinospora, Acacia.* Arjuna Leaf drugs: *Adhatoda, Vitex.*	
	2.4	Fruit and Seed drugs: *Mucuna, Terminalia belerica* Fruit Drug: *Coriandrum sativum* Linn	
3.0		**Evaluation of Drugs**	11
	3.1	Concept, considerations, parameters (Identity, quality and purity) and methods of quality control for medicinal plant materials as per various pharmacopoeia and other guidelines: Organoleptic (Morphological) evaluation	
	3.2	Microscopic or anatomical evaluation	
	3.3	Physical evaluation, chemical evaluation, analytical evaluation (Chromatographic techniques and spectrophotometric methods), biological evaluation (Introduction and Indication, significance, Methods of studies).	
	3.4	Presentation of data Monographs and Revisions, Synopsis. Use of GPS and computational in field work.	
4.0		**Cultivation of Drugs, Processing and Quality Control**	11
	4.1	Cultivation and Collection of drugs of natural origin.	
	4.2	Factors influencing cultivation of medicinal plants.	
	4.3	Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha and Homeopathy (AYUSH).	
	4.4	Formulation & Manufacturing, Quality Control & Analysis, Drug adulteration, type of adulterants, Regulatory Affairs.	
		Total	45

References:

1. Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015) Biochemistry and Molecular Biology of Plants. Second Edition. Wiley Blackwell.
2. Cseke, L. J., Kirakosyan, A., Kaufman P. B., Warber S., Duke J. A. and Brielman, H. L. (2006) Natural Products from Plants. 2nd Edition, CRC Press, Taylor & Francis Group.
3. Dewick, P. M. (2002) Medicinal Natural Products (A Biosynthetic Approach), 2nd Edition, John Wiley and Sons Ltd., England.
4. Evans, W. C. (2009) Trease and Evans' Pharmacognosy. Elsevier Health Sciences.
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6. Harborne, A. J. (1998) Phytochemical Methods A Guide to Modern Techniques of Plant Analysis. Third Edition. Chapman and Hall.
7. Pushpangadan, P., Nyman, U. L. F., George, V. (1995) Glimpses of Indian Ethanopharmacology. Tropical Botanic Garden and Research Centre Thiruvananthapuram, India
8. Raman N. (2006) Phytochemical Techniques. New India Publishing Agency, New Delhi, India.
9. Ramawat, K. G. and Merillon, J-M. (Editors) (2008) Bioactive Molecules and Medicinal Plants. Springer Verlag, Berlin, Heidelberg.

10. Schirmer, R.E., (2000) Modern Methods of Pharmaceutical Analysis, Vol. 1, 2. CRC Press, Boca Raton, Florida.
11. European Pharmacopoeia (Ph. Eur.) (2017) 9th Edition - European Directorate for the Quality of Medicines & HealthCare – EDQM.
12. Indian Pharmacopoeia (IP 2014) Drugs and Cosmetics Act, 1940 and Rules thereunder, 7th Edition, Indian Pharmacopoeia Commission (IPC).
13. Ramavat, K. G. and Goyal, S. (2009) Comprehensive Biotechnology. 1st Edition. S. Chand Publishing.
14. Sensen, C. W. (Editor) (2002) Essentials of Genomics and Bioinformatics, Wiley-VCH, Germany.
15. Wagner, H. and Bladt, S. (1996) Plant Drug Analysis A Thin Layer Chromatography Atlas. 2nd Edition. Springer.

SBOTE-452 Lab Course in Pharmacognosy

1. Pharmacognostic evaluation of roots of *Asparagus.*
2. Separation of alkaloids from roots of *Withania somnifera* by HPTLC.
3. Pharmacognostic evaluation of *Zingiber officinale* rhizome (Ginger) and stem of *Tinospora cordifolia.*
4. Quantitative estimation of curcumin from rhizome of *Curcuma longa.*
5. Detection of curcumin from rhizome of *Curcuma longa* using TLC.
6. Pharmacognostic evaluation of bark of *Acacia arabica* and fruits and seeds of *Mucuna prurenes.*
7. Pharmacognostic evaluation of leaves of *Adhathoda vasaka/ Vitex nugendo.*
8. Study of adulteration of leaf of Senna (*Cassia aungustifolia*) /Adulteration of Oil- Test for Neem, Karanj and Castor.
9. Chemical test for primary metabolites- Fats, Protein and Carbohydrates, (Morphology of starch grain).
10. Estimation of phenolics from plant sample.
11. Determination of antifungal activity by picrate paper method .
12. Determination of antibacterial activity by well plate method.
13. Extraction of alpha amylase from germinating seeds.
14. Determination of Km and Kmax of alpha amylase.
15. Location of plant species using Global Positioning System.
16. Field Trips: Departmental arranged one long (7 days/6 night) and four short field visits for plant collection and study of local flora.

CourseCode	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBOTE-453	Mycology and Plant Pathology	03	--	03	--	03

SBOTE-453: Mycology and Plant Pathology
Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBOTE-453	Mycology and Plant Pathology	15	15	15	60	--	--	75

Course pre-requisite:

- The students should be familiar with the plant pathogens and their interactions with the hosts.

  They should also be aware of methods of prevention of plant pathogen.

Course objectives:

- To have detailed knowledge of fungal characters and their classification.
- To have detailed understanding about pathogens causing plant diseases
- To understand the management to control diseases

Course outcomes: Upon completion of the course, the student shall be able

- To study different economically important fungi as well as pathogenic ones. Their study will help in integrated disease management.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1. 0	1	**Mycology I**	12
	1.1	General characters of fungi, substrate relationship in fungi, cell ultra-structure, unicellular and multicellular organization, cell wall composition, nutrition (saprophylic, biotrophic, symbiotic), heterothallism, heterokaryosis, parasexuality, recent trends in classification systems.	
	1.2	Salient features and life cycle of representative genera of the following	

		orders. Phylogenetic relationships of fungi. Myxomycotina: Plasmodiophorales	
	1.3	Salient features and life cycle of representative genera of the following orders. Phylogenetic relationships of fungi. Mastigomycotina: Peronosporales Zygomycotina: Entomophthorales	
	1.4	Salient features and life cycle of representative genera of the following orders. Phylogenetic relationships of fungi. Ascomycotina: Erysiphales, Eurotiales Basidiomycotina: Uredinales, Ustilaginales, Agaricales, Deuteromycotina: Moniliales	
2.0	2	**Mycology II**	11
	2.1	**Lichens:** Thallus structure, reproduction and economic importance	
	2.2	Fungi in industry as medicine, fungal toxins and diseases in humans	
	2.3	**Mushroom:** Introduction, cultivation technology, nutritional and medicinal properties of mushrooms.	
	2.4	**Mycorrhizae:** Types, Salient features, role and applications as biofertilizer and bio protector in forestry and agriculture	
3.0	3	**Fundamentals of Plant Pathology and Defence Mechanism**	11
	3.1	Mechanism of Pathogenesis, factors affecting disease development,	
	3.2	Dissemination of plant pathogens, plant quarantines.	
	3.3	Mode of infection and role of enzymes and toxins in plant diseases, Structural and biochemical defence mechanisms in plants,	
	3.4	Molecular aspects of host pathogen interactions**,** degradation of phytoalexins, systemic resistance mechanism.	
4.0	4	**Diseases of crop plants and their management**	11
	4.1	Classification of major crop plant diseases in India, Symptoms, causal organism, disease cycle and control measures of following diseases: Wheat: Rust, Smut	
	4.2	Groundnut: Tikka disease; Tur : Wilt; Sugarcane : Whip smut & Red rot;	
	4.3	Cotton : Black arm; Bhendi : Yellow vein mosaic; Brinjal : Little leaf; Citrus : Canker	
	4.4	Principles of plant disease control, cultural methods, chemical methods, Biological plant disease control.	
		Total	45

References:

Mycology:

1. Kirk, P. M., Cannon, P. F., Minter, D. W. and Stalpers, J. A. (2008) Ainsworth and Bisby's Dictionary of the fungi (10thed) by C.A.B. International, Oxon, Europe- UK.
2. Moore D, Robson GD, Anthony PJT (2011) 21st Centaury guidebook of fungi, Cambridge University Press, England.
3. John W, Roland W (2007) Introduction of Fungi, 3rd edition, Cambridge University Press, England.
4. Alexopolous J, Mims CW, Blackwell M (2007) Introductory Mycology, 4th Edition, Wiley India Pvt. Ltd.

5. Deacon JW (2006) Fungal Biology, 4th Edition, Blackwell Publishing Ltd, USA.
6. Foster MS, Wills GF, Mueller J M (2004) Biodiversity of Fungi: Inventory and Monitoring methods first edition, Academic Press.
7. Nair, L. N. (2007) Topics in Mycology and Pathology first edition, New Central Book Agency, Kolkata.
8. Singh, H. (2006) Mycoremediation: Fungal Bioremediation, First edition, John Wiley and Sons, Hoboken, New Jersey.
9. Dube , H. C. (2015) An introduction to fungi:, Scientific publisher India, fourth edition.
10. Hibbett, D. S., Binder, M., Bischoff, J. F., Blackwell, M., Cannon, P. F. and Eriksson O. E., (2007) A higher level phylogenetic classification of the Fungi, *Mycological Research* 111(5): 509–547.

Plant Pathology:

1. Agrios GN (2006) Plant Pathology, 5th Edition, Amsterdam, Netherlands.
2. Rangaswami G, Mahadevan A (1998) Diseases of Crop Plants in India, Prentice Hall India Learning Private Limited.
3. Sharma PD (2006) Plant Pathology, Narosa Publishing House, New Delhi.
4. Lucas JA (1998) Plant pathology and plant pathogens, 3rd Edition, Blackwell Science, Oxford, UK.
5. Walker JC (1957) Plant Pathology, McGraw-Hill Book Company, USA.
6. Trivedi PC (2015) Plant Pathology : Problems and Progress, Pointer Publishers, 807, Vyas Building, Chaura Rasta, Jaipur, India.
7. Mukerji KG (1992) Recent Development in Bio-Control of Plant Diseases, Aditya Books, New Delhi.
8. Wood RKS, Ballio A, Graniti A (1972) Phytotoxins in plant diseases, Published by Academic Press, USA.
9. Datta SK, Muthukrishnan S (1999) Pathogenesis-Related proteins in Plants, Taylor and Francis, Milton Park, in Oxfordshire, USA.
10. Robinson RA (2012) Plant pathosystem, Springer Science & Business Media, Berlin/Heidelberg, Germany.
11. Mehrotra, R. S. (1982) Plant Pathology, First edition, McGraw-Hill Education, Publication.
12. George, N. (2005) Agrios Plant Pathology, Fifth edition, Academic Press, London.
13. Jeng-Sheng (2001) Huang Plant Pathogenesis and Resistance, First edition, Springer, Netherlands.
14. Trivedi, P. C. (2007) Biocontrol of Plant Diseases, first edition, Aavishkar Publishers and Distributors.

SBOTE-454 Lab Course in Mycology and Plant Pathology

Mycology

1. Study of the representative genera belonging to Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina with respect to observations made, based on accessory organs, asexual and sexual structures and fruiting body.
2. Lichen: 1P
3. Mushroom cultivation
4. Isolation and identification of mycorrhizae.
5. Preparation of biofertilizer.
6. Preparation of PDA medium, isolation and culture of plant pathogenic fungi
7. Study of antagonistic activity of *Trichoderma* against fungi

Plant Pathology

8. Isolation and identification of plant pathogens from diseased plant parts.
9. Demonstration of cellulolytic and pectinolytic enzyme activity.
10. Detection of Aflatoxins using TLC.
11. Study of symptoms and causal organism and preparation of temporary slides of crop diseases
12. Study of symptoms of
    (a) Little leaf of Brinjal
    (b) Yellow vein mosaic of Bhendi.
13. Demonstration of fungicidal activity by fungal spore germination method.
14. Submission of herbariums of diseased plant samples.
15. Botanical excursion report.

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