॥ 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: BIOTECHNOLOGY

(Campus School)

(As Per NEP 2020)

FACULTY OF SCIENCE AND TECHNOLOGY

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 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, 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, Immunology and Virology, Genetics and Molecular Biology, Bioanalytical Techniques, Bioprocess Engineering and Technology, r-DNA Technology, Bioinformatics, Pharmaceutical Biotechnology, Plant Biotechnology and Genomics and Proteomics.

Apart from the core courses, the Department Specific Elective Courses deal with Microbial and Enzyme Technology, Environmental Biotechnology, Diagnostic Biology, Animal Biotechnology, Nanobiotechnology and Food 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 program, 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 also 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 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 resource for the industries.

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

Prerequisite:

Basic knowledge of Science at B.Sc. level. The optional courses of this program 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 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, AundhabNagnath, 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 Arun Ingale School of Life Sciences, North Maharashtra University, Umavinagar, Jalgaon Mob 9822708707	Member	9	Dr Prashant Thakare Department of Biotechnology, SGB Amravati University, Amravati. Mob 9822222822	Member
10	Dr A B Gulwe School of Technology, SRTM University Sub Campus , Latur. Mob 7387120874	Member	11	Dr Sanjog T. Thul Environmental Biotechnology and Genomics Division, National Environmental and Engineering Research Institute (CSIR-NEERI). Nagpur. Mob 9881877072	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-431606

Faculty of Science & Technology

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

Subject: M Sc Biotechnology (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	SBTTC-401 Biochemistry SBTTC-402 Cell and Developmental Biology SBTTC-403 Immunology and Virology	SBTTE-401 Biostatistics and Basic Computer **OR** SBTTE-403 Techniques in Microbiology	SVECR-401 Research Methodology (3-Cr)	--		SBTTP-401 Lab Course in Biochemistry SBTTP-402 Lab Course in Cell and Developmental Biology SBTTP-403 Lab Course in Immunology and Virology SBTTE-402 Lab Course in Biostatistics and Basic Computer **OR** SBTTE-404 Lab Course in Techniques in Microbiology	22	44
	2	SBTTC-451 Genetics and Molecular Biology SBTTC-452 Bioanalytical Techniques SBTTC-453 Bioprocess Engineering and Technology	SBTTE-451 Environmental Biotechnology **OR** SBTTE-453 Diagnostic Biology	---	SBTTX-451 (O/F/C)	--	SBTTP-451 Lab Course in Genetics and Molecular Biology SBTTP-452 Lab Course in Bioanalytical Techniques SBTTP-453 Lab Course in Bioprocess Engineering and Technology SBTTE-452 Lab Course in Environmental Biotechnology **OR** SBTTE-454 Lab Course in Diagnostic Biology	22	
Exit option: Exit Option with PG Diploma in Basic Biotechnology (After 2024-25)									
2	3	SBTTC-501 r DNA Technology SBTTC-502 Bioinformatics SBTTC-503 Pharmaceutical Biotechnology	SBTTE-501 Animal Biotechnology **OR** SBTTE-503 Microbial and Enzyme Technology	--	--	Research Project SBTTR-551 (4-Cr)	SBTTP-501 Lab Course in r DNA Technology and Bioinformatics SBTTP-502 Lab Course in Pharmaceutical Biotechnology SBTTE-502 Lab Course in Animal Biotechnology **OR** SBTTE-504 Lab Course in Microbial and Enzyme Technology	22	44
	4	SBTTC-551-Plant Biotechnology SBTTC-552-Genomics and Proteomics	SBTTE-551 Nanobiotechnology **OR** SBTTE-553 Food Biotechnology	SVECP- 551 Publication Ethics (2-Cr)	--	Research Project SBTTR-552 (6-Cr)	SBTTP-551 Lab Course in Plant Biotechnology SBTTP-552 Lab Course in Genomics and Proteomics SBTTE-552 Lab Course in Nanobiotechnology **OR** SBTTE-554 Lab Course in Food Biotechnology	22	
Total Credits		44	12	05	03	10	14	**Total Credits 88**	

DSE indicates Department Specific Elective Course. Biotechnology 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	SBTTC-401	Biochemistry	04	--	04	04	--
	SBTTC-402	Cell and Developmental Biology	04	--	04	04	--
	SBTTC-403	Immunology and Virology	04	--	04	04	--
Elective (DSE)	SBTTE-401 SBTTE-403	Biostatistics and Basic Computer **OR** Techniques in Microbiology	03	--	03	03	--
Research Methodology	SVECR-401	Research Methodology	03	--	03	03	
DSC Practical	SBTTP-401	Lab Course in Biochemistry	--	01	01	--	02
	SBTTP-402	Lab Course in Cell and Developmental Biology	--	01	01	--	02
	SBTTP-403	Lab Course in Immunology and Virology	--	01	01	--	02
DSE Practical	SBTTE-402 SBTTE-404	Lab Course in Biostatistics and Basic Computer **OR** Lab Course in Techniques in Microbiology	--	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	Biochemistry	20	20	20	80	--	--	100
	SBTTC-402	Cell and Developmental Biology	20	20	20	80	--	--	100
	SBTTC-403	Immunology and Virology	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-401 SBTTE-403	Biostatistics and Basic Computer **OR** Techniques in Microbiology	15	15	15	60	--	--	75
Research Methodology	SVECR-401	Research Methodology	15	15	15	60	--	--	75
DSE Practical	SBTTP-401	Lab Course in Biochemistry	--	--	--	--	05	20	25
	SBTTP-402	Lab Course in Cell and Developmental Biology	--	--	--	--	05	20	25
	SBTTP-403	Lab Course in Immunology and Virology	--	--	--	--	05	20	25
DSE Practical	SBTTE-402 SBTTE-404	Lab Course in Biostatistics and Basic Computer **OR** Lab Course in Techniques in Microbiology	--	--	--	--	05	20	25

M. Sc. First Year Semester II (Level 6)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	Practical	Total	Theory (Hrs/Week)	Practical (Hrs/Week/Batch)
Major	SBTTC-451	Genetics and Molecular Biology	04	--	04	04	--
	SBTTC-452	Bioanalytical Techniques	04	--	04	04	--
	SBTTC-453	Bioprocess Engineering and Technology	04	--	04	04	--
Elective (DSE)	SBTTE-451 SBTTE-453	Environmental Biotechnology **OR** Diagnostic Biology	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 Genetics and Molecular Biology	--	01	01	--	02
	SBTTP-452	Lab Course in Bioanalytical Techniques	--	01	01	--	02
	SBTTP-453	Lab Course in Bioprocess Engineering and Technology	--	01	01	--	02
DSE Practical	SBTTE-452 SBTTE-454	Lab Course in Environmental Biotechnology **OR** Lab Course in Diagnostic Biology	--	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	Genetics and Molecular Biology	20	20	20	80	--	--	100
	SBTTC-452	Bioanalytical Techniques	20	20	20	80	--	--	100
	SBTTC-453	Bioprocess Engineering and Technology	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-451 SBTTE-453	Environmental Biotechnology **OR** Diagnostic Biology	15	15	15	60	--	--	75
On Job Training/ Field Project/ Case Study	SBTTX-451	On Job Training (O)/ Field Work (F) / Case Study (C)	--	--	--	--	15	60	75
DSC Practical	SBTTP-451	Lab Course in Genetics and Molecular Biology	--	--	--	--	05	20	25
	SBTTP-452	Lab Course in Bioanalytical Techniques	--	--	--	--	05	20	25
	SBTTP-453	Lab Course in Bioprocess Engineering and Technology	--	--	--	--	05	20	25
DSE Practical	SBTTE-452 SBTTE-454	Lab Course in Environmental Biotechnology **OR** Lab Course in Diagnostic Biology	--	--	--	--	05	20	25

SBTTC-401: Biochemistry
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-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	
SBTTC-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 of 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. Tertiary and quaternary structures of proteins.	
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 monosaccharaides- mutarotation, glycoside bond formation, reduction and oxidation, epimerization and Esterification, important monosaccharaides and disaccharides	
	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.

SBTTP-401 Lab 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

SBTTC-402: Cell and Developmental Biology

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-402	Cell and Developmental Biology	04	--	04	--	04

Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-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, tumor 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	2	**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 Signaling, Cell division, Cell cycle and Cancer Biology**	15
	3.1	**Cell Signaling:** Hormones and their receptors, Cell surface receptors, Signaling through G-protein coupled and protein kinase associated receptors	
	3.2	Signal transduction pathways, Second messengers, Bacterial and plant two component signaling 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, Tumor 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	4	**Apoptosis, Morphogenesis 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, Watson J. D. (1994) Molecular Biology of Cell, Garland Publishing Company. New York.
2. Darnell J, Lodish H, Baltimore D (1990) Molecular Cell Biology by Scientific American Books, New York.
3. Backer, Kleinsmith and Hardin (2004) The World of the Cell by Pearson Education.
4. Gerald Karp, (1996), Cell and Molecular Biology by McGraw Hill Publishing Company, New York.
5. David E, Sadava (1992) Cell Biology – Organelle Structure and Function by Bostan and Bartlett publisher.
6. Loewy, Siekevitz, Manniger and Gallant (1991) Cell Structure and Function (An integrated Approach), Saunders college publishing house
7. Lewis JK, Kish VM (1997) Principles of Cell and Molecular Biology, Pearson Publication Company, London.
8. Philip Sheeler and Donald Bianehi (1987) Cell and Molecular Biology by John Wiley and Sons
9. Harrmann RG (1992) Cell organelles .Springer Verlag
10. Gilbert SF (2000) Developmental Biology, Sinauer Associates Inc.

SBTTP-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 Chironomus 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.

SBTTC-403: Immunology and Virology

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-403	Immunology and Virology	04	--	04	--	04

Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-403	Immunology and Virology	20	20	20	80	--	--	100

Course pre-requisite:

- Basic understanding of Molecular Biology, Genetics, and Microbiology.
- Knowledge of basic concepts in Immunology, including the immune system, antibodies, and antigen-antibody interactions.

Course objectives:

- To provide a comprehensive understanding of the principles and mechanisms of the immune system and viral infections.
- To explore the interactions between the immune system and viral pathogens and their impact on human health.
- To familiarize students with the techniques and methodologies used in immunological and virological research.

Course outcomes: Students will be able to

- Gain a thorough understanding of the components and functions of the immune system, including innate and adaptive immunity.
- Analyze and interpret the immune response to viral infections, including host-virus interactions, immune evasion, and immune-mediated pathogenesis.
- Develop practical skills in immunological and virological techniques, such as ELISA, flow cytometry, PCR, and viral culture, for the detection, diagnosis, and study of viral infections

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Basic concept and cells of the Immune System**	15
	1.1	Hematopoietic stem cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in innate and adaptive Immunity, MHC	
	1.2	Inflammatory response, Complement System Antigens and Antibodies: Factors responsible for immunogenicity, Epitopes, Adjuvants, Super antigens, Passive antibody therapy	
	1.3	Antigen Presentation and processing, Structure and function of antibodies, Antibody classes	
	1.4	Monoclonal antibody, Antibody engineering, Generation of antibody diversity	
2.0	2	**Immunological techniques**	15
	2.1	Cross reactivity, Precipitation and Agglutination reaction	
	2.2	Hemagglutination inhibition tests, Complement fixation, neutralization	
	2.3	Immune electrophoresis, RIA, ELISA, ELISPOT assay	
	2.4	Western blotting, Immunofluorescence and Flow cytometry	
3.0	3	**Autoimmunity, Hypersensitivity and Immunodeficiency**	15
	3.1	Autoimmunity, Hypersensitivity and Immunodeficiency, Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases	
	3.2	Hypersensitive reactions, Primary and secondary immunodeficiency(AIDS), Immune response to Infectious disease	
	3.3	Cancer and Transplantation: Immune response to viral infections, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection, Immunodiagnostics (diagnosis of infectious diseases)	
	3.4	Vaccine: Active and passive immunization, Vaccine types (Live but attenuated, Killed, Subunit, Recombinant, DNA and Peptide)	
4.0	4	**Replication of Viruses, Life cycle, interaction and growth**	15
	4.1	Introduction, Growth and assay of viruses, Methods of studying viruses, Structure of viruses, Classification of viruses	
	4.2	Replication of Viruses, Cultivation and Purification of viruses, Gene expression of DNA, RNA viruses	
	4.3	Virus cell interaction, Transmission of viruses, Modern approaches of virus control	
	4.4	Life cycle of some viruses- Tobacco mosaic virus, Tomato spotted wilt virus, Cauliflower mosaic virus, African cassava mosaic virus, Plum pox virus, Middle East respiratory syndrome coronavirus (MERS-CoV), Ebola virus disease, SARS, swine flu (H1N1), COVID-19 etc.	
		Total	60

Text Books and Reference Books

1. Janeway C. A. Travers P., Walport M., Immuno biology: the immune system in health and disease, Garland Science Publishing New York (2012) 8th ed.
2. Owen J. A., Punt J., Strandfold S.A, Jones P.P., Kuby- Immunology W.H. Freeman & Company (2013), 7 th ed.
3. Delves P. J., Martin J. S., Burton R. D., Roitt M. I. Roitt's Essential Immunology, Wiley Blackwell (2011) 12th ed.
4. Khan F.H. The Elements of Immunology, Pearson Education (2009)
5. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Latest edition / Pub. Date: January 1996. Publisher: Elsevier Science & Technology Books.
6. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor). Latest edition / Pub. Date: July 1993. Publisher: Marcel Dekker.
7. Diagnostic Virology Protocols: Methods in Molecular Medicine. John R. Stephenson (Editor), Alan Warnes Latest edition / Pub. Date: August 1998. Publisher: Humana Press.

SBTTP-403 LAB COURSE IN IMMUNOLOGY AND VIROLOGY

1. Blood film preparation and identification of cells
2. Immuno-diffusion / Radial Immune Diffusion
3. Hemagglutination
4. Agglutination inhibition
5. Rocket immune-electrophoresis
6. Western blotting, ELISA
7. Epitope prediction using Immuno-informatics tool
8. Isolation of Peripheral blood mononuclear cells
9. Phage Titration
10. Isolation of phage from sewage sample
11. Ouchterlony double diffusion technique
12. Purification of Ab (Antibody) by Affinity Chromatography

SBTTE-401 Biostatistics and Basic Computer

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-401	Biostatistics and Basic Computers	03	--	03	--	03

Teaching Scheme

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTE-401	Biostatistics and Basic Computers	15	15	15	60	--	--	75

Course pre-requisite:

- Basic understanding of mathematics and statistics.
- Familiarity with basic computer operations and software usage

Course objectives:

- To develop a solid foundation in Biostatistics and its applications in Biotechnological research analysis
- To acquire proficiency in basic computer tools and softwares commonly utilized in Biotechnology.

Course outcomes: Students will be able to

- Understand key statistical concepts and their applications in experimental design, data analysis, and interpretation in Biotechnology.
- Gain practical skills in utilizing statistical software for data analysis and visualization.
- Develop competency in utilizing basic computer tools and software for data management, literature search, and scientific communication in Biotechnology.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Introduction to Biostatistics**	11
	1.1	Introduction to Biostatistics, collection of data	
	1.2	Sampling methods	
	1.3	Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, mean deviation and variance	
	1.4	Processing & presentation of data	
2.0	2	**Basic Statistics**	11
	2.1	Correlation, Karl Pearson's coefficient of correlation	
	2.2	Regression Analysis, linear regression, regression equation	
	2.3	Software used in biostatistics- SPSS	
	2.4	Hypothesis testing: Types of hypothesis testing: t-test, $\chi 2$ -test, and F- test., ANOVA.	
3.0	3	**Computer Basics**	12
	3.1	Computer basics, hardware, software, architecture, input/output devices	
	3.2	Internet and resources related to Biology like Google scholar, science direct and other major free and commercial databases	
	3.3	Downloading open access articles, Searching for articles: search, advance search and search within search	
	3.4	E-mail: creating e-mail ID, sending and receiving, CC, BCC, attachments.	
4.0	4	**Word Processing**	11
	4.1	Word Processing Basics; Opening and Closing of documents, editing with online tools	
	4.2	Text creation and Manipulation; Formatting of text; Table handling; Spell check, language setting and thesaurus; Printing of word document.	
	4.3	Spread Sheet: Basics of Spreadsheet; Manipulation of cells; Formulas and Functions; Editing of Spread Sheet, printing of Spread Sheet and MS-Excel.	
	4.4	Presentation skill: Basics of presentation software; Creating Presentation; Preparation and Presentation of Slides; Slide Show; Taking printouts of presentation / handout and other formats	
		Total	45

References

1. Maheshwari R, Jain M (2017) Biostatistics: Principles and Practice, PHI Learning P Ltd.
2. Rao S, Richard J (2012) Introduction to Biostatistics and Research, Prentice Hall of India.
3. Gerstman B B (2014) Basic Biostatistics, Jones & Bartlett Learning, Burlington, Massachusetts.
4. Daniel WW, Chad L (2019) Biostatistics: A Foundation for Analysis in the Health Sciences, Publisher: Wiley Publishing House, Hoboken, New Jersey, U.S.
5. Normal G R, Streiner DL (2008) Biostatistics: The Bare Essentials, B.C. Decker Inc. USA.
6. Sinha P K, Sinha P (2004)"Computer Fundamentals, BPB Publications, India.
7. Rajaraman V (2014) Introduction to Computers, Prentice Hall of India
8. Rajaraman V (2007) Computer Basics and C Programming, PHI Learning Private Limited.
9. Stalling W (2013) Computer Organization and Architecture Pearson Education, London, UK.

SBTTE- 402 Lab Course in Biostatistics and Basic Computer

1. **Descriptive Statistics:**
- Calculation of mean, median, mode, and standard deviation for a given dataset.
- Construction of frequency distributions and histograms.
- Calculation of measures of central tendency and dispersion.

2.Probability and Probability Distributions:
- Calculation of probabilities for simple events and compound events.
- Understanding and working with probability distributions (e.g., binomial, normal distribution).
- Generating random numbers and simulating probability experiments.

3.Hypothesis Testing:
- Formulating null and alternative hypotheses.
- Performing t-tests and chi-square tests for hypothesis testing.
- Interpreting p-values and making conclusions based on the test results.

4. Analysis of Variance (ANOVA):
- Conducting one-way ANOVA to compare means across multiple groups.
- Post-hoc tests for pairwise comparisons of group means.
- Interpretation of ANOVA results and drawing conclusions.

5. Regression Analysis:
- Performing simple linear regression to analyze the relationship between two variables.
- Calculation of regression coefficients and interpretation of the results.
- Prediction of outcomes using regression models.

Practicals on Basic Computer:

1. Introduction to Operating Systems:
- Familiarization with different operating systems (Windows, Linux, mac OS).
- Navigating through the file system, creating folders, and managing files.

2. Word Processing:
- Creating and formatting documents using a word processing software (e.g., Microsoft Word, Google Docs).
- Working with headers, footers, tables, and images.
- Generating tables of contents and inserting citations/references.

3. Spreadsheet Analysis:
- Using a spreadsheet software (e.g., Microsoft Excel, Google Sheets) for data entry and manipulation.
- Performing calculations, creating formulae, and using built-in functions.
- Generating charts and graphs to visualize data.

4. Presentation Design:

- Creating visually appealing and informative presentations using presentation software (e.g., Microsoft PowerPoint, Google Slides).
- Working with slide layouts, adding multimedia elements, and applying animations/transitions.
- Delivering effective presentations with proper timing and audience engagement.

SBTTE-403 Techniques in Microbiology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-403	Techniques in Microbiology	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	Techniques in Microbiology	15	15	15	60	--	--	75

Course pre-requisite : Students should be aware of basics in Microbiology

Course objectives:

- To provide students with an in-depth understanding of various techniques and methodologies used in microbiological and biotechnological research.
- To develop practical skills in handling and culturing microorganisms, including aseptic techniques, media preparation, and isolation of pure cultures.
- To familiarize students with advanced techniques for microbial identification, characterization, and quantification, such as biochemical tests, molecular methods, and microscopy.

Course outcomes: Students will be able to

- Acquire theoretical knowledge and practical proficiency in a wide range of microbiological techniques, including sterilization, culture maintenance, microbial staining, and microscopy.
- Demonstrate the ability to identify and characterize microorganisms using various biochemical, molecular, and microscopic techniques, and interpret the obtained results accurately.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Introduction to Microbiology**	12
	1.1	Introduction to microbiology and microbes, history & scope of microbiology	
	1.2	Microbial classification of microorganisms, criteria for classification; classification of bacteria, Structure of bacteria Growth and nutrition of bacteria, nutritional requirements of bacteria : autotrophs, heterotrophs, chemotrophs and lithotrophs	
	1.3	Economically important bacteria : Cyanobacteria, acetic acid bacteria, Pseudomonas, lactic acid and propionic acid bacteria. Pathogenic Bacteria : endospore forming bacteria, Mycobacteria and Mycoplasma, Viruses	
	1.4	Archaea: Halophiles, Methanogens, thermophilic archae, Eukaryotes: algae, fungi, slime molds and protozoa	
2.0	2	**Microbial Culture Techniques**	11
	2.1	Preparation of culture media, types of media, Microbial Handling and Aseptic Techniques: Physical and chemical methods sterilization, antibiotics, antiviral and antifungal drugs, Antimicrobial resistance	
	2.2	Good laboratory practices and safety measures, Maintenance of Microbial Cultures, Isolation of Bacteria :Pure culture techniques, Culture maintenance and preservation, Microbial growth and reproduction, Bacterial growth curve	
	2.3	Enumeration of bacterial population	
	2.4	Depositories of Microbial cultures	
3.0	3	**Microbial Identification Methods**	11
	3.1	Morphological Observations : Phenotypic characterization of microorganisms	
	3.2	Light microscopy and staining methods (Differential Staining: Gram staining, acid-fast staining)	
	3.3	Biochemical tests for microbial identification	
	3.4	Immunological techniques: agglutination, ELISA, and Western blotting ; Antibiotic susceptibility testing: MIC	
4.0	4	**Advanced Techniques for Bacterial Identification**	11
	4.1	Genotypic Methods of Microbial Identification: PCR, DNA sequencing, 16S rRNA gene sequencing for bacterial identification	
	4.2	DNA barcoding for species identification	
	4.3	Next-generation sequencing (NGS) approaches for microbial identification	
	4.4	Metagenomics	
		Total	45

Text Books*:*

1. Pelczar MJ, Chan ECS, Krieg NR (1986) "Microbiology, McGraw-Hill Inc.,USA.Baveja CP (2021) Introduction to Microbiology, APC Publications, New Delhi.Black JG, Black LJ (2015) Microbiology: Principles and Explorations, John Wiley & Sons, Hoboken, New Jersey, USA.
2. Ananthanarayan R, Paniker CK, Kanungo R (2020) Textbook of Microbiology, Universities Press (India) Pvt. Ltd.
3. Vanitha N, Ibency CI, Ranjan S (2020) A Textbook of Industrial Microbiology, Ryan Publishers, Tiruchirappali, Tamilnadu.
4. Parija SC (2012) A textbook of Microbiology and Immunology, Elsevier Publications.
5. Dubey RC, Maheshwari DK (2013) Microbiology, S. Chand Publication, New Delhi.
6. Black J (1992) Microbiology: Principles and Applications, Prentice Hall India Publications
7. Leboffe MJ, Pierce BE (2010) Microbiology: Laboratory Theory and Application, Morton Pub Co, Eaglewood, USA.

Reference Books*:*

1. Willey J, Sherwood L, Woolverton CJ (2016) Prescott's Microbiology, McGraw Hill, USA.
2. Madigan MT, Martinko JM, Stahl DA, Clark DP (2010) Brock Biology of Microorganisms, Benjamin-Cummings Pub Co, California, USA.
3. Black JG, Black LJ (2015) Microbiology: Principles and Explorations, John Wiley & Sons, Hoboken, New Jersey, USA.
4. Cowan MK (2017) Microbiology: A Systems Approach, McGraw Hill, California, USA.
5. Tang YW, Stratton CW (2018) Advanced Techniques in Diagnostic Microbiology, Vol. 1: Techniques, Springer Science & Business Media, Berlin/Heidelberg, Germany.
6. Persing DH, Tenover FC, Hayden RT, Leven M, Miller MB, Nolte FS, Tang YW, van Belkum A (2016) Molecular Microbiology: Diagnostic Principles and Practice (ASM Books), ASM Press, Washington, DC, USA.
7. Breed RS, Murray EGD, Smith NR et. al. (1957) Bergeys Manual of Determinative Bacteriology, 7th Edition, The Williams and Wilkins Company, Baltimore.
8. Whitman WB (2012) Bergey's Manual of Systematic of Archaea and Bacteria, 1st Edition, John Wiley & Sons, Inc. Hoboken, New Jersey, USA.

SBTTE-404 Lab Course in Techniques in Microbiology:

1. Introduction to aseptic techniques and laboratory safety measures.
2. Study of Microscope: Compound
3. Staining methods for bacteria
4. Motility of Bacteria
5. Preparation of media (Solid and Liquid)
6. Isolation and purification of microbial cultures.
7. Identification of bacteria
8. Enumeration of Bacteria (SPC and DMC)
9. Estimation of microbial population using spectrophotometer.
10. Growth curve

11. Antibiotic Susceptibility Testing
12. Isolation of Bacteriophages
13. Polymerase Chain Reaction (PCR):
    Design and optimization of PCR reactions for amplification of target DNA.
    Gel electrophoresis for visualizing PCR products and analyzing amplification success
14. Production of lactic acid
15. Serological test: WIDAL test/ ELISA

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 Biotechnology 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 Biotechnology.
- 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 Biotechnology, 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 style(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

Text Books:

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

SBTTC-451: Genetics and Molecular Biology

Teaching Scheme

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

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-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 Genetics.
- To understand genome organization, genome duplication and genome function in Prokaryotes, Eukaryotes and Viruses.

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, pseudo allele, complementation tests) and principles of Mendelian Genetics (Dominance, segregation, independent assortment) and post Mendelian genetics (Co-dominance, 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 chronicity, 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: r RNA 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 EA (2006) Bacterial and Bacteriophage Genetics. 5th Edition. Sriger Publications
2. Klug WS, Spencer CA, Palladino MA (2009) Concepts of Genetics, 9th edition, Pearson.
3. Dale JW, Park SF (2005) Molecular Genetics of Bacteria 4th Edition Wiley and Sons Inc.
4. Griffiths AJF, Wessler SR, Lewontin RC, Carroll SB (2008) Introduction to Genetic Analysis, 9th Edition , WH Freeman Company, New York.
5. Weaver RF (2012) Molecular Biology, 5th Edition, The McGraw-Hill Companies, USA.
6. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P (2002) Molecular Biology of the Cell, 4th edition, Garland Science, New York.
7. Watson JD, Tania AB, Stephen PB, Alexander G, Michael L, Richard L (2017) Molecular Biology of the Gene, Pearson Education, California.
8. Snustad DP, Simmons MJ (2015) Principles of Genetics, 7th Edition, John Wiley & Sons.
9. Speicher M, Antonarakis SE, Motulsky AG (2009) Vogel and Motulsky's Human Genetics: Problems and Approaches, Springer, Germany.
10. Read A, Donnai D (2007) New Clinical Genetics, Scion Publishing Ltd, UK.
11. Strachan T, Read AP (2004) Human Molecular Genetics , 3rd Edition, Garland Science (Taylor and Francis Group), London and New York.
12. Synder L, Champness W (1997) Molecular Genetics of Bacteria. ASM Press.
13. Turn N, Trempy J (2006) Fundamental Bacterial Genetics. Blackwell Publishers.

SBTTP-451 Lab 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.

SBTTC-452: Bio-analytical techniques

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-452	Bio-analytical techniques	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	Bio-analytical 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 analyze 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 HH, Merrit LL Jr. and others (1986) Instrumental methods of Analysis 6th edition - CBS Publishers and Distributors.
2. Chatwal G, Anand S (1989) Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Mumbai.
3. Williams BL, Wilson KA (1975) Biologist's Guide to Principles and Techniques of Practical Biochemistry.
4. Hames BD (1998) Gel Electrophoresis of Proteins: A Practical Approach (Practical Approach Series, 197) 3rd Edition, Oxford University Press.
5. Jaines M (1988) Chromatography: Concepts and Contrasts, John Wiley and Sons Inc New York.
6. Holme D, Peck H (1998) Analytical Biochemistry, Prentice Hall, Hoboken, New Jersey, U.S.
7. Straughan BP, Walker SD (1976) Spectroscopy, Chapman & Hall, London.
8. Gordon (1984) Practical Aspects of Gas Chromatography and Mass Spectrometry. M. Message, John, Wiley and Sons New York.
9. Kremmer T, Boross L, et.al. (1979) Gel Chromatography: Theory, Methodology Application, John Wiley & Sons Inc., Hoboken, New Jersey, USA.

10. Thornburn CC (1972) Isotopes and Radiations in Biology, Butterworth and Co. Ltd. London
11. Chapman JM, Ayrey G (1981) The Use of Radioactive isotopes in the Life Sciences, George Allen and Unwin Ltd. London.

SBTTP-452 Lab Course in Bio-Analytical 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.

SBTTC-453: Bioprocess Engineering and Technology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-453	Bioprocess Engineering and Technology	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	Bioprocess Engineering and Technology	20	20	20	80	--	--	100

Course pre-requisite: Students should be aware of general engineering and biochemical principles and methods used in Biotechnology

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Course objectives:

- To apply fundamental principles and concepts of chemical engineering to biological systems.
- To understand media formulations, microbial growth kinetics, bioreactor selection, upstream & fermentation processes, and its role in manufacturing bio-products.

Course outcomes: On completion of this course, the students will able to:

- Explain how microorganisms and biochemical processes can be applied in engineered systems.
- Distinguish among batch, continuous and fed-batch culture systems for the production of Biochemical products.
- Describe microbial growth & cultivation, various bioreactor components, and types of Bioreactors used in Biotechnology industries.
- Design media sterilization and design of air filter in a bioprocess.
- Apply various concepts to improve bioreactor performance and evaluate process variables to analyze a bioprocess.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Biochemical Engineering and Microbial Growth Kinetics**	15
	1.1	Introduction: Interaction of two disciplines: biology and bio-chemical engineering, historical advancement in fermentation processes,	
	1.2	Current status of biochemical engineering in fermentation industry, range of microbial diversity in fermentative processes	
	1.3	Microbial Growth Kinetics: Growth, growth measurement, media formulation, stoichiometry of cell growth and product formation, factors influencing product formation on varying carbon & nitrogen source, batch culture	
	1.4	Monod's kinetics, modeling of batch growth kinetics, environmental factors affecting microbial growth, continuous culture, an ideal chemo stat, advantages and limitations of continuous over batch culture, fed-batch culture and its applications.	
2.0	2	**Aeration and Agitation**	15
	2.1	Fick's law, theories of mass transfer, mass transfer between two phases	
	2.2	Role of aeration and agitation in a bioprocess, oxygen transfer methodology in a fermentation process	
	2.3	Significance of volumetric transfer coefficient (KLa) and its determination, factors affecting KLa values in a bioreactor	
	2.4	Power requirements in gassed and ungassed bioreactors, rheological characteristics of fermentation fluids.	
3.0	3	**Bioreactor Selection and Design**	15
	3.1	Selection criteria for bioreactor, body construction of fermenter and its components i.e. impellers, stirred glands and bearings, seal assemblies, baffles, sparger and valves	
	3.2	Solid state and submerged fermentation	
	3.3	Design aspects of bubble column bioreactor, air-lift fermenter	
	3.4	Plug-flow and packed bed bioreactor, scaling up of bioreactor	
4.0	4	**Sterilization, Instrumentation and Process Control**	15
	4.1	Need of sterilization, media sterilization, Del factor, design of batch and continuous sterilization, air sterilization	
	4.2	Log penetration theory, scale up of sterilization process, filter design	
	4.3	Control systems in a bioprocess, methods of measuring process variables i.e. temperature, pressure, flow, dissolved oxygen, pH	
	4.4	Role of computers in fermentation process analysis	
		Total	60

References:

1. P.F. Stanbury and A. Whitaker-Principle of Fermentation Technology; Pergamon Press(1988).
2. M. L. Shuler and F. Kargi-Bioprocess Engineering: Basic Concepts" by, 2nd Edition, Pearson Education (2001).
3. P. M. Doran-Bioprocess Engineering Principles Academic Press (2012).
4. J. E. Bailey and D.F. Ollis-Biochemical Engineering Fundamentals, McGraw-Hill Book Co., New
   York (1986)
5. S. Aiba, A. E. Humphrey, N. F. Millis-Biochemical Engineering, Academic Press, New York 2nd Edition (1973)

SBTTP-453 Lab Course in Bioprocess Engineering and Technology

1. Sterilization of Fermenter and Media preparations
2. Preparation of inoculum
3. Bacterial growth kinetics
4. Effect of varying carbon substrate on specific growth rate
5. Production of citric acid and lactic acid
6. Production of Alcohol (Ethanol)
7. Comparative study on rate of product formation using immobilized and suspension cells
8. KLa determination using non-fermentative and fermentative methods
9. Effect of mixing and agitation rate on KLa

SBTTE-451: Environmental Biotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-451	Environmental 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-451	Environmental Biotechnology	15	15	15	60	--	--	75

Course pre-requisite: General awareness regarding environment and parameters of environment

Course objectives:

- To facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario
- To understand the value of regional and global natural and energy resources and emphasize on need for conservation of energy and environment.

Course outcomes: On completion of this course, the students will able to:

- Outline the scenario of natural resources and their status
- Calculate the flow of energy and mass balance in ecosystems
- Analyze environmental status of human settlements
- Monitor the energy performance of systems

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Natural Resources**	11
	1.1	Natural Resources: Biological, mineral and energy resources; Land, water and air	
	1.2	Natural Resources: Human settlements and resource consumption	

	1.3	Natural resources vis-à-vis human resources and technological resources	
	1.4	Concept of sustainability; Sustainable use of natural resources	
2.0	2	**Ecology, Agricultural and Industrial Systems**	12
	2.1	Ecology, Structure and Functioning of Natural Ecosystems: Ecology, ecosystems and their structure, functioning and dynamics	
	2.2	Energy flow in ecosystems; biogeochemical cycles and climate; Population and communities	
	2.3	Agricultural and industrial systems vis-à-vis natural ecosystems	
	2.4	Agricultural systems, and environment and natural resources; Industrial systems and environment	
3.0	3	**Environmental Pollution, Global Warming and Climate Change:**	11
	3.1	Air pollution (local, regional and global); Water pollution problems	
	3.2	Land pollution and food chain contaminations	
	3.3	Carbon cycle, greenhouse gases and global warming; Climate change – causes and consequences; Carbon footprint	
	3.4	Management of greenhouse gases at the source and at the sinks	
4.0	4	**Energy Technologies**	11
	4.1	Electrical energy and steam energy; Fossil fuels, hydropower and nuclear energy	
	4.2	Solar energy, wind energy and biofuels	
	4.3	Wave, ocean thermal, tidal energy and ocean currents	
	4.4	Geothermal energy; Future energy sources; Hydrogen fuels; Sustainable energy	
		Total	45

References:

1. Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).
2. Chapman, J.L. and Reiss, M.J., Ecology- Principles and Application, Cambridge University Press (LPE) (1999).
3. Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).
4. Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists, Longman And Harow (2006).
5. Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).6. Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008).
6. O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).

SBTTE-452 Lab Course in Environmental Biotechnology

1. Microorganisms form polluted environment/Soil /Water /Air

2. Biotransformation

3. Microbial degradation of textile dyes/pesticides/hydrocarbons and oils

4. Assay of enzymes involved in biotransformation.

5. Analysis of product

6. Evaluation of toxicity of the product.

7. Bioremediation

8. Pollutant removal using microorganisms from industrial effluent.

9. Removal of oil spills form soil

10. Biomineralization

11. Effect of heavy metals on microbial growth

12. Microbial leaching of metals

13. Effect of pesticides on soil microorganisms

14. Pollution control

15. Activated sludge process

16. ETP: Primary, chemical and biological treatment

SBTTE-453: Diagnostic Biology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-453	Diagnostic Biology	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	Diagnostic Biology	15	15	15	60	--	--	75

Course pre-requisite:

- General awareness regarding methods of disease diagnosis and sampling techniques in disease diagnosis.

Course objectives:

- To acquaint the students with basic principles and applications of new diagnostic techniques in various diseases and disorders.

Course outcomes: On completion of this course,

- Student will be able to understand the diagnostic techniques used in the diagnosis of various diseases and disorders.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	1	**Techniques in Disease diagnosis**	12
	1.1	Staining techniques in disease diagnosis (AFB), immunofluorescence, direct fluorescence	
	1.2	PCR in clinical microbiology, Real-time PCR, advanced PCR techniques next generation sequencing, radiology and hematology based diagnostic methods	
	1.3	Serodiagnosis (agglutination, ELISA, radio immunoassay, T cell based tests skin tests, interferon gamma assays)	
	1.4	VITEK-2 system, anti-microbial susceptibility testing (disc diffusion, inhibition zones E test , MIC) detection of viral infection (e- microscopy,	

		Ag &Ab detection, virus culture)	
2.0	2	**Diagnosis with metabolic molecules**	11
	2.1	Detection of blood glucose level, oral glucose tolerance test	
	2.2	Gestational diabetes & HB, AC, detection of serum bilirubin uric acid	
	2.3	Detection of Cholesterol, LFT, KFT	
	2.4	Alkaline phosphatase, Lipid profile	
3.0	3	**Enzymes in Medical diagnosis**	11
	3.1	Lactate dehydrogenase, malate dehydrogenase, Fructose 6 biphosphatase, acid and alkaline phosphatase	
	3.2	Glucose 6 phosphate dehydrogenase, Enzyme in cancer therapy	
	3.3	Genetic diseases, clotting disorders	
	3.4	Neonatal jaundice, surgery, toxicity.	
4.0	4	**Diagnosis of Fungal and Bacterial diseases**	11
	4.1	Medical Mycology, Introduction to fungi, Plant fungal pathogens and Human fungal pathogens and diagnosis	
	4.2	Spread, prevention and treatment of Tinea pedis or athlete's foot, *Candida albicans*, Infection Ring worm, Aspergillosis	
	4.3	Bacterial Diseases: Transmission, mechanism of pathogenesis and laboratory diagnosis of the diseases caused by *Pneumococcus, Neisseria, Clostridium*	
	4.4	Transmission, mechanism of pathogenesis and laboratory diagnosis of the diseases caused by *Mycobacterium tuberculosis and Helicobacter pylori*.	
		Total	45

References:

1. Blair, J.E.e., Lennette, E.H.e., and Truant, J.P.e. (1970) Manual of clinical microbiology, American Society for Microbiology, Bethesda.
2. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London.
3. Lennette, E.H., Balows, A., Hausler, W.J., and Shadomy, H.J. (1985) Manual of clinical microbiology. American Society for Microbiology, Washington, D.C.
4. Topley, W.W.C., Wilson, G.S.S., Parker, T., and Collier, L.H. (1990b) Topley and principles of bacteriology, virology and immunology. Edward Arnold.
5. Mukherjee, K.L. (2010) Medical Laboratory Technology .Tata McGraw-Hill Education.
6. Sood, R. 1999. Medical Laboratory Technology - Methods and Interpretations. Jaypee Brothers Medical Publishers(P) Ltd. New Delhi.
7. Cheesbrough, M. (2006) District Laboratory Practice in Tropical Countries. Cambridge University Press.
8. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989) Mackie & McCartney practical Medical Microbiology. Churchill Livingstone.
9. Black, J.G. (1999) Microbiology : principles and explorations. Prentice Hall International, London.

10. Kindt, T.J., Goldsby, R.A., Osborne, B.A., and Kuby, J. (2006) Kuby immunology.W.H. Freeman, New York.

SBTTE-454 Lab Course in Diagnostic Biology

1. Staining techniques in disease diagnosis (AFB, Capsule and Endospore)
2. PCR in clinical microbiology (RT-PCR for viral diagnosis)
3. Hematology based diagnostic methods (BMP, CBC, LC, Blood typing, hematocrit)
4. Serodiagnosis (Agglutination, ELISA, RIA, T-Cell based tests)
5. Antimicrobial assays (MIC, Disc diffusion)
6. Glucose tolerance test
7. Serum Analysis (Billirubin, Uric Acid)
8. HBAC Test
9. Detection of cholesterol
10. Liver Function test (LFT)
11. Kidney Function test (KFT)
12. Lipid Profile
13. Enzyme analysis (Lactate dehydrogenase, malate dehydrogenase, Fructose-6-phosphatase, Acid and Alkaline Phosphatase, Enzyme in Cancer)
14. Prenatal testing
15. Laboratory diagnosis of disease caused by Pneumococcus (Urine test)
16. Laboratory diagnosis of disease caused by Neisseria (Urine and NAAT test)
17. Laboratory diagnosis of disease caused by Clostridium (Faecal analysis)
18. Diagnosis of the diseases caused by *Mycobacterium tuberculosis* (TB Infection: Mantoux tuberculin skin test, TST)
19. Diagnosis of the diseases caused by *Helicobacter pylori* (Stool polymerase Chain Reaction)

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