॥ 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

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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

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

प रि प त्र क

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

1) M. Sc. II year Biotechnology (Affiliated College)
2) M. Sc. II year Biotechnology (Campus)
3) M. Sc. II year Bioinformatics (Sub Campus Latur)
4) M. Sc. II year Bioinformatics (Affiliated College)
5) M. Sc. II year Clinical Research (Affiliated College)
6) M. Sc. II year Botany (Campus)
7) M. Sc. II year Herbal Medicine
8) M. Sc. II year Boany (Affiliated College)
9) M. Sc. II year Geology (Campus)
10) M. Sc. II year Dairy Science
11) M. Sc. II year Electronics
12) M. Sc. II year Environmental Science
13) M. Sc. II year Environmental Science (Campus)
14) M. Sc. II year Geography (Campus)
15) M. Sc. II year Applied Mathematics
16) M. Sc. II year Mathematics
17) M. Sc. II year Mathematics (Campus)
18) M. Sc. II year Microbiology
19) M. Sc. II year Microbiology (Campus)
20) M. Sc. II year Statistics
21) M. Sc. II year Statistics (Campus)

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

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी/विवत्रंविपदवी/२०२४–२५/१०९
दिनांक १२.०६.२०२४

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

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

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

STRUCTURE AND SYLLABUS OF TWO-YEAR MASTERS

PROGRAM IN SCIENCE

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: BIOTECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY

M. Sc. Second Year

SCHOOL OF LIFE SCIENCES

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

With Effect From June 2024

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

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

SRTM University has been producing a good number of high calibre 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. M. K. Patil
Dean
Faculty of Science and Technology

Preamble:

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

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

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

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

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, Techniques in Microbiology 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 any B Sc or B Pharm or B Sc Agri from any statutory University.

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

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

Sr No	Name of the Member	Designation	Sr No	Name of the Member	Designation
1	**Dr Sunita Dhundiraj Lohare** Shri Havgiswami Mahavidyalaya, Udgir, Dist. Latur Mob 9284161504	Chairman	2	**Dr Babasaheb S Surwase** School of Life Sciences SRTM, University, Nanded 431606. Mob 9075829767	Member
3	**Dr Pratap V. Deshmukh** Nagnath Arts, Commerce and Science College, Aundha Nagnath, Dist. Hingoli Mob 9637202024	Member	4	**Dr Komal S. Gomare** Dept of Biotechnology, Dayanand Science College, Latur Mob 9284238413	Member
5	**Dr Vaibhav D. Deshpande** General Manager, Quality Corporate Office, Wockhardt, Mumbai Mob 9100988260	Member		--	
	Invitee Members				
6	**Dr Laxmikant Kamble** School of Life Sciences, SRTM University, Nanded 431606. Mob 8669695555	Member	7	**Dr M M V Baig** Dept of Biotechnology, Yeshwant Mahavidyalaya, Nanded. Mob 9422170641	Member
8	**Dr 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	13	**Dr Sunil Hajare** Department of Biotechnology, New Model Degree College, Hingoli . Mob 8378878817	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		VEC	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-501 (4-Cr)	SBTTP-501 Lab Course in rDNA 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-551 (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 Credits88**	

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

M. Sc. Second Year Semester III (Level 7.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	Practical	Total	Theory (Hrs/Week)	Practical (Hrs/Week/Batch)
Major (DSC)	SBTTC-501	rDNA Technology	04	--	04	04	--
	SBTTC-502	Bioinformatics	04	--	04	04	--
	SBTTC-503	Pharmaceutical Biotechnology	04	--	04	04	--
Elective (DSE)	SBTTE-501 SBTTE-503	Animal Biotechnology **OR** Microbial and Enzyme Technology	03	--	03	03	--
Research Project	SBTTR-501	Research Project	--	04	04	--	08
DSC Practical	SBTTP-501	Lab Course in rDNA Technology and Bioinformatics	--	01	01	--	02
	SBTTP-502	Lab Course in Pharmaceutical Biotechnology	--	01	01	--	02
DSE Practical	SBTTE-502 SBTTE-504	Lab Course in Animal Biotechnology **OR** Lab Course in Microbial and Enzyme Technology	--	01	01	--	02
Total Credits			**15**	**07**	**22**	**15**	**14**

M. Sc. Second Year Semester III (Level 7.0)

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 (DSC)	SBTTC-501	rDNA Technology	20	20	20	80	--	--	100
	SBTTC-502	Bioinformatics	20	20	20	80	--	--	100
	SBTTC-503	Pharmaceutical Biotechnology	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-501 SBTTE-503	Animal Biotechnology **OR** Microbial and Enzyme Technology	15	15	15	60	--	--	75
Research Project	SBTTR-501	Research Project	--	--	--	--	20	80	100
DSC Practical	SBTTP-501	Lab Course in rDNA Technology and Bioinformatics	--	--	--	--	05	20	25
	SBTTP-502	Lab Course in Pharmaceutical Biotechnology	--	--	--	--	05	20	25
DSE Practical	SBTTE-502 SBTTE-504	Lab Course in Animal Biotechnology **OR** Microbial and Enzyme Technology	--	--	--	--	05	20	25

M. Sc. Second Year Semester IV (Level 7.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme	
			Theory	**Practical**	**Total**	**Theory** (Hrs/Week)	**Practical** (Hrs/Week/Batch)
Major (DSC)	SBTTC-551	Plant Biotechnology	04	--	04	04	--
	SBTTC-552	Genomics and Proteomics	04	--	04	04	--
Elective (DSE)	SBTTE-551 SBTTE-553	Nanobiotechnology **OR** Food Biotechnology	03	--	03	03	--
Value Education Course	SVECP-551	Publication Ethics	02	--	02	02	--
Research Project	SBTTR-551	Research Project	--	06	06	--	12
DSC Practical	SBTTP-551	Lab Course in Plant Biotechnology	--	01	01	--	02
	SBTTP-552	Lab Course in Genomics and Proteomics	--	01	01	--	02
DSE Practical	SBTTE-552 SBTTE-554	Lab Course in Nanobiotechnology **OR** Lab Course in Food Biotechnology	--	01	01	--	02
Total Credits			**13**	**09**	**22**	**13**	**18**

M. Sc. Second Year Semester IV (Level 7.0)

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 (DSC)	SBTTC-551	Plant Biotechnology	20	20	20	80	--	--	100
	SBTTC-552	Genomics and Proteomics	20	20	20	80	--	--	100
Elective (DSE)	SBTTE-551 **OR** SBTTE-553	Nanobiotechnology **OR** Food Biotechnology	15	15	15	60	--	--	75
Value Education Course	SVECP-551	Publication Ethics	--	--	--	--	10	40	50
Research Project	SBTTR-551	Research Project	--	--	--	--	30	120	150
DSC Practical	SBTTP-551	Lab Course in Plant Biotechnology	--	--	--	--	05	20	25
	SBTTP-552	Lab Course in Genomics and Proteomics	--	--	--	--	05	20	25
DSE Practical	SBTTE-552 **OR** SBTTE-554	Lab Course in Nanobiotechnology **OR** Lab Course in Food Biotechnology	--	--	--	--	05	20	25

SBTTC-501: rDNA Technology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-501	rDNA 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-501	rDNA Technology	20	20	20	80	--	--	100

Course pre-requisite:
- Students should be aware of the basics of different processes of Genetics and Molecular Biology.

Course objectives:
- The objective of this course is to familiarize the students with concept of rDNA, clone and gene cloning, cloning strategies, tools and techniques, applications and advantages and alternatives to transgenics etc.

Course outcomes: Students will be able to be
- GM literate i.e. aware about rDNA technology, its advantages and disadvantages in addition to tools and techniques. It will help in avoiding spread of misconception about GMO in society.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Fundamentals of Genetic Engineering**	15
	1.1	Introduction to concept of r-DNA, clone and gene cloning. Scope and Milestones in Genetic Engineering.	
	1.2	Strategies and Molecular Tools: Restriction and modifying enzymes. DNA and RNA markers.	
	1.3	Vectors: Cloning and expression vectors; vector components: Promoters, selectable markers, reporter genre, ori, URRs, codon optimization, Properties and Applications.	
	1.4	Commonly used vectors: Plasmids, bacteriophages, Phagemids and	

		cosmids. Artificial chromosomes.	
2.0		**Gene Cloning strategies and tools**	15
	2.1	Isolation and purification of chromosomal and plasmid DNA, Yield analysis, Nucleic acid amplification and its applications. Genomic and c-DNA library preparation and application.	
	2.2	Cloning Methods: Blunt end cloning, Sticky end and sticky end PCR cloning, TA cloning, PCR recombination, Integration PCR, In-Fusion™ Cloning, TOPO Cloning, Gateway cloning etc.	
	2.3	Methods of screening: Selection by complementation, antibiotic resistance, colony PCR etc.	
	2.4	Expression analysis: Phenotype, RNA and Protein level. Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays, RT-PCR and Real time q-PCR, Nucleic acid microarray, Transcriptome sequencing, Western blotting.	
3.0		**Applications of r DNA Technology I**	15
	3.1	Heterologous expression of proteins. Vector engineering and codon optimization, host engineering	
	3.2	Expression in bacteria, expression in mammalian and plant cells,	
	3.3	Processing of Recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.	
	3.4	Process and applications of Phage Display. GMO (Microorganisms, Plants and animals) with traits having applications in different sectors: A. Health, B. Agriculture, C. Environment and D. Industrial	
4.0		**Applications of r DNA Technology II**	15
	4.1	Gene silencing: Strategies, applications and advantages. Genome editing: Strategies, applications and advantages.	
	4.2	Gene therapy: Principles of Gene therapy: Vector engineering.	
	4.3	Strategies of gene delivery. Gene replacement/augmentation therapy, success and limitations of gene therapy.	
	4.4	Genetic engineering guidelines, Regulatory bodies, GEAC, RCGM and IBSC.	
		Total	60

References:

1. Sambrook, J., Fritisch E. F. and Maniatis, T. Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, New York, 2000.
2. Glover, D. M. and Hames, B. D. DNA Cloning: a Practical Approach, IRL, Press, Oxford, 1995.
3. Kaufman, P. B., Wu, W., Kim, D. and Cseke, L. J. Molecular and Cellular Methods in Biology and Medicine, CRC Press, Florida, 1995.
4. Berger, S. L. and Kimmel, A. R. Methods in Enzymology ,Vol. 152, Guide to Molecular Cloning Techniques, Academic Press, Inc. San Diego, 1998.
5. Goeddel, D. V. Methods in Enzymology, Vol 185, Gene Expression Technology, Academic Press, Inc., San Diegoo, 1990.

6. Mickloss, D. A. and Freyer, G. A. DNA Science. A First Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York, 1990.
7. Primrose, S. B. DNA Science: A First Course in Recombinant Technology, Blackwell Scientific Publishers, Oxford, 1994.
8. Davies, J. A. and Raznikoff,, W. S. Milestones in Biotechnology. Classic papers on Genetic Engineering, Butterworth-Heinemann, Boston, 1992.
9. Walker, M. R. and Rapley, R. Route Maps in Gene Technology, Blackwell Science Ltd., Oxford, 1997.
10. Kingsman, S. M. and Kingsman, A. J. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes, Blackwell Scientific Publications, Oxford, 1998.
11. Glick, B. R., Pasternak, J. J. and Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 6th Edition, American Society for Microbiology, 1994.

SBTTP-501 Lab Course in rDNA Technology

Part A

1. Genetic recombination (conjugation, transformation, transduction) in bacteria.
2. Gene cloning: Restriction, digestion and ligation, DNA Cloning in plasmid vectors and analysis of gene products.
3. Preparation of competent cells and transformation by CaCl2 method.
4. DNA amplification.
5. DNA fingerprinting: RFLP, RAPD
6. Blotting and hybridization techniques: Western, Southern & Northern hybridization.
7. Gene expression in *E. coli*
8. Agarose gel electrophoresis by using DNA markers for molecular weight determination

SBTTC-502: Bioinformatics

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-502	Bioinformatics	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-502	Bioinformatics	20	20	20	80	--	--	100

Course pre-requisite:
The students should be aware of the basics of computers and Molecular Biology.

Course objectives:

- The objective of this course is to familiarize students with basic concepts of sequences, structural alignment, database searching and protein structure prediction..

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

- Explain the theoretical knowledge of database system and algorithms.
- Analyze and discuss the results in light of molecular biological knowledge (sequence alignment and Phylogenetic tree plot)
- Collect the proficient knowledge to solve biological system- a multi-disciplinary problem
- Develop the key skills of molecular modeling techniques currently practiced in any pharmaceutical research and development unit

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Introduction to Bioinformatics**	15
	1.1	Introduction to Bioinformatics Resources Bioinformatics Resources: NCBI, EBI, ExPASy	
	1.2	RCSB, And DDBJ: The knowledge of databases and bioinformatics tools available at these resources	
	1.3	Organization of databases: data contents, purpose and utility.	
	1.4	Open access bibliographic resources and literature databases: PubMed, BioMed Central, Public Library of Sciences (PloS), Cite Xplore	
2.0		**Sequence databases**	15

	2.1	Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, UniParc	
	2.2	Structure Databases: PDB, NDB, PubChem, ChemBank.	
	2.3	Sequence file formats: Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF etc.	
	2.4	Protein and nucleic acid properties: Proteomics tools at the ExPASy server, GCG utilities and EMBOSS, Computation of various parameters	
3.0		**Sequence analysis**	15
	3.1	Sequence Analysis: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and xenologues	
	3.2	Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences	
	3.3	PAM and BLOSUM series	
	3.4	Matrix derivation methods and principles	
4.0		**Sequence alignment**	15
	4.1	Sequence alignment: Measurement of sequence similarity; Similarity and homology.	
	4.2	Pairwise sequence alignment: Basic concepts of sequence alignment	
	4.3	Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties	
	4.4	Use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results.	
		Total	60

References

1. Mount, D., Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, New York, 2004.
2. Baxevanis, A. D. and Francis Ouellellette, B. F. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins, Wiley India Pvt Ltd, 2009.
3. David, P. S.,Attwood, T. K. Introduction to bioinformatics, 1st Edition, Pearson Education, 1999.

SBTTP-501 Lab Course in Bioinformatics

Part B

1. Proteomics tools
2. Structural and functional predictions
3. Phylogenetic Analysis, Phylogenetic tree construction
4. DNA and protein sequence and PDB file formats
5. Local and global sequence alignments of protein and DNA sequences
6. Needleman Wunsch and Smith-Waterman algorithm
7. BLAST, Multiple sequence alignment

SBTTC-503: Pharmaceutical Biotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-503	Pharmaceutical Biotechnology	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-503	Pharmaceutical Biotechnology	20	20	20	80	--	--	100

Course pre-requisite:

- Basic understanding of Molecular Biology, Genetics, and Microbiology.
- Knowledge of basic concepts in pharmaceutical sciences.

Course objectives:

- The objective of this course is to apply the basic concepts in the specific field of pharmaceutical biotechnology.
- To expose students to gain insights into identification and design of drugs that could be potentially useful in the identification of candidate drug which have efficacy in cell culture or animal models and thus the most effective compound could be employed based on the above results to put into clinical trials.

Course outcomes: Students will be able to

- Explain the strategies and various steps of new drug discovery process.
- Explain the concept of pharmacodynamics and pharmacokinetics
- Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones
- Carry out the quality control procedures in the production of various biopharmaceuticals
- Explain the regulatory aspects in the development of pharmaceuticals.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Antibiotics and Synthetic antimicrobial agents**	15
	1.1	Concept of bioassay, therapeutic index, MIC and LD50 Mechanism of action, microbial resistance	
	1.2	Therapeutic, prophylactic usage and adverse reactions of antibiotic and synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides, peptide antibiotics	
	1.3	Synthetic antibiotics: Sulphonamides, Chloramphenicol, Quinolone. Antifungal antibiotics: Amphotericin B, Griseofulvin and Fluconazole	
	1.4	Antiviral drugs: Acyclovir, Zidovudine, Amantadine. Antitumor drugs: Bleomycin, Dactinomycin	
2.0		**Drug discovery methods**	15
	2.1	Drug Discovery Process, biological activity directed and other types of screening, natural products	
	2.2	Combinatorial chemistry; General overview of validation techniques, Methods of Drug Discovery and development, QSAR and SAR.	
	2.3	Concepts of Bioavailability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy	
	2.4	Drug delivery considerations for the new biotherapeutics.	
3.0		**Pharmacology of drugs**	15
	3.1	Physicochemical properties in relation to biological action, Effects of route of administration, Drug Targets, Validation techniques of Pharmaceutical targets	
	3.2	Pharmacokinetics and pharmacodynamics of drugs, Drug Toxicity	
	3.3	Basic terminologies in drug delivery and drug targeting, Doses forms, Various routes of administration of drugs, Strategies for enhanced therapeutic efficacies	
	3.4	DNA vaccines, Vaccines & Monoclonal antibody-based pharmaceuticals and other pharmaceutical products: Streptokinase, streptodornase	
4.0		**Formulations and Regulations of drug**	15
	4.1	Formulation of Biotechnological Products, Drug Delivery,	
	4.2	Examples of some Biotechnological products in clinical development.	
	4.3	Role of FDA, ICH Guidelines	
	4.4	The Regulation of Pharmaceutical Biotechnological Products and Ethical Issues.	
		Total	60

Text Books and Reference Books

1. Hugo, W. B. & Russel, A. R., Pharmaceutical Microbiology, Sixth Edition. Blackwell Scientific Publications, 1998.

2. Kadam, S. S., Mahadik, K. R. and Bothra, K. G. Principles of medicinal chemistry, Vol. 1, Edition: 17, Nirali Publication, 2017.
3. Gokhale, S. D., KoKate, C. K. Pharmacognosy, Edition:18, Nirali Prakashan Educational Publication, 2017.
4. Singh., B. D. Biotechnology – Expanding Horizon, First Edition, Kalyani Publication, Delhi, 2004.
5. Vyas, S. P., & Dixit, V. K. Pharmaceutical Biotechnology, 12th edition, CBS publishers & distributors, New Delhi, 2009.
6. Hooper, D. C., Wolfson. J. S. Quinolone antimicrobial agents, Second edition, Washington, D.C. : American Society for Microbiology, 1993.
7. Murray, S., Cooper Quality control in the Pharmaceutical industry, Vol. 2, Academic Press Inc. U. S., New York, 1974.
8. Rhem, H. J. & Reed G. Biotechnology : Measuring, Modelling and Control, vol 4 ,Wiley India Pvt Ltd publications, 2010.
9. Gregory Gregoriadis, Drug carriers in biology & medicine, Academic Press New York London, 1979.
10. Hillery, A. M., Lloyd, A. W. and Swarbrick, J. Drug Delivery and Targeting For Pharmacists and Pharmaceutical Scientists, Harwood Academic Publisher, 2001.
11. Ansel, H. C., Allen, L. V. and Popovich, N. G. Pharmaceutical Dosage Forms and Drug Delivery Systems, 8th Edition, Lippincott Williams and Wilkins Publisher, 2005.
12. Shyam Mohapatra, Shivendu Ranjan, Nandita Dasgupta, Raghvendra Kumar and Sabu Thomas. Applications of Targeted Nano Drugs and Delivery Systems, 1st Edition, Elsevier, 2018.

SBTTP-502 Laboratory Course in Pharmaceutical Biotechnology

1. Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic methods as per IP/US Pharmacopoeia.
2. Microbiological assays of antibiotics.
3. Sterility testing and stability testing of parenteral formulations.
4. Sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins)
5. Assays for screening antimicrobial/antifungal agents from plants and other natural sources.
6. Test for disinfectants (phenol coefficient / RWC method).
7. Determination of antibacterial spectrum for drugs/antibiotics.
8. Testing for antibiotic / drug sensitivity /resistance.
9. Determination of MIC value for antimicrobial chemicals.

SBTTE-501 Animal Biotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-501	Animal 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-501	Animal Biotechnology	15	15	15	60	--	--	75

Course pre-requisite:

- Basic understanding of Cell and developmental Biology.

Course objectives:

- The objective of this course is to enable students to develop basic skills for vertebrate cell culture, maintenance of cell lines and in vitro application of cell and molecular techniques and also to understand the principles of animal cloning and its applications.

Course outcomes: Students will be able to

- Explain the fundamental scientific principles that underlie cell culture
- Acquire knowledge for isolation, maintaince and growth of cells.
- Develop proficiency in establishing and maintaining of cell lines.
- Acquire knowledge in animal cloning and its applications

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Introduction to Animal Cell Science**	11
	1.1	Structure and organization of animal cell. Equipments and materials for animal cell culture technology.	
	1.2	Primary and established cell line cultures. Introduction to the balanced salt solutions and simple growth medium.	
	1.3	Brief discussion on the chemical, physical and metabolic functions of	

		different constituents of culture medium.	
	1.4	Role of carbon dioxide. Role of serum and supplements. Serum and protein free defined media and their applications. Application of animal cell culture.	
2.0		**Cell lines and its applications**	11
	2.1	Primary and secondary culture of animal cells: types of primary cell cultures, isolation of tissue and primary culture.	
	2.2	Subcultured propagation, criteria for subculture and propagation, split ratio, subculture in suspension.	
	2.3	Basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.	
	2.4	Scaling- up of animal cell culture.	
3.0		**Cell lines and its applications**	12
	3.1	Culture and maintenance of cell lines, Biology and characterization of the cultured cells, Measurement of viability,	
	3.2	Model animals in animal biotechnology	
	3.3	DNA transfer techniques in to mammalian cells, Microinjection, electroporation, Stem cell etc.	
	3.4	Artificial insemination, IVF, somatic cell nuclear transfer and stem cell technology.	
4.0		**Animal Cloning**	11
	4.1	Principle, Concept and application of animal cloning	
	4.2	Embryonic stem cells and their applications.	
	4.3	Cell culture based vaccines, viral vectors, Gene therapy	
	4.4	Animal ethics and bio safety, Principle of tissue engineering	
		Total	45

References

1. Ian, R. Freshney Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications , 4th Edition, 2000.
2. Ranga, M. M. Animal Biotechnology, 2nd edition, Agrobios, 2007.
3. Masters, J. R. W. Animal Cell Culture, 3rd Edition, Oxford University Press, 2000.
4. Marshak, D. R., Gardner, R. L. and Gottlieb, D. Stem Cell Biology, Volume 40, Cold Spring Harbor Publication, 2001.

SBTTE- 502 Laboratory course in Animal Biotechnology

1. Enumeration of Red Blood cells (RBCs) from sheep and human blood
2. Isolation of Cells from Liver tissue and its Quantification
3. Cell Viability assay using dye-exclusion method
4. Micronucleus Assay
5. Hemolytic test for *Staphylococcus aureus*
6. Con-A induced Hemagglutination Assay
7. Anchorage independent cell culture(Lymphocyte culture)
8. Anchorage dependent cell culture (chick embryo cell culture)

9. Epithelial cell culture
10. Anti-angiogenic activity using chick chorio-allantoic membrane(CAM) assay
11. Preparation of culture media.

BTTE-503 Microbial and Enzyme Technology
Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-503	Microbial and Enzyme Technology	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-503	Microbial and Enzyme Technology	15	15	15	60	--	--	75

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

Course objectives:

- To make Students learn structural and functional relationships in enzymes and altering their structure in order to function 'better'.
- To provide basic knowledge of microbes and enzyme technology and use of enzymes as tools in industry, agriculture and medicine.
- To exploit microbes and enzymes for the production of human beneficial products

Course outcomes: Students will be able to

- Learn kinetics of enzyme catalyzed reactions & enzyme inhibitory and regulatory process.
- Perform immobilization of enzymes
- Understanding of microbial pathways
- Get exposure of wide applications of microbes and enzymes and their future potential

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Fundamentals of Microbial Metabolism**	12
	1.1	Isolation, development, presentation and improvement of industrially important micro-organism; isolation of auxotrophic mutants	

	1.2	Isolation of revertant mutants and use of recombinant systems for improvement of industrial microorganisms; metabolic pathways: Regulatory mechanism of metabolic pathways in industrial strains	
	1.3	Bioenergetics-basic principles; equilibria and concept of free energy; coupled processes; glycolysis and glycolytic enzymes regulation	
	1.4	TCA-cycle and enzyme regulation; oxidative phosphorylation and enzyme regulation; fatty acid metabolism; principles of metabolic regulation; regulatory steps	
2.0		**Enzyme catalysis and kinetics**	11
	2.1	Source of enzymes; production, isolation and purification of enzymes; characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effect of metal ions etc.	
	2.2	Enzyme kinetics: Enzymes as Biological catalysts; enzyme action: Active site, functional group, enzyme substrate complex, cofactors	
	2.3	Michaelis-Menten equation; enzyme inhibition; methods of plotting enzyme kinetics data	
	2.4	Enzyme turnover; enzyme induction, repression, covalent modification, isoenzymes, allosteric effect	
3.0		**Enzyme Engineering and Immobilization**	11
	3.1	Rationales for enzyme engineering, steps in enzyme engineering, chemical methods for modifying enzyme activity	
	3.2	Site directed mutagenesis, protein engineering, mechanism of protein folding and its pathological effects	
	3.3	Immobilized enzyme technology: different techniques of immobilization of enzymes and whole cells	
	3.4	Advantages and disadvantages of immobilization; application of cell and enzyme immobilization and biosensors	
4.0		**Clinical and Industrial Enzymes**	11
	4.1	Clinical and diagnostics enzymes and their applications, enzymes as therapeutic agents	
	4.2	Enzymes in food processing, leather, textile, detergent and pharmaceuticals and fine chemical industries	
	4.3	Enzymes in organic solvents and ionic liquids: various organic solvents and ionic liquids used in bio catalysis	
	4.4	Potential of enzymes in organic solvents and ionic solvents.	
		Total	45

Reference Books*:*

1. Dixon, M. and Webb, E. C. Enzyme Inhibition and Activation in: Enzymes, 3rd Edition, Pp. 126–136, 332–399, Academic Press, New York, 1979.
2. Palmer, T. Understanding enzymes, 4th edition, Prentice Halls/Ellis Horwood Ltd. Publication, London, 1995.
3. Price, N. C. and Stevens, L. Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins, 3rd Edition, Oxford science publications, New York, 1999.
4. Buchholz, K., Kasche, V. and Bornscheuer, U. T. Biocatalysts and enzyme technology, 2nd Edition, Wiley-Blackwell Publication, 2012.

5. Copeland, Robert, A. Enzymes: a practical introduction to structure, mechanism and data analysis, John Wiley & Sons, 2004.
6. Balasubramanian, D., Bryce, C. F. A., Dharmalingam, K., Green, J. and Jayaraman, K. Concepts in Biotechnology, 2nd Edition, Universities Press, 2004.
7. Rastogi, S. C., Mendiratta, N. and Rastogi, P., Bioinformatics - Methods and Applications :(Genomics, Proteomics and Drug Discovery), 4th Edition, PHI Learning, 2006.
8. Satyanarayana, U. and Chakrapani, U. Biotechnology, 1st Edition, Books and Allied Ltd. 2005.
9. Smith, J. E. Biotechnology, 5th Edition, Cambridge University Press, 2009.
10. Berg, J. M., Tymoczko, J. L., Gatto G. J. and Stryer, L. Biochemistry, 8th Edition, WH Freeman and Company, 2015.
11. Creighton, T. E. Protein - Structure and Molecular Properties, 2nd Edition, W.H. Freeman and Co. Ltd, 1993.
12. Primrose, S. B. and Twyman, R. M., Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing 2006.
13. Sambrook, J., Fritsch, E. R. and Maniatis, T. Molecular Cloning: A Laboratory Manual, 2nd Edition, Cold Spring Harbo Laboratory Press, 1989.

SBTTE-504 Laboratory Course in Microbial and Enzyme Technology

1. Isolation of microbial strains for the production of commercially important enzymes.
2. Production of commercially important enzymes from microbial source.
3. Standardization of medium, composition for the optimum production of enzymes
4. Partial purification of isolated enzymes
5. Determination of enzyme activity and specific activity of α-amylase/lipase.
6. Study of Maltose calibration curve
7. Characterization of enzymes effect of pH, temperature metal ions, substrate and inhibitors on enzyme activity.
8. Study of kinetic parameters Km, Vmax and Kcat
9. Molecular weight determination of enzyme by gel filtration method
10. Method of checking the purity of the enzymes SDS PAGE
11. Immobilization of enzymes
12. Characterization of clinical and industrially important enzymes

SEMESTER IV

SBTTC-551: Plant Biotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-551	Plant Biotechnology	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-551	Plant Biotechnology	20	20	20	80	--	--	100

Course pre-requisite:

- The students should be familiar with the fundamentals of Plant Sciences and Biotechnology

Course objectives:

- To acquaint the students with basic principles and various methods of Tissue Culture.
- To impart knowledge about varied methods of gene transfer and transgenic plant development.
- To underhand basics of secondary metabolites and their engineering.
- To acquire knowledge about molecular markers and their use in plant breeding.

Course outcomes: Students will

- Demonstrate the knowledge about the techniques of Plant Tissue Culture and acquire comprehensive knowledge on GM technology for quality characteristics and their role in crop improvement.
- Acquire knowledge in metabolic engineering and industrial products.
- Develop skills in molecular marker studies and their use in plant breeding.
- Shall develop scientific skills to work in Plant tissue culture, Pharmaceutical and Research laboratories.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**UNIT I**	15
	1.1	History: Important events in the history of plant tissue culture; Laboratory Requirements and General Techniques; Cellular Totipotency	
	1.2	Tissue Culture Media: Introduction, media constituents, media selection, media preparation; Callus Culture; Micropropagation: Introduction, techniques, applications, production of pathogen free plants	
	1.3	Somatic Embryogenesis; Haploid Production: Introduction, techniques, factor affecting androgenesis, ontogeny of androgenic haploids	

	1.4	Plant regeneration from pollen embryos, homozygous diploids, applications, limitations; Triploid production.	
2.0		**UNIT II**	15
	2.1	Somaclonal & gametoclonal variations; Protoplast Culture: Protoplast isolation, fusion and regeneration,	
	2.2	Cybrids; Embryo Culture and embryo rescue: Introduction, techniques; Synthetic Seeds	
	2.3	Cell and Suspension Culture: Introduction, isolation of single cells, suspension cultures, culture of single cells, plant cell reactors, applications of cell culture	
	2.4	Production of secondary metabolites: Introduction, strategies used to optimize product yield, commercial aspects	
3.0		**UNIT III**	15
	3.1	Introduction to transgenic technology: Conventional breeding versus Transgenesis; Introduction to *Agrobacterium tumefaciens* and *A. rhizogenes*, Features of Ti and Ri Plasmids and their use as vectors, Binary and co-integrate vectors	
	3.2	*Agrobacterium* mediated transformation, Direct DNA transfer to plants, Detection, characterization and expression of Transformants	
	3.3	Applications of plant transformation for productivity and performance: GM technology for Conferring resistance to biotic stresses (pests, viruses and fungi) and abiotic stresses (draught and salt), Herbicide resistance	
	3.4	Increasing shelf life of fruits and flowers, Enhancing the nutritional quality (pro-vitamin A), Chloroplast Transformation	
4.0		**UNIT IV**	15
	4.1	Metabolic engineering and industrial products: Plant secondary metabolites: alkaloids, industrial enzymes	
	4.2	Biodegradable plastic: polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, oleosin partitioning technology etc	
	4.3	Aspects related to commercial release of transgenic crops.	
	4.4	Molecular marker aided breeding**:** RFLP, RAPD, Microsatelites, AFLP etc.	
		Total	60

References :

1. Razdan, M. K. Introduction to Plant Tissue Culture, 2nd Edition, Oxford and IHB publishing Co. Pvt. Ltd. 2003.
2. Kumar, U. Methods in Plant Tissue Culture, 1st Edition, Bikaner: Agro Botanica, 1999.
3. Misawa M. Plant tissue culture: An Alternative for Production of Useful Metabolites, Daya Publishing House, New Delhi, 1994.
4. Bhojwani, S. S., and Razdan, M. K. Plant Tissue Culture, Theory and Practice a Revised Edition, Volume 5, Elsevier India Ltd, 1996.
5. S. Ignacimuthu, S. J. Applied Plant Biotechnology, Science Publishers,U.S., 1997.
6. Young, M. M., Flower, M. W. and Warren, G. S. Plant Biotechnology: Comprehensive Biotechnology, Second Supplement, 1st Edition, Oxford Pergaman press, 1992.

7. Hammond, J.; McGarvey, P., and Yusibov, V. Plant Biotechnology: New Products and Applications: 240 (Current Topics in Microbiology and Immunology), Springer-Verlag Berlin and Heidelberg GmbH & Co, New Delhi, 2000.
8. Mantell, J. H., Matthews, J. A. and Mckee, R. A. Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants, Oxford, Blackwell Scientific Publication, 1985.
9. Singh, C. H. Biotechnology in Crop Improvement, International Book Distribution Company, Lucknow, 1998.
10. Gupta, P. K. Elements of Biotechnology, Rastogi and Company Meerut, 1996.
11. Pareek, L. K. and Swarnakar, P. L. Trends in Plant Tissue Culture and Biotechnology, Agro Botanica Publishers, 1997.
12. Esra Galun, Adina Breiman, Transgenic Plants, Imperial College Press, 1997.
13. Singh, B. D. Biotechnology, Kalyani Publishers , Ludhiana, India, 1998.
14. Narayanaswamy, S. Plant Cell and Tissue Culture, Tata McGraw Hill Education Publication, 1992.
15. Hammond, J., McGarvey, P. and Yusibo, V. Plant Biotechnology : New Products and Applications: 240 (Current Topics in Microbiology and Immunology), Springer-Verlag Berlin and Heidelberg GmbH & Co., 1999.
16. Fu, T. J., Singh, G. and Curist, W. R. Plant Cell and Tissue Culture for the production of Food Ingredients, Springer Boston MA press, 1999.
17. Chawla, H. S. Biotechnology in Crop Improvement, International Book Distribution Company, 1998.

SBTTP-551 Laboratory Course in Plant Biotechnology

1. Preparation of MS medium
2. Surface sterilization
3. Micro propagation of plant through multiplication of pre-existing meristems.
4. Hardening of *in vitro* raised plants
5. Encapsulation of somatic embryos
6. Embryo culture and embryo rescue.
7. Protoplast isolation, fusion and culture.
8. *In vitro* production of fast growing normal root culture for production of secondary metabolites
9. Elicitation of plant cells for secondary metabolites
10. *Agrobacterium* Ti plasmid based vector mediated transformation, selection of transformants, reporter gene assay.
11. Transformation of plant tissues using *Agrobacterium rhizogenes* for hairy root production
12. Transformation and expression of GFP gene in suitable host.
13. Developing RFLP maps, Developing RAPD maps

SBTTC-552: Genomics and Proteomics

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTC-552	Genomics and Proteomics	04	--	04	--	04

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTC-552	Genomics and Proteomics	20	20	20	80	--	--	100

Course pre-requisite:

- The students should be familiar with the Computers and Basic concepts of Bioinformatics.

Course objectives:

- To understand the concept of proteomics and their applications.
- To expose the students to methods of studying genetic materials obtained from various environmental samples.
- To provide students the understanding of basic concepts of sequences, structural alignment, database searching, protein structure prediction and computer-based drug designing.

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

- Perform alignment of sequences and construct the matrix for alignment based on dynamic programming
- Construct the phylogenetics of different sequences.
- Analyze sequence and structure of bio-macromolecule data
- Edit the three-dimensional structure of protein using structural bioinformatics tools
- Explain the properties of genetic materials and storage and processing of genetic information.
- Analyze genomic data.
- Explain biological phenomena based on comparative genomics
- Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis
- Use metagenomics approach for studying phenomena associated with microbial communities.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Genomics**	15
	1.1	Introduction, Methods of preparing DNA (isolation and *in-vitro* chemical synthesis)	
	1.2	DNA separation techniques and DNA sequence analysis: Introduction, methods, sanger and dideoxy method	
	1.3	Automated sequencing, fluorescence method	
	1.4	Genome mapping: Introduction, methods, construction, use of online tools for genome map construction	
2.0		**Genome Engineering**	15
	2.1	Microarray technology: Introduction, methods and application,	
	2.2	Combinational genomics: Introduction and application,	
	2.3	Synthetic chromosome pharmacogenomics and proteomics	
	2.4	Synthetic life pharmacogenomics and proteomics.	
3.0		**Proteomics**	15
	3.1	Introduction and scope	
	3.2	Polyacrylamide gel electrophoresis, Isoelectric focusing	
	3.3	Two dimensional PAGE for proteome analysis and image analysis of 2D gel	
	3.4	Mass spectrometry for protein identification	
4.0		**Protein Structure Prediction**	15
	4.1	Introduction, principle, tools, application for structure prediction of primary to quaternary structure of proteins	
	4.2	Protein engineering: Introduction, protein chips and functional proteomics,	
	4.3	Protein modeling, introduction, methods and tools	
	4.4	Assigning secondary structure	
		Total	60

References:

1. Primrose, S. B. and Twyman, R. M. Principles of Gene Manipulation and Genomics, 7th edition, Wiley - Blackwell Publishing, 2006.
2. Lesk, A. M. Introduction to Genomics, 7th Edition, Oxford University Press, 2007.
3. Lesk, A. M. Introduction to Bioinformatics, 3rd Edition, Oxford University Press, 2017.
4. Ghosh, Z. and Mallick, B. Bioinformatics: Principles and Applications, Oxford University Press India, 2008.
5. Lewin, B. Genes VIII: International Edition, Pearson Education International, 2003.

SBTTP-552 Laboratory course in Genomics and Proteomics

1. Proteomics tools,
2. Structural and functional predictions,

3. Phylogenetic Analysis, Phylogenetic tree construction
4. DNA and protein sequence and retrieval and submission
5. Local and global sequence alignment of protein and DNA sequences,
6. Needleman Wunsch and Smith-Waterman algorithm,
7. BLAST, Multiple sequence alignment

SBTTE-551: Nanobiotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-551	Nanobiotechnology	03	--	03	--	03

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SBTTE-551	Nanobiotechnology	15	15	15	60	--	--	75

Course pre-requisite: General awareness regarding Nanomaterials and Biotechnological techniques

Course objectives:

- To introduce to the students various opportunities in the emerging field of Bioscience & nano-bioscience through nanotechnology and to make the students familiar with the important concepts applicable to bioscience and nano biotechnology and its applications.

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

- Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.
- Learn various approaches of synthesizing nanomaterials, their advantages and limitations.
- Gain knowledge about various techniques used for characterizing nanomaterials.
- Comprehend the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications.
- Evaluate the potential toxic effects of nanotechnology on living organisms and the environment.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0	**1**	**Introduction to Nano Science**	11
	1.1	Basic concepts of quantum mechanics and quantum theory	
	1.2	mechanical properties of nanomaterials, structural properties, optical properties, melting and electrical conductivity of nanoparticles	
	1.3	Analytical techniques used in Nanotechnology: Diffraction, UV-visible spectroscopy, optical microscope	
	1.4	Analytical techniques used in Nanotechnology: Atomic force microscope, electron microscope SEM and TEM	
2.0	**2**	**Methods of Synthesis of Nanoparticles**	12

	2.1	Use of bacteria, Fungi, Actinomycetes	
	2.2	Magnetotactic bacteria for synthesis of magnetic nanoparticles, mechanism of formulation	
	2.3	Viruses as components for formulation of nanostructured materials, Synthesis process and applications	
	2.4	Role of plants in nanoparticles synthesis.	
3.0	**3**	**Nano-biomaterials**	11
	3.1	Biocompatibility, anti-bacterial activity	
	3.2	Principles involved applications. Biomaterial	
	3.3	Nanocircuitry, protein based nanocircuitry	
	3.4	DNA nanostructures for mechanics and computing, DNA based nanomechanical devices	
4.0	**4**	**Nanomedicines**	11
	4.1	Development of nanomedicine, nanodrug administration	
	4.2	Diagnostic application, therapeutic applications	
	4.3	Nano-tribology, drug and gene delivery for human health	
	4.4	Nano-biosensors, Nanomatechnology of cleaning environment for heavy metals and bioremediation.	
		Total	45

References:

1. Sulbha Kulkarni, Nanotechnology - Principles and Practices, 3rd Edition, Springer Nature Publication, 2015.
2. Mark Ratner and Donier Ratner Nanotechnology - A Gentle Introduction to Next Big Idea, 1st Edition, Pearson Publication, 2002.
3. Satya Prakash, Quantum Mechanics, Pragati Prakashan Publication Limited, Meerut, 2016.
4. Charles P. P. (Jr.), Frank J. O. Introduction to Nanotechnology, 1st Edition, Wiley-Interscience Publication, 2003.
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, 2004.
6. Niemeyer, C. M. and Mirkin, C. A. Nanobiotechnology: Concepts, Applications and Perspectives, Wiley, VCH, 2004.
7. Leggett, G. J. and Jones, R. A. L. Bionanotechnology: In Nanoscale Science and Technology, John Wiley & Sons, 2005.
8. Murthy, B. S., Shankar, P., Raj, B., Rath, B. B. and Murday, J. Textbook of Nanoscience and Nanotechnology (Universities Press-IIM Series in Metallurgy and Materials Science), Springer Publication, 2012.
9. Pradeep, T. Nano: The Essentials Understanding Nanoscience and Nanotechnology, McGraw Hill Publishing Company Ltd. 2007.
10. Goodsell, D. S. Bionanotechnology : Lessons from Nature, John Wiley & Sons, 2004.
11. Bhushan, B. Springer Handbook of Nanotechnology, 2nd Edition, Springer Publications, 2007.
12. Nalwa, H. S. Encyclopedia of Nanoscience and Nanotechnology, Volume1-10, American Scientific Publishers, 2004.

SBTTE-452 Lab Course in Nanobiotechnology

1. Synthesis of nanomaterials by using microbial sources (bacteria, Fungi, Actinomycetes)
2. Synthesis of nano-magnetic particles
3. Detection and Analysis of Nanomaterials using UV-Spectrophotometer
4. Study of topography of Nanomaterials by Atomic Force Microscopy
5. Characterizations and Analysis of Nanomaterials by SEM/TEM
6. Antimicrobial activity of Nanomaterials
7. Evaluation of efficacy of drug conjugated with nanomaterials.
8. Bioremediation of heavy metals by Nanotechnology
9. Pollutant removal using Nanomaterials from industrial effluent.

SBTTE-553: Food Biotechnology

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SBTTE-553	Food 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-553	Food Biotechnology	15	15	15	60	--	--	75

Course pre-requisite:

- General awareness of food items

Course objectives:

- To provide basic knowledge about food biotechnology and preliminary preparation of food before actual processing steps.
- To know the effect of microorganisms on food and to make the clear understanding about chemical and microbiological properties of food etc.
- To understand the concept of food born infections and to aware about laws and standards in food biotechnology.

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

- Comprehend the different microorganisms roles involved in food biotechnology with different food items.
- Define and explain different preliminary steps before and after food fermentation.
- Comprehend phenomenon of food degradation and spoilage by microorganisms with change in the properties of food.
- To create awareness about different laws and standards in food biotechnology.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Microbes and Food**	12
	1.1	Characteristics of Microorganisms in Food, Types of microorganisms associated with food	

	1.2	Factors affecting the growth of micro-organisms in food, Microbial Food Spoilage, Sources of Microorganisms in foods	
	1.3	Some important food spoilage microorganisms, Spoilage of specific food groups- Milk and dairy products, Meat, poultry and seafood's, Cereal and cereal products	
	1.4	Fruits, vegetables and Canned food products.	
2.0		**Food fermentations**	11
	2.1	Food Fermentations – Definition and types of fermented food, Microorganisms used in food fermentations	
	2.2	Dairy Fermentations- starter cultures and their types	
	2.3	Concept of probiotics, biotechnological process for food fortification	
	2.4	Prebiotics and oligosaccharides, fermented foods-types, methods of manufacture for vinegar, sauerkraut, tempeh, miso, soya sauce, beer, wine and traditional Indian fermented foods.	
3.0		**Food-borne Diseases**	11
	3.1	Foodborne Diseases, Types – Food borne infections, food borne intoxications and toxin infections, with common and recent examples.	
	3.2	Control of microorganisms in foods, Principles and methods of preservation, Physical Methods of Food Preservation- Dehydration, Freezing, Cold storage, Heat Treatment, Irradiation	
	3.3	Bio-preservatives i.e Bacteriocins and other natural products	
	3.4	Role of lactic acid bacteria in preservation of food items	
4.0		**Food safety laws and Standards**	11
	4.1	Food safety Laws and Standards: Food quality & analysis: Pre and Post-harvest factors in food quality	
	4.2	Physical, Chemical and Microbiological factors of quality, proximate analysis of foods, sample and sample preparation in foods.	
	4.3	Food laws: voluntary and mandatory food laws in India.	
	4.4	Food certification agencies.	
		Total	45

References:

1. Hotchkiss, N. N., Potter and Joseph, H. Food Science, 5th Edition, Science Technology Publication, 2007.
2. M. Shafiur Rahman, Handbook of Food Processing, 2nd Edition, CRC Press Taylor and Francis group, 2007.
3. Frazier, W. C., Westhoff, D. C. and Vanitha N. M. Food Microbiology, 5th Edition, McGraw Hill Education Publication, 2004.
4. Sivasankar, B. Food Processing and Preservation, Prentice Hall India Learning Private Limited Publication, 2002.
5. Avantina Sharma, Textbook of Food Science & Technology, Vol-I & II, 1st Edition, International Book Distributing Company, 2006.

6. Cheung, P. C. K., Mehta, B. M. Handbook of Food Chemistry, Ist Edition, Springer-Verlag Berlin Heidelberg, 2015.
7. Jay, J. M., Golden, D. A. and Loessner M. J. Modern Food Microbiology (Food Science Text Series), Springer-Verlag New York Inc. Publication, New Delhi, 2000.
8. Garbutt, John. Essentials of Food Microbiology, Hodder Arnold H&S Publication, London, 1997.
9. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. Microbiology, 5th Edition, Affiliated East-West Press Private Limited Publication, 1993.
10. Lawley, R., Curtis L. and Davis, J. The Food Safety Hazard Guidebook, Royal Society of Chemistry publication, 2004.

SBTTE-454 Laboratory course in Food Biotechnology

1. Isolation of microorganism from spoiled food (Dairy products, Meat products, Vegetables & Fruits)
2. Isolation of microorganism from traditional Indian fermented foods
3. Production and characterization of bacteriocin from probiotic microorganisms.
4. Antimicrobial activity of spices and oils against food spoilage causing microorganism
5. Microbiological Analysis of Milk: Raw and Pasteurized Milk - MBRT, SPC, Coliform, Sterilized Milk / LHT Milk - Spore Count.
6. Microbiological analysis of Milk Products: Analysis of butter, ice cream, Paneer, Standard plate count, coliform count, yeast and mold count.
7. Proximate analysis of dairy & fermented foods

SVECP-551: Publication Ethics

Teaching Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SVECP-551	Publication Ethics	02	--	02	--	02

Assessment Scheme

Course Code	Course Name	Theory				Practical		Total
		CA			ESA			
		Test I	Test II	Avg of (T1+T2)/2		CA	ESA	
SVECP-551	Publication Ethics	10	10	10	40	--	--	50

Course pre-requisite:

- General awareness regarding publication basics

Course objectives:

- To know rules, issues, options, and resources for research ethics.
- To familiarize with various institutional ethics review boards/academic integrity guidelines.
- To understand the purpose and value of ethical decision-making.
- To have a positive disposition towards continued learning about research ethics

Course outcomes:

- To have a positive disposition towards continued learning about research philosophy & ethics.
- To know Rules, Regulations, Issues, Options, and Scientific Resources of Research Ethics.
- To learn the culture of fairness, honesty and integrity in academic communications and to understand the purpose and value of ethical decision-making.
- Avoid wasteful and duplicate publications & encourage original contributions to advance Academic Research and Scholarship.
- Acquiring knowledge & professional competence and expertise about Patents, Copyrights, and other forms of Intellectual Property Rights.
- To promote social good and prevent or mitigate societal hazards through innovative ideas, creativity and research advocacy

Curriculum Details:

Curriculum Details:

Module No.	Unit No.	Topic	Hrs.
1.0		**Publication ethics**	**08**
	1.1	Publication ethics: definition, introduction and importance, Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest	
	1.2	Publication misconduct: definition, concept, problems that lead to unethical behavior and vice verse, types	
	1.3	Violation of publication ethics, authorship and contributor ship	
	1.4	Identification of publication misconduct, complaints and appeals. Predatory publishers and journals	
2.0		**Open access publishing**	**07**
	2.1	Open access publications and initiatives.	
	2.2	SHERPA/RoMEO online resource to check publisher copyright and self- archiving policies	
	2.3	Software tool to identify predatory publications developed by SPPU	
	2.4	Journal finder/ journal suggestion tools viz. JANE	
3.0		**Publication misconduct**	**07**
	3.1	Subject specific ethical issues, FFP, authorship	
	3.2	Conflicts of interest	
	3.3	Complaints and appeals: examples and fraud from India and abroad	
	3.4	Use of plagiarism software like Turnitin, Urkund and other open source software tools.	
4.0		**Databases and research metrics**	**08**
	4.1	Databases: Indexing databases	
	4.2	Citation databases: Web of Science, Scopus, etc.	
	4.3	Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score.	
	4.4	Metrics: h-index, g index, i10 index, altmetrics	
		Total	**30**

References:

1. Donna M. Mertens, Pauline E. Ginsberg The Handbook of Social Research Ethics, SAGE (2009).
2. Rose Wiles, Bloomsbury What are Qualitative Research Ethics? (2013).
3. Robin Levin Penslar, eds, Research Ethics: Cases and Materials, Indiana University Press (1995).
4. Gary Comstock, Research Ethics: A Philosophical Guide to the Responsible Conduct of Research, Cambridge University Press (2013)
5. Bird, A. Philosophy of Science. Routledge, 2006.

6. MacIntyre, Alasdair A Short History of Ethics London, 1967
7. P. Chaddah Ethics in Competitive Research: Do not get scooped; do not get plagiarized, 2018
8. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009).
9. On being a Scientist: A Guide to Responsible Conduct in Research. Third Edition. National Academies Press.
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    http://www.insaindia.res.in/pdf/Ethics Book.pdf

**********04.06.2024**********