॥ 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 पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४–२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यात येत आहे.

01	**B.Sc. III Year Biotechnology (Vocational)**
02	**B.Sc. III Year Bioinformatics**
03	**B.Sc. III Year Biotechnology**

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/परिपत्रक/पदवी/बीएस्सी/२०२६–२७/125
दिनांक : ०५.०८.२०२६

5/8

उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळे) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :–

१) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. प्र.कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ
३) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परिक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
६) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यांना देवून कळविण्यात येते की, परिपत्रक अभ्यासक्रम संकेतस्थळावर प्रसिध्द करण्यात यावेत.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

STRUCTURE AND SYLLABUS OF FOUR YEAR MULTIDISCIPLINARY

DEGREE PROGRAM WITH MULTIPLE ENTRY AND EXIT OPTIONS

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: BIOTECHNOLOGY (Single Major)

FACULTY OF SCIENCE AND TECHNOLOGY

B. Sc. Third Year
(Affiliated Colleges)

With Effect from June 2026

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 the New Education Policy 2020 provided such an opportunity. 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 firsthand work experience, teamwork 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

From the Desk of the Chairman, BOS in Biotechnology and Bioinformatics:

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 Bioinformaticshas 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 directly be 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 stakeholdersare welcome for upbringing this curriculum.

Salient Features:

The syllabus of B.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 deals with Plant Biotechnology, Recombinant DNA Technology, Animal Biotechnology and Fundamental Genomics.

Apart from the core courses, the Elective Courses deal with Bioprocess Engineering OR Food Biotechnology and Industrial Biotechnology or Pharmaceutical Biotechnology

The Skill Enhancement Courses like Biopesticide and Biofertilizer Production Technology offered during this program are designed with the aim of imparting specific skills to the students, which will lead to the self-employability and development of their own enterprises.

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

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

Program Educational Objectives:

The Objectives of this program are:

PEO1: To offer undergraduate programin 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-employabilityand for the development of their own enterprises.

Program Outcomes:

The Outcomes of this program are:

PO1: This Biotechnology program shall promote and popularize biotechnology at grass root level and shall also attract young and budding talents.

PO2: This program will expose the students to the different emerging fields of Biotechnology.

PO3: This will provide updated curriculum with recent advances in the subject that enable the students to face NET, SET, MPSC, UPSC and other competitive examinations successfully.

PO4: This program shall train and orient the students so as to develop human resource for the educational institutes and other organizations.

PO5: This program shall train and orient the students so as to develop active and frontline researchers and human resource for the industries.

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

Dr. M. M. V. Baig
Chairman, BOS in Biotechnology and Bioinformatics
Swami Ramanand Teerth Marathwada University, Nanded.

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	Address	Designation
1	Dr. M. M. V, Baig Yeshwant Mahavidyalaya, Nanded Mob. No. 942210641	Chairman	2	Dr. Babasaheb S.Surwase School of Life Sciences SRTM University, Nanded Mob. No.9075829767	Member
3	Dr. Pratap V. Deshmukh Nagnath Arts, Commerce and Science College, Aundha Nagnath, Dist. Hingoli Mob. No. 9637202024	Member	4	Dr. Komal S. Gomare Dept of Biotechnology Dayanand Science College, Latur Mob. No. 9284238413	Member
5	Dr. Vaibhav D. Deshpande General Manager, Quality Corporate Office, Wockhardt, Mumbai Mob. No. 9100988260	Member	-	--	
	Invitee Members				
6	Dr. Laxmikant Kamble School of Life Sciences, SRTM University, Nanded 431606. Mob. No.8669695555	Member	7	Dr B. Y. Gottigalla Dept of Biotechnology, Yeshwant Mahavidyalaya, Nanded. Mob. No. 9960742399	Member
8	Dr. A.B. Gulwe School of Technology, SRTM University Sub Campus, Latur. Mob. No. 7387120874	Member	9	Dr Makarand N. Cherekar Dept. of Biotechnology & Bioinformatics, MGM's College of CS and IT, Nanded. Mob: 9421454254	Member
10	Dr. Nilesh More Dept. of Biotechnology, College of CS & IT, Latur. Mob: 8329502899	Member	11	Dr. Firdous Samad Biradar Dept. of Biotechnology, Dayanand Science College, Latur. Mob 7972993782	Member

Swami RamanandTeerthMarathwada University, Nanded

Faculty of Science and Technology

Credit Framework for B.Sc.III Year

Multidisciplinary Degree Program with Multiple Entry and Exit

Subject: BIOTECHNOLOGY(Major)

Year & Level	Semester	Major *(From the same Faculty)*		Minor 1 *(From the same Faculty)*	Minor 2 *(From the same Faculty)*	Generic Elective (GE) (select from Basket 3 of *Faculties other than Science and Technology*)	Vocational & Skill Enhancement Course	Ability Enhancement Course (AEC) (Basket 4) Value Education Courses (VEC) / Indian Knowledge System (IKS) (Basket 5)	FieldProject/ Case Study/ OJT/	Credits	Total Credits
1	2	3		4	5	6	7	8	9	10	11
3 (5.5)	V	SBTTCT 1301 (3cr) SBTTCT 1302 (3cr) SBTTIKS 1303 (2cr) SBTTCP 1301 (2cr) SBTTCP 1302 (2cr) 12 Credits	Major Elective SBTTET 1301 (2cr) SBTTEP 1301 (2cr) 04 Credits	--	--	--	SBTTVC1301 02 Credits	--	FP/CS SBTTFP1301 Or SBTTCP1301 04 Credits	22	132
	VI	SBTTCT1351 (3cr) SBTTCT1352 (3cr) SBTTCT 1353 (2cr) SBTTCP1351 (2cr) SBTTCP1352 (2cr) 12 Credits	Major Elective SBTTET 1351 (2cr) SBTTEP 1351 (2cr) 04 Credits	--	--	--	SBTTVC1351 02 Credits	--	OJT SBTTOJ1351 04 Credits	22	
	Cum. Cr.	56		16	08	08	08+4=12	22	08+2=10	44	
Exit option: UG Diploma in Major Biotechnology and Minor Biotechnology on completion of 88 credits and additional 4 credits NSQF / internship in Biotechnology											

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SBTTCT 1301	Plant Biotechnology	03	--	12	03	--
	SBTTCP 1301	Practical Based on SBTTCT 1301	--	02		--	04
	SBTTCT 1302	Recombinant DNA Technology	03	--		03	--
	SBTTCP 1302	Practical Based on SBTTCT 1302	--	02		--	04
	SBTTIKS 1303	IKS in Biotechnology	02	--		02	--
Elective	SBTTET 1301	Bioprocess Engineering OR Food Biotechnology	02	--	04	02	--
	SBTTEP 1301	Practical Based on SBTTET 1301	-	02		--	04
Vocational Course	SBTTVC1301	Biopesticide Production Technology	--	02	02	--	04
Field Project/ Case Study/ OJT	SBTTFP1301 Or SBTTCS1301	Field Project/ Case Study	--	04	04	--	08
Total Credits 22			10	12	22	10	24

B. Sc. Third Year Semester V*(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (***CA***) and 60% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SBTTCT 1301	Plant Biotechnology	15	15	30	45	--	--	75
	SBTTCP 1301	Practical Based on SBTTCT 1301	--	--	--	--	20	30	50
	SBTTCT 1302	Recombinant DNA Technology	15	15	30	45	--	--	75
	SBTTCP 1302	Practical Based on SBTTCT 1302	--	--	--	--	20	30	50
	SBTTIKS 1303	IKS in Biotechnology	10	10	20	30	--	--	50
Elective	SBTTET 1301	Bioprocess Engineering OR Food Biotechnology	10	10	20	30	--	--	50
	SBTTEP 1301	Practical Based on SBTTET 1301	--	--	--	--	20	30	50
Vocational Course	SBTTVC1301	Biopesticide Production Technology	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SBTTFP1301 Or SBTTCS1301	Field Project/ Case Study	--	--	--	--	40	60	100

Teaching Scheme

	Course Code	CourseName	CreditsAssigned			TeachingScheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SBTTCT 1351	Animal Biotechnology	03	--	12	03	--
	SBTTCP 1351	Practical Based on SBTTCT 1351	--	02		--	04
	SBTTCT 1352	Fundamental Genomics	03	--		03	--
	SBTTCP 1352	Practical Based on SBTTCT 1352	--	02		--	04
	SBTTCT 1353	Bio entrepreneurship	02	--		02	--
Elective	SBTTET 1351	Industrial Biotechnology OR Pharmaceutical Biotechnology	02	--	04	02	--
	SBTTEP 1351	Practical Based on SBTTET 1351	-	02		--	04
Vocational Course	SBTTVC1351	Biofertilizer Production Technology	--	02	02	--	04
Field Project/ Case Study/ OJT	SBTTOJT1301	OJT	--	04	04	--	08
Total Credits 22			10	12	10	12	22

B. Sc. Third Year Semester VI*(Level 5.5)*

Examination Scheme

[40% Continuous Assessment (***CA***) and 60% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

Subject (1)	Course Code (2)	CourseName (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SBTTCT 1351	Animal Biotechnology	15	15	30	45	--	--	75
	SBTTCP 1351	Practical Based on SBTTCT 1351	--	--	--	--	20	30	50
	SBTTCT 1352	Fundamental Genomics	15	15	30	45	--	--	75
	SBTTCP 1352	Practical Based on SBTTCT 1352	--	--	--	--	20	30	50
	SBTTCT 1353	Bio entrepreneurship	10	10	20	30	--	--	50
Elective	SBTTET 1351	Industrial Biotechnology OR Pharmaceutical Biotechnology	10	10	20	30	--	--	50
	SBTTEP 1351	Practical Based on SBTTET 1351	--	--	--	--	20	30	50
Vocational Course	SBTTVC1351	Biofertilizer Production Technology	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SBTTOJT1301	OJT	--	--	--	--	40	60	100

SEMESTER V

B.Sc. Biotechnology
SBTTCT-1301: Plant Biotechnology

Credits: 3 **Hours: 45**

Course pre-requisite: Basic knowledge of Plant Biology, Genetics, and Molecular Biology.

Course objectives:

- To Understand the fundamentals of plant biotechnology.
- To Learn plant tissue culture and genetic engineering techniques.
- To Explore applications in crop improvement and agriculture.

Course Outcomes: Students shall be able to

- Explain basic concepts of plant biotechnology.
- Apply plant tissue culture techniques.
- Describe plant genetic engineering methods.
- Discuss applications of plant biotechnology in agriculture and industry

Module No.	Unit No.	Topic	Hrs
1.0		**Introduction to Plant Biotechnology and Applications**	**12**
	1.1	Definition, scope and importance of plant biotechnology; History and milestones in plant biotechnology.	
	1.2	Plant cell totipotency and differentiation; Plant growth regulators and their role in tissue culture. Culture media: MS medium, B5 medium, White's medium, Nitsch medium	
	1.3	**Applications :** Crop improvement strategies. Insect-resistant crops (Bt crops). Herbicide-resistant crops. Disease-resistant crops. Abiotic stress tolerance. Biofortification.	
	1.4	Production of secondary metabolites. Hairy root culture technology. Edible vaccines. Plant-made pharmaceuticals. Future prospects of plant biotechnology.	
2.0		**Plant Tissue Culture**	**11**
	2.1	Basic concepts of plant tissue culture. Laboratory organization and aseptic techniques Explant selection and sterilization; Callus culture;	
	2.2	Cell suspension culture; Organ culture; Meristem culture; Embryo culture and embryo rescue. Anther and pollen culture; Ovary and ovule culture;	
	2.3	Micropropagation; Somatic embryogenesis. Synthetic seeds; Germplasm conservation and cryopreservation.	
	2.4	Applications: Production of virus-free plants, Rapid clonal propagation, Conservation of endangered plants, Crop improvement.	
3.0		**Somatic Hybridization and Molecular Markers**	**11**
	3.1	Protoplast isolation; Protoplast fusion techniques: Somatic hybridization, Cybrid production.	
	3.2	Somaclonal variation. Gametoclonal variation.	
	3.3	Molecular markers: RFLP, RAPD, AFLP, SSR SNP markers, DNA fingerprinting.	
	3.4	Applications of molecular markers in plant breeding	

4.0		Plant Genetic Engineering	11
	4.1	Recombinant DNA technology. Restriction enzymes and ligases.	
	4.2	Cloning vectors: Ti plasmid , Ri plasmid, Plant viral vectors (CaMV, TMV);	
	4.3	Gene transfer methods: Agrobacterium-mediated transformation, Particle bombardment, Electroporation, Microinjection; Marker genes and reporter genes.	
	4.4	Development of transgenic plants. Molecular analysis of transformants. Biosafety and ethical issues.	

SBTTCP-1301: Lab Course in Plant Biotechnology

Credit 2 **Hours: 60**

Sr.No.	List of Experiments: Plant Biotechnology
1.	Preparation of tissue culture media (MS medium).
2.	Sterilization techniques.
3.	Micropropagation of plants (Demonstration)
4.	Establishment of aseptic culture.
5.	Callus induction from explants.
6.	Anther culture.
7.	Embryo culture.
8.	Isolation of plant genomic DNA.
9.	Quantification of DNA.
10.	Agarose gel electrophoresis.
11.	PCR amplification of plant DNA.
12.	Demonstration of Agrobacterium-mediated transformation.
13.	Protoplast isolation (demonstration

Text and Reference Books

1. Introduction to plant tissue culture – M.K. Razdan-Oxford and IBH
2. Biotechnological innovations in crop improvement- BIOTOL- Elsevier
3. Plant Cell and Tissue Culture: A Tool in Biotechnology- Karl-Hermann, A. Kumar-Springer
4. Plant Tissue Culture-Bhojwani and Razdan-Elsevier
5. Methods in Plant Tissue culture- U Kumar- Agrobios India
6. Plant Biotechnology – P.K. Gupta
7. Plant Biotechnology: Principles and Applications – B.D. Singh
8. A Textbook of Biotechnology – R.C. Dubey
9. Biotechnology: Fundamentals and Applications – S.S. Purohit
10. Plant Tissue Culture – S. Ignacimuthu
11. Plant Biotechnology – H.S. Chawla

B.Sc. Biotechnology
SBTTCT1302 : Recombinant DNA Technology

Credits: 3 **Hours: 45**

Course pre-requisite: Basic knowledge of Cell Biology, Genetics, Molecular Biology, and Biochemistry.

Course objectives:

- To Understand the principles of recombinant DNA technology.
- To Learn gene cloning and DNA manipulation techniques.
- To Study applications of genetic engineering in biotechnology.

Course Outcomes: Students shall be able to

- Explain the basic concepts of recombinant DNA technology.
- Describe DNA cloning, vectors, and gene transfer methods.
- Apply molecular biology techniques used in genetic engineering.
- Discuss applications of recombinant DNA technology in medicine, agriculture, and industry.

Module No.	Unit No.	Topic	Hrs
1.0		**Fundamentals of Recombinant DNA Technology**	**11**
	1.1	Introduction, history, and scope of recombinant DNA technology. Concept of gene cloning and genetic engineering.	
	1.2	Restriction endonucleases: Types I, II, and III (Nomenclature and properties);	
	1.3	DNA modifying enzymes: DNA ligases, DNA polymerases, Reverse transcriptase, Alkaline phosphatase, Polynucleotide kinase;	
	1.4	Vectors: Plasmids (pBR322, pUC18/19), Bacteriophages (λ Phage, M 13 Phage), Cosmids, Artificial Chromosomes-BAC. Choice of Vector.	
2.0		**r- DNA Techniques.**	**12**
	2.1	Gene Cloning Strategies: Preparation of recombinant DNA molecules. Transformation methods: Calcium chloride method, Electroporation;	
	2.2	Selection and screening of transformants: Antibiotic resistance markers, Blue-white screening.	
	2.3	Electrophoresis: Agarose Gel Electrophoresis, Blotting techniques: Southern , Northern , Western Blotting and applications.	
	2.4	DNA Sequencing: Sanger's and Maxam Gilbert's Method, Automated DNA sequencing. PCR: Mechanism, Types and Application. DNA chips (Micro array) principle & application.	
3.0		**DNA Library**	**11**
	3.1	Library construction, screening and applications: Genomic library, cDNA library	
	3.2	Nucleic Acid Probe, Chemical Synthesis of DNA	

	3.3	Autoradiography of DNA	
	3.4	Screening of library-Probe based direct and indirect methods.	
4.0		**Applications, Biosafety and Bioethics**	**11**
	4.1	Applications in agriculture: Transgenic plants (Bt Cotton); Insect-resistant crops; Herbicide-resistant crops.	
	4.2	Industrial applications: Enzyme production; Biofuels; DNA fingerprinting and forensic applications.	
	4.3	Pharmaceutical Applications : i) Recombinant hormones ii) Vaccines iii) Blood Clotting factors iv) Human growth hormone. Concept of gene therapy.	
	4.4	Intellectual Property Rights (IPR), patents, and biotechnology. Biosafety guidelines. Bioethical issues in genetic engineering. National and international regulations on genetically modified organisms (GMOs).	

SBTTCP-1302: Lab Course in Recombinant DNA technology

Credit 2 **Hours: 60**

Sr.No.	List of Experiments: Plant Biotechnology
1.	Isolation of Plasmid DNA.
2.	Isolation of Genomic DNA from Bacteria / Plant /Animal.
3.	Quantification of DNA by spectrophotometry
4.	Agarose gel Electrophoresis of DNA
5.	Restriction digestion of DNA.
6.	Ligation of DNA (demonstration).
7.	Preparation of Competent Cells & Cell Transformation.
8.	Bacterial transformation.
9.	Blue-white screening of transformants.
10.	Blotting Techniques- Southern, Western (Demonstration).
11.	Principle and study of PCR based experiments.
12.	Experiments based on molecular markers RAPD, RFLP and SNP etc.
13.	Visit to Molecular Biology & Genetic Engineering Research Laboratory/ Company.

Text and Reference Books

1. Principles of Gene Manipulation and Cloning - Old & Primrose-Black well Science
2. From Genes to Clones- Winnacker- Panima
3. Molecular Biotechnology –Glick-ASM
4. ABC of Gene cloing- Wong-Springer
5. Genomes 3 - T.A.Brown-Garland Science
6. Gene cloning and DNA Analysis- T.A. Brown- Wiley- Blackwell
7. Text book of Biotechnology – U Satyanarayan –Book & Allied
8. Jogdand S.N- Gene Biotechnology-Himalaya
9. Joshi P (2002) - Genetic Engineering and its applications, Agrobios Pub
10. MitraSandhya (2006) - Genetic Engineering, MacMillan India

B.Sc. Biotechnology

SBTTIKS1301: Indian Knowledge System for Biotechnology

Credits: 2 **Hours: 30**

Course pre-requisite:

A prerequisite for Fundamental Genomics course will be knowledge of Basic knowledge of Biology (Class XII level) along with Fundamentals of Microbiology and Cell Biology and a General awareness of Indian history and culture (desirable, not mandatory

Course Objectives:

- To introduce students to the rich legacy of Indian Knowledge Systems (IKS) in the life sciences, agriculture, medicine, and natural philosophy.
- To familiarize students with ancient Indian contributions to biology, botany, fermentation, and bioresource management relevant to modern biotechnology.
- Inspire students to integrate IKS principles with modern OBE-aligned scientific inquiry, fostering a culturally rooted and globally competent scientific temperament.

Course Outcomes:

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

- Recall and explain the historical contributions of ancient Indian scholars to biological sciences, medicine, and agriculture as documented in classical texts
- Analyze traditional Indian agricultural practices, fermentation techniques, and microbial knowledge in the context of contemporary biotechnology
- Evaluate India's biodiversity heritage, sacred grove traditions, and ethnobotanical knowledge systems for their relevance to conservation and bioresource biotechnology
- Design a conceptual framework or case study integrating IKS principles with a modern biotechnological application

Module No	Unit no.	Topics	Hrs
1.0		**Overview of Indian Knowledge Systems (IKS)**	
	1.1	Definition, scope, and significance of IKS in the context of science and technology	**8**
	1.2	NEP 2020 mandate for IKS integration in higher education	
	1.3	Classification of IKS: Shruti, Smriti, Darshana, and applied sciences (Vidyas)	
	1.4	IKS versus Western epistemology: complementarity and convergence	
2.0		**Traditional Indian Agriculture and Soil Management**	
	2.1	Biofertilizers in traditional practice: cow dung (Panchagavya), green manures, and vermicomposting antecedents	**8**
	2.2	Traditional pest management: Neem (Azadirachta indica), Tulsi, and botanical pesticides	
	2.3	Water harvesting, irrigation (stepwells), and watershed	

		management from ancient practice	
	2.4	Folk seed preservation technologies and traditional plant breeding	
3.0		**Fermentation in Indian Tradition**	
	3.1	Fermented foods in India: Idli, Dosa, Dhokla, Kanji, Toddy, and Jaggery fermentation	**7**
	3.2	Indigenous fermentation vessels, starters, and temperature regulation practices	
	1.3	Microbiological significance: LAB, yeast, and mold-based fermentations and their modern parallels	
	3.4	Traditional vinegar and dairy fermentation (curd/yoghurt/ghee) and probiotic science	
4.0		**Ethnobotany and Medicinal Plant Heritage**	
	4.1	Concept of ethnobotany and India as a mega-biodiversity hotspot	**7**
	4.2	Role of tribal communities: Adivasi knowledge of plants, fungi, and insects, Documentation efforts: TKDL, FRLHT	
	4.3	Phytochemical screening of traditional plants: alkaloids, terpenoids, flavonoids, saponins	
	4.4	Neem, Turmeric, Ashwagandha, Tulsi: scientific validation of traditional claims	

Text Books and Reference Books:

1. **Kirtikar, K.R. & Basu, B.D.** (2022, reprint). *Indian Medicinal Plants* (Vols. 1–4). International Book Distributors, Dehradun.
2. **Sharma, P.V.** (2019). *Dravyaguna Vigyana* (Vol. 1 & 2). Chaukhambha Bharati Academy, Varanasi.
3. **Jain, S.K.** (1991). *Dictionary of Indian Folk Medicine and Ethnobotany.* Deep Publications, New Delhi.
4. **Nadkarni, K.M.** (2022, reprint). *Indian Materia Medica* (3rd ed., Vols. 1–2). Popular Prakashan, Mumbai.
5. **Nair, M.N.B. & Sharma, A.** (Eds.). (2020). *Indian Knowledge System: Traditions in Science and Technology.* IKS Division, Ministry of Education, Govt. of India.
6. **Singh, R.H.** (2011). *Exploring Issues in the Development of Ayurvedic Research Methodology.* Journal of Ayurveda and Integrative Medicine.
7. **Schultes, R.E. & von Reis, S.** (Eds.). (1995). *Ethnobotany: A Reader.* Timber Press, Oregon.
8. **Sarangi, B.K.** (2013). *Biodiversity Conservation and Traditional Knowledge.* Scientific Publishers, Jodhpur.
9. **Vankar, P.S.** (2015). *Handbook of Natural Dyes and Pigments.* Woodhead Publishing.
10. **Siddiqui, T.O.** (2016). *Traditional Knowledge Digital Library: TKDL as a Model.* CSIR-NISTADS Publication.
11. **Bhattacharya, S.** (2019). *Bioprospecting for Industrial Molecules.* Elsevier.
12. **Reddy, P.P.** (2016). *Agro-ecological Approaches to Pest Management for Sustainable Agriculture.* Springer, Singapore.
13. **MoE-IKS Division.** (2022). *IKS Reference Document for Higher Education.* Ministry of Education, Govt. of India.

B.Sc. Biotechnology
SBTTET 1301: Bioprocess Engineering

Credits: 2 **Hours: 30**

Course Prerequisites- basics of fermentation microbial processes knowledge and the basics of microbial growth

Course objectives

- To provide knowledge of many procedures in industries.
- Role of microbial Techniques in industries .
- Techniques used to improve product formation in industries.

Course Outcomes:

- To know basic knowledge about bioprocess engg.
- To know about Air & Media sterilization.
- Able to know about types of bioprocess.
- To know about Scale up in bioprocess.

Module	Unit	Topic	Hrs
1		**Introduction to Concepts of Bioprocess engineering**	**6**
	1.1	Definition of Bioprocesses engineering.	
	1.2	Fermenters, Bioreactors: Construction, Design & Operation,	
	1.3	Materials of Constructions	
	1.4	Welding, Surface treatment Components of the fermenters & their specifications	
2		**Air & Media sterilization :**	**8**
	2.1	Air Sterilization Principles, Mechanisms of capture of particles in Air,	
	2.2	Depth & Screen Filters, Sizing, Testing & validation of filters for air	
	2.3	Principles of Media Sterilization, Decimal reduction.	
	2.4	Design of sterilization cycle using kinetics of thermal death of microbes, Equipments used insterilization.	
3		**Types of Bioprocesses :**	**8**
	3.1	Bioproducts and classification of bioproducts,	
	3.2	Microbial Growth Kinetics: Batch, Fed-batch, continuous.	
	3.3	Measurement & Control of Bioprocesses Parameters: Cell growth. pH, temperature,	
	3.4	Substrate consumption, product formation, Measurement of O2/CO2 uptake. Strategies for fermentation control.	
4		**Scale up in Bioprocesses**	**8**
	4.1	Computer controlled fermentations, Foam & its control. Oxygen uptake rate (OUR), Viscosity & its control.	
	4.2	Scale up in Bioprocesses fermentations, Factors used in scale up.	
	4.3	Quality Control, Quality assurance,	
	4.4	Standard Operating Procedures (SOP) & Good, Manufacturing Practices (GMP).	
		Total	**30**

SBTTEP-1301: Lab Course in Bioprocess Engineering

Credit 2 **Hours: 60**

List of Experiments

1 Isolation and Screening of Industrially important Microbes-Acid, Antibiotics, Enzymes
2 Study of Strain improvement
3 Sterilization Techniques- Media, Air
4 Maintenance of pure Culture
5 Study of Growth Curve of Bacteria, Fungi
6 Growth kinetics: Effect of pH & Temp
7 Media Formulation
8 Sterilizer Design- TDP, TDT
9 Cell and Enzyme immobilization
10 Visit to Fermentation Industry

Reference books

1 Principles of Fermentation Technology - Whittaker & Stanberry- Elsevier
2 Bioprocess Engineering Principles - Pauline Doran- Elsevier
3 Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann
4 Bioreactor Design & Product Yield, BIOTOL series - Elsevier
5 Bioprocess Engineering: Systems, Equipment & Facilities - Ed. B. Lydersen, Delia &. Nelson, John Wiley
6 Bioprocess Engineering- Shuller&Kargi -Pearson Education
7 Process Biotechnology Fundamentals-Mukopadhaya- Viva
8 Biochemical Engineering- Bailey & Bhatia- CBS
9 Biochemical Engineering Fundamentals- Bailey, Ollis- McGraHill
10 Fermentation and Biochemical Engineering Hand book-Vogel, Todaro-Strand Publisher

B.Sc. Biotechnology
SBTTET 1301: Food Technology

Credits: 2 **Hours: 30**

Course pre-requisite: Basic knowledge of Biology, Biochemistry, Microbiology, and Nutrition.
Course objectives:

- To Understand the principles of food science and nutrition.
- To Learn food processing, preservation, and safety techniques.
- To Explore applications of biotechnology in the food industry.

Course Outcomes: Students shall be able to

- Explain the fundamentals of food science and nutrition.
- Understand food microbiology, quality control, and food safety.
- Describe food processing, preservation, and packaging methods.
- Discuss the applications of biotechnology in food production and improvement.

Module No.	Unit No.	Topic	Hrs
1.0		**Introduction to Food Science and Nutrition**	**08**
	1.1	Scope and importance of food technology; Food groups and food pyramid.	
	1.2	Nutritional composition of foods: Carbohydrates, Proteins, Lipids, Vitamins, Minerals.	
	1.3	Balanced diet and nutritional requirements; Functional foods and nutraceuticals;	
	1.4	Malnutrition and nutritional disorders; Food additives and their applications.	
2.0		**Food Microbiology and Food Safety**	**08**
	2.1	Introduction to food microbiology; Microorganisms associated with foods. Food-borne pathogens: Salmonella, Staphylococcus, Clostridium, Listeria, Escherichia coli.	
	2.2	Food spoilage microorganisms; Beneficial microorganisms in food production. Fermented foods: Yogurt, Cheese, Bread, Vinegar, Probiotics.	
	2.3	Food Poisoning and food infections. Food Safety Management Systems;	
	2.4	Food standards and regulations**:** Food Safety and Standards Authority of India (FSSAI); Codex Alimentarius Commission; World Health Organization guidelines;	
3.0		**Food Processing and Preservation**	**06**
	3.1	Principles of food processing; Food spoilage and deterioration;	
	3.2	Preservation methods: Low temperature preservation, High temperature processing, Drying and dehydration,	
	3.3	Canning, Irradiation, Chemical preservation, Fermentation technology.	

	3.4	Packaging materials and packaging techniques; Storage of food products.	
4.0		**Food Quality Control, Biotechnology and Industrial Applications**	**08**
	4.1	Food quality parameters; Food quality control and assurance; HACCP (Hazard Analysis and Critical Control Points);	
	4.2	Good Manufacturing Practices (GMP); Good Laboratory Practices (GLP); Food adulteration and detection methods. Biosensors in food quality monitoring	
	4.3	Applications of biotechnology in food processing; Single Cell Protein (SCP); Production of enzymes for food industry; Probiotics and prebiotics;	
	4.4	Genetically Modified (GM) foods; Bio-fortified foods; Waste management in food industries.	

B.Sc. Biotechnology

SBTTEP-1301: Lab Course in Food technology

Credit 2 **Hours: 60**

B.Sc. Biotechnology **Marks: 50**

Sr. No.	List of Experiments: Food technology
1.	Food Analysis and Processing
2.	Determination of moisture content in food.
3.	Determination of ash content.
4.	Estimation of reducing sugars.
5.	Estimation of protein by Lowry/Biuret method.
6.	Estimation of fat content.
7.	Preparation of jam and jelly.
8.	Production of Milk products
9.	Preparation of fermented food products vinegar / cider / wine.
10.	Microbiological examination of food samples.
11.	Isolation of microorganisms from food.
12.	Total plate count of food samples.
13.	Detection of coliform bacteria in food.
14.	Quality assessment of packaged foods.
15.	Detection of common food adulterants.
16.	Visit to a food processing industry and report preparation.

Text and Reference Books

Food Science – Norman N. Potter & Joseph H. Hotchkiss
Food Microbiology – William C. Frazier & Dennis C. Westhoff
Fundamentals of Food Microbiology – Bibek Ray & Arun Bhunia
Food Biotechnology – Kalidas Shetty, Gopinadhan Paliyath, Alan Pometto, Robert Levin
Food Processing and Preservation – G. Subbulakshmi & Shobha Udipi
Introduction to Food Engineering – R. Paul Singh & Dennis R. Heldman
Food Biotechnology – Y.H. Hui
Food Chemistry – Owen R. Fennema
Essentials of Food Science – Vickie A. Vaclavik & Elizabeth W. Christian
Food Microbiology: An Introduction – Thomas J. Montville & Karl R. Matthews
Principles of Food Sanitation – Norman G. Marriott & Robert B. Gravani
Food Biochemistry and Food Processing – Benjamin K. Simpson

B.Sc. Biotechnology

SBTTVC-1301: Biopesticides Production Technology

Credits: 2 **Hours: 60**

Pre requisite: Basic knowledge of microorganisms

Course Objectives

- Understand the importance of biopesticides in sustainable agriculture.
- Study the biology and production technology of major microbial biopesticides.
- Develop skills in isolation, cultivation, formulation and quality control of biopesticides.
- Acquire hands-on training in mass multiplication and application of microbial biocontrol agents.
- Promote entrepreneurship in biopesticide production.

Course Outcomes

- Explain the significance of biopesticides.
- Describe major microbial biopesticides and their applications.
- Demonstrate isolation and cultivation techniques.
- Perform formulation and quality assessment.
- Apply biopesticide production technology for agriculture and entrepreneurship.

Theory Syllabus

- Unit I: Introduction to Biopesticides – concept, classification, advantages, limitations, IPM and regulations.
- Unit II: Trichoderma spp., Pseudomonas fluorescens and Bacillus thuringiensis – biology, mode of action and applications.
- Unit III: Bio pesticides Production technology, formulation, packaging, storage, quality control and entrepreneurship.

Practical Syllabus

- Preparation of culture media.
- Sterilization techniques.
- Isolation of Trichoderma spp.
- Identification of Trichoderma.
- Isolation of Pseudomonas fluorescens.
- Isolation and cultivation of Bacillus species.
- Observation of Beauveria bassiana.
- Mass multiplication of Trichoderma.
- Mass multiplication on grain substrate.
- Preparation of carrier-based formulation.
- Determination of viable count.
- Quality control testing.
- Seed treatment and soil application.
- Production flow chart and documentation.
- Industrial visit and viva voce.

Reference Books

- Biological Control of Plant Diseases – G.C. Papavizas
- Agricultural Microbiology – G. Rangaswami and D.J. Bagyaraj
- Plant Pathology – George N. Agrios
- Principles of Plant Pathology – R.S. Mehrotra and A. Aggarwal
- Microbial Biotechnology – Alexander N. Glazer and Hiroshi Nikaido
- Biofertilizers and Biopesticides – K.R. Aneja
- ICAR Manuals on Biopesticide Production and Quality Control
- FAO Publications on Biological Pest Management

SEMESTER VI

B.Sc. Biotechnology
SBTTCT 1351Animal Biotechnology

Credits: 3 **Hours: 45**

Course pre-requisite: A prerequisite for an Animal Biotechnology course will be knowledge of comprehensive understanding of animal biology, physiology, and genetics is crucial.
Courses in cell biology, embryology, and genomics are often recommended.

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, maintenance, and growth of cells.
- Develop proficiency in establishing and maintaining cell lines.
- Acquire knowledge in animal cloning and its applications.

Module No.	Unit No.	Topic	Hrs.
1		**Unit I: Animal Cell Culture Laboratory and Cell Types**	**11**
	1.1	Animal cell culture laboratory design, equipment, and materials.	
	1.2	Aseptic techniques and sterile handling.	
	1.3	Types of cells and tissues in culture.	
	1.4	Primary, established, and transformed cell lines.	
2		**Unit II: Cell Culture Media and Basic Techniques**	**12**
	2.1	Nutritional and physical requirements of cultured cells.	
	2.2	Culture media: BSS, MEM, serum-based and serum-free media.	
	2.3	Cell isolation, primary culture, cell counting, and maintenance.	
	2.4	Monolayer, suspension, and embryonic cell cultures.	
3		**Unit III: Cell Growth, Preservation, and Characterization**	**11**
	3.1	Cell synchronization and cryopreservation.	
	3.2	Characterization of cultured cells and tissue typing.	
	3.3	Cell–cell interactions and scale-up techniques.	
	3.4	Growth measurement, apoptosis, and cytotoxicity assays.	
4		**Unit IV: Molecular Techniques and Applications**	**11**
	4.1	Cell transformation and gene delivery methods.	
	4.2	Hybridoma technology and cell fusion.	
	4.3	Vaccine production and gene therapy.	
	4.4	Application of animal cell culture	
		Total	**45**

ReferenceBooks:

1 Animal cell culture; A practical approach, - Freshney. R.I.- John Wiley publication.
2 Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford
3 Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
4 Principles of genetic manipulation; - Old and Primrose- Blackwell science
5 Biotechnological innovations in Animal productivity- BIOTOL – Elsevier
6 Arora M.P.- Biotechnology-Himalaya Publishing.
7 Gangal Sudha- Principles and Practice of Animal Tissue Culture-Universities
8 Animal Cell Culture – John Masters- Oxford University Press
9 In Vitro Cultivation of Animal cells- Butterworth- Heinemann, BIOTOL, Elsevier
10 Developmental biology- SF Gilbert -Sinauer associates.

SBTTCP-1351: Lab Course in Animal Biotechnology

Credit 2 **Hours: 60**

Sr. No. List of Experiments : Animal Biotechnology

1 Packing and sterilization of glass and plastic wares for cell culture.
2 Preparation of reagents and media for cell culture.
3 Primary culture technique for chicken embryo fibroblast.
4 Secondary culture of chicken embryo fibroblast.
5 Cultivation of continuous cell lines.
6 Quantification of cells by trypan blue exclusion dye.
7 Isolation of lymphocytes and cultivation of lymphocytes
8 Study of effect of toxic chemicals on cultured mammalian cells

Reference Books:

1. Animal cell culture; A practical approach, - Freshney. R.I.- John Wiley publication.
2. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford
3. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
4. Principles of genetic manipulation; - Old and Primrose- Blackwell science
5. Biotechnological innovations in Animal productivity- BIOTOL – Elsevier
6. Arora M.P.- Biotechnology-Himalaya Publishing.
7. Gangal Sudha- Principles and Practice of Animal Tissue Culture- Universities
8. Animal Cell Culture – John Masters- Oxford University Press
9. In Vitro Cultivation of Animal cells- Butterworth- Heinemann, BIOTOL, Elsevier
10. Developmental biology- SF Gilbert -Sinauer associates**.**

B.Sc. Biotechnology
SBTTCT-1352: Fundamental Genomics

Credits: 3 **Hours: 45**

Course pre-requisite:
A prerequisite for Fundamental Genomics course will be knowledge of Cell Biology and Genetics, Biochemistry – Biomolecules and Metabolism, Molecular Biology, Basic Computer Applications and Introduction to Bioinformatics, Microbiology and Virology – Basic Concepts (desirable) with essential knowledge of basic concepts of DNA, RNA, and Gene Expression

Course Objectives:
- To acquaint with fundamental principles of genome organisation, genome mapping, and various
- To impart understanding of DNA sequencing technologies, including next-generation and long-read platforms.
- To understand the structure, and functional characterisation of genomes across prokaryotes, eukaryotes, and
- To Enable students to utilise bioinformatics tools and public databases (NCBI, DDBJ etc,) for genomic data retrieval, analysis, and interpretation

Course Outcomes:
On completion of this course, the students shall be able to:
- describe genome organization, the evolution of sequencing technologies from Sanger to third-generation platforms
- interpret genomic data retrieved from databases such as NCBI and DDBJ.
- apply bioinformatics tools to analyse genomic datasets including sequence alignment and phylogenetic tree construction.
- analyse the implications of these technologies in medicine, agriculture, and biosafety.
- design simple experimental workflows in genomics for given research scenarios,
- evaluate published omics studies with respect to methodology, data quality, and biological significance.

Module No	Unit no.	Topics	Hrs
1.0		**Introduction to Genomics**	
	1.1	Definition and scope of genomics; Historical milestones: Human Genome Project (HGP) – goals, strategies, and outcomes	**12**
	1.2	Prokaryotic genome: size, structure, operons, horizontal gene transfer	
	1.3	Eukaryotic genome: chromosomal organisation, chromatin structure	
	1.4	Repetitive DNA: SINEs, LINEs, satellite DNA, microsatellites; their significance;	
2.0		**Genome mapping technology**	
	2.1	Gene families and multigene families: globin genes, rRNA gene clusters,	**11**
	2.2	Non-coding DNA: pseudogenes, introns, long non-coding RNAs (lncRNAs)	
	2.3	Physical mapping: restriction mapping, STS (sequence-tagged sites), linkage mapping: recombination frequency, genetic markers,	

	2.4	Molecular markers: RFLP, RAPD, AFLP, SSR/ microsatellites, SNPs	
3.0		**Genome sequencing technology**	
	3.1	First-generation sequencing: Sanger chain-termination method; Maxam-Gilbert chemical sequencing	**11**
	3.2	Automation of Sanger sequencing: capillary electrophoresis, fluorescent dye-labelled terminators	
	1.3	Second-generation (next generation) sequencing (NGS):(Illumina and Ion Torrent)	
	3.4	Third-generation sequencing (Pacific Biosciences (PacBio) & Oxford Nanopore Technologies	
4.0		**Applications of Genomics**	
	4.1	Genomics in medicine: disease gene identification, precision medicine,	**11**
	4.2	Ancient DNA, phylogeography, DNA fingerprinting,	
	4.3	Agricultural genomics: crop improvement, marker-assisted selection (MAS),	
	4.4	Microbial genomics for metabolic engineering	

Text Books and Reference Books:

1. Genomics, Proteomics and Bioinformatics, S. C. Bhatia, IK International Publishing House, 4th Edition, 2022
2. Genomes 4, T. A. Brown, Garland Science / CRC Press, 4th Edition, 2017
3. Molecular Biology of the Gene, Watson, Baker, Bell et al., Pearson / Benjamin Cummings, 8th Edition, 2019
4. Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley-Blackwell, 3rd Edition, 2015
5. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 5th Edition, 2019
6. The Cell: A Molecular Approach, Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates / OUP, 8th Edition, 2019
7. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Glick, Pasternak, Patten, ASM Press, 5th Edition, 2017
8. Structural Bioinformatics, Gu and Bourne (Eds.), Wiley-Blackwell, 2nd Edition, 2009
9. Next-Generation Sequencing Data Analysis, Xinkun Wang, CRC Press, 2015

SBTTCP-1352: Lab Course in Fundamental Genomics

Credit 2 **Hours: 60**

(Perform any 15 practicals of the given)

1. Isolation of DNA – Methods and Principles –Phenol-chloroform extraction method
2 Isolation of DNA – Methods and Principles – Detergent-based isolation methods
3 Isolation of DNA – Methods and Principles – Density-gradient centrifugation (CsCl method)
4 Isolation of RNA – Methods and Principles –Guanidinium thiocyanate-based isolation
5 Isolation of RNA – Methods and Principles –TRIzol-based RNA isolation (1-step)
6 Primer and Probe Design – Parameters and Guidelines –
7 Primer design parameters: Product amplicon:Probe design:
8 PCR: Polymerase Chain Reaction
9 Introduction to Bioinformatics Databases: Navigation of NCBI (GenBank, RefSeq), Ensembl, and UCSC Genome Browser; retrieval of a gene of interest (e.g., human BRCA1); extraction of CDS, mRNA,; interpretation of database entries
10 BLAST Sequence Analysis, Perform BLASTN, BLASTP, and BLASTX analyses using NCBI BLAST.
11 Multiple Sequence Alignment (MSA), Align multiple nucleotide and protein sequences using Clustal
12 Multiple Sequence Alignment (MSA), Align multiple nucleotide and protein sequences using Omega
13 Multiple Sequence Alignment (MSA), Align multiple nucleotide and protein sequences using MUSCLE via EMBL-EBI web server
14 Restriction digestion and Gel Electrophoresis Analysis
15 Perform in silico restriction enzyme analysis using NEBcutter.
16 Perform actual agarose gel electrophoresis and compare with in silico results
17 Genome Annotation Exercise.
18 Annotate a short prokaryotic genome sequence using RAST and/or Prokka.
19 Identify ORFs, functional categories, and COG assignments.
20 Generate a circular genome map using CGView

Text Books and Reference Books:

1. Genomics, Proteomics and Bioinformatics, S. C. Bhatia, IK International Publishing House, 4th Edition, 2022
2. Genomes 4, T. A. Brown, Garland Science / CRC Press, 4th Edition, 2017
3. Molecular Biology of the Gene, Watson, Baker, Bell et al., Pearson / Benjamin Cummings, 8th Edition, 2019
4. Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley-Blackwell, 3rd Edition, 2015
5. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 5th Edition, 2019
6. The Cell: A Molecular Approach, Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates / OUP, 8th Edition, 2019
7. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Glick, Pasternak, Patten, ASM Press, 5th Edition, 2017
8. Structural Bioinformatics, Gu and Bourne (Eds.), Wiley-Blackwell, 2nd Edition, 2009
9. Next-Generation Sequencing Data Analysis, Xinkun Wang, CRC Press, 2015

B.Sc. Biotechnology
SBTTCT-1301: Bio-entrepreneurship

Credits: 2 **Hours: 30**

Course pre-requisite:
A prerequisite for **bio-entrepreneurship** course will be Completion of core B.Sc. Biotechnology courses up to Semester IV, Basic understanding of molecular biology, microbiology, and bioprocessing, General awareness of science and technology ecosystem in India (desirable), Fundamentals of biology-based industries (pharmaceutical, agricultural, environmental)

Course Objectives:
- To introduce students to the concept, scope, and significance of bio-entrepreneurship as a career pathway within the life sciences and biotechnology sector.
- To familiarize students with the ecosystem of biotech startups, innovation incubators, government funding schemes, and regulatory frameworks in India and globally.
- To enable students to identify entrepreneurial opportunities arising from biotechnology innovations in healthcare, agriculture, environment, and industrial sectors.
- To equip students with practical knowledge of business plan development, financial management, technology commercialization.

Course Outcomes:
On completion of this course, the students shall be able to:
- Recall and explain fundamental concepts of entrepreneurship, the entrepreneurial mindset, and the unique characteristics of the bio-entrepreneurship landscape in India and globally
- Identify and analyze entrepreneurial opportunities in biotechnology sectors including pharmaceuticals, agri-biotech, diagnostics, biofuels, and environmental biotech
- Construct a structured and viable business plan for a biotechnology-based venture, incorporating market research, financial projections, and operational planning
- Evaluate technology transfer mechanisms, regulatory pathways, and compliance requirements relevant to biotech startups
- Design a pitch deck or innovation brief for a bio-based startup and demonstrate communication skills for presenting a business concept to potential investors or stakeholders

Module No	Unit no.	Topics	Hrs
1.0		**Introduction to bio-entrepreneurship**	
	1.1	Origin of bio-entrepreneurship, significance of bio-entrepreneurship; Relationship between biotechnology and bio-entrepreneurship	**8**
	1.2	Pillars of bio-entrepreneurship – management, capital and technology	
	1.3	Essential bio-entrepreneurial skills: curiosity, time management, strategic thinking, efficiency.	
	1.4	Essential bio-entrepreneurial skills: communications, networking, finance, branding, and sales.	
2.0		**Bio-entrepreneurship Development**	
	2.1	Steps of bio-entrepreneurship development	**7**
	2.2	Categories of biotech firms: bio-agricultural, bioinformatics, biopharmaceutical and bio-industrial.	
	2.3	Importance of bio-based entrepreneurship: production of fuel, feed and heal, environmental protection, health biotechnology,	

		food biotechnology	
	2.4	economics and prosperity associated with bio-entrepreneurship	
3.0		**Bio-entrepreneurship and Industries I**	
	3.1	Modern agricultural biotechnology products for entrepreneurship,	**8**
	3.2	large scale production of plants, gm crops, insects' resistance, drought resistance, biofortification, hybrid seed production, biofertilizers and biopesticides, bio-feed for livestock industry, plant-based drugs and medicines, floral industry	
	1.3	Entrepreneurship in Environmental Biotechnology: phytoremediation, different techniques of phytoremediation,	
	3.4	microbial bioremediation water bioremediation, oil spill bioremediation	
4.0		**Bio-entrepreneurship and Industries II**	
	4.1	***Entrepreneurship in Medical biotechnology***: Medical biotechnology innovation	**7**
	4.2	Nanotechnology, targeted cancer therapies, HPV vaccine, nanozymes	
	4.3	Entrepreneurship in pharmaceutical, Innovation in pharma.	
	4.4	Digitization of medicine through healthcare	

Text Books and Reference Books:

1. **Shimasaki, C.D.** (2020). *Biotechnology Entrepreneurship: Leading, Managing and Commercializing Innovative Technologies* (2nd ed.). Academic Press / Elsevier, USA.
2. **Mohanty, B.** (2015). *Bio-Entrepreneurship Development.* Biotech Books / Biotech.co.in, New Delhi.
3. **Burns, P.** (2022). *Entrepreneurship and Small Business: Start-up, Growth and Maturity* (5th ed.). Macmillan International / Red Globe Press.
4. **Khanka, S.S.** (2019). *Entrepreneurial Development* (Revised ed.). S. Chand Publishing, New Delhi.
5. **Desai, V.** (2017). *Dynamics of Entrepreneurial Development and Management* (5th ed.). Himalaya Publishing House, Mumbai.
6. **Drucker, P.F.** (2014). *Innovation and Entrepreneurship.* Routledge Classics, New York.
7. **Neelakantan, S.** (2021). *Bioinformatics, Genomics and Biotechnology Entrepreneurship.* PHI Learning Pvt. Ltd., New Delhi.
8. **Dorf, R.C. & Byers, T.H.** (2018). *Technology Ventures: From Idea to Enterprise* (4th ed.). McGraw-Hill Education, New York.
9. **Onetti, A. & Zucchella, A.** (2014). *Business Modeling for Life Science and Biotech Companies.* Routledge, New York.
10. **Hine, D. & Kapeleris, J.** (2006). *Innovation and Entrepreneurship in Biotechnology: An International Perspective.* Edward Elgar Publishing.
11. **Singh, D.** (2018). *Intellectual Property Rights in Biotechnology.* Biotech Books, New Delhi.
12. **Kumar, S.** (2020). *Startup India: A Guide to Entrepreneurship and Innovation Ecosystem.* IICA Publication.
13. **BIRAC Annual Reports (2022–2024).** Biotechnology Industry Research Assistance Council, DBT-MoE, Govt. of India.
14. **Timmons, J.A. & Spinelli, S.** (2019). *New Venture Creation: Entrepreneurship for the 21st Century* (10th ed.). McGraw-Hill Education.
15. **Cohen, S.S. & Fields, G.** (1999). *Social Capital and Capital Gains in Silicon Valley.* California Management Review *(classic reference for ecosystem building)*.

B.Sc. Biotechnology
SBTTET-1351: Industrial Biotechnology

Credits: 2 **Hours: 30**

Course Prerequisites :
Should known basic design of fermenter, knowledge about quality control and quality assurance.

Course objectives :
To provide knowledge of many procedures in industries
Role of microorganisms in industries and
Techniques used to improve product formation in industries.

Course Outcomes:
- Screening, isolation, selection and improvement of isolated strain by different methods
- Know the different steps of product recovery from fermentation broth.
- To study the fermentation process of different industrially important products
- Get the knowledge of different quality control methods and good manufacturing practices

Module	Unit	Topics	Hrs
I		**Strain Improvement :**	**8**
	1.1	Selection of Mutants producing improved level of Primary Metabolites with suitable Example.	
	1.2	Isolation of mutants which do not produce feedback inhibitors or repressors.	
	1.3	Mutants that do not recognize presence of inhibitors or repressors.	
	1.4	Modification of Permeability.	
II		**Down Stream Processing.**	**8**
2.1	2.1	Removal and Recovery of cell mass (Precipitation, Filtration and Centrifugation)	
2.2	2.2	Cell disruption- Physical and Chemical methods.	
2.3	2.3	Purification of Product Liquid-liquid extraction : Solvent Recovery. Chromatography: Adsorption, Ion-exchange, HPLC	
2.4	2.4	Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.	
III		**Fermentation Processes.**	
3.1	3.1	Fermentation processes: Microorganisms involved, Inoculum preparation, Medium used and product Recovery.	8
3.2	3.2	Enzyme: Protease, pectinase. Organic acid: Citric acid.	
3.3	3.3	Antibiotic: Penicillin, erythromycin.	
3.4	3.4	Vitamin: Vitamin B12, vitamin B2.	
IV		**Quality Control, Process Economics and GLP.**	**6**
4.1	4.1	Sterility testing.Pyrogen testing.Carcinogenicity testing.Toxicity testing.	
4.2	4.2	Fermentation Economics: Cost Estimates, Process Design, Capital Cost Estimates,	
4.3	4.3	Operating Cost Estimates.	
4.4	4.4	Concept of QC, QA, Good Laboratory Practices, GMP.	
		Total	**30**

Text &References :

1. Casida L.E - Industrial Microbiology- New Age
2. Crueger W and Crueger A - Biotechnology: A Textbook of Industrial Microbiology- Panima Publishing
3. Patel A.H. - Industrial Microbiology, Macmillan India
4. Peppler H.J and Perlman D - Microbial Technology, Vol I and II-Elsevier
5. Stanbury P.F., Whitaker A. and Hall S.J - Principles of Fermentation Technology-Elsevier
6. Prescott and Dunn‟s- Industrial Microbiology-CBS
7. Ed. G. Subramaniam- Bioseparation& Bioprocessing - Wiley –VCH
8. Product Recovery in Bioprocess Technology, „BIOTOL series, Butter worth Heinemann 1992
10. LarlSchuger-Solvent Extraction in Biotechnology - Spinger
11. Roger Harrison-Bioseparation Science & Engineering-Oxford
12. N.K. Prasad-Downstream Process Technology-PHI

SBTTEP-1351: Lab Course in Industrial Biotechnology

Credit 2 **Hours: 60**

Lab Course in Industrial Biotechnology

1 Isolation and Screening of Industrially important Microbes-Acid, Antibiotics, Enzymes
2 Isolation & identification of bacteria from different milk & water samples.
3 Fermentative production purification and estimation of antibiotics/ vitamins
4 Fermentative production purification and estimation of Citric Acid
5 Fermentative production purification and Estimation of alcohol.
6 Estimation of fermentative product (Acetic acid from vinegar).
7 Qualitative estimations of fermentation products by analytical instruments
8 Wine production & estimation of alcohol with fermentation economics.
9 Production of cheese using different substrate from microorganism.
10 Visit to Fermentation Industry

B. Sc. Biotechnology
SBTTET-1351: Pharmaceutical Biotechnology

Credits: 2 **Hours: 30**

Course pre-requisite: The students should have basic knowledge of biochemistry, cell biology, and genetics is necessary.

Course objectives:

- To apply the basic concepts in the specific field of pharmaceutical biotechnology.
- To gain insights into identification and design of drugs that could be potentially useful.
- To identify 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 putinto clinical trials..

Course outcomes:

Students will be able to

- 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

Module	Unit	TOPIC	Hrs
I		**Introduction to Pharmaceutical Biotechnology**	**8**
	1.1	Scope and importance of pharmaceutical biotechnology, Biopharmaceuticals and their significance	
	1.2	Career opportunities in pharmaceutical biotechnology	
	1.3	Cloning vectors, restriction enzymes and DNA ligase	
	1.4	Recombinant DNA technology and its applications, Production of recombinant insulin and interferons	
II		**Chemotherapy**	**7**
	2.1	Types of Antibiotics: Classification of antibiotics with example. General characteristics of an Antimicrobial Drug.	
	2.2	Mechanism of action of antimicrobial agent (General account).	
	2.3	Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism), Application of antibiotics in various fields.	
	2.4	Assaying antimicrobial activity: Principle and Methods of microbial assay (MIC and Different types of agar diffusion.)	
III		**Chemotherapeutics Agents**	**7**
	3.1	Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones.	
	3.2	Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin	
	3.3	Mechanism of action of Anticancer drugs,	
	3.4	Antidiabetic drugs and Antihypertensive drugs	
IV		**Vaccines and Immunobiologicals**	**8**

	4.1	Overview of the immune system, Types of immunity	
	4.2	Conventional and recombinant vaccines, DNA vaccines and edible vaccines	
	4.3	Monoclonal antibodies and Hybridoma technology	
	4.4	Applications of monoclonal antibodies	

SBTTEP-1351: Lab Course in Pharmaceutical Biotechnology

Credit 2 **Hours: 60**

1. Laboratory safety and GMP
2. Preparation of buffers
3. Demonstration of recombinant DNA tools
4. ELISA demonstration
5. Antibacterial Activity of Antibiotics
6. Antiviral Activity of Antibiotics
7 Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
8. Determination of shelf life of antibiotics (Expired drugs)
9 Bioassay of antifungal compounds
10 Study of vaccine production processes
11 Microbial production of pharmaceutical enzymes
12 Enzyme immobilization
13 Sterility testing of pharmaceutical preparations

Reference Books

- Pharmaceutical Biotechnology: Fundamentals and Applications – Crommelin et al.
- Biopharmaceuticals: Biochemistry and Biotechnology – Gary Walsh
- Biotechnology and Biopharmaceuticals – Rodney J. Y. Ho
- Principles of Gene Manipulation and Genomics – Primrose & Twyman
- Molecular Biotechnology – Glick & Pasternak
- Pharmaceutical Biotechnology – S. P. Vyas and V. K. Dixit
- Therapeutic proteins and peptides
- Production of hormones and growth factors
- Upstream and downstream processing
- Purification techniques for biopharmaceuticals
- Quality control of biopharmaceutical products
- Good Manufacturing Practices (GMP)

B.Sc. Biotechnology
SBTTVC-1351: Bio fertilizers Production Technology (SEC)
Credits: 2 **Hours: 30**

Course Objectives
Understand importance of bio fertilizers in sustainable agriculture.
Study Rhizobium, Azotobacter and PSB.
Learn isolation, mass multiplication, formulation and quality control.
Develop practical skills in biofertilizer production technology.

Course Outcomes
Explain significance of bio fertilizers.
Describe Rhizobium and Azotobacter biology.
Demonstrate isolation and cultivation techniques.
Perform formulation and quality assessment.
Apply bio fertilizer technology for agriculture and entrepreneurship.

Theory Syllabus
Unit I: Introduction to Bio fertilizers – concept, importance, types, advantages, limitations, quality standards.
Unit II: Rhizobium and Azotobacter – characteristics, nitrogen fixation, isolation, identification, mass production.
Unit III: PSB and Commercial Production – phosphate solubilization, isolation, screening, carrier materials, quality control, packaging, storage and applications.

Practical Syllabus
Preparation of culture media.
Sterilization techniques.
Isolation of Rhizobium from root nodules.
Isolation of Azotobacter from soil.
Isolation and screening of PSB.
Gram staining and microscopic examination.
Mass multiplication of cultures.
Preparation of carrier-based bio fertilizers.
Viable cell count determination.
Quality control testing.
Seed treatment and root dip methods.
Documentation and industrial visit.
Record and viva voce.

Text Books and Reference Books

Subba Rao, N.S. Bio fertilizers in Agriculture and Forestry. Oxford & IBH Publishing Co., New Delhi.
Rangaswami, G. and Bagyaraj, D.J. Agricultural Microbiology. Prentice Hall of India.
Subba Rao, N.S. Soil Microbiology. Oxford & IBH Publishing Co.
Black, Jacquelyn G. Microbiology: Principles and Explorations. Wiley Publications.
Sylvia, D.M. et al. Principles and Applications of Soil Microbiology. Pearson Education.
Aneja, K.R. Biofertilizers and Biopesticides. Scientific Publishers.
Trivedi, P.C. Manual of Soil, Plant and Water Analysis. Agrobios Publications.
Holt, J.G. Bergey's Manual of Determinative Bacteriology. Williams & Wilkins.
Glazer, A.N. and Nikaido, H. Microbial Biotechnology. Cambridge University Press.
ICAR Publications on Biofertilizers and Organic Farming.
Department of Agriculture & Farmers Welfare, Government of India – Biofertilizer specifications and quality standards.
National Centre of Organic and Natural Farming (NCONF) – Biofertilizer production protocols and standards.

Suggested Journals

Indian Journal of Agricultural Sciences
Journal of Applied Microbiology
Applied Soil Ecology
World Journal of Microbiology and Biotechnology