Karmaveer Bhaurao Patil University, Satara

(A State Public University Est. u/s 3(6) of MPUA 2016)

Syllabus for

B. Sc. III Biotechnology

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2025 - 2026

Title: B. Sc. Biotechnology

1. **Year of Implementation:** 2024-25

2. **Preamble:** As per the NEP 2020 guidelines this updated syllabus is prepared for first year undergraduate students of Biotechnology. At this level, to develop their interest towards Biotechnology as applied science and also to prepare them for the academic and industrial exposure simultaneously. Introduction of life science subjects will help to form a basic foundation of concepts for students. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at first year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The Reference books are mentioned with relevance.

3. General Objectives:

1. Construction and redesigning of the courses to suite local needs
2. More emphasis on applied aspects of biotechnology
3. To develop aptitude of students in the field of research
4. Enrichment of basic knowledge in areas of Biotechnology

4. Program Outcomes: The students will be

1. Graduate with proficiency in the biotechnology
2. Eligible to continue higher studies in the subject
3. Eligible to peruse post graduate study in abroad
4. Eligible to appear for the examination for a job in the government sector.

5. Program Specific Objectives:

1. The students are expected to understand the fundamentals, principles, concept and recent developments in Biotechnology.
2. The practical course is framed in relevance with theory courses to improve understanding of various concepts in biotechnology.
3. It is expected to inspire and boost interest of students in Biotechnology.
4. To enrich students' knowledge and train them in various branches of Biotechnology.

6. Program Specific Outcomes:

1. Understand basics of Biotechnology
2. Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in the classroom
3. Develop the ability to apply the knowledge acquired in classroom and laboratories to specific problems in theoretical and experimental biotechnology.
4. Identify the area of interest in the academic research and development.
5. Perform job in various fields like food, pharmaceutical, agriculture, healthcare, public services and business etc.
6. Be an entrepreneur with precision, analytical mind, innovative thinking, and clarity of thought, expression and systematic approach.

7. **Duration:** One Year
8. **Pattern:** Semester wise
9. **Medium of Instruction:** English

STRUCTURE OF COURSE:

As per NEP-2020 (1.0)

Level	Sem.	Course				VSC	FP	CEP	OJT	Total
		DSC		DSE*						
		T	P	T	P					
5.5	V	DSC I (2) DSC II (2)	DSC P (4)	DSE I (2) DSE II (2)	DSE P (2)	VSC (4)	FP (2)	CEP (2)	--	22
5.5	VI	DSC I (2) DSC II (2)	DSC P (4)	DSE I (2) DSE II (2)	DSE P (2)	VSC (2)	FP (2)	--	OJT (4)	22

* DSE - 2 Papers out of four for each semester.

1. COURSE TITLE

1) Fifth Semester

Sr. No.	Course	Theory				Practical		
		Course No. & Course Code	Title of Paper	No. of lectures per week	Credits	Course No. & Course Code	No. of Practical Per week	Credits
1.	DSC I	BBTT 351	Basics in Genetic Engineering	2	2	BBTP 357	1	2
2.	DSC II	BBTT 352	Industrial Biotechnology	2	2	BBTP 358	1	2
3.	DSE I	BBTT 353	Metabolic Pathways	2	2	BBTP 359	1	2
4.	DSE I	BBTT 354	Bioanalytical Techniques					
5.	DSE II	BBTT 355	Plant Tissue Culture	2	2			
6.	DSE II	BBTT 356	Nanotechnology					
7.	VSC	--	--	--	--	BBTPVSC IV	2	4
8.	FP	--	--	--	--	BBTFP I	1	2
9.	CEP	--	--			BBTCEP I	1	2

2) Sixth Semester

Sr. No.	Course	Theory				Practical		
		Course No. & Course Code	Title of Paper	No. of lectures per week	Credits	Course No. & Course Code	No. of Practical Per week	Credits
1.	DSC I	BBTT 361	Computational Biology	2	2	BBTP 367	1	2
2.	DSC II	BBTT 362	Food and Microbial Biotechnology	2	2	BBTP 368	1	2
3.	DSE I	BBTT 363	Application of Biotechnology in Agriculture and Health	2	2	BBTP 369	1	2
4.	DSE I	BBTT 364	Research Methodology					
5.	DSE II	BBTT365	Bio-Entrepreneurship	2	2			
6.	DSE II	BBTT 366	IPR, Bioethics and Quality Management					
7.	VSC	--	--	--	--	BBTPVSC V	1	2
8.	FP	--	--	--	--	BBTFP II	1	2
9.	OJT	--	--	--	--	BBTOJT I	2	4

2. EVALUATION STRUCTURE:

Semester V (5.5)

Course	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	Mid - Semester	CCE-II			
DSC	T	BBTT 351	05	10	05	30	50	02
	T	BBTT 352	05	10	05	30	50	02
	P	BBTP 357	--	--	--	50	50	02
	P	BBTP 358	--	--	--	50	50	02
DSE (2 Theory Papers Out of Four)	T	BBTT 353	05	10	05	30	50	02
	T	BBTT 354	05	10	05	30	50	02
	T	BBTT 355	05	10	05	30	50	02
	T	BBTT 356	05	10	05	30	50	02
	P	BBTP 359	--	--	--	50	50	02
VSC	P	BBPVSC III	--	--	--	50	50	02
	P	BBPVSC IV	--	--	--	50	50	02
FP	P	BBTFP I	--	--	--	50	50	02
CEP	P	BBTCEP I	--	--	--	50	50	02
Total							**550**	**22**

Semester VI

Course	Course Category	Course Code	Internal Evaluation			ESE	Total Marks	Credits
			CCE-I	Mid - Semester	CCE-II			
DSC	T	BBTT 361	05	10	05	30	50	02
	T	BBTT 362	05	10	05	30	50	02
	P	BBTT 367	--	--	--	50	50	02
	P	BBTP 368	--	--	--	50	50	02
DSE (2 Theory Papers Out of Four)	T	BBTT 363	05	10	05	30	50	02
	T	BBTT 364	05	10	05	30	50	02
	T	BBTT 365	05	10	05	30	50	02
	T	BBTT 366	05	10	05	30	50	02
	P	BBTP 369	--	--	--	50	50	02
VSC	P	BBTVSC V	--	--	--	50	50	02
FP	P	BBTFP II	--	--	--	50	50	02
OJT	P	BBTOJT I	--	--	--	100	100	04
Total							**550**	**22**

DSC: Discipline Specific Course; DSE: Discipline Specific Elective VSC: Vocational Skill Course; OJT: On Job Training; FP: Field Project; CEP: Community Engagement Program, T: Theory; P: Practical.

OTHER FEATURES:

A) LIBRARY:

Reference books, Textbooks, journals, and Periodicals are available in Institute and Departmental Library.

(Separate reference lists are attached along with the respective course syllabus)

B) EQUIPMENT:

a) Computer, LCD projector, visualizer, smart board

b) Laboratory Equipment:

1. Microscope with a digital camera 2. Hot Air Oven

3. Digital weighing balance 4. Incubator

5. pH meter 6. Refrigerator

7. Microtome 8. Autoclave

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 351: Basics in Genetic Engineering

Course Objectives: Student should be able to…

1) learn molecular tools in r-DNA technology
2) know various vectors used in genetic engineering
3) cloning methodologies and libraries.
4) study DNA Sequencing, PCR and cloning methodologies

Course Outcomes: Students will be able to…

1) discuss enzymes and vectors used in genetic engineering.
2) describe various cloning methodologies, gene libraries.
3) explain pcr and its applications in genetic engineering.
4) discuss sequencing methods and blotting techniques.

Module	Title and Contents	Hrs
Module -1:	**Molecular Tools in r-DNA technology** : 1.1 Introduction and Scope 1.2 Enzymes and its application -Restriction enzymes- types (I, II, III), Nomenclature, recognition sequences, cleavage patterns, modification of cut ends (linkers and adaptors), application, 1.3 Enzymes in r-DNA technology: Alkaline phosphatases, DNA ligases, Reverse Transcriptase, Polymerases- Klenow enzymes (T4 DNA Polymerases, Taq DNA Polymerases), Polynucleotide kinase.	7
Module -2:	**Cloning Vectors** 2.1 Introduction, Properties of good vectors, Properties of good host, Cloning & expression vectors 2.2 Types-E.coli vector: plasmid (pBR 322), Bacteriophage vectors (λ phage vector), Cosmid vector, Phagemid vector (pBlue script II KS/SK), Yeast vector, YAC , Animal vectors (Simian Virus 40), Plant vector (Ti plasmid,), Shuttle vector, Selection of recombinant vector.	8
Module -3:	**Cloning methodologies** 3.1 Agrobacterium mediated gene transfer, 3.2 Chemical methods- CaCl2 coprecipitation, polycation mediated gene transfer. 3.3 Physical methods- Liposomes, microingection, electroporation, biolistics. 3.4 Screening of recombinants- Direct selection, Insertional inactivation selection, Blue white selection, 3.5 DNA Libraries**:** Synthesis of complete gene, cDNA and genomic DNA library, 3.6 Screening of libraries- immunological screening and colony or plaque hybridization.	7
Module -4:	**PCR** 4.1 Primer designing, Annealing Temperature, PCR efficiency, Steps in PCR reaction, 4.2 Types of PCR - RT-PCR, Real time PCR, Applications, Advantages of PCR, and Limitations. 4.3 DNA Sequencing: Maxam-Gilbert method, Sanger-Coulson method, and Automated DNA sequencing. 4.4 Methods of labelling probes: Nick translation, End labeling, Primer extension, 4.5 Blotting technique**:** Southern Blotting, Western blotting	8

Reference Books:-

1) Dubey, R. C. Advanced Biotechnology. New Delhi: S. Chand & Company, 2014.
2) Howe, C. Gene Cloning and Manipulation. 2nd ed. Cambridge: Cambridge University Press, 2007.
3) Singh, B. D. Biotechnology, Expanding Horizons. 5th ed. New Delhi: Medtech Science Press, 2023.
4) Primrose, Sandy B., Richard Twyman, and Bob Old. Principles of Gene Manipulation: An Introduction to Genetic Engineering. 6th ed. Oxford: Wiley-Blackwell, 2001.
5) Nicholl, D. S. T. An Introduction to Genetic Engineering. 3rd ed., South Asian ed. Cambridge: Cambridge University Press, 2010.
6) Glick, B. R., and J. J. Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd ed. Washington, D.C.: American Society for Microbiology, 2002.
7) Sambrook, Joseph, and David Russell. Molecular Cloning: A Laboratory Manual. Vols. I, II, III. 3rd ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2000.
8) Lewin, Benjamin. Genes IX. Sudbury, MA: Jones and Bartlett Publishers, 2007.
9) Rastogi, Smita, and Neelam Pathak. Genetic Engineering. New Delhi: Oxford University Press, 2009.
10) Setlow, Jane K., ed. Genetic Engineering: Principles and Methods. Vol. 13.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 05Marks • Internal Work -2 Mid Sem -10 marks • Internal Work -3 CCE 05Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

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Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 352: Industrial Biotechnology

Course Objectives: Student should be able to…

1) introduce the fundamental concepts and scope of industrial biotechnology.
2) provide knowledge of various microorganisms used in industrial production processes.
3) study the design, types, and working principles of bioreactors and fermenters.
4) impart knowledge on upstream and downstream processing techniques in bioproduct manufacturing.

Course Outcomes: Students will be able to…

1) explain the scope, significance, and applications of industrial biotechnology in various sectors.
2) analyze the production processes of key industrial bioproducts such as enzymes, antibiotics, alcohols, organic acids, and biofuels.
3) describe the characteristics and industrial importance of microorganisms used in fermentation and bioprocesses.
4) apply the concepts of upstream (media design, inoculum development) and downstream processing (product recovery and purification).

Module	Title and Contents	Hrs
Module -1:	**Introduction to Industrial Biotechnology:** 1.1 Concept and range of fermentation technology, Types of fermentations (Batch,continuous, dual, multiple), Concept of solid state & submerged fermentation. 1.2 Microbial metabolic products- Primary & Secondary products. Basic design of fermenter- Components of fermenter and their functions, Fermentation economics, 1.3 Types of fermenters-- Stirred tank fermenter, Airlift fermenter, Tower fermenter, Tubular fermenter, Bubble cap fermenter. Aeration and agitation of fermentation broth.	8
Module -2:	**Microbial Screening, Scale up and strain improvement** 2.1 Selection strategy and techniques, Primary and secondary screening, Primary screening of antibiotic, organic acid, enzyme, vitamin C and amino acid, Secondary screening of antibiotic producers. 2.2 Scale up of fermentations. Production of Biogas,Microbial insecticides -Bacillus thuringensis. 2.3 Strain improvement concept, Maintenance and preservation of industrially important cultures.	7
Module -3:	**Fermentation Media and sterilization** 3.1 Composition of typical fermentation media. Criteria for typical fermentation medium Types of fermentation media, 3.2 General role of media components water, carbon source, nitrogen source, minerals, precursors, growth factors, buffers, antifoams, oxidation-reduction potentials,	8

	inducers, inhibitors. 3.3 Sterilization of media, Indicator microorganism, Sterilization of media- In situ and Ex situ sterilization, Batch and continuous sterilization, equipment used, Filter sterilization.	
Module -4:	**Downstream Process and Product Recovery** 4.1 Downstream Processes in fermentation and bioprocess technology Solid and liquid separation. 4.2 Flocculation and Flotation, filtration and centrifugation - Cell disruption by solid and liquid shear, ultra sonication, enzyme action and mechanical disruption, Product recovery and purification principle Precipitation, Crystallization. 4.3 Liquid-Liquid extraction, Distillation (Fractional and Steam), Evaporation, Chromatographic separation (Principles), Adsorption and concentration, Membrane filtration, Lyophilization, spray drying.	7

Reference Books:-

1) Callister, William D., Jr., and David G. Rethwisch. Materials Science and Engineering: An Introduction. Hoboken, NJ: John Wiley & Sons, 2000.
2) Doran, Pauline M. Bioprocess Engineering Principles. 2nd ed. Amsterdam: Academic Press, 2012.
3) Das, Debabrata, and SoumyaPandit. Industrial Biotechnology: Sustainable Production and Use of Biofuels and Biochemicals. Boca Raton, FL: CRC Press, 2021.
4) John Wiley & Sons, Inc. An Introduction to Nanoscience and Nanotechnology. Hoboken, NJ: John Wiley & Sons, 2008.
5) Kelsall, Robert W., Ian W. Hamley, and Mark Geoghegan. Nanotubes and Nanomaterials: Synthesis, Properties, and Applications. Oxford: Oxford University Press, 2023.
6) Kulkarani, S. K. Nanotechnology: Principles and Practices. 3rd ed. New Delhi: Capital Publishing, 2014.
7) Moo-Young, Murray, ed. Comprehensive Biotechnology. 2nd ed. Oxford: Elsevier, 2011.
8) Singh, Ratneshwar, and Ashok Pandey. Biotechnology for Agro-Industrial Residues Utilization: Utilization of Agro-Residues. Dordrecht: Springer, 2009.
9) Wittmann, Christoph, and James C. Liao, eds. Industrial Biotechnology: Sustainable Growth and Economic Success. Weinheim: Wiley-VCH, 2017.
10) Zhang, Jin Zhong. Optical Properties and Spectroscopy of Nanomaterials. Singapore: World Scientific Publishing (WSPC), 2009.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 05 Marks • Internal Work -2 Mid Sem -10 marks • Internal Work -3 CCE 05Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

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Programme: B.Sc.	**Semester** - V
Type : Elective I	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 353: Metabolic Pathway

Course Objectives: Student should be able to…

1) study different types of biosynthetic pathways of biomolecules.
2) understand the metabolic reaction occurred in cells.
3) know various energy yielding pathways.
4) study types of hormones and their role.

Course Outcomes: Students will be able to…

1) differentiate different methods of studying metabolism.
2) understand biosynthetic pathways of biomolecules with their energetics.
3) apply the concept of free energy concept.
4) understand the pathways of sugar degradation and bioenergetics of these pathways.

Module	Title and Contents	Hrs
Module -1:	**Metabolism** 1.1 Introduction to metabolism, anabolism &catabolism , catabolism & its three stages, 1.2 Types of metabolic reactions, 1.3 Methods employed to study metabolism using auxotrophic mutants, radioisotopes, and high-energy compounds..	8
Module -2:	**Carbohydrates Metabolism** 2.1 Reactions and energetics of Glycolysis 2.2 TCA cycle, Glyoxylatecycle, Gluconeogenesis, 2.3 Glycogenesis and Glycogenolysis, 2.4 HMP and its significance.	7
Module -3:	**Lipid Metabolism** 3.1 Fatty Acid Biosynthesis: Synthesis of malonyl-CoA (Acetyl-CoA carboxylase), Fatty Acid Synthase complex, Steps of fatty acid elongation for Palmitic acid. 3.2 β-Oxidation (Fatty Acid Degradation): Activation of fatty acids, 3.3 Transport into mitochondria (Carnitine shuttle), Steps of β-oxidation cycle, Energy yield from fatty acid oxidation 3.4 Regulation of β-oxidation for Palmitic acid	8
Module -4:	**Introduction to Hormones** 4.1 Introduction to Hormones- Definition , Types as Steriod, Peptide, Amino acid 4.2 Metabolism of amino acids- Transamination reactions, Deamination, Urea cycle.	7

Reference Books:-

1) Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter. Molecular Biology of the Cell. 7th ed. New York: W.W. Norton & Company, 2022.
2) Berg, Jeremy M., John L. Tymoczko, and LubertStryer. Biochemistry. 9th ed. New York: W.H. •Frayn, Keith N. Metabolic Regulation: A Human Perspective. 4th ed. Hoboken, NJ: Wiley-Blackwell, 2018.
3) Himmel, Michael E., and Yannick J. Bomble, eds. Metabolic Pathway Engineering. New York: Springer, 2020.

4) Metabolic Pathway Engineering: Analysis and Applications in the Life Sciences. Boca Raton, FL: CRC Press, 2022.
5) Michal, Gerhard, and DietmarSchomburg. Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology. 2nd ed. Hoboken, NJ: Wiley, 2012.
6) Nelson, David L., and Michael M. Cox. Lehninger Principles of Biochemistry. 8th ed. New York: W.H. Freeman, 2021.
7) Salway, J. G. Metabolism at a Glance. 4th ed. Hoboken, NJ: Wiley-Blackwell, 2016.
8) Smolke, Christina D., ed. The Metabolic Pathway Engineering Handbook: Fundamentals. Boca Raton, FL: CRC Press, 2010.
9) Voet, Donald, and Judith G. Voet. Biochemistry. 5th ed. Hoboken, NJ: John Wiley & Sons, 2011.
10) Smolke, Christina D., ed. The Metabolic Pathway Engineering Handbook: Fundamentals. Boca Raton, FL: CRC Press, 2010.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 05Marks • Internal Work -2 Mid Sem -10 marks • Internal Work -3 CCE 05Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

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Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Elective II	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 354: Bioanalytical Techniques

Course Objectives: Student should be able to…

1) learn action mechanism of different analytical instruments
2) introduce students to modern bio-analytical instrumentation and principles.
3) develop analytical reasoning in interpreting complex biological data.
4) aquire students with knowledge of molecular and immunological detection systems.

Course Outcomes: Students will be able to…

1) understand the principles and working of advanced analytical techniques.
2) apply suitable techniques for biological sample analysis.
3) interpret data from spectroscopy, chromatography, and tracer techniques.
4) utilize immunochemical and tracer methods in research and diagnostics.

Module	Title and Contents	Hrs
Module -1:	**Spectroscopy and types of spectroscopy** 1.1 Spectroscopy: Principle, action mechanism, instrument details and applications of: Fourier-transform infrared spectroscopy (FTIR), 1.2 Liquid Chromatography Mass Spectroscopy (LC-MS), Plasma emission spectroscopy, Fluorescence spectroscopy, 1.3 Luminometry, Circular dichroism/ Optical rotatary dispersion (CD/ORD) spectroscopy, Light scattering, Surface plasmon resonance (SPR), Inductively coupled plasma mass spectrometry (ICP MS)	8
Module -2:	**Immunochemical techniques** 2.1 Introduction, Making antibodies, Immunoassay formats, Immuno microscopy, Lateral flow devices, Epitope mapping, 2.2 Cell and tissue staining techniques, Immunocapture polymerase chain reaction(PCR) 2.3 Immunoaffinity chromatography (IAC), Antibody-based biosensors, 2.4 Therapeutic antibodies, ELISA reader.	7
Module -3:	**Tracer Techniques** 3.1 Principles and applications of tracer techniques in biology, 3.2 Measurement of alpha, beta and gamma radiations, Radiation dosimetry, Radioactive isotopes and half-life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.	7
Module -4:	**Allied bio-analytical techniques** 4.1 Principle, action mechanism, instrument details and applications of – Flow cytometry, Partition chromatography, 4.2 Immunoaffinity chromatography (IAC), Fluorescence microscope, Atomic force	8

	microscopy, Capillary electrophoresis, Microchip electrophoresis, 4.3 Next generation sequencing, PPSQ10 protein sequencing	

Reference Books:-

1) Banwell, C. N. Introduction to Molecular Spectroscopy. New Delhi: Tata McGraw-Hill, 1994.
2) Glick, Bernard R., and Jack J. Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th ed. Washington, DC: ASM Press, 2010.
3) Griffiths, Peter R., and James A. De Haseth. Fourier Transform Infrared Spectrometry. 2nd ed. Hoboken, NJ: Wiley-Interscience, 2007.
4) Harris, Daniel C. Quantitative Chemical Analysis. 9th ed. New York: W. H. Freeman, 2016.
5) Kricka, Larry J., and Paul C. Whitehead. Principles of Immunochemical Techniques. Boca Raton, FL: CRC Press, 2008.
6) Kumari, Veera. Bioinstrumentation. New Delhi: MJP Publishers, 2009.
7) Skoog, Douglas A., F. James Holler, and Stanley R. Crouch. Principles of Instrumental Analysis. 7th ed. Boston: Cengage Learning, 2017.
8) Upadhyay, Upadhyay, and Nath. Biophysical Chemistry. 4th ed. New Delhi: Himalaya Publishing House, 2016.
9) Watson, David G. Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists. 3rd ed. Edinburgh: Elsevier Health Sciences, 2012.
10) Wilson, Keith, and John Walker. Principles and Techniques of Biochemistry and Molecular Biology. 7th ed. Cambridge: Cambridge University Press, 2010.
11) Wilson, Keith, and John Walker. Principles and Techniques of Biochemistry and Molecular Biology. 8th ed. Cambridge: Cambridge University Press, 2018.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 05Marks • Internal Work -2 Mid Sem -10 marks • Internal Work -3 CCE 05Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

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Programme: B.Sc.	**Semester** - V
Type : Elective III	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 355: Plant Tissue Culture

Course Objectives: Student should be able to…

1) make students aware of fundamentals of Plant Tissue culture
2) understand laboratory organization for plant tissue culture.
3) Study of callus, organ, anther and pollen culture Technique.
4) aquire knowledge about suspension, protoplast culture and micropropagation technique.
5) use and application of Plant Tissue culture

Course Outcomes: Students will be able to…

1) learn about laboratory organization for plant tissue culture.
2) Know technique of preparation of plant tissue culture media.
3) Knowledge about various techniques for plant tissue culture.
4) Job oriented skill developments of students to start or work in commercial plant tissue culture laboratory.

Module	Title and Contents	Hrs
Module -1:	**Introduction to plant tissue culture** 1.1 Definition, History ,Cellular totipotency, techniques in plant tissue culture. 1.2 Infrastructure & Organization of Plant Tissue Culture Laboratory- General and aseptic laboratory- different work areas, equipment and instruments required, other requirements. 1.3 Aseptic Techniques- Washing and preparation of glassware's, media sterilization, surface sterilization, aseptic workstation, precautions to maintain aseptic conditions. 1.4 Culture Medium- Nutritional requirements of explants, Plant Growth Regulator and their invitro roles, composition of basal Murashige and Skoog medium and media preparation.	8
Module -2:	**Techniques of Plant Tissue Culture** 2.1 Callus Culture Techniques- Introduction, principle, protocol, morphology and internal structure, genetic variations, applications. 2.2 Anther & Pollen Culture Technique- Introduction, principle, protocol, factors affecti applications. 2.3 Organ Culture Technique- Introduction, principle, protocol, applications, with respec culture, leaf culture, ovary and ovule culture.	7
Module -3:	**Micropropagation** 3.1 Introduction, stages of Micropropagation, factors affecting, advantages and applications 3.2 Different Pathways of Micropropagation- somatic embryogenesis, organogenesis (Introduction, principle, protocol, factors affecting, applications, limitations). 3.3 Somaclonal Variation- Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations.	8

Module -4:	**Types of plant cell culture** 4.1 Suspension Culture Technique- Introduction, principle, protocol, types, growth measurement, viability test, synchronization, applications. limitations. 4.2 Plant Protoplast Culture:-History, Principle, protocol for isolation-Mechanical and Enzymatic, protoplast culture methods, viability test and applications.	7

Reference Books:-

1) Altman, A. Plant Tissue Culture: Applications and Limitations. Dordrecht: Springer, 1998.
2) Bhojwani, S. S., and M. K. Razdan. Plant Tissue Culture: Theory & Practice. 1st ed. Amsterdam: Elsevier Science, 1996.
3) Chawla, H. S. Introduction to Plant Biotechnology. 2nd ed. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd., 2000.
4) De, K. K. Plant Tissue Culture. 1st ed. Kolkata: New Central Book Agency (P) Ltd., 2017.
5) Debergh, P., and R. H. Zimmerman. Micropropagation Technology and Application. 1st ed. Dordrecht: Springer, 1991.
6) Gamborg, O. L., and G. C. Phillips. Plant Cell, Tissue and Organ Culture: Fundamental Methods. 1st ed. Berlin: Springer, 1995.
7) Kumar, U. Methods in Plant Tissue Culture. 1st ed. Bikaner: Agro-Botanica Publishers, 1999.
8) Pierik, R. L. M. In Vitro Culture of Higher Plants. 2nd ed. Dordrecht: Springer, 1997.
9) Razdan, M. K. Introduction to Plant Tissue Culture. 2nd ed. Enfield, NH: Science Publishers, 2003.
10) Thorpe, T. A., ed. Plant Propagation by Tissue Culture. Volume 1: The Technology. 3rd ed. Dordrecht: Springer, 2013.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 05Marks • Internal Work -2 Mid Sem -10 marks • Internal Work -3 CCE 05Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

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Programme: B.Sc.	**Semester** - V
Type : Elective IV	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 356: Nanobiotechnology

Course Objectives: Student should be able to…

1) introduce the fundamental concepts of the nanoscience.
2) provide a comprehensive understanding of nanoparticles, nanowires.
3) explore the integration of biomolecules as nanostructures.
4) explain physical, chemical methods for synthesis of nanostructures.

Course Outcomes: Students will be able to…

1) Identify and explain methods used to synthesize nanostructures using physical, chemical, and biological techniques.
2) Analyze the physicochemical properties of nanomaterials using appropriate characterization tools.
3) Apply nanobiotechnology concepts to develop biosensors, drug delivery systems, and therapeutic platforms.
4) Understand and evaluate the interaction of functionalized nanomaterials with biological molecules and systems.

Module	Title and Contents	Hrs
Module -1:	**Introduction to Nano world, Nano science and Nanotechnology** **1.1** Nanoparticles, nanowires, thin films Applications in various fields viz. Physical and Chemical, Materials, life sciences. **1.2** Nanobiotechnology: Introduction, Biomolecules as nanostructures and their applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, cancer therapy, gene therapy etc.	8
Module -2:	**Synthesis of nanostructure** **2.1** Physical methods– Mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition (CVD), electric arc deposition. **2.2** Chemical methods: Synthesis of nanoparticles by colloidal route, microemulsion, sol-gel method, chemical precipitation, pyrolysis. 2.3Biological methods: Synthesis using microorganism, synthesis using plant extracts, use of proteins and template like DNA.	7
Module -3:	**Properties and Characterization of nanomaterial** 3.1 Optical (UV-Vis / Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, Light scattering, Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM), 3.2 Magnetic, Electrical and Electrochemical.	8
Module -4:	Functionalization of Nanoparticles for biological applications 4.1 Proteins- Lipids-RNA-DNA, Protein targeting –small molecules / Nanomaterial-Protein interaction. 4.2 Nanomaterial-cell interaction – manifestation of surface modification (polyvalency),	7

	Lipid nanoparticles for Drug Delivery, Inorganic Nanoparticles for Drug Delivery, metal / Metalic oxide nanoparticles (antibacterial/ antifungal/antiviral).	

Reference Books:-

1) Bhushan, Bharat. Springer Handbook of Nanotechnology. 4th ed. Cham: Springer, 2017.
2) Goodsell, David S. Bionanotechnology: Lessons from Nature. Hoboken, NJ: John Wiley & Sons, Inc., 2004.
3) Hornyak, Gabor L., H.F. Tibbals, JoydeepDutta, and John J. Moore. 2008. Introduction to Nanoscience and Nanotechnology.
4) Kannangara, Kamali, Chris T. Smith, Michelle Simmons, and Barry Raguse. Nanotechnology: Basic Science and Emerging Technologies. Amsterdam: Overseas Press, 2005.
5) Kulkarni, Sulabha K. Nanotechnology: Principles and Practices. Revised ed. New Delhi: Capital Publishing Company, 2009.
6) Niemeyer, Christof M., and Chad A. Mirkin, eds. Nanobiotechnology. Weinheim: Wiley-VCH, 2004.
7) Papazoglou, Elisabeth S., and AravindParthasarathy. BioNanotechnology. 1st ed. San Rafael, CA: Morgan & Claypool Publishers, 2007.
8) Sharon, Maheshwar, and Madhuri Sharon. Nano Forms of Carbon and Its Applications. Manad Nanotech Pvt. Ltd., 2007.
9) Stroscio, Michael A., and MitraDutta. Biological Nanostructures and Application of Nanostructures in Biology. Dordrecht: Kluwer Academic Publishers, 2004.
10) Shoseyov, Oded, and Ilan Levy, eds. Nanobiotechnology: BioInspired Devices and Materials of the Future. Totowa, NJ: Humana Press, 2008.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1 CCE 10Marks • Internal Work -2 Mid Sem -20 marks • Internal Work -3 CCE 10Marks	• Question -1 10 Marks • Question -2 20 Marks • Question -3 20 Marks

Karmaveer Bhaurao Patil University, Satara

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTP 357: Techniques in Genetic Engineering

Course Objectives: Student should be able to…

1) Prepare and explain foundational reagents and demonstrating understanding of their chemical roles.
2) Amplify and analyze DNA and RNA, using PCR, RT-PCR, RAPD, gel electrophoresis, Southern blotting, and restriction mapping.
3) learn methods of screening and selecting genetically modified organisms.
4) understand the principles behind genetic manipulation in bacteria and plants.

Course Outcomes: Students will be able to..

1) extract, quantify, amplify, and manipulate DNA and proteins in laboratory conditions.
2) acquire hands-on experience in techniques such as restriction digestion, ligation, and recombinant screening.
3) understand the use of model organisms like *E. coli* and *Agrobacterium* for genetic engineering.
4) capable of interpreting results, maintaining lab records, and troubleshooting experimental errors in molecular biology workflows.

Sr. No.	Name of the Practical	Hrs
1.	Preparation of loading dye - 6 X gel loading dye, 5X gel loading dye	60
2.	Calculation of molecular size of digested DNA	
3.	Construction of restriction map of plasmid DNA	
4.	Plasmid extraction from Bacterial cells	
5.	Quantification of DNA sample by using spectrophotometer	
6.	Preparation of Competent Cells	
7.	Transformation of E. Coli	
8.	Selection of recombinants using antibiotic	
9.	Selection of recombinants using blue white screening	
10.	SDS PAGE	
11.	Western blotting technique	
12.	Gel Electrophoresis for a DNA sample	
13.	Southern blotting technique	
14.	Agrobacterium transformation in plants	
15.	DNA Amplification by PCR	
16.	cDNA cloning by Reverse Transcription PCR	
17.	RAPD analysis	
18.	Expression of gene in E. Coli (GST)	
19.	Ligation of DNA	
20.	Purification of DNA fragment from agarose gel	

Reference Books:-

1) Attwood, Teresa K., and David J. Parry-Smith. Introduction to Bioinformatics. Harlow: Pearson Education Asia, 2001.

2) Ausubel, Frederick M., ed. Current Protocols in Molecular Biology. New York: John Wiley & Sons, 2003.
3) Baxevanis, Andreas D., and B. F. Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 2nd ed. New York: John Wiley & Sons, 2001.
4) Bhasin, S. K., and Sudha Rani. Lab Manual of Biochemistry, Molecular Biology and Biotechnology. New Delhi: I.K. International Publishing House, 2015.
5) Glick, B. R., and J. J. Pasternak. Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press, 1998.
6) Glover, David, and B. D. Hames, eds. DNA Cloning: A Practical Approach. 2nd ed. Oxford: Oxford University Press, 2009.
7) Miller, Heather, Sue Carson, and Rick L. Myers. Molecular Biology Techniques: A Classroom Laboratory Manual. 2nd ed. San Francisco: Pearson, 2010.
8) Sadashivam, S., and A. Manickam. Biochemical Methods. New Delhi: New Age International, 1996.
9) Sambrook, J., and David W. Russell. Molecular Cloning: A Laboratory Manual. 4th ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2012.
10) Sambrook, J., and David W. Russell. The Condensed Protocols from Molecular Cloning: A Laboratory Manual. 3rd ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2006.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• **Internal work 1: 20 Marks**	• **Question -1 : 30 Marks**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTP 358: Techniques in Industrial Biotechnology

Course Objectives: Student should be able to…

1) understand downstream processes in fermentation.
2) provide hands-on experience in the cultivation and maintenance of industrially important microorganisms
3) understand bioprocess technology
4) prepare students for industrial training or research in biotechnology-based companies.

Course Outcomes: Students will be able to

1) learn about fermentation technology, types of fermentations,
2) list of course objective regarding practical of industrial biotechnology
3) understand and implement aseptic and biosafety practices in industrial biotechnology labs.
4) learn about bioprocess technology.

Sr. No.	Name of the Practical	Hrs
1.	Primary screening of antibiotic producers by crowded plate technique	60
2.	Primary screening of amylase producers by Replica Plate technique	
3.	Production of Amylase - Purification, Immobilization and Activity.	
4.	Production of alcohol and estimation by specific gravity method	
5.	Production of sauerkraut	
6.	Production of wine	
7.	Ion Exchange chromatography for purification of downstream processing	
8.	Gel Filtration Chromatography for purification of downstream processing	
9.	Monitoring bioprocess parameters: temperature, pH, DO	
10.	Screening and Isolation of Industrially Important Microorganisms from Soil Samples	
11.	Selection and screening of mutants	
12.	Demonstration of Bioreactor Operation and Parameter Monitoring	
13.	Production of Citric Acid Using *Aspergillusniger*	
14.	Assay of Protease Enzyme Using Casein as Substrate	
15.	Strain Improvement of *E. coli* by UV Mutagenesis for Enhanced Enzyme Production	
16.	Production of Lactic Acid Using *Lactobacillus* Species	
17.	Solid State Fermentation for Enzyme Production	
18.	Bioplastic Production Using *Pseudomonas* Species	
19.	Effect of pH and Temperature on Enzyme Activity	
20.	Industrial Visit to fermentation industry	

Reference Books:-

1) Crueger, Wolfgang, and Anneliese Crueger. 2017. *Biotechnology: A Textbook of Industrial Microbiology*. 3rd ed. New Delhi: Panima Publishing.
2) Stanbury, Peter F., Stephen J. Hall, and A. Whitaker. 2016. *Principles of Fermentation Technology*. 3rd ed.

Oxford: Elsevier.
3) Casida, L.E. 2019. *Industrial Microbiology*. Reprint ed. New Delhi: New Age International Publishers.
4) Glazer, Alexander N., and Hiroshi Nikaido. 2007. *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 2nd ed. Cambridge: Cambridge University Press.
5) Patel, A.H. 2020. *Industrial Microbiology*. 2nd ed. New Delhi: Macmillan India Ltd.
6) Waites, M. J., Neil L. Morgan, John S. Rockey, and Gary Higton. 2001. *Industrial Microbiology: An Introduction*. Oxford: Wiley-Blackwell.
7) Satyanarayana, T., and Bhavdish Narain Johri, eds. 2005. *Microbial Diversity: Current Perspectives and Potential Applications*. New Delhi: I.K. International.
8) Moo-Young, Murray, ed. 2011. *Comprehensive Biotechnology*. 2nd ed. Vol. 3. Oxford: Pergamon Press.
9) Pandey, Ashok, Carlos Ricardo Soccol, and Christian Larroche, eds. 2008. *Current Developments in Solid-State Fermentation*. New Delhi: Springer.
10) Dubey, R.C. 2014. *A Textbook of Biotechnology*. 6th ed. New Delhi: S. Chand & Company Ltd.

Evaluation Pattern:	
Total Marks: 50	
Internal Continuous Evaluation: • **Internal work 1: 20 Marks**	**End Semester Examination:** • **Question -1 : 30 Marks**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Elective Lab I	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTP 359 : Laboratory exercises in Metabolic Pathway and Plant Tissue Culture

Course Objectives: Student should be able to…

1) Learn Techniques in Metabolic Pathways
2) Acquire knowledge about chromatography and electrophoresis techniques.
3) To make students aware of fundamentals of Plant Tissue culture.
4) Study of callus and various micropropogation culture Techniques.

Course Outcomes: Students will be able to…

1) Identify and apply biochemical tests for carbohydrates, proteins, and lipids.
2) Demonstrate laboratory skills in biochemical testing, chromatography, and spectrophotometry.
3) Knowledge about laboratory organization for plant tissue culture.
4) Know technique of preparation of plant tissue culture media.

Sr. No.	Name of the Practical	Hrs
1.	Estimation of fructose by Resorcinol method.	60
2.	Estimation of DNA by Diphenylamine method	
3.	Estimation of RNA by Orcinol Method.	
4.	Cellulose acetate paper electrophoresis of Amino Acid.	
5.	Adsorption chromatography of amino acid.	
6.	Isolation of Amylase from germinating seed.	
7.	Isolation of Amylase from saliva.	
8.	Extraction of lipids from plant seeds .	
9.	Separation of biomolecules by gel filtration chromatography	
10.	Extraction and assay of nitrate reductase from plant tissue	
11.	Organizing Plant tissue culture Laboratory	
12.	Preparation of M.S. stock solutions & medium	
13.	Perform Aseptic seed germination	
14.	Embryo culture technique.	
15.	Micropropagation stage I-Initiation of micropropagation–Shoot tip or axillary bud culture technique tissue culture	
16.	Micropropagation stage II-Subculture & multiplication of culture	
17.	Micropropagation stage III-Rooting- in vitro & ex vitro	
18.	Micropropagation stage IV-Acclimatization & hardening	
19.	Callus culture technique- Initiation of culture, callus morphology	
20.	Isolation of Protoplast	

Reference Books:-

1) Lodish, Harvey, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, and Alexander J. Lewis.

Molecular Cell Biology. 7th ed. New York: W.H. Freeman, 2012.
2) Michal, Gerhard, and DietmarSchomburg. Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology. 2nd ed. Hoboken, NJ: Wiley, 2012.
3) Miller, Glenn L. “Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugar.” Analytical Chemistry 31, no. 3 (1959): 426–428.
4) Ruck, J.A. “Chemical Methods for Analysis of Fruits and Vegetable Products.” Summerland Research Station, Canada Department of Agriculture, 1963.
5) Salway, J. G. Metabolism at a Glance. 3rd ed. Oxford: Wiley-Blackwell, 2004.
6) Bhojwani, S. S., and M. K. Razdan. Plant Tissue Culture: Theory & Practice. 1st ed.Elsevier Science, 1996.
7) Gamborg, O. L., and G. C. Phillips. Plant Cell, Tissue and Organ Culture:
8) Fundamental Methods. 1st ed. Springer, 1995.
9) Thorpe, T. A., ed. Plant Propagation by Tissue Culture, Volume 2: In Vitro Culture of Higher Plants. 3rd ed. Springer, 2013.
10) George, E. F., and L. M. Sherrington. Plant Propagation by Tissue Culture, Volume 2: In Practice. 3rd ed. Springer, 2003.

Evaluation Pattern:	
Total Marks: 50	
Internal Continuous Evaluation: • **Internal work 1: 20 Marks**	**End Semester Examination:** • **Question -1 : 30 Marks**

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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science,Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : Elective Lab II	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTP 359: Laboratory Exercise in Bioanalytical techniques and Nanobiotechnology

Course Objectives: Student should be able to…

1) understand spectroscopic and optical instrumentation
2) gain knowledge of advanced analytical tool.
3) understand the principles and techniques involved in the synthesis of nanoparticles
4) gain practical experience in the characterization of nanomaterials

Course Outcomes: Students will be able to…

1) analyze enzymatic decomposition of hydrogen peroxide and determine catalase activity.
2) estimate dna concentration and purity based on absorbance.
3) synthesize nanoparticles using various methods like the stöber method, green synthesis, and chemical method.
4) apply nanoparticle-based assays for environmental monitoring (e.g., heavy metal detection) and biomedical applications.

Sr. No.	Name of the Practical	Hrs
1.	Colorimetric Estimation of Glucose (DNS Method)	60
2.	Catalase Activity from Plant Extracts	
3.	Ascorbic Acid Estimation by Iodometric Titration	
4.	Determination of Chlorophyll Content by Acetone Extraction	
5.	Antibody titer estimation by indirect ELISA	
6.	Quantification of DNA Using UV-Visible Spectrophotometry	
7.	Calibration and Validation of an ELISA Microplate Reader	
8.	Monitoring microbial growth via resazurin reduction assay	
9.	Separation by charge and size in a capillary under electric field.	
10.	Immunoaffinity Chromatography for Protein Purification	
11.	Determination of minimum inhibitory concentration (MIC) of nanoparticles using broth dilution method.	
12.	Comparison of antibacterial activity between silver and copper nanoparticles using agar well diffusion method.	
13.	Zone of inhibition analysis of plant-extract synthesized nanoparticles on gram-positive and gram-negative bacteria.	
14.	Effect of nanoparticle concentration on bacterial growth curve using spectrophotometry.	
15.	Assessment of antimicrobial activity using disk diffusion method	
16.	Preparation of silver nanoparticles using plant extract (green synthesis).	
17.	Effect of pH on antibacterial efficacy of nanoparticles.	
18.	Observation of antibacterial activity of metal oxide nanoparticles.	
19.	Green synthesis of copper nanoparticles using leaf extracts.	

20.	Analysis of antibacterial properties using agar diffusion with metal nanoparticles.	

Reference Books:-

1) Miller, Glenn L. “Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugar.” Analytical Chemistry 31, no. 3 (1959): 426–428.
2) Aebi, H. “Catalase in vitro.” Methods in Enzymology 105 (1984): 121–126.
3) Ruck, J.A. “Chemical Methods for Analysis of Fruits and Vegetable Products.”SummerlandResearch Station, Canada Department of Agriculture, 1963.
4) Arnon, D.I. “Copper Enzymes in Isolated Chloroplasts. Polyphenoloxidase in Beta vulgaris.”Plant Physiology 24, no. 1 (1949): 1–15.
5) Crowther, John R. The ELISA Guidebook. 2nd ed. New York: Humana Press, 2009.
6) Stroscio, Michael A., and MitraDutta. Biological Nanostructures and Application ofNanostructures in Biology. Dordrecht: Kluwer Academic Publishers, 2004.
7) Goodsell, David S. Bionanotechnology: Lessons from Nature. Hoboken, NJ: John Wiley &Sons, Inc., 2004.
8) Papazoglou, Elisabeth S., and Aravind Parthasarathy. BioNanotechnology. 1st ed. San Rafael,CA: Morgan & Claypool Publishers, 2007.
9) Sharon, Maheshwar, and Madhuri Sharon. Nano Forms of Carbon and Its Applications.Manad Nanotech Pvt. Ltd., 2007.
10) Kannangara, Kamali, Chris T. Smith, Michelle Simmons, and Barry Raguse. Nanotechnology: Basic Science and Emerging Technologies. Amsterdam: Overseas Press, 2005.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• **Internal work 1: 20 Marks**	• **Question -1 : 30 Marks**

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Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : VSC Lab I	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTPVSC: BBTPVSC-IV Lab exercise based on Biotechnology and Business management in nursery -I

Course Objectives: Student should be able to…

1) understand different types of tools in nurseries
2) know various facilities required to set up of a nursery
3) commiserate with various practices in a nursery
4) study methods and applications of business management in nursery

Course Outcomes: Students will be able to…

1) explain nursery business management.
2) apply the technique of different tools used in nursery management
3) analyze various techniques for nursery management
4) demonstrate techniques used in labour, customer with marketing in nursery management.

Sr. No.	Name of the Practical	Hrs
1.	Concept and scope of nursery management	60
2.	Designing the layout of a commercial nursery: urban and rural perspectives	
3.	Nursery types: structure, purpose, and applications	
4.	Key inputs required for efficient nursery operations	
5.	Soil and bed preparation techniques in nursery management	
6.	Principles of seed and propagule selection in plant propagation.	
7.	Modern and traditional sowing methods in nursery management.	
8.	Nursery-based vegetative propagation methods for plant multiplication.	
9.	Principle and role of seed science and technology in nursery establishment.	
10.	Sterilization of soil and tools: a preventive approach in nursery management	
11.	Techniques and guidelines for transplanting seedlings in nursery management.	
12.	Maintenance and monitoring of nursery plants: principles and practices.	
13.	Preparation of potting mixtures and potting techniques in nursery management.	
14.	Applications of shade nets and polyhouses for protected cultivation.	
15.	Planning nursery activities through a seasonal calendar	
16.	Nursery pests and diseases: monitoring,identification, symptoms, and control measures	
17.	Development preparation and application of organic pesticide sprays for pest control	
18.	Biological control techniques in nursery practices: applications of *trichoderma*	
19.	Technology-driven approaches to plant health assessment in nurseries.	
20.	Infrastructure development and maintenance in nursery management	

Reference Books:-

1) Chadha, K.L. Handbook of Horticulture. ICAR Publication, 2019.
2) Bose, T.K., S.K. Mitra, and M.K. Sadhu. Propagation of Horticultural Plants. Naya Udyog.
3) Tiwari, G.N., and M.K. Ghosal. Fundamentals of Renewable Energy and Applications. Narosa Publishing, 2005.

4) Singh, S.P. Commercial Floriculture. Agro-Bios India, 2008.
5) Randhawa, G.S., and A. Mukhopadhyay. Floriculture in India. Allied Publishers, 1986.
6) Bal, J.S. Fruit Growing. Kalyani Publishers, 2011.
7) Kumar, N. Introduction to Horticulture. Rajalakshmi Publications, 2010.
8) Reinert, J., and Y.P.S. Bajaj. Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture. Springer, 1977.
9) Desai, Vasant. Small Scale Industries and Entrepreneurship. Himalaya Publishing, 2008.
10) Kotler, Philip, and Gary Armstrong. Principles of Marketing. Pearson Education, 2013.

Evaluation Pattern:	
Total Marks: 50	
Internal Continuous Evaluation: • **Internal work 1: 20 Marks**	**End Semester Examination:** • **Question -1 : 30 Marks**

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Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - V
Type : VSC Lab II	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTPVSC: BBTPVSC-IV Lab exercise based on Biotechnology and Business management in nursery -II

Course Objectives: Student should be able to…

1) impart practical knowledge of nursery establishment and plant propagation techniques
2) develop skills in biotechnological applications for quality plant production
3) introduce nursery-based business planning, marketing, and financial management
4) prepare students for entrepreneurship and commercial nursery management

Course Outcomes: Students will be able to…

1) apply practical nursery management techniques.
2) demonstrate use of biotechnological tools in nursery plant production.
3) analyze and prepare business models for nursery enterprises.
4) develop entrepreneurial skills for setting up a commercial nursery.

Sr. No.	Name of the Practical	Hrs
1.	Cost-Benefit Analysis of Nursery Production	60
2.	Market Survey and Demand Forecasting for Nursery Plants	
3.	Intellectual property rights in nursery	
4.	Buisness plans developement in nursery	
5.	Marketing and business properties in nursery	
6.	Record Keeping and Inventory Management in Nursery Business	
7.	Evaluation of Marketing Channels for Nursery	
8.	Packaging and Labelling Techniques for Nursery Plants	
9.	Training Module Design for Nursery Staff and Workers	
10.	Use of ICT Tools in Nursery Business Management	
11.	Customer relationship management in nursery	
12.	Entrepreneurial Skill Assessment of Nursery Owners	
13.	Study of Legal and Financial Requirements for Starting a Nursery	
14.	Preparation of Advertisement and Promotion Plan for a Nursery	
15.	Role of Branding in Enhancing Nursery Business	
16.	Online Marketing Strategies for Selling Nursery Plants	
17.	Preparation of an Invoice and Billing System for Nursery Plants	
18.	Preparation of videos on nursery media preparation and application business management in nursery.	
19.	Visit Report of a Successful Urban/Rural Nursery Unit	
20.	Case study	

Reference Books:-

1) Bhojwani, S. S., and M. K. Razdan. Plant Tissue Culture: Theory and Practice. Elsevier, 2004.
2) Dubey, R. C. A Textbook of Biotechnology. S. Chand Publishing, 2016.

3) George, E. F., M. A. Hall, and G. J. De Klerk. Plant Propagation by Tissue Culture. 3rd ed. Springer, 2008.
4) Hartmann, H. T., et al. Plant Propagation: Principles and Practices. 8th ed. Prentice Hall, 2011.
5) Khoshgoftarmanesh, A. H., and H. Shariatmadari. "Biotechnology and Nursery Plant Production." ScientiaHorticulturae 98 (2003): 93-102.
6) National Small Industries Corporation (NSIC). Project Profiles for Nursery Units. NSIC, no date.
7) Tiwari, S., and A. Singh. "Business Plan Development for Nurseries Using Biotech Tools." Indian Journal of Agricultural Economics 75, no. 1 (2020): 112–122.
8) Verma, A. Entrepreneurship Development and Business Communication. Firewall Media, 2018.
9) Chawla, H.S. (2002) – Introduction to Plant Biotechnology – Oxford & IBH
10) Rai, M. & Rai, A.K. (2003) – Plant Tissue Culture and Molecular Markers – Scientific Publisher.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• **Internal work 1: 20 Marks**	• **Question -1 : 30 Marks**

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Board of Studies in Biotechnology

Programme: B.Sc.	**Semester** - VI
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 361: Computational Biology

Course Objectives: Student should be able to…

1) make students aware about various bioinformatics tools and techniques.
2) understand Concepts of various databases and various methods.
3) how to use Bioinformatics tools for the analysis of the biological and Experimental data.
4) learn Sequencing techniques and gene annotation

Course Outcomes: Students will be able to…

1) understand concepts of various databases and various methods for the data retrieval, data storage, and data mining and use that data for the further analysis.
2) in- Silico approach for the protein modeling and drug discovery process.
3) sequencing techniques and gene annotation as well as submission of the sequences to the various databases.
4) various bioinformatics tools and techniques and how to use that for the analysis of the biological experimental data.

Module	Title and Contents	Hrs
Module -1:	**Introduction to Bioinformatics** 1.1 Introduction to Bioinformatics:-History, Computers in Biology and Medicines, 1.2 Internet, and related programs; Networking HTTP, HTML, WAN, LAN, MAN, applications in communication. 1.3 Information Resources:- Introduction, aim and objectives, INSDC: International Nucleotide Sequence Database Collection (NCBI, DDBJ, EMBL), Sequence retrieval system (SRS): (Entrez, DBGet) 1.4 Genomics:- Human Genome Project (HGP)- Goal and applications, final draft of HGP	8
Module -2:	**Protein Sequence Databases** 2.1 Proteomics: - Introduction to amino acids and protein, Proteome, Protein structure, 2.2 Primary protein sequence databases- SWISS-PROT, PIR, MIPS, NRL- 3D, TrEMBL, Annotation and applications 2.3 Secondary protein sequence databases: PROSITE, PROFILE, PRINT, pfam, BLOCK, IDENTIFY; applications. Other databases: Literature database, PubMed, PubMed central. 2.4 Structural databases: Introduction,Difference between Primary structure and 3D structure, Protein databank (PDB), Molecular modelling databank (MMDB). CATH, SCOP, PdbSum.	7
Module -3:	**Sequence Alignment** 3.1 Sequence Alignment:- Introduction, Protein sequence, Nucleic acid sequence, Pair wise sequence alignment, Multiple sequence alignment, Local and Global sequence alignment, 3.2 Algorithm used in sequence alignment, Matrices- Dot matrix, PAM, BLOSSOM. 3.3 Phylogenetic analysis: Introduction: Evolution, definition of phylogenetic tree, nodes, internodes, root, tree, styles; cladogram, phenogram, curvogram, Steps involved in construction of phylogenetic tree 3.4 Methods of phylogenetic analysis:- Distance method, Character based Method Phylogenetic analysis tool (Phylip, MEGA).	8

Module -4:	**Application software** 4.1 Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients, PCA etc 4.2 Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. 4.3 Introduction to MSWORD word processor editing, copying, moving, formatting, Table insertion, drawing flow charts etc	7

Reference Books:-

1) Altschul, Stephen F., Thomas L. Madden, Alejandro A. Schäffer, Jianping Zhang, Zhiyong Zhang, Webb Miller, and David J. Lipman. "Gapped BLAST and PSI-BLAST: A New Generation of Protein Database Search Programs." *Nucleic Acids Research* 25 (17): 3389–3402, 1997. https://doi.org/10.1093/nar/25.17.3389.
2) Bairoch, Alain, and Richard Apweiler. "The SWISS-PROT Protein Sequence Database and Its Supplement TrEMBL in 2000." *Nucleic Acids Research* 28 (1): 45–48, 2000. https://doi.org/10.1093/nar/28.1.45.
3) Benson, David A., M. Cavanaugh, K. Clark, I. Karsch-Mizrachi, J. Ostell, K. D. Pruitt, and E. W. Sayers. "GenBank." *Nucleic Acids Research* 41 (D1): D36–D42, 2013. https://doi.org/10.1093/nar/gks1195.
4) Felsenstein, Joseph. *PHYLIP (Phylogeny Inference Package) Version 3.6*. Seattle, WA: Department of Genome Sciences, University of Washington, 2005.
5) Kumar, S., Glen Stecher, Michael Li, Claudio Knyaz, and Koichiro Tamura. "MEGA X: Molecular Evolutionary Genetics Analysis across Computing Platforms." *Molecular Biology and Evolution* 35 (6): 1547–1549, 2018. https://doi.org/10.1093/molbev/msy096.
6) Lesk, Alan M. *Introduction to Bioinformatics*. 5th ed. Oxford, UK: Oxford University Press, 2019.
7) Mount, David W. *Bioinformatics: Sequence and Genome Analysis*. 2nd ed. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2004.
8) Sneath, Peter H. A., and Robert R. Sokal. *Numerical Taxonomy: The Principles and Practice of Numerical Classification*. San Francisco, CA: W.H. Freeman, 1973.
9) Tatusova, Tatiana, Sandra Ciufo, Steven Federhen, Boris Fedorov, Robert McVeigh, Kevin O'Neill, and Irina Tolstoy. "Update on RefSeq Microbial Genomes Resources." *Nucleic Acids Research* 43 (D1): D599–D605, 2015. https://doi.org/10.1093/nar/gku1062.
10) Walkenbach, John. *Excel 2013 Bible: The Comprehensive Tutorial Resource*. Hoboken, NJ: John Wiley & Sons, 2013.

Evaluation Pattern:60/40	
Total Marks: 50	
Internal Continuous Evaluation: • Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	**End Semester Examination:** • Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Board of Studies in Biotechnology (Biotechnology)

Programme: B.Sc.	**Semester** - VI
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 362: Food and Microbial Biotechnology

Course Objectives: Student should be able to…

1) make students aware of Food Biotechnology.
2) understand concepts of microbial biotechnology.
3) study the advantages of fermented food products.
4) aware the techniques of food preservation for avoid the spoilage and toxicity

Course Outcomes: Students will be able to…

1) basic concepts of microbial culture mass production.
2) give basic Knowledge of fermented food production techniques.
3) different techniques used for food preservation and avoid toxicity preparation.
4) study newly prepared genetically modified food analysis for market acceptance.

Module	Title and Contents	Hrs
Module -1:	**Microbial Cultures and Production** 1.1 Concept of pure and mixed culture, Microbial growth kinetics basic concept (Batch, Continuous and Fed Batch), Microbial 1.2 Production of Enzymes (amylase –koji fermentation), Antibiotics (Penicillin), Vitamins (B12), Amino acids (Lysine), Organic acid (Citric acid), Probiotics 1.3 Edible mushroom, commercial cultivation of mushroom, Single Cell Protein (Spirulina)	7
Module -2:	**Fermented Foods and Beverages** 2.1 Dairy Products – Cheese, Dahi, Yoghurt. Indian Foods – Idli**,** 2.2 Bakery Products – Bread**,** Fermented Pickles – Sauerkraut 2.3Beverages – Beer, Wine (Red table and white table)- Types, Fermentation Process, Aging Process.	7
Module -3:	**Food Spoilage, preservation & toxicity:** 3.1 Types of spoilage- Physical, Chemical and Biological (auto and microbial) 3.2 Preservation methods: High and Low temperatures, retort process for unrefrigerated storage, Controlled atmosphere and Anerobiosis, Radiations and Asepsis, Chemical preservatives (Salt, sugar, organic acids, SO2, NO2) 3.3 Food Toxicity – Mycotoxin (Aflatoxin), Exotoxin (*Staphylococcal*), Neurotoxin (Botulinum), Food borne illness- Shigellosis, Amoebiosis, Aspergillosis.	8
Module -4:	**Impact of GM food on human health** 4.1 Principle, Risk analysis and Regulations, Multidisciplinary perspectives of GM foods and impact Public health principles, 4.2 Characteristics of food supply for public health, Food Safety, Capacity to supply nutritional adequacy, Sustainability, Capacity for Consumer choice, Accessibly and affordability to all.	8

Reference Books:-

1) Adams, Martin R., and Maurice O. Moss. *Food Microbiology*. 3rd ed. Royal Society of Chemistry, 2007.

2) Batt, Carl A., and Mary Lou Tortorello. *Encyclopedia of Food Microbiology*. 2nd ed. Academic Press, 2014.
3) Demain, Arnold L., and Julian E. Davies. *Manual of Industrial Microbiology and Biotechnology*. 3rd ed. ASM Press, 2009.
4) Frazier, William C., and Dennis C. Westhoff. *Food Microbiology*. 5th ed. McGraw Hill Education, 2017.
5) Jay, James M., Martin J. Loessner, and David A. Golden. *Modern Food Microbiology*. 7th ed. Springer, 2005.
6) Lee, Young W., and W. W. Wood. *Microbial Biotechnology*. Wiley, 2015.
7) Madigan, Michael T., Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, and David A. Stahl. *Brock Biology of Microorganisms*. 15th ed. Pearson, 2018.
8) Montville, Thomas J., and Karl R. Matthews. *Food Microbiology: An Introduction*. 2nd ed. ASM Press, 2008.
9) Prescott, Harley, and Klein. *Microbiology*. 10th ed. McGraw Hill Education, 2017.
10) Ray, Bibek, and Arun Bhunia. *Fundamental Food Microbiology*. 5th ed. CRC Press, 2013.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	• Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Programme: B.Sc.	**Semester** - VI
Type : Elective I	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: 363 Applications of Biotechnology in Agriculture and Health

Course Objectives: Student should be able to…
1) learn techniques of Micro propagation.
2) understand knowledge about preservative techniques used for plants and seeds.
3) learn the techniques production and commercialization of bio fertilizer and bio pesticide.
4) gain the knowledge of advanced biotechnological application in agriculture.

Course Outcomes: Students will be able to learn…
1) techniques of Micropropagation.
2) knowledge about preservative techniques used for plants and seeds.
3) production of recombinant vaccines.
4) techniques of forensic medicine and Public health.

Module	Title and Contents	Hrs
Module -1:	**Somatic hybridization** 1.1 Artificial Seed and Germplasm preservation , Somatic hybridization- Definition, protoplast fusion technique, selection of hybrids, symmetric and asymmetric hybrids, 1.2 Cybrid production, Artificial Seed – Definition, Techniques, factors affecting, applications limitations. 1.3 Germplasm preservation- Introduction, principle, Long term storage, short, medium storage techniques, factors affecting, cryopreservation, applications, limitations.	8
Module -2:	**Transgenic Plants** 2.1 Herbicide resistant: Glyphosate resistance, Phosphinothricin resistance 2.2 Fungal and Bacterial disease resistance approaches: PR proteins, Chitinase, Glucanase, RIPs proteins, 2.3 Virus resistance**:** Virus coat proteins, Movement proteins, Trasmission proteins, Satellite RNAs, Antisense RNAs, Ribozymes. 2.4 Insect resistance approaches: BT protein (BT-Cotton, BT-Brijal), Non BT protein, 2.5 Transgenic plant with improved nutrition: Golden Rice, Molecular farming.	7
Module -3:	**Monoclonal Antibodies, Biosensor and Gene therapy** 3.1 Monoclonal antibodies- Production, Formulation, Applications- Diagnostics & Therapeutic 3.2 Biosensors- Principle &their applications. 3.3 Gene therapy – Introduction and types- Somatic & Germ line gene therapy. Current status and future trends in telepathology and digital pathology	8
Module -4:	**Vaccines- Principle & practice:** 4.1 Concept and types of vaccine, preparation of vaccine , Subunit vaccines- Hepatitis B vaccine, Foot and Mouth disease Vaccine, 4.2 DNA Vaccines, Edible Vaccines, 4.3 Recombinant vaccines- Cholera Vaccine, Vaccinia Virus Vaccine.	7

Reference Books:-

1) Chaudhary, R. C. *Introduction to Plant Breeding*. 1st ed.

2) Dubey, R. C. 2014. *A Textbook of Biotechnology*. 5th ed. New Delhi: S. Chand & Company.
3) Jogdand, S. N. 2008. *Medical Biotechnology*. 2nd ed. Mumbai: Himalaya Publishing House.
4) Jogdand, S. N. 2012. *Advances in Biotechnology*. 5th ed. Mumbai: Himalaya Publishing House.
5) Satyanarayana, U. 2013. *Biotechnology*. 4th ed. Kolkata: Books and Allied Pvt. Ltd.
6) Singh, B. D. 2005. *A Textbook of Plant Breeding*. 2nd ed. New Delhi: Kalyani Publishers.
7) Singh, B. D. 2010. *Biotechnology*. 2nd ed. New Delhi: Kalyani Publishers.
8) Vyas, S. P., and V. K. Dixit. 2010. *Pharmaceutical Biotechnology*. 1st ed. New Delhi: CBS Publishers & Distributors.
9) Dubey, R. C. *A Textbook of Biotechnology*. (Duplicate entry – see item 2. Remove or revise if necessary.)
10) Freshney, Ian. 2010. *Animal and Cell Biotechnology*. Hoboken, NJ: Wiley-Blackwell.

Evaluation Pattern:60/40	
Total Marks: 50	
Internal Continuous Evaluation: • Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	**End Semester Examination:** • Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Programme: B.Sc.	**Semester** - VI
Elective II	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT- 364 Research Methodology

Course Objectives: Student should be able to…

1) give a background on the history of research and highlighting the methodologies used to do research.
2) understand the basis of these methodologies to understand and appreciate scientific ethics.
3) know the framework of these methodologies for understanding effective lab practices, scientific communication and language.
4) understand the Research Process.

Course Outcomes: Students will be able to…

1) apply the methodologies of scientific research, to published papers.
2) Collect and present the data.
3) practicing scientific reading and to write an effect research proposal.
4) develop critical thinking skills, enabling them to analyze, evaluate, and synthesize information from different sources and research designs.

Module	Title and Contents	Hrs
Module -1:	**Basic in research** 1.1 Definition and perspective - application perspective, objectives perspective mode of enquiry perspective. 1.2 selection of problems - stages in the execution of research; preparation of manuscript - report writing – 1.3format of journals - proof reading - sources of information; journals, reviews, books, and monographs-bibliography. 1.4 Preparation for Research -Choosing a mentor, lab and research question; Maintaining a lab notebook with date-wise entry.	8
Module -2:	**Scientific Writing Skills** 2.1 Problems while writing a scientific document, Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References, Drafting titles and framing abstracts. 2.2 Publishing scientific papers - the peer review process and problems, recent developments such as open access and non-blind review, Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism. Characteristics of effective technical communication, Scientific presentations, Ethical issues	7
Module -3:	**Data collection and documentation** 3.1 Maintaining a laboratory record, Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography. 3.2 Comparison of means: chi square test, students t test, ANOVA with interpretation of data- introduction to 3.3 MANOVA- statistical tables and their use - significance test and fixing levels of	8

	significance - use of statistical software like COSTAT and STATISTICA.	
Module -4:	**Scientific Communication:** 4.1 Journals: standard of research journals - impact factor - citation index. 4.2 Information retrieval - access to archives and databases, 4.3Search engines - google, PubMed - national informatics centre network services. Online data base library.	7

Reference Books:-

1) Alley, Michael. *The Craft of Scientific Writing*. 3rd ed. New York: Springer, 1996.
2) Booth, Wayne C., Gregory G. Colomb, and Joseph M. Williams. *The Craft of Research*. 4th ed. Chicago: University of Chicago Press, 2016.
3) Davis, Gordon B., and Clyde A. Parker. *Writing the Doctoral Dissertation: A Systematic Approach*. 2nd ed. New York: Barron's Educational Series, 1997.
4) Day, Robert A., and Barbara Gastel. *How to Write and Publish a Scientific Paper*. 7th ed. Cambridge: Cambridge University Press, 2012.
5) Glasman-Deal, Hilary. *Science Research Writing for Non-Native Speakers of English*. London: Imperial College Press, 2010.
6) Kothari, C. R., and Gaurav Garg. *Research Methodology: Methods and Techniques*. 4th ed. New Delhi: New Age International Publishers, 2019.
7) Kumar, Ranjit. *Research Methodology: A Step-by-Step Guide for Beginners*. 6th ed. New Delhi: Sage Publications, 2022.
8) Pechenik, Jan A. *A Short Guide to Writing About Biology*. Boston: Pearson, 2016.
9) Subramanyam, Krishna. *Scientific and Technical Information Resources*. New York: Marcel Dekker Inc., 1981.
10) Wilson, Keith, and John Walker, eds. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th ed. Cambridge: Cambridge University Press, 2010.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	• Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Programme: B.Sc.	**Semester** - VI
Type : Elective III	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT-365 IPR, Bioethics and Quality Management

Course Objectives: Student should be able to…
1) learn concept of Intellectual Property Rights.
2) know rules and regulation for patent filing.
3) aquire the dynamic role of entrepreneurship.
4) understand the quality control and management at industrial level

Course Outcomes: Students will be able to…
1) discuss the rules and regulation regarding IPR.
2) describe the patent laws and patent filing.
3) learn fundamentals of Management and Administration.
4) use the importance of quality control, management, and industrial safety.

Module	Title and Contents	Hrs
Module -1:	**General Regime of Intellectual Property Rights:** 1.1 Concept of intellectual property; Types of Intellectual Property- Origin and Development- An Overview; Intellectual Property Rights as Human Right; 1.2 Role and function of International Institutions- World Intellectual Property Organisation (WIPO) and World trade organization WTO; 1.3 Introduction to copyright; trademark; Geographical Indications and The Protection of Plant Varieties and Farmers' Rights- Farmers rights acts 2001; authority and registry.	8
Module -2:	**Patent Law** 2.1 Introduction to patent laws - (a) Paris Convention (b) Patent Cooperation Treaty (c) WTO- TRIPS (d) Harmonisation of CBD and TRIPs 2.2 Indian Patent Law- (a) The Patents Act, 1970 (b) Amendments to the Patents Act 2.3 (c) Patentable Subject Matter, Patentability Criteria (d) 2.4Procedure for Filing Patent Applications, Patent Granting Procedure (e) Revocation, Patent Infringement and Remedies (f) Relevant Provisions of the Biological Diversity Act, 2002 (g) Access and Benefit Sharing Issues	7
Module -3:	**Bioethics and Biotechnology** 3.1 Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide. 3.2 Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.	8

Module -4:	**Quality management** 4.1 Introduction to quality assurance and quality control- Definition, concept Building (premises) for manufacture of drugs, Packaging material, Personnel, hygiene, sanitation, waste and disposal, Quality control for: all instruments, clothing's, packing, processing line. 4.2 Quality management- Production Management and Documentation: ICH, ISO 9000 series, total quality management, validation for tablets and parenterals, practice of WHO GMP. 4.3 Industrial Safety: Industrial hazards and their prevention, fire,accidents, mechanical and electrical equipments, industrial effluent testing.	7

Reference Books:-

1) Ali, Feroz. *The Law of Patents*. LexisNexis.
2) Ali, Feroz. *The Touchstone Effect: The Impact of Pre-grant Opposition on Patents*. LexisNexis, 2009.
3) Beauchamp, Tom L., and James F. Childress. 2019. *Principles of Biomedical Ethics*. 8th ed. New York: Oxford University Press.
4) Correa, Carlos M. 2018. *Intellectual Property and the Development of Biotechnology*. Cambridge: Cambridge University Press.
5) Encyclopedia of Bioethics. 5 vol. set. 2003. ISBN-10: 0028657748.
6) Khurana, R. K., and S. L. Arora. 2010. *Intellectual Property Rights: Legal and Practical Aspects*. New Delhi: Anmol Publications.
7) Slusky, Ronald D. *Invention Analysis and Claiming – A Patent Lawyer's Guide*. 2nd ed. American Bar Association, 2012.
8) Wadehra, B. L. *Law Relating to Intellectual Property*. 5th ed. Universal Law Publishing Co. Pvt. Ltd., 2011.
9) Willing, Sidney H., Murray M. Tuckerman, and Williams Hitchings IV. *Good Manufacturing of Pharmaceuticals: A Plan for Total Quality Control*. 3rd ed. Bhalani Publishing House, Mumbai.
10) World Intellectual Property Organization (WIPO). *Website*. http://www.wipo.int/portal/index.html.en.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	• Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Programme: B.Sc.	**B. Sc. III, Semester** - VI
Type : Elective IV	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 366: Bio-entrepreneurship

Course Objectives: Student should be able to…

1) understanding the dynamic role of entrepreneurship and small businesses
2) organizing and Managing a Small Business.
3) financial Planning and Control.
4) forms of Ownership for Small Business

Course Outcomes: Students will be able to…

1) develop the business plan
2) understand fundamentals of Management and Administration.
3) understand Legal forms of the business for registration of the small scale industries, agencies for the registration of the companies.
4) understand Key Concepts in Bioentrepreneurship

Module	Title and Contents	Hrs
Module -1:	**An Overview of Entrepreneurs and Entrepreneurship** 1.1 definition, Basic principles and practices of management- Definition, concepts and application; Organization types, coordination, control and decision making in management	8
Module -2:	**Entrepreneurial Traits and Market Insights in Biotechnology** 2.1 Characteristics for being an entrepreneur in biotechnology, Case studies of successful and unsuccessful bio-entrepreneurs 2.2 Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors.	7
Module -3:	**Types of Enterprises and Ownership Structures in Biotechnology** 3.1 Types of Enterprises and Ownership Structure: small scale, medium scale and large scale enterprises, 3.2 Role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.	8
Module -4:	**Government Support and Key Factors in Bioentrepreneurship** 4.1 Role of government and schemes, financial institutions in fostering Bioentrepreneurship 4.2 Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources , project location, end product, quality issues, etc).	7

Reference Books:-

1) Balasubramanian, P. 2015. Biotechnology and Entrepreneurship: Creating BioWealth. New Delhi: CRC Press India.
2) Blundel, Richard, and Nigel Lockett. 2011. Exploring Entrepreneurship: Practices and Perspectives. Oxford: Oxford University Press.
3) Entrepreneurial Development: Text and Cases. 1992. New Delhi: Sultan Chand & Sons.
4) Hisrich, Robert D., Michael P. Peters, and Dean A. Shepherd. 2017. Entrepreneurship. 10th ed. New York: McGraw-Hill Education.

5) Jogdand, S. N. Entrepreneurship and Business of Biotechnology. Mumbai: Himalaya Publishing House. (
6) Kumar, S. Anil. 2003. Entrepreneurship Development. New Delhi: New Age International (P) Ltd. Publishers.
7) Mehta, Shreefal S. 2008. Commercializing Successful Biomedical Technologies. Cambridge: Cambridge University Press.
8) Mellor, Robert. 2009. Entrepreneurship for Everyone: A Student Textbook. London: Sage Publications Ltd.
9) Patzelt, Holger, and Thomas Brenner, eds. 2008. Handbook of Bioentrepreneurship. Berlin: Springer.
10) Shimasaki, Craig D. 2014. *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Academic Press.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-CCE-I-05 Marks • Internal Work -2 –Mid Semester- 10 Marks • Internal Work -3-CCE- II -05 Marks	• Question -1-10 Marks • Question -2 -20 Marks • Question -3 -20 Marks

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Programme: B.Sc.	**Semester - VI**
Type : Major	**Marks: 50**
Credits : 2	**From: A. Y. 2025-26**

Name of the Course: BBTP 367: Techniques in Application of computational Biology

Course Objectives: Student should be able to…

1) provide practical skills in using bioinformatics software and web-based tools like BLAST, ClustalW, and MEGA.
2) perform and interpret pairwise and multiple sequence alignments of DNA and protein sequences.
3) develop microbial methods to prevent spoilage and extend shelf life.
4) control harmful pathogens in food.

Course Outcomes: Students will be able to…

1) access, retrieve, and interpret nucleotide and protein sequences from global databases such as NCBI, EMBL, DDBJ, SWISS-PROT
2) students will be able to visualize and interpret 3D structures of proteins using structural databases like PDB and tools like RasMol
3) explain the role of beneficial microorganisms in food production, preservation, and enhancement of nutritional value.
4) perform basic laboratory techniques used in microbial and food biotechnology, including isolation, culturing, and identification of microbes.

Sr. No.	Name of the Practical	Hrs
1.	Introduction to PUBMED Central database	60
2.	Getting the amino acid sequences by exploring and querying the protein Sequence database.	
3.	Getting the gene sequences by exploring and querying the nucleic acid Databases.	
4.	Similarity search for nucleotide using the BLASTn	
5.	Similarity search for protein using the BLASTp	
6.	Perform the Multiple Sequence Alignment by using NCBI	
7.	Proceed Pairwise Sequence Alignment Using BLAST	
8.	Retrieval of DNA and Protein Sequences from GenBank, EMBL, and DDBJ	
9.	Construction of Phylogenetic Tree	
10.	Interpreting Evolutionary Relationships Through Different Phylogenetic Tree Styles (Cladogram, Phenogram, Curvogram)	
11.	Perform Primer Designing .	
12.	Calculate PI/MW of protein using ExPasy web tool.	
13.	Analysis of Secondary and tertiary structure of protein using visualizing software Rasmol.	
14.	Perform Sequence Retrieval Using Entrez	
15.	Retrieving and Analyzing Protein Sequences from SWISS-PROT	
16.	Exploring Structural Databases: PDB, MMDB,	
17.	Prediction of the secondary structure of protein using ExPasy web tool (GOR method).	
18.	Introduction to MS Excel: Data Entry, Editing, and Formatting	
19.	Introduction to Microsoft Excel (Draw Graphs, Uses of formula)	
20.	Document Preparation Using MS Word: Formatting, Tables, Flowcharts, and Reports	

Reference Books:-

1) Adams, Martin R., and Maurice O. Moss. 2007. *Food Microbiology*. 3rd ed. Cambridge: Royal Society of Chemistry.
2) Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic local alignment search tool. *J Mol Biol*. 215(3):403–410. doi:10.1016/S0022-2836(05)80360-2
3) Bairoch A, Apweiler R. 2000. The SWISS-PROT protein sequence database and its supplement TrEMBL. *Nucleic Acids Res*. 28(1):45–48. doi:10.1093/nar/28.1.45
4) Benson DA, Cavanaugh M, Clark K, Karsch-Mizrachi I, Ostell J, Pruitt KD, Sayers EW. 2013. GenBank. *Nucleic Acids Res*. 41(D1):D36–D42. doi:10.1093/nar/gks1195
5) Felsenstein J. 2005. *PHYLIP (Phylogeny Inference Package) version 3.6*. Seattle (WA): University of Washington.
6) Frazier, William C., and Dennis C. Westhoff. 2017. *Food Microbiology*. 5th ed. New York: McGraw-Hill Education.
7) Gasteiger E, Gattiker A, Hoogland C, Ivanyi I, Appel RD, Bairoch A. 2003. ExPASy: the proteomics server for in-depth protein knowledge and analysis. *Nucleic Acids Res*. 31(13):3784–3788. doi:10.1093/nar/gkg563
8) Hutkins, Robert W. 2006. *Microbiology and Technology of Fermented Foods*. Ames, IA: Blackwell Publishing.
9) Jay, James M., Martin J. Loessner, and David A. Golden. 2005. *Modern Food Microbiology*. 7th ed. New York: Springer.
10) Joshi, V. K., and R. S. Singh. 2019. *Biotechnology: Food Fermentation (Microbiology, Biochemistry, and Technology)*. Vol. 1. Jodhpur: Educational Publishers and Distributors.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-20 Marks	• Question -1 -30 Marks

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Programme: B.Sc.	**Semester** - VI
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTP 368: Techniques in Food and Microbial Biotechnology

Course Objectives: Student should be able to…

1) provide hands-on training in microbiological techniques used in food and industrial biotechnology.
2) train students in the preparation and sterilization of culture media used in food and microbial biotechnology.
3) study microbial fermentation processes used in the production of food and beverages.
4) expose students to quality control and assurance practices in microbial and food biotechnology.

Course Outcomes: Students will be able to

1) demonstrate aseptic techniques and biosafety procedures in handling microbial cultures and food samples.
2) Prepare and sterilize various types of culture media used in food and microbial biotechnology experiments.
3) analyze the quality and safety of fermented and processed food products through biochemical and microbiological testing.
4) record, interpret, and report experimental data related to food and microbial biotechnology.

Sr. No.	Name of the Practical	Hrs
1.	Isolation of vitamin B12 requiring mutants.	60
2.	Production of citric acid.	
3.	Citric acid recovery and estimation by titration.	
4.	Bio-assay of Vit B12.	
5.	Bio-assay of Penicillin.	
6.	Production of wine.	
7.	Analysis of wine (pH, colour and alcohol content)	
8.	Assay of Amylase by DNSA Method. (Graphical estimation)	
9.	Amylase production by using *Bacillus* species	
10.	Quantitative analysis if Milk by Standard Plate Count (SPC) method	
11.	Microbiological analysis of food products.	
12.	Preparation of Curd Using Lactic Acid Bacteria	
13.	Isolation of lactic acid bacteria from fermented food.	
14.	Examination of Milk by Direct microscopic count (DMC)	
15.	Effect of pH or Temperature on Curd Formation	
16.	Isolation of Yeast from Fruit Peels (e.g., Grapes or Apple)	
17.	Antibacterial Activity of Natural Substances (like Garlic or Ginger) Against Common Bacteria	
18.	Demonstration of wine production by using grape juice.	
19.	Preperation of sauerkraut.	
20.	Demonstration of wine production by using wild fruits.	

Reference Books:-

1) Dwevedi, Alok. 2012. *Microbial Biotechnology: A Laboratory Manual for Bacterial Systems*. Singapore: Springer.
2) Aneja, K. R. 2003. *Experiments in Microbiology, Plant Pathology and Biotechnology*. 4th ed. New Delhi: New Age International Publishers.
3) Cappuccino, James G., and Natalie Sherman. 2019. *Microbiology: A Laboratory Manual*. 11th ed. Boston: Pearson Education.
4) Benson, Harold J. 2011. *Microbiological Applications: Laboratory Manual in General Microbiology*. 12th ed. New York: McGraw-Hill.
5) Dubey, R. C., and D. K. Maheshwari. 2016. *Practical Microbiology*. 2nd ed. New Delhi: S. Chand & Company Ltd.
6) Sharma, K. D. 2010. *Manual of Microbiology: Tools and Techniques*. New Delhi: Ane Books Pvt. Ltd.
7) Joshi, V. K., and R. S. Rana. 2012. *Practical Manual of Fermentation Technology*. New Delhi: New India Publishing Agency.
8) Salle, A. J. 1971. *Fundamental Principles of Bacteriology*. 7th ed. New York: McGraw-Hill.
9) Frazier, William C., and Dennis C. Westhoff. 2008. *Food Microbiology*. 4th ed. New Delhi: Tata McGraw-Hill Education.
10) Jay, James M. 2005. *Modern Food Microbiology*. 7th ed. New York: Springer.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• **Internal work 1: 20 Marks**	• **Question -1 : 30 Marks**

Karmaveer Bhaurao Patil University, Satara
(A State Public University Est. u/s 3(6) of MPUA 2016)
Faculty of Science and Technology

Yashavantrao Chavan Institute of Science, Satara

Board of Studies in Biotechnology (Biotechnology)

Programme: B.Sc.	**Semester - VI**
Type : minor	**Marks: 50**
Credits : 2	**From: A. Y. 2025-26**

Name of the Course: BBTP 369Techniques in Application of Biotechnology in Agriculture and Health and Bio-entrepreneurship

Course Objectives: Student should be able to…

1) isolation and characterization of agriculturally important microbes.
2) learn mass production protocols.
3) understand biosafety guidelines and regulatory frameworks related to GMOs.
4) learn the basics of business plan drafting, financial planning, and loan proposal writing.

Course Outcomes: Students will be able to…

1) apply standard biochemical and microbiological techniques for the analysis of milk, blood, and plant-based products.
2) apply knowledge of instruments in biochemical study.
3) analyze and interpret biosafety guidelines for genetically modified organisms.
4) apply financial calculation methods relevant to business scenarios, such as interest computation and costing.

Sr. No.	Name of the Practical	Hrs
1.	Analysis of Milk and milk products -Estimation of lactic acid/ Fat/ MBRT	60
2.	Determination of antibacterial activity of crude plant extract.	
3.	Estimation of blood glucose fasting and post prandial	
4.	DNA fingerprinting-RFLP	
5.	Isolation of *Azotobacter* from soil sample.	
6.	Isolation of *Rhizobium* from root nodules	
7.	Isolation of PSB from soil.	
8.	Production of Biofertilizer- *Azotobacter*, PSB	
9.	Isolation of *Trichoderma / Bacillus thuringenisis*	
10.	Production of Biopesticide – *Trichoderma / Bacillus thuringenisi*	
11.	Analysis of Biosafety Guidelines for GMO	
12.	Design of a Logo and Brand Name for a Bioproduct	
13.	Drafting of a project proposal for bank loan	
14.	Study of Product Costing and Pricing Strategies	
15.	Basic financial calculations (Ex. Calculation of interest)	
16.	Strategies for solving the business problems	
17.	Design and Development of Product Advertisement	
18.	Presentation on success story of an entrepreneur	
19.	Preparation of a Basic Business Plan for a Biotech Product	
20.	Presentation of a Biotech Startup Idea.	

Reference Books:-

1) Graf, Chris, Elizabeth Wager, Sabine Bowman, et al. "Best Practice Guidelines on Publication Ethics: A Publisher's Perspective." *International Journal of Clinical Practice* 61, Suppl. 152 (2016): 1–26.
2) Katz, Michael J. *From Research to Manuscript: A Guide to Scientific Writing*. 2nd ed. New York: Springer, 2015.
3) Kothari, C. R. *Research Methodology: Methods and Techniques*. 2nd ed. New Delhi: New Age International,

2004.
4) Kumar, Ranjit. *Research Methodology: A Step-by-Step Guide for Beginners*. 6th ed. London: Sage Publications, 2022.
5) Purvis, Dan, and Lita Nelsen. *Bioentrepreneurship: A Beginner's Guide to Starting a Biotech Company*. New York: Biotech Publishing, 2018.
6) Shimasaki, Craig D. *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Academic Press, 2014.
7) Khanka, S. S. *Entrepreneurship Development*. New Delhi: S. Chand & Company Ltd., 2007.
8) Hisrich, Robert D., Michael P. Peters, and Dean A. Shepherd. *Entrepreneurship*. 10th ed. New York: McGraw-Hill Education, 2017.
9) Montgomery, Douglas C. *Design and Analysis of Experiments*. 8th ed. Hoboken, NJ: Wiley, 2012.
10) Peat, Jennifer. *Scientific Writing: Easy When You Know How*. London: BMJ Books, 2013.

Evaluation Pattern:60/40

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-20 Marks	• Question -1 -30 Marks

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Board of Studies in Biotechnology (Biotechnology)

Programme: B.Sc.	**Semester - VI**
Type : Minor	**Marks: 50**
Credits : 2	**From: A. Y. 2025-26**

Name of the Course: BBTP369 Techniques in Application of Research methodology and IPR, Bioethics and Quality Management

Course Objectives: Student should be able to…

1) analyze and classify different types of Intellectual Properties (IP) — patents, copyrights, trademarks, trade secrets.
2) study real examples of biological patents.
3) write a research proposal.
4) understand scientific data analysis.

Course Outcomes: Students will be able to…

1) Identify and distinguish between different types of IP relevant to biotech innovations.
2) Conduct basic patent searches and analyze real-world biological patent cases.
3) Formulate a clear research problem and hypothesis for a biotechnology-based study.
4) Design a basic research plan with appropriate methodology and timelines.

Sr. No.	Name of the Practical	Hrs
1.	Case Study Analysis on Intellectual Property Types	60
2.	Patent Search Exercise	
3.	Case Study on Biological Patents (Plant, Animal, Microbial)	
4.	Study of Major IPR Treaties and Conventions	
5.	Drafting a Hypothetical Biotechnology Patent	
6.	Understanding Intellectual Property Rights (IPR) in Biotechnology	
7.	Comparative Study: Process vs Product Patent (with real case studies)	
8.	Study of International Conventions on Patenting Biological Materials	
9.	Report on Patenting of Genes, DNA sequences, and Transgenic Organisms	
10.	Preparation of a Mock Patent Application for a Biotech Innovation	
11.	Identifying a Research Problem: A Case Study Approach	
12.	Comparative Study of Research Perspectives: Application vs Objective-Based	
13.	Designing a Research Plan: From Hypothesis to Report	
14.	Proofreading a Sample Research Paper: Common Errors and Corrections	
15.	Maintaining a Scientific Lab Notebook: A Week in the Lab	
16.	Writing an Abstract and Title for a Hypothetical Research Paper	
17.	Comparative Analysis of Peer-Reviewed vs Open Access Journals	
18.	Case Studies in Academic Misconduct and How to Avoid Plagiarism	
19.	Creating a Scientific Poster Presentation on a Chosen Topic	
20.	Designing Tables and Graphs from Hypothetical Data	

Reference Books:-

1) Creswell, John W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th ed. Thousand Oaks, CA: Sage Publications, 2014.
2) Day, Robert A., and Barbara Gastel. *How to Write and Publish a Scientific Paper*. 5th ed. Westport, CT: Greenwood Press, 1998.
3) Fowler, Floyd J. *Survey Research Methods*. 4th ed. Thousand Oaks, CA: Sage Publications, 2009.
4) Glasman-Deal, Hilary. *Science Research Writing for Non-Native Speakers of English*. 2nd ed. London:

Imperial College Press, 2020.
5) Creswell, John W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th ed. Thousand Oaks, CA: Sage Publications, 2014.
6) Day, Robert A., and Barbara Gastel. *How to Write and Publish a Scientific Paper*. 5th ed. Westport, CT: Greenwood Press, 1998.
7) Fowler, Floyd J. *Survey Research Methods*. 4th ed. Thousand Oaks, CA: Sage Publications, 2009.
8) Glasman-Deal, Hilary. *Science Research Writing for Non-Native Speakers of English*. 2nd ed. London: Imperial College Press, 2020.
9) The Business of Biosciences – What makes a biotech entrepreneur? Springer http://www.springer.com/978-1-4419-0063-0 2009
10) Balasubramanian, P. *Biotechnology and Entrepreneurship: Creating BioWealth*. New Delhi: CRC Press India, 2015.
11) Biotechnology Industry Research Assistance Council (BIRAC). 2024. "Empowering Biotech Startups in India." Accessed April 30, 2025. https://birac.nic.in.

Evaluation Pattern:

Total Marks: 50

Internal Continuous Evaluation:	**End Semester Examination:**
• Internal Work -1-20 Marks	• Question -1 -30 Marks

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Programme: B.Sc.	**Semester - VI**
Type : VSC	**Marks: 50**
Credits : 2	**From: A. Y. 2025-26**

Name of the Course: BBTPVSC 5- Urban and Rural Management -II

Course Objectives: Student should be able to…

1) understand different types of tools in nurserie.
2) know various facilities required to set up of a nursery
3) commiserate with various practices in a nursery
4) study methods and applications of digital documentation used management in nursery

Course Outcomes: Students will be able to…

1) explain urban & rural nursery Management.
2) apply the technique of different tools used in nursery management.
3) analyze various techniques for nursery management.
4) demonstrate digital documentation techniques used in nursery management.

Sr. No.	Name of the Practical	Hrs
1.	Site selection for biotech-integrated nursery.	60
2.	Layout designing using CAD or digital tools.	
3.	Establishment of eco-friendly urban/rural nurseries.	
4.	Preparation of sterilized nursery media.	
5.	Testing pH & EC of soil and media.	
6.	Role of cocopeat, perlite, and vermiculite in biotech nurseries.	
7.	Aseptic seed germination under lab conditions	
8.	Use of plant growth regulators (auxins, cytokinins) in nurseries	
9.	Effect of biostimulants on seedling vigor	
10.	Use of biofertilizers and PGPR (plant growth-promoting rhizobacteria)	
11.	Molecular identification of pests/diseases and Preparation and application of biopesticides	
12.	Hardening of tissue culture-raised plants in nursery conditions	
13.	Scaling and testing genetic fidelity of micropropagated plants	
14.	Certification process for nursery plants	
15.	Germplasm conservation and documentation	
16.	Labeling and barcode tagging for plant identification	
17.	Digital record-keeping and plant inventory management	
18.	Designing nursery catalog using digital tools	
19.	Packaging of biotech nursery products	
20.	Study of nursery marketing trends and e-commerce platforms	

Reference Books:-

1) Bhojwani, S. S., and M. K. Razdan. *Plant Tissue Culture: Theory and Practice*. Elsevier, 2004.
2) Chawla, H. S. *Introduction to Plant Biotechnology*. Oxford & IBH Publishing, 2009.
3) Food and Agriculture Organization (FAO). *Good Agricultural Practices for Nursery Management*. Food and Agriculture Organization, 2012.
4) Hartmann, H. T., et al. *Plant Propagation: Principles and Practices*. Prentice Hall, 2010.
5) Indian Council of Agricultural Research (ICAR). *Urban and Peri-Urban Agriculture*. Indian Council of Agricultural Research, 2015.

6) National Bank for Agriculture and Rural Development (NABARD). *Rural Nursery Model Bankable Project*. NABARD, 2021.
7) Rao, V. S. *Principles of Weed Science and Nursery Management*. Scientific Publishers, 2019.
8) Sharma, J. P. *Entrepreneurship in Agriculture and Allied Sectors*. New India Publishing Agency, 2016.
9) Singh, B. D. *Biotechnology: Expanding Horizons*. Kalyani Publishers, 2018.
10) Tamil Nadu Agricultural University (TNAU) Agritech Portal. *Nursery Management Practices*. Tamil Nadu Agricultural University, no date.

Evaluation Pattern:60/40	
Total Marks: 50	
Internal Continuous Evaluation: • Internal Work -1-20 Marks	**End Semester Examination:** • Question -1 -30 Marks

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