॥ 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 OPTION

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: Biotechnology (Vocational)

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 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 firsthand 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

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

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 with energized and capable faculty, online and digital education and effective governance and leadership.

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

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

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 Vocational Biotechnology. Studying Vocational Biotechnology prepares the students for their career working either in educational institutions or industries in which they can be directly involved in the teaching, research and development. Also, to ensure uniform curriculum and its quality at UG/PG level , curriculum of different Indian Universities, syllabus of NET, SET, MPSC and UPSC and the UGC model curriculum is 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 B Sc Biotechnology (Vocational) 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 field of Vocational Biotechnology.

The Core Courses deal with Plant Bioengineering, Basics of Fermentation technology, Traditional Indian Wisdom in Biotechnology, Therapeutic Biotechnology, Bioproduction technology, Entrepreneurship in Biotechnology

Apart from the core courses, the Department Specific Elective Courses deal with Environment Biotechnology, Nutritional Biotechnology, Basics of Bioinformatics, Agricultural Biotechnology

The Skill Enhancement Courses like Microbial Bioprocessing and Bioinoculant Production offered during this program are designed with the aim of imparting specific skills to the students which will lead to the employability and the development of their own enterprises.

This would help students to lay a strong foundation in the field of Vocational 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 program in Biotechnology (Vocational) based on the needs of industries, academic and research institutions worldwide.

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

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

PEO4: To update curriculum by introducing recent advances in the subject that enable the students to successfully face NET, SET, MPSC, UPSC and other competitive examinations.

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 employability and for the development of their own enterprises.

Program Outcomes:

The Outcomes of this program are:

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

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

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

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

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

PO6: This will also develop specific skills amongst students for employability and for the

development of their own enterprises.

Prerequisite:

The students should have basic knowledge of science at 10+2 level. The optional courses are offered to the students registered for under-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 10+2 examination from any recognized Board.

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 Ramanand Teerth Marathwada 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)	ield Project/ Case Study/ OJT/	Credits	Total Credits
1	2	3		4	5	6	7	8	9	10	11
	V	SBTVCT 1301 (3cr) SBTVCT 1302 (3cr) SBTVIKS 1303 (2cr) SBTVCP 1301 (2cr) SBTVCP 1302 (2cr) 12 Credits	Major Elective SBTVET 1301 (2cr) SBTVEP 1301 (2cr) 04 Credits	--	--	--	SBTVSC1301 02 Credits	--	FP/CS SBTVFP1301 Or SBTVCS1301 04 Credits	22	

3 (5.5)	**VI**	**SBTVCT 1351 (3cr) SBTVCT 1352 (3cr) SBTVCT 1353 (2cr) SBTVCP1351 (2cr) SBTVCP1352 (2cr) 12 Credits**	**Major Elective SBTVET 1351 (2cr) SBTVEP 1351 (2cr) 04 Credits**	**--**	**--**	**--**	**SBTVSC 1351 02 Credits**	**--**	**OJT SBTVOT1351 04 Credits**	**22**	**132**
	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**											

B. Sc. ThirdYear Semester V*(Level 5.5)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SBTVCT 1301**	**Plant Bioengineering**	03	--		03	--
	SBTVCP 1301	**Practical Based on SBTVCT 1301**		02			04
	SBTVCT 1302	**Basics of Fermentation technology**	03	--		03	--
	SBTVCP 1302	**Practical Based on SBTVCT 1302**	-	02		--	04
	SBTVIKS 1303	**Traditional Indian Wisdom in Biotechnology**	02	--	**12**	02	--
Elective	**SBTVET 1301**	**Environment Biotechnology OR Nutritional Biotechnology**	02	--	**02**	02	--
	SBTVEP 1301	**Practical Based on SBTVET 1301**	--	02	**02**	-	04
Vocational Course	**SBTVSC1301**	**Microbial Bioprocessing**	--	02	**02**	--	04
Field Project/ Case Study/ OJT	**SBTVFP1301 Or SBTVCS1301**	**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 (7+8) / Col (9+10) (11)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (8)	CA (9)	ESA (10)	
Major	SBTVCT 1301	Plant Bioengineering	15	15	30	45	--	--	75
	SBTVCP 1301	Practical Based on SBTVCT 1301	--	--	--	--	20	30	50
	SBTVCT 1302	Basics of Fermentation technology	15	15	30	45	--	--	75
	SBTVCP 1302	Practical Based on SBTVCT 1302	--	--	--	--	20	30	50
	SBTVIKS 1303	Traditional Indian Wisdom in Biotechnology	10	10	20	30	--	--	50
Elective	SBTVET 1301	Environment Biotechnology OR Nutritional Biotechnology	10	10	20	30	--	--	50
	SBTVEP 1301	Practical Based on SBTVET 1301	--	--	--	--	20	30	50
Vocational Course	SBTVSC1301	Microbial Bioprocessing	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SBTVFP1301 Or SBTVCS1301	Field Project/ Case Study	--	--	--	--	40	60	100

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

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SBTVCT 1351**	**Therapeutic Biotechnology**	03	--	**12**	03	--
	SBTVCP 1351	**Practical Based on SBTVCT 1351**	-	02		--	04
	SBTVCT 1352	**Bioproduction technology**	03	--		03	--
	SBTVCP 1352	**Practical Based on SBTVCT 1352**		02		--	04
	SBTVCT 1353	**Entrepreneurship in Biotechnology**	02	--		02	--
Elective	**SBTVET 1351**	**Basics of Bioinformatics OR Agricultural Biotechnology**	02	--	**02**	02	--
	SBTVEP 1351	**Practical Based on SBTVET 1351**	--	02	**02**	--	04
Vocational Course	**SBTVSC1351**	**Bioinoculant Production**	--	02	**02**	--	04
Field Project/ Case Study/ OJT	**SBTVOT1351**	**OJT**	--	04	**04**	--	08
Total Credits 22			**10**	**12**	**22**	**10**	**24**

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)	Course Name (3)	Theory				Practical		Total Col (7+8) / Col (9+10) (11)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (8)	CA (9)	ESA (10)	
Major	SBTVCT 1351	Therapeutic Biotechnology	15	15	30	45	--	--	75
	SBTVCP 1351	Practical Based on SBTVCT 1351	--	--	--	--	20	30	50
	SBTVCT 1352	Bioproduction technology	15	15	30	45	--	--	75
	SBTVCP 1352	Practical Based on SBTVCT 1352	--	--	--	--	20	30	50
	SBTVCT 1353	Entrepreneurship in Biotechnology	10	10	20	30	--	--	50
Elective	SBTVET 1351	Basics of Bioinformatics OR Agricultural Biotechnology	10	10	20	30	--	--	50
	SBTVEP 1351	Practical Based on SBTVET 1351	--	--	--	--	20	30	50
Vocational Course	SBTVSC1351	Bioinoculant Production	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SBTVOJT1351	OJT	--	--	--	--	40	60	100

Syllabus for B. Sc.

BIOTECHNOLOGY

(Vocational)

Third Year

Semester – V

As Per National Education Policy- 2020

To be implemented from

Academic Year
2026-2027

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester-V) Major Core Theory Course

Code – SBTVCT1301

Title of the Course: PLANT BIOENGINEERING

[No. of Credits: 3 Credit] [Total:45 Hours]

Course pre-requisite:

A prerequisite for a Industrial Biotechnology course will be knowledge of basic plant biology, plant genetics, plant molecular biology, plant biochemistry with a foundational course in plant cell biology, with essential knowledge of basic plant science concepts, such as morphology, anatomy, physiology, structure and function plant cells.

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:

On completion of this course, the students shall:

- 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 markers studies and their use in plant breeding.
- Shall develop scientific skills to work in Plant tissue culture, Pharmaceutical and Research Laboratories.

Curriculum Details: SBTVCT 1301-Plant Bioengineering

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		**Plant tissue culture**	
	1.1	Introduction to *in vitro* methods. History of tissue culture Techniques. Beginning of *in vitro* cultures in our country Terms and definitions. Concept of Totipotency. Sterilization techniques	
	1.2	Structure and organization of Plant tissue culture laboratory. Tissue culture media: Types, Composition and preparation.	**12**
	1.3	Initiation and maintenance of callus and suspension culture. Embryo culture, preparation of embryos for culture, Applications of embryo culture. Embryo Rescue.	
	1.4	Haploid production. Introduction, Definitions, Androgenesis, pathways of early development, pollen dimorphism, factors affecting Androgenesis, Pollen culture.	

2.0		**Transgenic Crops**	**11**
	2.1	Haploid production. Introduction, Definitions, Androgenesis, factors affecting Androgenesis, Pollen culture. Applications of Haploids. Embryo culture, preparation of embryos for culture, Applications of embryo culture.	
	2.2	Somatic embryogenesis, Shoot tip culture, Protoplast culture.	
	2.3	Embryo culture and embryo rescue. Anther, Pollen and Ovary culture for production of haploid plants	
	2.4	Cryopreservation, slow growth and DNA banking for germ plasm	
3.0		**Vectors for the production of transgenic plants**	**10**
	3.1	.Plant virus vectors. Cauliflower mosaic virus, Gemini viruses, Tobacco mosaic virus, brome mosaic virus.	
	3.2	Plasmid vectors. lntroduction to *A.tumefaciens*. Tumor formation on plants using *A.tumefaciens* (monocots Vs Dicots). Root - formation using *A.rhizogenes*.Practical application of genetic transformation.Basis of tumor formation, hairy root, features of Ri & Ti plasmids.	
	3.3	Mechanism of DNA transfer, role of virulence genes, use of Ti & Ri as vectors Binary vectors, use of reporter genes, methods of nuclear transformation, viral vectors and their applications.	
	3.4	Multiple gene transfers vector less or direct gene transfer, particle bombardment, Electroporation, microinjection, transformation of monocots	
4.0		**Applications of Transgenic plants**	**12**
	4.1	Molecular marker aided breeding: RFLP, RAPD, Microsatellites etc	
	4.2	Production of crops with resistance to biotic stresses, viruses, fungal and bacterial	
	4.3	Crops with resistance to abiotic stresses (Herbicides and drought conditions): strategy and examples.	
	4.4	Terminator technology. Ecological risk assessment of genetically modified crops	
		Total	**45**

Text Books and Reference Books:

1. Razdan, M. K. Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd.
2. B.D Singh . Plant Biotechnology S Chand Publication
3. Schöpfer, K., & Kumar, A. Plant Cell and Tissue Culture: A Tool in Biotechnology. Springer- Verlag.
4. Bhojwani, S. S., & Razdan, M. K. Plant Tissue Culture. Elsevier Science Publishers.
5. Kumar, U. Methods in Plant Tissue Culture. Agrobios (India) Ltd.
6. Purohit, S. S. Agricultural Biotechnology. Agro Botanica, India. 1999.
7. Endress, R. Plant Cell Biotechnology. Springer-Verlag Berlin Heidelberg. 1994.
8. Subbarao, N. S. Soil Microbiology. Oxford University Press. 1999.
9. Melhotra, R., & Agarwal, G. C. Plant Pathology. Tata McGraw-Hill Publishing Company Ltd. 1983.
10. Gupta, P. K. Genetics and Biotechnology in Crop Improvement. Rastogi Publications .2008..
11. Pande S. N and Sinha B. K. (2010) Plant Physiology Vikas Publication

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - V) Major Core Practical Course

Course Code – SBTVCP 1301

Title of the Course: Practical Based on SBTVCT 1301

[No. of Credits: 2 Credit] [Total: 60 Hours]

Curriculum details: SBTVCP 1301: Practical Based on SBTVCT 1301

Sr. No	Practical Exercises	Hrs. Required
1.	Preparation of Tissue culture Media.	4
2.	Preparation Callus Culture.	4
3.	Sterilization of explant	4
4.	Preparation of shoot culture media	4
5.	Preparation of root culture media	4
6.	Study of organogenesis	4
7.	Protoplast isolation and culture.	4
8.	Anther Culture/ Production of haploids.	4
9.	Micro propagation via somatic embryogenesis	4
10.	Anther/microspore culture.	4
11.	Embryo/ovule culture	4
12	Isolation of Agrobacterium sp from soil	4
13	selection of tranformants, GUS assay	4
14	Isolation of plant genomic DNA	4
15	Agrobacterium mediated gene transfer method demonstration	4
	Total	**60**

Text Books and Reference Books:

1. Bendre and Kumar (1997). A Textbook of Practical Botany, Vol II., Rastogi Publications, Meerut.
2. Pandey B. P. (2019) Modern Practical Botany Vol. I, S. Chand and Company.
3. Pandey B. P. (2019) Modern Practical Botany Vol. II, S. Chand and Company
4. Jain V. K (2022) Fundamentals of Plant Physiology S. Chand Publication New Delhi.
5. Pande S. N and Sinha B. K (2010) Plant Physiology Vikas Publication.
6. Gupta, P. K. Genetics and Biotechnology in Crop Improvement. Rastogi Publications.2008
7. Melhotra, R., & Agarwal, G. C. Plant Pathology. Tata McGraw-Hill Publishing Company 1983.

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B.Sc. Biotechnology, III Year (Semester -V) Major Core Theory

Course Course Code – SBTVCT1302

Title of the Course: Basics of Fermentation Technology

[No. of Credits: 3 Credit] [Total:45 Hours]

Course pre-requisite:

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

.

Course objectives:

- To learn the microbial techniques for the isolation, screening, preservations and maintenance of

microorganisms.

- To become aware of the designs and types of bioreactors
- To know about various types of Fermentation processes, media formulation and bioreactor design.
- To obtain knowledge of scale up process.

Course outcomes:

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

Curriculum Details: SBTVCT 1302- Basics of Fermentation Technology

Module No.	Unit No.	Topics	Hrs. Required
1.0		**An introduction to fermentation**	**12**
	1.1	Introduction to Fermentation: Introduction, Fermentation and Components of Fermentation, Types of Fermentation	
	1.2	Screening: Definition and Objectives, Strain Improvement, Inoculum Development, Design of media: Constituents of media, their estimation & quantification	
	1.3	Media Constituents: Carbon Source , Nitrogen Source, minerals, buffers, growth factors, antifoams agents and Medium Optimization	
	1.4	Batch sterilization; Continuous Sterilization: Design and Methods, inoculum development.	
2.0		**Bioreactor**	**11**
	2.1	Basic aspect of Bioreactor Designing, Types of Bioreactors, Ideal Properties of Bioreactor,.	
	2.2	Body Construction, Agitator, Impeller, Baffles, etc	
	2.3	Packed-bed reactor, Air –lift, Trickle bed, Photo bioreactors, Rotating Biological Reactors	
	2.4	Instrumentation and Control	
3.0		**Microbial kinetics**	**10**

	3.1	Measurement & Control of Bioprocesses Parameters: Cell growth. pH, temperature, Substrate consumption, product formation,	
	3.2	Measurement of O2/CO2 uptake, evolution. Strategies for fermentation control.	
	3.3	Microbial Growth Kinetics: Batch, Fed-batch, & continuous.	
	3.4	Concept of scale up of fermentation. Comparative account of batch and continuous sterilization.	
4.0		**Scale up in Fermentation**	**12**
	4.1	Computer controlled fermentations, Foam & its control. Oxygen uptake rate (OUR), Ka, Viscosity & its control.	
	4.2	Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good, Manufacturing Practices (GMP).	
	4.3	Scale up in Bioprocesses fermentations, Factors used in scale up.	
	4.4	Standard Operating Procedures (SOP) & Good, Manufacturing Practices (GMP).	
		Total	**45**

Text Books and Reference Books:

1. Rutledge, C. R. Basic Biotechnology. Cambridge University Press. 2019.
2. Bailay, S. M., & Ollis, D. F. Fundamentals of Biochemical Engineering. Tata McGraw Hill. 2010.
3. Doran, P. M. Principles of Bioprocess Engineering. Elsevier. 2011.
4. Shuler, M. L., & Kargi, F. Basic of Bioprocess Engineering. Prentice Hall. 2001.
5. Moo-Young, M. Ed.. Comprehensive Biotechnology, Volume III. Elsevier. 2011.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. Principles of Fermentation Technology. Elsevier. 2016.
7. Crueger, W., & Crueger, A. Introduction to Industrial Microbiology. Springer. 2005.
8. Casida, L. E. Industrial Microbiology. American Society for Microbiology. 2005.
9. Whittaker & Stanberry- Principles of Fermentation Technology Elsevier. 2019
10. Pauline Doran Bioprocess Engineering Principles Elsevier 2021
11. Bioreactor Design & Product Yield, BIOTOL series - Elsevier
12. B. Lydersen, Delia &. Nelson, John Wiley Bioprocess Engineering: Systems, Equipment & Facilities - Ed.
13. Shuller & Kargi Bioprocess Engineering- -Pearson Education 2018

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B.Sc. Biotechnology, III Year (Semester - V) Major Core Practical Course

Course Code – SBTVCP 1302

Title of the Course: Practical Based on SBTVCT 1302

[No. of Credits: 2 Credit] [Total: 52 Hours]

Curriculum details: SBTVCP 1302: Practical Based on SBTVCT 1302

Sr. No	Practical Exercises	Hrs. Required
1.	Media formulation and optimization	4
2.	Study of Growth Kinetics of Bacteria by turbidometry	4
3.	Study of Growth Kinetics of Yeast by turbidometry	4
4.	Screening of industrially important microorganism- Acids	4
5.	Screening of industrially important microorganism- Antibiotics producer	4
6.	Screening of industrially important microorganism- Enzymes producer	4
7.	Study of scale up of fermentation	4
8.	Study of design of bioreactor	4
9.	Determination of TDP	4
10.	Determination of TDT	4
11	Study of types of fermentation process (Surface and submerged)	4
12	Maintenance of pure Culture	4
13	Visit to Fermentation Industry	4
	Total	**52**

Text Books and Reference Books:

1. Crueger, W., & Crueger, A. Introduction to Industrial Microbiology. Springer. 2005.
2. Casida, L. E. Industrial Microbiology. American Society for Microbiology. 2005.
3. Whittaker & Stanberry- Principles of Fermentation Technology Elsevier. 2019
4. Pauline Doran Bioprocess Engineering Principles Elsevier 2021
5. Bioreactor Design & Product Yield, BIOTOL series - Elsevier
6. B. Lydersen, Delia &. Nelson, John Wiley Bioprocess Engineering: Systems, Equipment & Facilities - Ed.
7. Shuller & Kargi Bioprocess Engineering- -Pearson Education 2018

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B.Sc. Biotechnology, III Year (Semester - V) Major Core Theory Course

Course Code – SBTVIKS 1303

Title of the Course: Traditional Indian Wisdom in Biotechnology

[No. of Credits: 2 Credit] [Total:30 Hours]

Course pre-requisite:

. Students entering the Fundamental Genomics course are expected to have a working grasp of Class XII-level Biology, together with a basic foundation in Microbiology and Cell Biology. A general familiarity with Indian history and culture is helpful, though it is not a compulsory requirement.

Course objectives:

- Acquaint learners with the extensive heritage of Indian Knowledge Systems (IKS) across the life sciences, agriculture, medicine, and natural philosophy.
- Expose learners to notable historic Indian achievements in biology, botany, fermentation, and bioresource management, and connect these to present-day biotechnology.
- Encourage learners to blend IKS concepts with contemporary outcome-based scientific inquiry, cultivating a mindset that is both culturally grounded and globally competent.

Course outcomes: Students will be able to

- Identify and describe the historic contributions of early Indian scholars to the biological sciences, medicine, and agriculture, as recorded in classical literature.
- Examine conventional Indian farming methods, fermentation approaches, and microbial understanding in relation to modern biotechnology.
- Assess India's biodiversity legacy, sacred grove customs, and ethnobotanical knowledge for their relevance to conservation and bioresource-based biotechnology.
- Develop a conceptual model or case study that merges IKS ideas with a current biotechnological application.

Curriculum Details: SBTVIKS 1303

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		**Introduction to Indian Knowledge Systems (IKS)**	**8**
	1.1	Meaning, extent, and importance of IKS with respect to science and technology	
	1.2	NEP 2020 directive on incorporating IKS into higher education	
	1.3	Categorization of IKS: Shruti, Smriti, Darshana, and the practical sciences (Vidyas)	
	1.4	Comparing IKS and Western ways of knowing: shared ground and complementary aspects	
2.0		**Indigenous Indian Farming and Soil Care**	**8**
	2.1	Traditional biofertilizer use: cow-dung based Panchagavya, green manuring,	
	2.2	Conventional pest-control methods: Neem (Azadirachta indica), Tulsi, and plant-derived pesticides	
	2.3	Historic approaches to rainwater collection, stepwell irrigation, and watershed conservation	
	2.4	Community-based seed-saving methods and traditional crop breeding	

3.0		**Fermentation Practices in Indian Heritage**	**7**
	3.1	Indian fermented foods: Idli, Dosa, Dhokla, Kanji, Toddy, and Jaggery	
	3.2	Native fermentation containers, starter cultures, and temperature-control techniques	
	3.3	Microbiological relevance of lactic acid bacteria, yeast, and mould-based fermentation, and their modern counterparts	
	3.4	Traditional vinegar making and dairy fermentation (curd, yoghurt, ghee) alongside probiotic research	
4.0		**Ethnobotany and the Legacy of Medicinal Plants**	**7**
	4.1	Understanding ethnobotany and India's standing as a mega-biodiversity region	
	4.2	Contribution of tribal communities — Adivasi understanding of plants, fungi, and insects; documentation initiatives such as TKDL and FRLHT	
	4.3	Chemical screening of traditional plant compounds: alkaloids, terpenoids, flavonoids, and saponins	
	4.4	Scientific verification of traditional claims about Neem, Turmeric, Ashwagandha, and Tulsi	
		Total	**30**

Text Books and Reference Books:

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

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B.Sc. Biotechnology, III Year (Semester -V) Major Elective Theory Course

Course Code – SBTVET-1301

Title of the Course: Environmental BT

[No. of Credits: 2 Credit] [Total: 30 Hours]

Course pre-requisite:

- A prerequisite for a Environmental Biotechnology course will be knowledge of Solid foundation in basic biology, ecology, and environmental science is required.
- Courses in biochemistry, microbiology, and molecular biology are beneficial,
- Fundamental knowledge of ecology and environmental will be helpful.

Course Objectives:

- To understand how biotechnology can help in monitoring or removing the pollutants
- To develop an understanding of new trends such as biofuels, renewable energy sources,
- microbial technologies which can minimize the harmful impact of pollutants in the environment.

Course Outcomes: Students will be able to

- Comprehend environmental issues and role of biotechnology in the clean-up of contaminated environments
- Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals
- Comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.
- Demonstrate innovative biotechnological interventions to combat environmental challenges.

Curriculum Details: SBTVET 1301- Environmental BT

Module No.	Unit No.	Topics	Hrs. Required
1.0		**CONCEPT OF ENVIRONMENT**	**08**
	1.1	Environment Basic concepts & issues Introduction to environmental biotechnology	
	1.2	Physical environment, biotic environment Biotic and abiotic interactions. Types of Environmental pollution	
	1.3	Environmental pollution; global environmental change, greenhouse effect, Ozone depletion, Ultraviolet Radiation, Acid Rain,	
	1.4	Biotechnological approaches for management.	
2.0		**BIODEGRADATION**	**07**
	2.1	Biodegradation; Definition and Concept and methods	
	2.2	Aerobic and anaerobic degradation pathways	
	2.3	Biodegradation of Hydrocarbon with suitable example. Xenobiotic Degradation;	
	2.4	Pesticide degradation-principle with suitable example Herbicide degradation- principle with suitable example	
3.0		**BIOREMEDIATION**	**08**
	3.1	Bioremediation; Definition,and concept	
	3.2	Methods of bioremediation (Insitu and Exsitu methods).	

	3.3	Phytoremediation ; Definition ,concept and types	
	3.4	Applications of bioremediation	
4.0		**BIOENERGY**	**07**
	4.1	Concept of Bioenergy : Biogas and biodiesel production and applications	
	4.2	Biabsorption technology, Mushroom Production on agrowaste,	
	4.3	Vermicomposting, GMF-advantages and disadvantages	
	4.4	Biomass; Composition of biomass, types of biomass, biomass conversion	
		Total	**30**

Text Books and Reference Books:

1. Asthana D.K. and Asthana M.,-Environment : Problems and Solutions- S. Chand
2. Chatterji A.K., Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd
3. Jogdand S.N.- Environmental Biotechnology- Himalaya Publishing House
4. Kalaichelvan P.T., I Arul Pandi- Bioprocess Technology, MJP Publishers
5. Murugesan A. G.andRajakumari C-Environmental Science and Biotechnology: Theory &Techniques,
6. Rajendran, Gunashekaran- Microbial Bioremediation-MJP
7. Indushekhar Thakur- Environmental Biotechnology-I K International
8. P. Mohapatra-Text book of Environmental Biotechnology-I K International
9. Biotechnology – B.D.Singh
10. Biotechnology – R. C Dubey
11. Ecology – Odum
12. Ecology and Environment - P.D Sharma
13. Environmental Biotechnology – Indu shekharThakur

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B.Sc. Biotechnology, III Year (Semester -V) Major Elective Practical Course

Course Code – SBTVEP 1301

Title of the Course: Practical Based on SBTVET 1301

[No. of Credits: 2 Credits] [Total: 60 Hours]

Curriculum details: SBTVEP 1301: Practical Based on SBTVET 1301

Sr. No	Practical Exercises	Hrs. Required
1	Determination of Dissolved Oxygen and Biological Oxygen Demand of polluted water.	4
2	Determination of Chemical Oxygen Demand of polluted water.	4
3	Bacterial Examination of Water by MPN Test	4
4	Presumptive and Confirmed Coliform test.	4
5	Determination of soil pH and Total organic carbon	4
6	Determination of Total Phosphorus of soil & water	4
7	NPK determination of soil samples	4
8	Determination of Alkalinity of water.	4
9.	Estimation of Ca and Mg from given water and soil sample.	4
10.	Estimation of Chlorides by Silver nitrate method	4
11	Biodegradation of polymer compounds	4
12	Biodegradation of textile dyes	4
13	Determination of Hardness of water	4
14	Determination of TS ,TDS & TSS of water	4
15	Determination of Total sodium of water samples	4
		60

Text Books and Reference Books:

1. Indushekhar Thakur- Environmental Biotechnology-I K International
2. P. Mohapatra-Text book of Environmental Biotechnology-I K International
3. Biotechnology – B.D.Singh
4. Biotechnology – R. C Dubey
5. Ecology – Odum
6. Ecology and Environment - P.D Sharma
7. Environmental Biotechnology – Indu shekharThakur

National Education Policy 2020

B.Sc. Biotech, III Year (Semester -V) Major Elective Theory Course Course Code – SBTVET 1301

Title of the Course: Nutritional Biotechnology-I

[No. of Credits: 2 Credit] [Total: 30 Hours]

Course pre-requisite:

- The course is offered for a student who completes second year undergraduate programme with Biotechnology as a major subject.
- The students should have basic knowledge of plant sciences and required credit in their Academic Bank of Credits.

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 awareness about laws and standards in food biotechnology.

Course outcomes:

- Students will 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: SBTVET 1301-Nutritional Biotechnology

Module No.	Unit No.	Topics	Hrs. Required
1.0		**Biotechnology for Food Ingredients**	
	1.1	Impact of Biotechnology on the nutritional quality of foods	
	1.2	Technologies used for microbial productions of food ingredients,	
	1.3	Biotechnology of microbial polysaccharides in food.	**8**
	1.4	Causes of food spoilage and methods to preserve food..	
2.0		**Aspects of food production**	
	2.1	Food safety: HACCP system to food protection,	
	2.2	Food additives: Definition, Types and functional characteristics,	**8**
	2.3	Advantages of natural colour over artificial,	
	2.4	Sweeteners: Types and applications	
3.0		**Fermented Foods**	
	3.1	Fermented dairy products: Cheese and youghurt, ,	
	3.2	Spoilage of fermented dairy products and their control, Prodution of Baker‟s yeast	
	3.3	Food enzymes and food additives. Fermentative production of wine.	

	3.4	Biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables.	
4.0		**Food Speciality**	**7**
	4.1	Functional foods and probiotics, ,	
	4.2	Beneficial effects of spices	
	4.3	Spirulina, antioxidants and other food constituents.	
	4.4	Biosensors for food quality assessment,	
		Total	**30**

List of Reference/Text books

1. Industrial Microbiology by Prescott and Dunn.
2. Industrial Microbiology by L.E. casida
3. General Microbiology, Vol. II by Power and Daginawala
4. Biotechnology by U. Satyanarayana
5. Outlines of dairy technology by Sukumar De
6. Nutrition and dietetics foods by Arnold E. Bender
7. Nutrition and dietetics by Shubhangini A. Joshi
8. Basic nutrition in health and disease by P. S. Howe,W.B.Saunders
9. Food Microbiology Adams & Moss- Royal Society of Chemistry
10. Food Microbiology Frazier- - Tata Mc Graw Hill
11. Food Spoilage- James and jay

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester -V) Major Elective Practical Course Course Code – SBTVEP 1301

Title of the Course: Practical Based on SBTVET 1301

[No. of Credits: 2 Credit] [Total: 48 Hours]

Curriculum details: Practical Based on SBTVET 1302

Sr. No	Practical Exercises	Hrs. Required
1.	Survey and Characterization of available market food products (Two)	04
2.	Preparation of Tomato and Mix veg soups	04
3.	Production of fermented products like vinegar / cider / wine	04
4.	Production of Milk products	04
5.	Qualitative analysis of milk and products	04
6.	Quantitative analysis of milk and products	04
7.	Analysis of ghee – RM value, Boudomin‟s and other tests for adulterations	04
8.	Production of Idli, Dosa etc	04
9.	Evaluation of quality of dairy products: Specific gravity of milks	04
10.	Microbial production of Polysachharides	04
11.	Visit to dairy Industry	04
12	SCP of Food	04
	Total	**48**

Text Books and Reference Books:

1. Industrial Microbiology by Prescott and Dunn.
2. Industrial Microbiology by L.E. casida
3. General Microbiology, Vol. II by Power and Daginawala
4. Biotechnology by U. Satyanarayana
5. Outlines of dairy technology by Sukumar De
6. Nutrition and dietetics foods by Arnold E. Bender
7. Nutrition and dietetics by Shubhangini A. Joshi
8. Basic nutrition in health and disease by P. S. Howe,W.B.Saunders
9. Food Microbiology Adams & Moss- Royal Society of Chemistry
10. Food Microbiology Frazier- - Tata Mc Graw Hill
11. Food Spoilage- James and jay

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B.Sc. Biotechnology, III Year (Semester -V) VSC Course

Course Code – SBTVSC 1301

Title of the Course: MICROBIAL BIOPROCESSING

[No. of Credits: 2 Credit] [Total: 48 Hours]

Curriculum details: SBTVSC 1301: Microbial Bioprocessing

Sr. No	Practical Exercises	Hrs. Required
1.	Basic requirements in the fermentation technology	04
2.	Isolation of industrially important microorganisms	04
3.	Preservation of microbial culture	04
4.	Basic design of fermentor	04
5.	Lactic acid Production	04
6.	Production of technology of fermented alcoholic beverages (wine)	04
7.	Design of fermentation media	04
8.	Optimization of media	04
9.	Ethanol fermentation from organic waste	04
10	Growth curve of bacteria	04
11	Enzyme Production (alpha amylase)	04
12	Visit to fermentation industry	04
	Total	**48**

Text Books and Reference Books:

1. Principles of Fermentation Technology - Whittaker & Stanberry
2. Casida L.E - Industrial Microbiology- New Age
3. Crueger W and Crueger A - Biotechnology: A Textbook of Industrial Microbiology- Panima Publishing
4. Patel A.H. - Industrial Microbiology, Macmillan India
5. Peppler H.J and Perlman D - Microbial Technology, Vol I and II-Elsevier
6. Biochemical Engineering Fundamentals- Bailey, Ollis- McGraHill

Semester – VI B.Sc. III Year Biotechnology

(Vocational)

As Per National Education Policy- 2020

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - VI) Major Core Theory Course

Course Code – SBTVCT-1351

Title of the Course: THERAPEUTIC BIOTECHNOLOGY

[No. of Credits: 3 Credit] [Total:45 Hours]

Course pre-requisite:

- The course is offered for a student who completes second year undergraduate programme with Biotechnology as major subject.
- The students should have basic knowledge of biochemistry, cell biology, and genetics is necessary. Courses in organic chemistry and microbiology are often recommended and required credit in their Academic Bank of Credits.

Course objectives:

- The objective of this course is to apply the basic concepts in the specific field of pharmaceutical biotechnology.
- The student will gain insights into identification and design of drugs that could be potentially useful.
- 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 putinto clinical trials..

Course outcomes:

Students will be able to

- Describe the pharmacological mechanisms of key biological therapeutics, differentiating between standard small-molecule drugs
- Anto microbial drug viz.. antibacterial drug, anti-fungal drugs, antiviral, etc
- Analyze the discovery and development of drug targeting, Combinatorial drug discovery, Rational Drug designing

Curriculum Details: SBTVCT 1351- Therapeutic Biotechnology

Module No.	Unit No.	Topics	Hrs. Required
1.0		**Secondary Metabolites**	**10**
	1.1	Introduction to Secondary Metabolites and its types	
	1.2	Medicinal Applications of Secondary metabolites.	
	1.3	Production of Secondary metabolites in Plants Through hairy Root Culture	
	1.4	Factors affecting Secondary metabolite production (Precursors, Growth Factors and Nutrients)	
2.0		**Chemotherapy**	
	2.1	Types of Antibiotics: Classification of antibiotics with example. General characteristics of an Antimicrobial drug	**12**
	2.2	Mechanism of action of antimicrobial agent (General account).	
	2.3	Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism).	

	2.4	Application of antibiotics in various fields. Assaying antimicrobial activity: Methods of microbial assay (MIC and Different types of agar diffusion.)	
3.0		**Chemotherapeutics Agents**	**11**
	3.1	Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones.	
	3.2	Antiviral drug: Amantadne, Azidothymidine	
	3.3	Antifungal drug: Nystatin, Griseofulvin.	
	3.4	Mechanism of action of Anticancer drugs, Antidiabetic drugs and Antihypertensive drugs	
4.0		**Protein Engineering and Drug Discovery**	**12**
	4.1	Protein engineering: Principles and Application.	
	4.2	Discovery and Development: History, drug targeting, Combinatorial drug discovery, Rational Drug designing	
	4.3	Concept of Pharmacokinetics Pharmacodynamics. Drug delivery systems, Liposomes.	
	4.4	Introduction to Indian and International Pharmacopoeia. Cheminformatics	
		Total	**45**

Text Books and Reference Books:

1. Glick, B. R., & Pasternak, J. J. (Eds.). Molecular biotechnology: Principles and applications (Vol. 1). ASM Press. 2009
2. Kar, A. Pharmacology and pharmaco biotechnology. New Age International Publishers. 2003.
3. Razdan, B. Medicinal chemistry. CBS Publishers & Distributors. 2019.
4. Doble, M. Drug designing. McGraw Hill Education. 2005.
5. Hugo, W. B., & Russell, A. D. (2009). Pharmaceutical microbiology. Wiley India Pvt.Limited.
6. Barar, F. S. K. (2010). Essentials of pharmaceuticals. S. Chand & Company Ltd.
7. Satoskar, R. S., & Bhandarkar, S. D. Pharmacology and pharmacotherapeutics.Popular Prakashan. 1988.
8. Vyas, S. P., & Dixit, V. K. Pharmaceutical biotechnology. CBS Publishers Distributors. 2018.
9. Walsh G. Biopharmaceuticals: biochemistry and biotechnology. John Wiley & Sons; 2013.
10. Sambamurthy K. Pharmaceutical biotechnology. New Age International; 2006. Development, 6th edition. New York, NY: OUPress, Sinauer Associates.
11. Jogdand S.N - Biopharmaceuticals, Himalaya Publishing
12. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford
13. Gupta P.K. - Biotechnology and Genomics, Rastogi Publication

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - VI) Major Core Practical Course

Course Code – SBTVCP 1351

Title of the Course: Practical Based on SBTVCT 1351

[No. of Credits: 2 Credit] [Total: 52 Hours]

Curriculum details: SBTVCP 1351: Practical Based on SBTVCT 1351

Sr. No	Practical Exercises	Hrs. Required
1.	Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin and Quinolones	04
2.	Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic	04
3.	Determination of shelf life of antibiotics (Expired drugs)	04
4.	Bioassay of antifungal compounds	04
5.	Testing of antibiotic resistance	04
6.	Sterility testing of commercial pharmaceuticals.	04
7.	Sterility testing of injectable as per IP.	04
8.	Effect of chemical disinfectant on growth of bacteria	04
9.	Study of microbial spoilage of pharmaceuticals.	04
10.	Estimation of penicillin/streptomycin by biological assay.	04
11.	Estimation of penicillin/streptomycin by chemical assay.	04
12.	Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin	04
13.	Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic	04
	Total	**52**

Text Books and Reference Books:

1. Hugo, W. B., & Russell, A. D. (2009). Pharmaceutical microbiology. Wiley India Pvt.Limited.
2. Barar, F. S. K. (2010). Essentials of pharmaceuticals. S. Chand & Company Ltd.
3. Satoskar, R. S., & Bhandarkar, S. D. Pharmacology and pharmacotherapeutics.Popular Prakashan. 1988.
4. Vyas, S. P., & Dixit, V. K. Pharmaceutical biotechnology. CBS Publishers Distributors. 2018.
5. Walsh G. Biopharmaceuticals: biochemistry and biotechnology. John Wiley & Sons; 2013.
6. Sambamurthy K. Pharmaceutical biotechnology. New Age International; 2006. Development, 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
7. Jogdand S.N - Biopharmaceuticals, Himalaya Publishing
8. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford
9. Gupta P.K. - Biotechnology and Genomics, Rastogi Publication

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - VI)

Major Core Theory Course

Course Code – SBTVCT-1352

Title of the Course: BIOPRODUCTION TECHNOLOGY

[No. of Credits: 3 Credit] [Total:45 Hours]

Course pre-requisite:

- A prerequisite for a Industrial Biotechnology course will be knowledge of basic microbiology, Genetics, Molecular Biology, Biochemistry with a foundational course in basic microbial culture Techniques, fermentation process.

Course objectives:

- To learn the analytical techniques for the identification of microbial products.
- To understand the Microbial production of Organic Acids and Solvents.
- To learn the Concept of quality control and quality assessment.

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

- Demonstrate knowledge about the techniques of microbial productions and acquire comprehensive knowledge on quality control and quality assessment.
- Acquire knowledge in Production and purification of microbial enzymes and other industrial products.
- Able to work in the section of quality control of Food industry.
- Shall develop scientific skills to work in Pharmaceutical and Research laboratories

Curriculum Details: SBTVCT 1352- Bioproduction Technology

Module No.	Unit No.	Topics	Hrs. Required
1.0		**Strain Improvement**	
	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	**11**
	1.4	Modification of Permeability	
2.0		**Down Stream Processing**	
	2.1	Removal and Recovery of cell mass (Precipitation, Filtration and Centrifugation)	
	2.2	Cell disruption - Physical and Chemical methods. Purification of Product Liquid-liquid extraction :	**12**
	2.3	Solvent Recovery. Chromatography : Adsorption, Ion-exchange, HPLC	
	2.4	Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.	
3.0		**Fermentation Processes**	**11**
	3.1	Fermentation processes: Microorganisms involved, Inoculum preparation, Medium used and product Recovery	

	3.2	Enzyme Production : Protease, pectinase	
	3.3	Production of Organic acid: Citric acid. & Vitamin B12	
	3.4	Antibiotic production : Penicillin, erythromycin.	
4.0		**Quality Control, Process Economics and GLP**	**1**
	4.1	Sterility testing.Pyrogen testing. Carcinogenicity testing. Toxicity testing. .	
	4.2	Fermentation Economics: Cost Estimates ,Process Design ,Capital Cost Estimates, Operating Cost Estimates	
	4.3	Concept of QC, QA	
	4.4	Good Laboratory Practices, GMP.	
		Total	**45**

Text Books and Reference Books:

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
9. Paul A. Belter, Cussler- Bioseparation :Downstraem Processing for Biotechnology - Academic Press
10. LarlSchuger-Solvent Extraction in Biotechnology - Spinger
11. Roger Harrison-Bioseparation Science & Engineering-Oxford
12. N.K. Prasad-Downstream Process Technology-PHI

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - VI) Major Core Practical Course

Course Code – SBTVCP 1352

Title of the Course: Practical Based on SBTVCT 1352

[No. of Credits: 2 Credit] [Total:48 Hours]

Curriculum details: SBTVCP 1352: Practical Based on SBTVCT 1352

Sr. No	Practical Exercises	Hrs. Required
1.	Isolation & identification of bacteria from different water samples.	4
2.	Isolation & identification of bacteria from different milk	4
3.	Fermentative production purification and estimation of vitamins	4
4.	Fermentative production purification and estimation of antibiotics	4
5.	Fermentative production purification and estimation of Citric Acid	4
6.	Fermentative production purification and Estimation of alcohol. Using *Saccharomyces cerevisiae*	4
7.	Estimation of fermentative product (Acetic acid from vinegar).	4
8.	Qualitative estimations of fermentation products by analytical instruments	4
9.	Wine production & estimation of alcohol	4
10.	Production of cheese using different substrate from microorganism	4
11	Study of fermentation economics with any one example	4
12	Visit to Fermentation Industry	4
	Total	**48**

Text Books and Reference Books:

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

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester - V) Major Core Theory Course

Course Code – SBTVCT 1353

Title of the Course: Entrepreneurship in Biotechnology

[No. of Credits: 2 Credit] [Total:30 Hours]

Course pre-requisite:

- The course can be selected without former knowledge in Bio-Business, Innovation and entrepreneurship.

Course objectives:

- To introduce students to learn the central skills in science-based entrepreneurship in the Biotech industry.

Course outcomes:

- The course provides students with the necessary knowledge on how to bridge science and business and translate biotech concepts into commercial terms.
- It also enables students to understand the differences in issues and challenges in science-based industries related to entrepreneurship and innovation.
- Finally, students will develop the skills to successfully work in interdisciplinary teams and jointly produce business plans that are ready for submission to a business plan competition or presented to potential venture capitalists**.**

Curriculum Details: SBTVCT1353- Entrepreneurship in Biotechnology

Module No.	Unit No.	Topic	Hrs.
1. 0		**BASIC ENTREPRENEURSHIP**	08
	1.1	Introduction: Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology	
	1.2	pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits, and motivation,	
	1.3	Nature and importance of Entrepreneurs,	
	1.4	Government schemes for commercialization of technology	
2.0		**PROJECT MANAGEMENT**	07
	2.1	Project management: Search for a business idea, concept of project and classification	
	2.2	Project identification, project formulation	
	2.3	Project design and network analysis	
	2.4	Risk management	
3.0		**FINANCIAL MANAGEMENT**	
	3.1	Financial analysis	08
	3.2	Ratio analysis, Investment process, Break even analysis	
	3.3	Profitability analysis	
	3.4	Budget and planning process.	
4.0		**BIOTECH ENTERPRISES**	

	4.1	Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry	07
	4.2	Quality control in Biotech industries	
	4.3	Location of an enterprise, steps for starting a small industry,	
	4.4	Incentives and subsidies, exploring export possibilities	
		Total	**30**

Textbook and Reference Books:

1. The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
2. Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
3. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris, 2006
4. Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005.
5. Projects Planning Analysis, Selection, Implementation & Review by Prasannan.
6. Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008.

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester -VI) Major Elective Theory Course

Course Code – SBTVET 1351

Title of the Course: Basics of Bioinformatics

[No. of Credits: 2 Credit] **[Total: 30 Hours]**

Course pre-requisite:

- The course offered for a student who completes second year undergraduate programme with Biotechnology as major subject.
- For a Computational Biology course will be knowledge of Strong foundation in mathematics and statistics is essential.
- Basic bioinformatics knowledge, Courses in biochemistry, molecular biology, or genetics are crucial for applying computational skills.

Course objectives:

- To understand the concept of genomics, proteomics, biostatics and their applications.
- To learn about methods of studying genetic materials obtained from various environmental Samples.
- To understand basic concepts of sequences, structural alignment, database searching, protein structure prediction.

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

Curriculum Details: SBTVET1351- Basics of Bioinformatics

Module No.	Unit No.	Topics	Hrs. Required
1.0		**HISTORY, SCOPE AND IMPORTANCE**	**8**
	1.1	Various definitions of Bioinformatics - Important contributions - aims and tasks of Bioinformatics -	
	1.2	Applications of Bioinformatics - challenges and opportunities -	
	1.3	Internet basics- HTML,URLs, Role of internet and www in Bioinformatics	
	1.4	Advance fields in bioinformatics(Genomics – Proteomics – Transcriptomes)	
2.0		**SEQUENCE ALIGNMENTS AND VISUALIZATION**	**8**
	2.1	Introduction to Sequences, alignments and Dynamic Programming;	
	2.2	Local alignment and Global alignment (algorithm and example),	
	2.3	Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).	

	2.4	Methods for presenting large quantities of biological data: sequence viewers (Artemis, 3D structure viewers (Rasmol, Cn3D, PyMol)	
3.0		**GENE EXPRESSION AND REPRESENTATION OF PATTERNS AND RELATIONSHIP**	**7**
	3.1	General introduction to Gene expression in prokaryotes and eukaryotes	
	3.2	Transcription factors binding sites. SNP, EST, STS.	
	3.3	Introduction to Regular Expression, Hierarchies, and Graphical models	
	3.4	Genetic variability and connections to clinical data.	
4.0		**STRUCTURAL BIOINFORMATICS**	**7**
	4.1	Protein secondary structure classification databases - -	
	4.2	Protein secondary structure prediction methods - Motif and Domain	
	4.3	Protein Tertiary structure prediction methods - Molecular Docking of Protein	
	4.4	Structure prediction of collagen and myoglobin	
		Total	**30**

Text Books and Reference Books:

1. Baxevanis, A.D. and Francis Ouellellette, B.F. (1998) "Bioinformatics– a practical guide to the analysis of genes and proteins" John Wiley and Sons
2. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)
3. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India.
4. Bergman N. H. (2007),"Comparative genomics" Volume 2, Humana Press
5. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human Genome Project" John Wiley and Sons
6. Attwood, T., & Parry-Smith, D. Introduction to bioinformatics. Prentice Hall. 1999
7. Pevzner, P. A. Computational molecular biology. MIT Press. 2000
8. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare
9. Clark M (2000), "Comparative genomics" Springer
10. T.A. Brown, "Genome", John Wiley & sons, 2006
11. Primrose S. B., Twyman R. M. (2004), "Genomics: applications in human biology" Wiley-Blackwell

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B.Sc. Biotechnology, III Year (Semester -VI) Major Elective Practical Course

Course Code – SBTVEP 1351

Title of the Course: Practical Based on SBTVET 1351

[No. of Credits: 2 Credit] [Total:60 Hours]

Curriculum details: SBTVEP 1351: Practical Based on SBTVET 1351

Sr. No	Practical Exercises	Hrs. Required
1.	Knowledge of different biological database	4
2.	Different file formats –Genbank, Genpept, FASTA, EMBL, NBRF/PIR, , PDB file format	4
3.	Protein and gene sequence data bases (NCBI, DDBJ, EMBL, SWISS PROT, PIR)	4
4.	Prediction of secondary structure of proteins.	4
5.	Prediction of 3D structure of proteins	4
6.	Visualization of tertiary structure of proteins	4
7.	Accessing existing databases on www – Artemis	4
8.	Sequence alignment	4
9.	Homology search tools like BLAST and modeller.	4
10.	Genomics- Genome databases, Annotation of genome, Perdition of ORFs	4
11.	Gene prediction GENSCAN and GeneMark	4
12.	Molecular Docking	4
13	Protein identification & characterization with peptide mass fingerprinting data.	4
14	Getting an amino acid sequence, nucleotide sequence by BLAST	4
15	Primary/ secondary structure analysis of proteins	4
	Total	**60**

Text Books and Reference Books:

1. Sharma, V. Munjal, A. and Shankar, A. (2008) “A text book of Bioinformatics” first edition, Rastogi Publication, Meerut – India.
2. Bergman N. H. (2007),”Comparative genomics” Volume 2, Humana Press
3. Cantor C.R., Smith C.L., (1993) “Genomics: the science and technology behind the Human Genome Project” John Wiley and Sons
4. Attwood, T., & Parry-Smith, D. Introduction to bioinformatics. Prentice Hall. 1999
5. Pevzner, P. A. Computational molecular biology. MIT Press. 2000
6. Choudhuri S., Carlson D. B. (2008), “Genomics: fundamentals and applications” Informa Healthcare

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B.Sc. Biotechnology, III Year (Semester -VI)

Major Elective Theory Course

Course Code – SBTVET 1351

Title of the Course: Agricultural BT

[No. of Credits: 2 Credit] [Total:30 Hours]

Course pre-requisite:

- The course offered for a student who completes second year undergraduate programme with Biotechnology as major subject.
- The students should have basic knowledge of plant science and required credit in their Academic Bank of Credits.

Course objectives:

- To know about the fundamentals of N2 fixation.
- To know about the Production and use of Biofertilizer & Biopestcide
- To study in detail the process of Plant Defence mechanism and disease management.
- To acquire knowledge of different plant diseases in different plants and their control measures.
- To acquire knowledge the knowledge of SCP production

Course Outcomes:

- The students will be able to understand fundamentals of plant pathology.
- The students will be able to understand in detail the process of Plant Defense mechanism and disease management.
- Students will acquire knowledge of Biofertilizer & Biopestcide production and its application
- Students will acquire knowledge SCP and Mushroom production

Curriculum Details: SBTVET 1352- Agricultural BT

Module No.	Unit No.	Topics	Hrs. Required
1.0		**Nitrogen Fixation and Phytohormones.**	**8**
	1.1	**Symbiotic N2 fixation** - Legume, Rhizobium symbiosis, Host specificity, Infection, Nodule Development, .	
	1.2	Mechanism of N2 Fixation .**Non Symbiotic N2 Fixation** - Diazotrophy, Sites of N2 Fixation, Nitrogenase Complex,	
	1.3	Cyanobacteria, Azotobacter, Azospirillum	
	1.4	**Phytoharmones-** Definition, Classification, Physiological Effects, Functions of Auxin, Cytokinin,Gibberellins.Assimilation of Sulphur and Phosphorus in Plants	
2.0		**Biofertilizers**	**7**
	2.1	Concept and Types of Biofertilizer. Microbial Inoculums - Rhizobium Inoculant, Azotobacter, Biofertilizer	

	2.2	Blue-Green algae as Biofertilizer	
	2.3	Sulphur and Phosphate Solubilizing Biofertilizer	
	2.4	Applications of Biofertilizer	
3.0		**Plant Pathology**	
	3.1	Concept of Plant Pathology. Host Pathogen Relationship. Pathogenesis mechanism- Enzymes, Toxins, Nutrition etc. , Mechanism of Plant defence, resistance to disease	**8**
	3.2	Classification of Plant Diseases based on Symptoms. Plant Diseases: Causative agent.	
	3.3	Mechanism of Action and Control Measures (Chemical and Biological)	
	3.4	Bacterial Blight of Cotton , Whip Smut of Sugar Cane, Powdery Mildew of Wheat , Citrus Canker of Lemon	
4.0		**Agro-Biotechnology7**	
	4.1	Bio-pesticides- Definition and Types (Microbial and Botanical) Advantages of Biopesticides over chemical pesticides.	**7**
	4.2	Biomass : Composition , Types, Biomass as a energy Source, Biomass conversion and Utilization	
	4.3	Single Cell Protein and its Nutritive Value eg.Spirulina	
	4.4	Mushroom production	
		Total	30

List of Reference/Text books

1. Diseases of crop plants in India- G. Rangaswami
2. Principles of Plant Pathology- R.S. Singh
3. Plant Pathology- B. P. Pande
4. Plant Pathology- R.S. Mehrotra
5. Plant Protection- Chattopadhyay
6. Genetics and Biotechnology in Crop Improvement Gupta P.K. -, Rastogi Publications
7. Fundamentals of Plant Pathology Pathak V.N, Khatri N.K.,Pathak M. -, Agrobotanical Publications
8. Text book of Biotechnology R.C. Dubey –-S.Chand publications
9. Soil Microbiology SubbaRao- - Oxford IBH
10. Plant Pathology Melhotra and Agarwal- - TataMcGraw Hill
11. Biofertilizer and Organic Farming VyasS..,and Modi H.A.(1998) -, AktaPrakashan.
12. Experiments in Microbiology, Plant Pathology, Tissue Culture & MushrooCultivation- K.R. Aneja

National Education Policy 2020

B.Sc. Biotech, III Year (Semester -VI) Major Elective Practical Course

Course Code – SBTVEP 1351

Title of the Course: Practical Based on SBTVET 1351

[No. of Credits: 2 Credit] [Total: 56 Hours]

Curriculum details: SBTVEP 1352: Practical Based on SBTVET 1352

Sr. No	Practical Exercises	Hrs. Required
1.	Isolation of *Rhizobium* sp.from root nodule of leguminous plant.	04 04
2.	Isolation & Study of non symbiotic nitrogen fixing organims	04
3.	Isolation and study of PSBs	04
4.	Estimation of leg haemoglobin from root nodule of leguminous plant.	04
5.	Assay of IAA	04
6.	Cultivation and study of Spirulina algae,	04
7.	Isolation & identification of plant pathogen (*Xanthomonas)* from infected citrus fruit /leaf.	04
8.	Study of Bio pesticides: *Trichoderma*	04
9	Study of community by quadrate method (Frequency, Density and Abundance of Species)	04
10	Study of Symptoms, causal organisms, disease cycle and control measures of Bacterial Blight of Cotton	04
11	Study of Symptoms, causal organisms, disease cycle and control measures of Citrus Canker of Lemon	04
12	Study of Symptoms, causal organisms, disease cycle and control measures of Whip Smut of Sugar Cane,	04
13	Visit to Cell Culture Facilities /Production /Biofertilizer Industry	04
14	Mushrooms Production	04
	Total	**56**

List of Reference/Text books

1. Diseases of crop plants in India- G. Rangaswami
2. Principles of Plant Pathology- R.S. Singh
3. Plant Pathology- B. P. Pande
4. Plant Pathology- R.S. Mehrotra
5. Plant Protection- Chattopadhyay
6. Genetics and Biotechnology in Crop Improvement Gupta P.K. -, Rastogi Publications
7. Fundamentals of Plant Pathology Pathak V.N, Khatri N.K.,Pathak M. -, Agrobotanical Publications
8. Text book of Biotechnology R.C. Dubey –-S.Chand publications
9. Soil Microbiology SubbaRao- - Oxford IBH
10. Plant Pathology Melhotra and Agarwal- - TataMcGraw Hill
11. Biofertilizer and Organic Farming VyasS..,and Modi H.A.(1998) -, AktaPrakashan.
12. Experiments in Microbiology, Plant Pathology, Tissue Culture & MushrooCultivation- K.R. Aneja

National Education Policy 2020

B.Sc. Biotechnology, III Year (Semester -VI) VSC Course

Course Code – SBTVSC 1351

Title of the Course: Bioinoculant Production

[No. of Credits: 2 Credits] [Total:52 Hours]

Course pre-requisite:

- The course is offered for a student who completes second year undergraduate programme with Biotechnology as major subject.
- The students should have basic knowledge of plant sciences and required credit in their Academic Bank of Credits.

Course objectives:

- To know about the fundamentals of N2 fixation.
- To know about the Production and use of Biofertilizer
- To isolate N2 Fixing microorganism's from soil.
- To study in detail biofertilizer production and its application in fields

Course outcomes:

- Students will acquire knowledge of Biofertilizer & Biopestcide production and its application
- Students will acquire knowledge SCP and Mushroom production

Curriculum details: SBTVSC 1351: Bioinoculant Production

Sr. No	Practical Exercises	Hrs. Required
1.	**Biofertilizers :** Introduction to Biofertilizers , Advantages of biofertilizers over chemical	04
2.	Cite selection and sample collection for isolation of agriculturally important micro- organism	04
3.	Identification and characterization of Micro-organism	04
4.	Media preparation	04
5	Screening of superior strains using some *in vitro* technique	04
6	Inoculum development	04
7	Check for cross contaminations	04
8	Large scale production of Bio-inoculant by using Lab fermenter	04
9	Preparation of carrier	04
10	Mixing of Inoculum and carrier	04
11	Effect of packaging on viability of inoculants	04
12	Study of shelf life of inoculant	04
13	Efficacy check of developed inoculant by using Pot experiment and its comparison with already available commercial Biofertilizers	04
	Total	**52**

Text Books and Reference Books:

1. S. G. Borkar, 2019, *Microbes as Bio-Fertilizers and Their Production Technology,* Publication: New India Publishing Agency
2. R. P. Gupta, Anu Kalia, and Shammi Kapoor, 2007, *Bioinoculants: A Step Towards Sustainable Agriculture,* New India Publishing Agency [
3. K. Surendra Gopal, 2021, *Biofertilizers for Sustainable Production of Horticultural Crops*, New India Publishing Agency
4. S. Kannaiyan, K. Kumar, and K. Govindarajan, 2010, *Biofertilizers Technology,* Scientific Publisher (India)
5. Amitava Rakshit, Vijay Singh Meena, Manoj Parihar, H.B. Singh, et al., 2021–2024, *Biofertilizers: Volume 1: Advances in Bio-inoculants* / *Bio-inoculants in Horticultural Crops (Vol. 3),* Elsevier / Woodhead Publishing.
6. Sukhminderjit Kaur, Vagish Dwibedi, and Pramod Kumar Sahu, 2023–2024, *Metabolomics, Proteomes and Gene Editing Approaches in Biofertilizer Industry,* Springer Nature Singapore
7. Surender Singh, Radha Prasanna, and Kumar Pranaw, 2023, *Bioinoculants: Biological Option for Mitigating Global Climate Change,* Springer Nature Singapore

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