Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. II (Biotechnology)

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2025-2026

Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
Syllabus for Bachelor of Science Biotechnology

1. **Title:** B. Sc. Biotechnology
2. **Year of Implementation:** 2025-26
3. **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 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, and 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.

4. **General Objectives:**
    1) Construction and redesigning of the courses to suit 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

5. **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.

6. **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.

7. **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.

8. Duration: One Year

9. **Pattern:** Semester wise

10. Medium of Instruction: English

11. Structure of Course:

Sem (Level)	Courses			OE	VSC/ SEC	AEC/ VEC/ IKS	OJT/ FP/ CEP/ CC/ RP	Total Credits
	Course I	Course II	Course III					
	Major	Minor	-					
Sem III (5.0)	Major V (2) Major VI (2) Major P III (2)	Minor V (2) Minor VI (2) Minor P III (2)	-	OE III (2)	VSC I (2) (P) (Major specific) SEC I (2) (T+P)	AEC I (2) (English) IKS II (2) (Major Specific)	-	22
Sem IV (5.0)	Major VII (2) Major VIII (2) Major P IV (2)	Minor VII (2) Minor VIII (2) Minor P IV (2)	-	OE IV (2)	VSC II (2) (P) (Major specific) SEC II (2) (T+P)	AEC II (2) (English) VEC II (2) (Environmental studies)	-	22
Credits	12	12	-	04	08	08	-	44

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Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Department of Biotechnology "NEP Implementation 2020"

BIOTECHNOLOGY COURSE TITLE

	Major Subject: 1			**Minor Subjects**			**Subject: 3 (GE/OE)**		**VSEC**						**AES,VEC**			**TOTAL**
Sem	**Course**	**Course Title**	**Credit**	**Course**	**Course Title**	**Credit**	**Paper**	**Course Title**	**Credit**	**Course**	**VSC**	**Credit**	**Course**	**SEC**	**Credit**	**AES**	**VEC**	**CC**	
III	BBTT 231	Molecular Biology	2	BBTT 234	Developmental Biology	2	BBTTOE	–	–	BBTPVSC1	Lab exercise in Basics of Biotechnology in Nursery Management	2	BBTTSEC1	Advances in Hydroponics	1	BBTTAEC1 : English for communication I & English for communication II (2)	BBTTIKS2 :Indian Health Sciences IKSII (2)	–	22
	BBTT 232	Metabolic Pathways	2	BBTT 235	Cell Biology - II	**2**	BBTTOE	–	–				BBTPSEC1	Laboratory exercise based on Advances in Hydroponics	1				
	BBTP 233	Lab exercise based on Molecular Biology & Metabolic Pathways	2	BBTP 236	Lab exercise based on Developmental Biology and Cell Biology	2	BBTTOE-3	Agricultural Economics	2										

IV	BBTT 241	Plant Tissue Culture	2	BBTT 244	Genetics	2	BBTTOE	–	–	BBTPVSC2	Lab exercise based on Tools and Techniques of Biotechnology in nursery management	2	BBTTSEC2	Applications in Hydroponics	1	English for communication III & English for communication IV(2)	VEC II Environmental Studies (2)		22
	BBTT 242	Plant Physiology &Biochemistry	2	BBTP 245	Immunology	2	BBTTOE 4	Business Economics	2				BBTPSEC 2	Laboratory exercise based on application in Hydroponics	1				
	BBTP 243	Lab exercise based on Plant Tissue Culture and Plant Physiology &Biochemistry	2	BBTP 246	Lab exercise based on Genetics and Immunology	2													

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** - III
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course:BBTT 231 Molecular Biology

Course Objectives: Students should be able to…

1) aware of the basics of origin of DNA and RNA.
2) study process of DNA replication and repair
3) understand process of synthesis of RNA
4) learn concept of synthesis of protein

Course Outcomes: The students will be able to...

1) explain History of DNA and RNA
2) discuss the process of DNA replication and repair.
3) describe transcription process
4) elaborate process of synthesis of proteins

Module	Title and Contents	Hrs
Module -1:	**Experimental Evidences for DNA** **1.1** Experimental Evidences for DNA as a genetic material: Griffith's Exp. Avery, Macleod, McCarty Exp.,Blender Exp. **1.2** RNA As a genetic material. (Gierer and Schram expt.)	07
Module -2:	**DNA Replication and Repair** **2.1** DNA Replication: Semi conservative model of replication (M.S Expt.) **2.2** Variation in prokaryote and Eukaryote polymerases. Mechanism of DNA replication and regulation in brief. **2.3** D loop model, Rolling circle model **2.4** DNA damage and types of DNA damage in brief –Base substitution, Frameshift mutation, Chemical damage, Physical breakdown **2.5** DNA repair mechanisms and types in brief - Excision repair, **2.6** Mismatch repair, SOS repair, Photo reactivation, Recombination repair	08
Module -3:	**Transcription and Regulation of Gene Expression** **3.1** RNA polymerase, Transcription in prokaryote and Eukaryote. Transcription (Initiation, Elongation, termination) **3.2** Post transcriptional Modification - Capping, splicing, and RNA editing, polyadenylation **3.3** Developmental and environmental regulation of gene expression: i) Lac operon ii) Tryptophan operon **3.4** Regulation of gene expression: Promoter, Enhancers, Activators, Repressor, Co repressors	08
Module -4:	**Translation** **4.1** Genetic Code Triplet nature, Salient feature of genetic code, **4.2** Decipheration of genetic code - Methods of assignment of codons with Unknown sequences and known sequences **4.3** Technique Wobble Hypothesis, Variation in genetic code **4.4** Translation in prokaryote and Eukaryote Structure and role of ribosome in translation	07

Reference Books:-

1) Nadeem, Asif, Faiz-ul Hassan, and Maryam Javed. Introduction to Molecular Genomics. Bentham Science Publishers, 2021.

2) Tropp, Burton E. Molecular Biology: Genes to Proteins. 4th ed. Jones & Bartlett Learning, 2011.

3) Lewin, Benjamin. Genes XI. 11th ed. Jones & Bartlett Inc., 2012.

4) Watson, James D., Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick. Molecular Biology of the Gene. 6th ed. Pearson Education Inc. and Dorling Kindersley Publishing Inc., 2008.

5) Pal, Jayanta K., and Saroj S. Ghaskadbi. Fundamentals of Molecular Biology. Oxford University Press, 2009.

6) Wilson, Keith, and John Walker, eds. Principles and Techniques of Biochemistry and Molecular Biology. 7th ed. Cambridge University Press, 2010.

7) Craig, Neil, Rachel Green, Carol Greider, and Oliver Cohen. Molecular Biology: Principles of Genome Function. 2nd ed. Oxford University Press, 2014.

8) Twyman, Richard M., and William Wisden. Advanced Molecular Biology: A Concise Reference. BIOS Scientific, 1998.

9) Weaver, Robert. Molecular Biology. 5th ed. McGraw-Hill Science, 2011.

10) Brown, T.A. Essential Molecular Biology: Volume I. IRL Press, Oxford, 1995.

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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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science Satara

Board of Studies in Biotechnology

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

Name of the Course:BBTT 232 Metabolic Pathways

Course Objectives: Students should be able to…

1) students are aware of metabolism.
2) to study different types of metabolism and its study.
3) understand the concepts of metabolism of Biomolecules.
4) study the Metabolic Pathways with its Energetics.

Course Outcomes: Students will be able to…

1) principle & types of metabolism.
2) parameters used to study metabolism
3) biosynthesis of lipid, carbohydrates and hormones.
4) metabolic pathways with regulation.

Module	Title and Contents	Hrs
Module -1:	**Metabolism** **1.1** Introduction to metabolism, **1.2** Anabolism &catabolism, catabolism& its three stages, **1.3** Types of metabolic reactions **1.4** Methods employed to study metabolism (using auxotrophic mutants, radioisotopes), High energy compounds.	07
Module -2:	**Carbohydrates Metabolism** **2.1** Reactions and energetics of Glycolysis, TCA cycle, Glyoxylate cycle, **2.2** Gluconeogenesis **2.3** Glycogenesis and Glycogenolysis **2.4** HMP and its significance.	08
Module -3:	**Lipid Metabolism** **3.1** Biosynthesis of fatty acid with respect to Palmitic acid **3.2** Degradation of fatty acid(β-oxidation)with respect to Palmitic acid.	07
Module -4:	**Introduction to Hormones** **4.1** Definition , Types as Steroid, Peptide, Amino acid **4.2** Metabolism of amino acids **4.3** Transamination reactions, Deamination, Urea cycle	08

Reference Books:-

1) Berg, Jeremy M., John L. Tymoczko, Gregory J. Gatto Jr., and LubertStryer. Biochemistry. 9th ed. New York: W.H. Freeman, 2019.
2) Conn, Eric E., and Paul K. Stumpf. Outlines of Biochemistry. 5th ed. New Delhi: Wiley India Pvt. Ltd., 2009.
3) Devlin, Thomas M. Textbook of Biochemistry with Clinical Correlations. 7th ed. Hoboken, NJ: Wiley-Liss, 2010.
4) Garrett, Reginald H., and Charles M. Grisham. Biochemistry. 6th ed. Boston: Cengage Learning, 2016.
5) Jain, J.L., Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry. 7th ed. New Delhi: S. Chand Publishing, 2016.
6) Murray, Robert K., David A. Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, and P. Anthony Weil. Harper's Illustrated Biochemistry. 31st ed. New York: McGraw Hill Education, 2018.
7) Nelson, David L., and Michael M. Cox. Lehninger Principles of Biochemistry. 8th ed. New York: W.H. Freeman, 2021.
8) Rama Rao, A. Textbook of Biochemistry. 12th ed. New Delhi: UBS Publishers Distributors Pvt. Ltd., 2010.
9) Satyanarayana, U., and U. Chakrapani. Biochemistry. 5th ed. Hyderabad: Elsevier India, 2020.
10) Voet, Donald, and Judith G. Voet. Biochemistry. 4th ed. Hoboken, NJ: Wiley, 2016

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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Faculty of Science and Technology

Yashavantrao Chavan Institute of Science Satara

Board of Studies in Biotechnology

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

Name of the Course:BBTP 233 - Lab exercise based on Molecular Biology & Metabolic Pathways

Course Objectives: Student should be able to…

1) analyse experimental systems required in biochemical research.
2) learn techniques used to purification of biomolecules.
3) knowhow to use the instruments.
4) update with analysis methods

Course Outcomes: Students will be able to…

1) analyze biomolecules with techniques used in laboratories.
2) examine various biochemical methods to study biomolecules.
3) apply knowledge of instruments for molecular study.
4) examine biomolecules with different methods.

Sr. No.	Name of the Practical	Hrs
1.	Preparation of chemicals required in molecular biology laboratory.	60
2.	To perform Restriction digestion of DNA /Plasmid	
3.	To isolate bacterial genomic DNA	
4.	To isolate Eukaryotic DNA from - Plant Material	
5.	To isolate Eukaryotic DNA from	
6.	Qualitative analysis of DNA by agarose gel electrophoresis	
7.	Quantification of Genetic material	
8.	Isolation of RNA from animal tissue.	
9.	Plasmid isolation by alkaline lysis methods.	
10.	To determine the melting temperature of DNA.	
11	Paper chromatographic separation of amino acids from mixture.	
12	Paper chromatographic identification of amino acids by using RF value.	
13	Paper chromatographic separation of sugars from binary mixture.	
14	Study of column packaging by using gel beads.	
15	Perform gel filtration chromatography.	
16	Estimation of nitrate reductase enzyme activity.	
17	Study of lipase activity.	
18	Immobilization of baker's yeast cells by gel entrapment method.	
19	Study of invertase activity by using immobilized yeast cells.	
20.	Study of carcinogen signs and symbols.	

Reference Books:-

1) David Plummer, 2017, An Introduction to Practical Biochemistry, Third edition, McGraw Hill Education.
2) J. Jayraman, 2011, Laboratory Manual in Biochemistry, Second edition, new age international publisher.
3) S.K. Sawhney, Randir Singh, 2015, Introductory practical Biochemistry, First edition, Alpha science international ltd.
4) P.M. Swamy, 2008, Laboratory manual on Biotechnology, First edition, Rastogi publications.
5) S. Harisha, 2008, Biotechnology Procedures and Experiments Handbook, First edition, Laxmi publication.
6) Rajgopal&Toora, 2014, Practical Biochemistry, Third edition, Ahuja publishing house.
7) Sadashivam&Manikam, 2018, Biochemical methods, Third edition, New age international publisher.
8) Dr. A. C. Deb, 2013, Viva and Practical Biochemistry, First edition, New central book agency (p) ltd.
9) Watson, Pearson education, 2017, Molecular biology of the gene, Seventh edition, Pearson education.
10) Brown, T.A.1995 Essential Molecular Biology: Volume I. IRL Press, Oxford.

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.	**B. Sc. II, Semester** - III
Type : Minor	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course:BBTT 234 Developmental Biology (Plant and Animal)

Course Objectives: Students should be able to…

1) study the concepts of plant and animal embryology.
2) understand different developmental stages in plants and animals.
3) imbibe the concept of animal embryology.
4) understand the concept of Differentiation and Regeneration.

Course Outcomes: Students will be able to…

1) explain the concept of plant embryology.
2) describe the different developmental stages in plants and animals.
3) discuss the concept of animal embryology with reference to chick.
4) analyze differentiation and Regeneration in plants and animals.

Module	Title and Contents	Hrs
Module -1:	**Plant Embryology** **1.1** Gametogenesis and Fertilization in plants: Introduction of Development of male and female Gametophyte, Gametogenesis in Plants, Development of male and female Gametophyte, Process of fertilization in Angiosperms. **1.2** Development of Embryo and Endosperm: Development of embryo and endosperm, Types of endosperm in Angiosperm **1.3** Apomixis : Introduction, Definition, Types **1.4** Polyembryony: Introduction, Definition, Types	07
Module -2:	**Pollen germination and Meristem organization** **2.1** Introduction of pollen germination: Pollen germination Pollen germination, factors affecting. **2.2** Self incompatibility: Definition, types and its genetic control. **2.3** Plant Meristem: Plant Meristem- organization and differentiation, Organization of shoot apical Meristem, Organization of root apical Meristem.	08
Module -3:	**Animal embryology** **3.1** Structure of gametes Gametogenesis in animals, **3.2** Fertilization in animals. **3.3** Early development in animals:Types and patterns of cleavages in animals, Blastulation, gastrulation in chick up-to the Formation of three germ layers **3.4** embryonic induction, Fetal membranes, Types and significance of placenta.	07
Module -4:	**Differentiation and Regeneration** **4.1** Differentiation: Differentiation, Dedifferentiation **4.2** Rediffrentitation, Commitment **4.3** Transdifferentiation, Developmental Plasticity. **4.4** Regeneration: Definition, mechanism, factors affecting regeneration.	08

Reference Books:-

1) Arnold, E., and E. Cutter. *Plant Anatomy*. 1970.
2) Arumugam, N. *Developmental Biology*. 1st ed. Saras Publications, 2019.
3) Maheswari, P. *An Introduction to the Embryology of Angiosperms*. 2nd ed. Nabu Press, 2011.
4) Verma, P.S., and V.K. Agarwal. *Developmental Biology*. 2nd ed. S. Chand & Company, 2000.
5) Patten, B.M., and B.M. Carlson. *Foundations of Embryology*. 6th ed. McGraw-Hill, 2003.
6) Twyman, R. *Instant Notes in Developmental Biology*. 1st ed. Taylor & Francis, 2000.
7) Pandey, S.N., and A. Chadha. *Plant Anatomy and Embryology*. 1st ed. Vikas Publishing House, 1997.
8) Bhojwani, S.S., and S.P. Bhatnagar. *The Embryology of Angiosperms*. 2nd ed. Vikas Publishing House, 2018.
9) Gilbert, S.F. *Developmental Biology*. 6th ed. Sinauer Associates, 2001.
10) Subramanyam, S. *Textbook of Bryophytes, Pteridophytes, Gymnosperms, and Paleobotany*. I.K. International Publishing House, 2013.

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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Board of Studies in Biotechnology

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

Name of the Course: BBTT 235 Cell Biology II

Course Objectives: Students should be able to…

1) understand the concept of cell signaling.
2) learn how proteins are transported to the various organelles.
3) study of cell cycle and their control.
4) explain the concept of membrane transport.

Course Outcomes: Students will be able to…

1) discuss principles and transduction pathways of cell signaling and cell surface receptor proteins.
2) explain secretory pathways and transport of proteins into various organelles.
3) illustrate cell cycle, cell division and cellular events.
4) study phases of cell division, Cancer cells, and tumor suppressor genes.

Module	Title and Contents	Hrs
Module -1:	**Membrane Transport And Its Types** **1.1** Cell, cell membrane, Passive transport- simple diffusion, facilitated diffusion, osmosis. **1.2** Active transport- primary and secondary transport, Sodium potassium pump, Calcium pump, ATPase pump. **1.3** Bulk transport -endocytosis and exocytosis, pinocytosis.	07
Module -2:	**Cell Division Cycle** **2.1** Introduction, definition, phases of cell cycle. Control of cell cycle and its checkpoints **2.2** Molecular events of cell cycle- CDK and cyclins, s-phase, CDK cyclins Complex, M-phase CDK cyclins complex, anaphase promoting complex. **2.3** Programmed cell death, Necrosis	08
Module -3:	**Cell Signaling** **3.1** Introduction Types of cell signaling-contact dependent signaling, autocrine, paracrine, synaptic, endocrine, gap junctions, combinatorial signaling, **3.2** Secondary Messengers **3.3** Cell surface receptor proteins, Ion channel linked receptors, G-protein linked receptors, and enzyme linked receptors. Signaling through G-protein linked receptors - IP3 and DAG Pathway	07
Module -4:	**Secretory Pathway and Protein Trafficking** **4.1** Secretary pathway **4.2** ER associated ribosomal translation Co-translational transport of nascent polypeptide chain to ER lumen. **4.3** Transport of proteins to- mitochondria, chloroplast, peroxisomes, nucleus, Golgi apparatus	08

Reference Books:-

1) Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter. *Molecular Biology of the Cell*. 5th ed. New York: Garland Science, 2008.
2) Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter. *Molecular Biology of the Cell*. 5th ed. New York: Garland Science, 2002.
3) Levin, B. *Gene XI*. 7th–11th ed. Jones & Bartlett Inc., 2012.
4) Berg, Jeremy M., John L. Tymoczko, and LubertStryer. *Biochemistry*. 8th ed. New York: W.H. Freeman, 2015.
5) Powar, C. B. *Cell Biology*. 3rd ed. Mumbai: Himalaya Publishing House, 2010.
6) Karp, G. *Cell Biology*. 7th ed. Hoboken, NJ: Wiley, 2013.
7) 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.
8) Michal, Gerhard, and DietmarSchomburg. *Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology*. 2nd ed. Hoboken, NJ: Wiley, 2012.
9) Verma, P.S., and V.K. Agarwal. *Cell Biology, Genetics, Molecular Biology*. Reprint ed. New Delhi: S. Chand & Company, 2006.
10) Salway, J.G. *Metabolism at a Glance*. 3rd ed. Oxford: Wiley-Blackwell, 2004

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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Faculty of Science and Technology

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Board of Studies in Biotechnology

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

Name of the Course:BBCP 236 - Laboratory exercises in Developmental Biology (Plant and animal) and Cell Biology

Course Objectives: Students should be able to…

1) study the concept of plant and animal embryology.
2) understand different developmental stages in plants and animals
3) perform pollen germination incompatibility.
4) study the different techniques of Membrane permeability.

Course Outcomes: Students will be able to…

1) explain different developmental stages in plants and animals.
2) describe plant and animal embryology.
3) apply knowledge of isolation techniques for various organelles.
4) demonstrate the different techniques of Membrane permeability.

Sr. No.	Name of the Practical	Hrs
1.	Methods of studying plant development a.Maceration b.Sectioning c. Staining d. Mounting e.Dissection	60
2.	Study of apices and meristem –Root apical meristem & Shoot apical meristem	
3.	Microsporogenesis : anther squash technique Development of male gametophytes & female gametophytes	
4.	Developmental stages during plant embryogenesis in monocots/dicots	
5.	Examination of pollen grain morphology using acetolysis method.	
6.	To study the types of placenta in animals with charts and photographs	
7.	Study of ultrastructure of Sperm and Ovum of Mammal.	
8.	Study of different types of eggs.	
9.	Study of holoblastic,meroblastic cleavage and its types with the help of Slide / Photograph / Chart / Model	
10.	Study of staging & staining of Chick embryos with whole mount slides (18 h,24h,48h,72h)	
11	Measurement of size of plant cell/animal cell by micrometry	
12	Effect of temperature on membrane permeability of cells.	
13	Effect of organic solvent on membrane permeability of cells	
14	Study of mitosis and preparation of slides and identification of different stages.	
15	Study of Meiosis and preparation of slides and identification of different stages.	
16	Isolation of chloroplast.	
17	Estimation of amount of chlorophyll present in the leaf disc	
18	Isolation of nucleus.	
19	Study of methodology of cell lyses.	
20	Study of plasmolysis in leaf plant cell.	

Reference Books:-

1) Arnold, Edward, and E. Cutter. *Plant Anatomy*. 1970.
2) Crowe, R., H. Ozer, and Dr. Rifkin. *Experiments with Normal and Transformed Cells*. Cold Spring Harbor Laboratory, 1978.
3) Freshney, R. Ian. *Culture of Animal Cells: A Manual of Basic Technique*. 2nd ed. New York: A.R. Liss, 1987.
4) Maheswari, P., and Nabu. *An Introduction to the Embryology of Angiosperms*. 2nd ed. SRM University, 2011.
5) Merchant, D.J., R.H. Kahn, and W.H. Murphy. *Handbook of Cell and Organ Culture*. 2nd ed. Minneapolis: Burgess Publishing Company, 1969.
6) Pandey, S.N., and A. Chadha. *Plant Anatomy and Embryology*. 1st ed. New Delhi: S. Chand & Company, 1997.
7) Pollack, R. *Readings in Mammalian Cell Culture*. 2nd ed. Cold Spring Harbor Laboratory, 1981.
8) Pollack, R., and S. Pfeiffer. *Animal Cell Culture*. 1st ed. Cold Spring Harbor Laboratory, 1971.
9) Twyman, Richard. *Instant Notes in Developmental Biology*. 1st ed. Taylor & Francis, 2000.
10) Freshney, R. Ian. *Culture of Animal Cells: A Manual of Basic Technique*. 2nd ed. New York: A.R. Liss, 1987

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

Karmaveer Bhaurao Patil University, Satara

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Board of Studies in Biotechnology

Programme: B.Sc. II	**B. Sc. II, Semester** - III
Type : VSC 1	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTPVSC 1: Lab exercise in basics of biotechnology in nursery management

Course Objectives: Students should be able to…

1) understand the importance of nursery and basic infrastructure to establish it
2) know various facilities required to set up of a nursery
3) understand the basic concepts of plant tissue culture and garden designing.
4) study methods of biotechnology and its applications of Nursery

Course Outcomes: Students will be able to…

1) discuss nursery management.
2) explain different technique of plant tissue culture used in nursery management
3) discuss nursery management techniques.
4) demonstrate techniques used in nursery.

Sr. No.	Name of the Practical	Hrs
1.	To study the layout of a nursery.	60
2.	Handling of nursery tools, equipment and types of containers	
3.	To study types of nurseries, its classification.	
4.	Preparation and application of biofertilizer-Azotobacter	
5.	Preparation and application of biofertilizer-Rhizobium	
6.	Preparation and application of biofertilizer- PSB (Phosphate solubilizing bacteria)	
7.	Preparation and application of compost - cow dung slurry	
8.	Preparation and application of compost - Vermicompost	
9.	Preparation and application Green manure	
10.	To study application of Biopesticide in nursery management	
11.	Nursery bed preparation	
12.	To study calculation of seed germination parameters	
13.	To study nursery technology of commercially important tree species	
14.	To study nursery diseases and its management	
15.	Watering, weeding and management of nursery	
16.	Seed collection, treatment and rising of seedlings on nursery bed	
17.	Handling of grafting and layering techniques in the nursery	
18.	Maintaining of the seedlings / cuttings in the nursery	
19.	To study the technique pricking and transplanting from mother bed	
20.	To study the propagation technique and management practices in nursery	

Reference Books:-

1) Dwivedi, Deepa H., and NavaldeyBharti. *A Handbook for Skill Development: Nursery Management*. 2019.
2) Krishnan, M. Ratha, Rajwant K. Kalia, J.C. Tewari, et al. *Plant Nursery*. 2014.
3) Kumar, Vikas, and Anjali Tiwari. *Practical Manual of Nursery Management*. 2018.
4) Lokare, Priya. *Plant Nursery Development & Management: An Innovative Way of Self Employment*. 1st ed. Notion Press, 2022.
5) Panda, H. *Biofertilizer and Organic Farming*. Nir Project Consultancy Services, 2023.
6) Pears, Pauline. *Organic Book of Compost: Easy and Natural Techniques to Feed Your Garden*. Paperback import ed., 2020.
7) Rajamanickam, C., A. Subbiah, J. Rajangam, et al. *Principles & Practices of Plant Propagation and Nursery Management*. 2021.
8) Ray, P.K. *How to Start and Operate a Plant Nursery*. 2012.
9) Ray, P.K. *Essentials of Plant Nursery Management*. 2020.
10) Roy, M.M. *Plant Nursery Management: Principles and Practices*. Central Arid Zone Research Institute, ISO 9001:2008. Indian Council of Agricultural Research, 2014

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. II	**Semester** - III
Type : SEC1	**Marks:** 25
Credits : 1	**From:** A. Y. 2025-26

Name of the Course: BBTTSEC1 : Advances in Hydroponics

Course Objectives: Students should be able to…

1) teaches techniques for monitoring and controlling environmental factors such as light, temperature, humidity and pH.
2) familiarize students with integrated pest and disease management specific to hydroponics.
3) promote sustainable and resource-efficient farming practices through hydroponics.
4) prepare students for careers in commercial hydroponics, urban farming, and agri-entrepreneurship.

Course Outcomes: Students will be able to…

1) monitor and control environmental parameters like pH, ec, temperature, and light for optimal plant growth.
2) detect and manage common pests and diseases using integrated and preventive approaches.
3) demonstrate problem-solving skills in troubleshooting hydroponic system failures or crop issues.
4) evaluate the sustainability and economic viability of hydroponic farming in various contexts.

Module	Title and Contents	Hrs
Module -1:	**Technological Innovations in Hydroponics** **1.1** Automation in Hydroponic Systems: Use of Sensors, Timers, and IoT, Role of Artificial Intelligence (AI) and **1.2** Machine Learning in Crop Monitoring Hydroponics and Precision Agriculture, Use of Drones and Imaging Tools for **1.3** Plant Health Assessment, Smart Nutrient Delivery Systems (automated dosing units, real-time pH/EC regulation),Data Logging and Cloud-based Management Platforms	07
Module -2:	**Advanced Techniques and Integrated Systems** **2.1** Vertical Farming and Urban Hydroponics, Integration of Hydroponics with Aquaponics and Aeroponics, Energy Efficiency and Sustainable Design in Controlled Environments **2.2** Use of Renewable Energy Sources (solar, geothermal) in Hydroponic Units, Advances in LED Grow Light **2.3** Technology and Spectral Optimization, Nanotechnology in Nutrient Delivery and Plant Protection, Research Trends in Crop Improvement for Hydroponic Systems	08

Reference Books:-

1) Sardare, MamtaDeorao, and S.V. Admane. "A Review on Plant without Soil—Hydroponics." *International Journal of Research in Engineering and Technology* 2, no. 3 (March 2013): 299–304.
2) Kumar, D. *Protected Cultivation of Horticultural Crops*. New Delhi: New India Publishing Agency, 2017.
3) Food and Agriculture Organization (FAO). "Hydroponics as an Advanced Agricultural Technology for Food Security in Urban Areas." FAO, 2019.
4) Sharma, Nisha, SomenAcharya, Kaushal Kumar, Narendra Singh, and O.P. Chaurasia. "Hydroponics as an Advanced Technique for Vegetable Production: An Overview." *Journal of Soil and Water Conservation* 17, no. 4 (2018): 364–371.
5) Gruda, Nazim S. "Do Soilless Culture Systems Have an Influence on Product Quality of Vegetables?" *Journal of Applied Botany and Food Quality* 82, no. 2 (2009): 141–147.
6) Wright, G. *Hydroponics Made Easy*. Ramsbury: The Crowood Press Ltd, 2001.
7) Jones, J. Benton. *Hydroponics: A Practical Guide for the Soilless Grower*. 2nd ed. Boca Raton: CRC Press, 2005. https://www.routledge.com/Hydroponics-A-Practical-Guide-for-the-Soilless-Grower/Jones-Jr/p/book/9780849331671.
8) Singh, B., and R. Prasad. *Modern Techniques of Raising Field Crops*. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd, 2014.
9) Savvas, Dimitrios, and H.C. Passam, eds.*Hydroponic Production of Vegetables and Ornamentals*. Athens: Embryo Publications, 2002.
10) Raviv, Michael, and J.H. Lieth. *Soilless Culture: Theory and Practice*. Amsterdam: Elsevier, 2008.

Evaluation Pattern:

Total Marks: 25

Internal Continuous Evaluation:	**End Semester Examination:**
● Internal Work -1: CCE1 – 5 Marks ● Internal Work -2 CCE 2 – 5 Marks	● Question -1 : 15 Marks

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Board of Studies in Biotechnology

Programme: B.Sc. II	**B. Sc. II, Semester** - III
Type : SEC 1	**Marks:** 25
Credits : 1	**From:** A. Y. 2025-26

Name of the Course:BBTPSEC1 : Laboratory exercise based on Advances in Hydroponics

Course Objectives: Students should be able to…

1) understand successful cultivation of crops using hydroponics techniques.
2) know basic farming practices; and some experience in crop farming.
3) learn to apply key principles of plant science, soil and water chemistry, and mathematics to the production of sustainable hydroponic and greenhouse crops.
4) aware to diagnose, problem-solve, and prevent common production issues in hydroponic crops

Course Outcomes: Students will be able to…

1) establish hydroponics set up.
2) run a hydroponics setup for crop cultivation.
3) acquire the basics of several common hydroponic systems.
4) evaluate crop quality/performance, and diagnose and correct/prevent common plant nutritional and physiological disorders

Sr. No.	Name of the Practical	Hrs
1.	Study the use of hydroponics clay pebbles	30
2.	Study of Plant selection for hydroponic gardening	
3.	Study the cleaning of hydroponics clay pebbles.	
4.	Study how to prevent algae growth in hydroponics	
5.	Study of changing water in hydroponics system	
6.	Study of managing insect in hydroponics system	
7.	Study of managing diseases in hydroponics system	
8.	Study the separate pebbles and water	
9.	Preparation of seedling for hydroponics.	
10.	Study Deep water culture systems.	

Reference Books:-

1) Anon. *Hydroponics: Soil-less Culture Book*. Department of Agriculture, Ministry of Agriculture, 2009.
2) Dahama, A.K. *Organic Farming for Sustainable Agriculture*. 2nd ed., reprint. Agrobios (India), 2002.
3) Jones, J. Benton. *Hydroponics: A Practical Guide for the Soilless Grower*. 2nd ed. CRC Press, 2004. ISBN: 9780849331671.
4) Pardossi, A., G. Carmassi, C. Diara, L. Incrocci, R. Maggini, and D. Massa. *Fertigation and Substrate Management in Closed Soilless Culture*. Dipartimento di BiologiadellePianteAgrarie, Università di Pisa, 2011.
5) Prasad, S., and R.J. Kumar. *Green House Management for Horticultural Crops*. Agro-Bios India, 2005. ISBN-13: 978-8177541243.
6) Resh, Howard M. *Hobby Hydroponics*. 1st ed. CRC Press, 2003.
7) Roberto, L. Keith. *How to Hydroponics*. 4th ed. The Future Garden Press, 2003.
8) Sabir, Naved, Balraj Singh, M. Hasan, R. Sumitha, SikhaDeka, R.K. Tanwar, D.B. Ahuja, B.S. Tomar, O.M. Bambawale, and E.M. Khah. *Good Agricultural Practices (GAP) for IPM in Protected Cultivation*. Tech. Bull. No. 23. National Centre for Integrated Pest Management, New Delhi, 2010.
9) Subbarao, N.S. *Biofertilizers in Agriculture and Forestry*. 3rd rev. ed. Oxford & IBH Publishing Company Pvt. Ltd., 1995.
10) Van der Lugt, Geerten, HarmenTjallingHolwerda, KatjaHora, Griselli Durant, Mauricio Uribe, Camila Miranda, Marcel Bugter, and Peter de Vries. *Nutrient Solution for Greenhouse Crops*. 2016.

Evaluation Pattern:

Total Marks: 25

Internal Continuous Evaluation:	End Semester Examination: ● Question -1 : 25 Marks

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Faculty of Science and Technology

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Board of Studies in Biotechnology

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

Name of the Course: BBTTIKS 2: Indian Health Sciences

Course Objectives: Students should be able to…

1) explore the most fundamental ideas that have shaped indian knowledge traditions over the centuries
2) understand various aspects of iks which are related to their study fields
3) to promote interest in knowing and exploring more
4) study the methods of ancient systems of treatment with ayurveda

Course Outcomes: Students will be able to…

1) apply knowledge of ayurveda pharmacopeia
2) implement ayurvedic prospective in diseases diagnosis
3) demonstrate knowledge of human physiological systems
4) discuss the ancient medical treatment with ayurveda

Module	Title and Contents	Hrs
Module -1:	**Introduction of BharatavarshaVaidya** **1.1** Charaka and Sushruta on the qualities of a Vaidya. The whole world is a teacher of the good Vaidya. Charaka's description of a hospital. **1.2** Hospitals in ancient and medieval India. How Ayurveda continued to flourish till 18/19th centuries. Surgical practices, inoculation. Current revival of Ayurveda and Yoga.	07
Module -2:	**Ayurveda pharmacopeia** **2.1** Important Texts of Ayurveda. **2.2** Selected extracts from Astāngahrdaya (selections from Sūtrasthāna) and Suśruta-Samhitā (sections on plastic surgery, cataract surgery and anal fistula). **2.3** The large pharmacopeia of Ayurveda.	08
Module -3:	**Foundations of Ayurveda** **3.1** Vedic foundations of Ayurveda. Ayurveda is concerned both with maintenance of good health and treatment of diseases. Basic concepts of **3.2** Ayurveda. The three Gunas and Three Doshas, Pancha-mahabhuta and Sapta-dhatu.	07
Module -4:	**Ayurveda: A health prospective** **4.1** The importance of Agni (digestion). Six Rasas and their relation to Doshas. Ayurvedic view of the cause of diseases. **4.2** Dinacharya or daily regimen for the maintenance of good health. Ritucharya or seasonal regimen.	08

Reference Books:-

1. BaladevUpadhyaya, SamskrtaŚāstromkaItihās, Chowkhambha, Varanasi, 2010.
2. J. K. Bajaj and M. D. Srinivas, Annam BahuKurvita Recollecting the Indian Discipline ofGrowing and Sharing Food in Plenty, Centre for Policy Studies, Chennai, 1996.
3. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.
4. Astāngahrdaya, Vol. I, Sūtrasthāna and Śarīrasthāna, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
5. Dharampal, Some Aspects of Earlier Indian Society and Polity and Their Relevance Today, New Quest Publications, Pune, 1987.
6. J. K. Bajaj and M. D. Srinivas, Timeless India Resurgent India, Centre for Policy Studies, Chennai, 2001.
7. Dharampal, Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts, Dharampal Classics Series, RashtrotthanaSahitya, Bengaluru, 2021
8. Dharampal, The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century, Dharampal Classics Series, RashtrotthanaSahitya, Bengaluru, 2021.
9. J. K. Bajaj and M. D. Srinivas, Indian Economy and Polity in Eighteenth century Chengalpattu, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

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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Board of Studies in Biotechnology

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

Name of the Course:BBTT 241 Plant Tissue Culture

Course Objectives: Students should be able to…

1) to make students aware of fundamentals of plant tissue culture
2) study of laboratory organization for plant tissue culture.
3) study of callus, organ, anther and pollen culture technique.
4) study of suspension ,protoplast culture and Micropropagation

Course Outcomes: Students will be able to…

1) knowledge 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 a commercial plant tissue culture laboratory.

Module	Title and Contents	Hrs
Module -1:	**Introduction to plant tissue culture** **1.1 Introduction to plant tissue culture-** Definition, History,Cellular totipotency, techniques in plant tissue culture. **1.2 Aseptic Techniques-** Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation, precautions to maintain aseptic conditions. **1.3 Culture Medium-** Nutritional requirements of explants, Plant Growth Regulator and their *invitro*roles, composition of basal Murashige and Skoog medium and media preparation.	07
Module -2:	**Culture Techniques** **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 affecting, applications. **2.3 Organ Culture Technique-** Introduction, principle, protocol, applications, with respect to root tip culture, leaf culture, ovary and ovule culture.	08
Module -3:	**Micropropagation** 3.1 **Micropropagation-** Introduction, stages of Micropropagation, factors affecting, advantages and applications (with suitable examples) **3.2 Different Pathways of Micropropagation-** Axillary bud proliferation, somatic embryogenesis, organogenesis, meristem culture (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.	07

Module -4:	**Suspension Culture Technique** **4.1 Suspension Culture Technique**- Introduction, principle, protocol, types, growth measurement, viability test, synchronization, applications. **4.2 Production of Secondary Metabolites**- Introduction, types of secondary metabolites, principle, systems of culture, optimization of yield, commercial aspects, applications, limitations. **4.3 Plant Protoplast Culture:-**History, Principle, protocol for isolation- Mechanical and Enzymatic, protoplast culture methods, viability test and applications.	08

Reference Books:-

1) Bhojwani, S.S., and M.K. Razdan. Plant Tissue Culture: Theory and Practice. 1st ed. Amsterdam: Elsevier Science, 1996.
2) Chawla, H.S. Introduction to Plant Biotechnology. 2nd ed. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
3) De, K.K. Plant Tissue Culture. Kolkata: New Central Book Agency (P) Ltd., 2017.
4) Debergh, P., and R.H. Zimmerman, eds. Micropropagation: Technology and Application. Dordrecht: Springer, 1991.
5) Gamborg, O.L., and G.C. Phillips, eds. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Berlin: Springer, 1995.
6) Jain, S.M., and H.C. Häggman, eds. Plant Tissue Culture: Techniques and Applications. Dordrecht: Springer, 2007.
7) Kumar, U. Methods in Plant Tissue Culture. New Delhi: Agro-Botanica Publishers, 1999.
8)Razdan, M.K. Introduction to Plant Tissue Culture. 2nd ed. New Delhi: Science Publishers, 2003.
9)Sharma, G.K. General Techniques of Plant Tissue Culture. 1st ed. Raleigh, NC: Lulu Press Inc., 2015.
10)Smith, R.H. Plant Tissue Culture: Concepts and Laboratory Exercises. Boca Raton: CRC Press, 2000.

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 II	**Semester** - IV
Type : Major	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course:BBTT 242: Plant Physiology & Biochemistry

Course Objectives: Students should be able to…

1) understand basics of physiology of plants.
2) study biochemistry in growth and development of plant.
3) understand biosynthesis and role of plant hormones in plant.
4) imbibe the concept of Photosynthesis and oxidative photophosphorylation.

Course Outcomes: Students will be able to…

1) understand mechanism of plant growth and development.
2) know about photosynthesis, respiration and biosynthesis.
3)understand synthesis and applications of secondary metabolites
4) apply basic concept of plant -water relation and related theories.

Module	Title and Contents	Hrs
Module -1:	**Plant Water Relationship** **1.1** Introduction, Absorption of water- Mechanism, Theories (Active and Passive), **1.2** Translocation of water- Mechanism, Ascent of Sap, Root pressure theory, Vital theory **1.3** Bohm'sTheory,Transpiration- Types, Mechanism of Transpiration and factors affecting transpiration	07
Module -2:	**Photosynthesis** **2.1** Ultra structure of chloroplast, Photosynthetic pigments, red drop and Emerson's enhancement effect, **2.2** Mechanism of photosynthesis- Cyclic and non-cyclic flow of electron transfer, light reaction, dark reaction, **2.3** C-3 pathway, C-4 pathway, CAM, photorespiration.	08
Module -3:	**Respiration** **3.1** Aerobic-Flow of electrons through reducing power in ETC, Complexes of electron transport, **3.2** Redox potential components of ETC, Mechanism of ATP generation- Chemiosmotic hypothesis ATP synthase complex. **3.3** Anaerobic Respiration: - Alcoholic and Lactic acid fermentation	07
Module -4:	**Introduction to Plant Hormones** **4.1** Chemistry, Biosynthesis, Distribution, modeofactionand physiological effects of - Auxin, **4.2** Cytokinin, Gibberellins, Absisic acid, Ethylene **4.3** Secondary Metabolites: Biosynthesis of plant secondary metabolites (Shikimate pathway, **4.4** Mevalonate pathway, MEP pathway)	08

Reference Books:-

1) Buchanan, Bob B., Wilhelm Gruissem, and Russell L. Jones, eds. 2015. Biochemistry and Molecular Biology of Plants. 2nd ed. Chichester: Wiley Blackwell.
2) Devlin, Robert M. 1983. Plant Physiology. 4th ed. Boston: PWS Publishers.
3) Jain, J.L. Fundamentals of Biochemistry. Revised ed. S. Chand Publishing.
4) Nelson, David L., and Michael M. Cox. 2013. Principles of Biochemistry. 4th ed. Macmillan Publishers.
5) Salisbury, Frank B., and Cleon W. Ross. 1992. Plant Physiology. 4th ed. Belmont, CA: Wadsworth Publishing.
6) Satyanarayanan, U., and U. Chakrapani. 2009. Biochemistry. 4th ed. Book and Allied Pvt. Ltd.
7) Stryer, Lubert, Jeremy M. Berg, and John L. Tymoczko. 2019. Biochemistry. 9th ed.
8) Taiz, Lincoln, Eduardo Zeiger, Ian Max Møller, and Angus Murphy. 2015. Plant Physiology and Development. 6th ed. Sunderland, MA: Sinauer Associates.
9) Voet, Donald, and Judith Voet. 2010. Principles of Biochemistry. 3rd ed.
10) Wilson, Keith, and John Walker. 2018. Principles & Techniques of Biochemistry & Molecular Biology. 7th ed. Paperback publication.

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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Board of Studies in Biotechnology

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

Name of the Course -BBTP 243: Lab exercise based on Plant Tissue Culture and Plant Physiology and Biochemistry

Course Objectives: Student should be able to…

1) study of laboratory organization for plant tissue culture.
2) study of callus and various micropropagation culture techniques
3) know effect of different parameter on photosynthesis
4) learn the different extraction techniques of Secondary metabolites

Course Outcomes: Students will be able to…

1) knowledge about laboratory organization for plant tissue culture.
2) know technique of preparation of plant tissue culture media.
3) estimate chlorophyll content.
4) demonstrate the osmosis process.

Sr. No.	Lab exercise based on Plant Tissue Culture and Plant Physiology and Biochemistry (Any Fifteen)	Hrs
1.	Preparation of Murashige and Skoog (MS) Stock Solutions and Medium	60
2.	Aseptic Seed Germination Techniques	
3.	Embryo Culture Methodology	
4.	Micropropagation Stage	
5.	Callus Culture Techniques: Initiation and Morphological Analysis	
6.	Study of Isolation of Protoplasts	
7.	Anther Culture Technique: Initiation and Development	
8.	Cell Suspension Culture: Initiation and Maintenance	
9.	Pollen Culture Technique: Induction of Haploid Embryos	
10.	Study of Ovary and Ovule Culture	
11.	Study of extraction of plant secondary metabolites by Continuous shaking method	
12.	Study of extraction of plant secondary metabolites by steam bath assistant method	
13.	Study of extraction of plant secondary metabolites by ultrasound- assisted extraction	
14.	Study of extraction of plant secondary metabolites by microwave extraction method	
15.	To demonstrate osmosis in living plant cells by potato osmoscope.	
16.	Extraction of Protein from plant material using suitable extraction Method	
17.	Extraction of Carbohydrates from plant material using suitable extraction Method	
18.	Extract starch from potatoes and detection by iodine method	
19.	Determination of Tannins	
20.	To demonstrate the process of inhibition	

Reference Books:-

1) Chawla, H.S. 2000. Introduction to Plant Biotechnology. 2nd ed. Oxford & IBH Publishing Co. Pvt. Ltd.
2) De, K.K. 2017. Plant Tissue Culture. New Central Book Agency (P) Ltd.
3) Jain, V.K. 2010. Fundamentals of Plant Physiology: A Laboratory Manual. 2nd ed. New Delhi: S. Chand Publishing.
4) Kumar, U. 1999. Methods in Plant Tissue Culture. Agro-Botanica Publishers.
5) Pandey, B.P. 2011. Practical Plant Physiology. S. Chand Publishing.
6) Pattabiraman, T.N. 2000. Laboratory Manual in Biochemistry. New Delhi: All India Publishers and Distributors.
7) Sadasivam, S., and A. Manickam. 2008. Biochemical Methods. 3rd ed. New Delhi: New Age International Publishers.
8) Sharma, G.K. 2015. General Techniques of Plant Tissue Culture.
9) Smith, R.H. 2000. Plant Tissue Culture: Concepts and Laboratory Exercises. CRC Press.
10) 10)Srivastava,H.S. 2006.Practical Plant Physiology:Experimental Plant Physiology. New Delhi: Narosa Publishing House.

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 II	**Semester** - IV
Type : Minor	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course: BBTT 244 –Genetics

Course Objectives: Students should be able to…

1) study principles of mendelian genetics.
2) understand gene interaction and gene expression.
3) learn to analyze concepts of cytogenetics.
4) imbibe basic concepts of microbial genetics.

Course Outcomes: Students will be able to…

1) explain the inheritance biology.
2) describe gene interaction and gene expression.
3) analyze structural and numerical changes in chromosomes.
4) discuss mechanisms of bacterial genetics such as:-transformation, conjugation, transduction and recombination.

Module	Title and Contents	Hrs
Module -1:	**Mendelian Genetics** **1.1** Introduction ,History and terminologies used in genetics. **1.2** Mendel's laws of Inheritance: Principles of segregation, independent assortment and dominance. **1.3** Variety of gene expression: modifiers, suppressors, pleiotropic gene, multiple allele. **1.4** Interaction of gene:- Epitasis, complimentary gene, duplicate gene	07
Module -2:	**Linkage and Crossing Over** **2.1** Linkage:-Introduction and definition, coupling and repulsion hypothesis, linkage groups. 2.2 Gene mapping methods- linkage maps and Tetrad analysis. **2.3** Crossing over- Mechanism and theory. **2.4** Transposable Genetic elements (Definition, characteristics and types).	08
Module -3:	**Cytogenetics** **3.1** Study of chromosomes –Structure and types of chromosomes. **3.2** Chromosomal Aberrations:-Structural and numerical changes in chromosomes. **3.3** Extra chromosomal inheritance-mitochondria and plastids. **3.4** Human karyotype	07
Module -4:	**Microbial Genetics** **4.1** Plasmid- Introduction to plasmid. **4.2** Genetic recombination in bacteria- Definition, fate of exogenote in recipient **4.3** Cell transformation **.** **4.4** Transduction- mechanism of recombination.	08

Reference Books:-

1) Clark, David, and Nanette Pazdernik. 2012. Molecular Biology. 2nd ed. Academic Press.
2) Griffiths, Anthony J.F., Susan R. Wessler, Sean B. Carroll, and John Doebley. 2015. Introduction to Genetic Analysis. W.H. Freeman.
3) Hartl, Daniel L. 2018. Essential Genetics: A Genomics Perspective. Jones & Bartlett Learning.
4) Hartwell, Leland H., Michael L. Goldberg, Janice A. Fischer, and Leroy Hood. 2017. Genetics: From Genes to Genomes. McGraw-Hill Education.
5) Maloy, Stanley, John Cronan, and David Freifelder. 2008. Microbial Genetics. 2nd ed. Boston: Jones and Bartlett Publishers.
6) Snustad, D. Peter, and Michael J. Simmons. 2015. Principles of Genetics. Wiley.
7) Snyder, Larry, Joseph Peters, TinoHenkin, and Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th ed. Washington, DC: John Wiley & Sons.
8) Strickberger, Monroe. 2015. Genetics. 3rd ed. New Delhi: Pearson Publishers.
9) Verma, P.S., and V.K. Agarwal. 2013. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. 1st ed. S. Chand Publishing.
10) Watson, James D., Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick. 2014. Molecular Biology of the Gene. Cold Spring Harbor Laboratory.

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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Board of Studies in Biotechnology

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

Name of the Course: BBTT 245-Immunology

Course Objectives: Students should be able to…

1) study the overview of vertebrates immune system to understand the types and mechanism of defense.
2) know the cells and organs of the immune system.
3) understand antigen and antibody reactions.
4) study immune response and parasitic immunology

Course Outcomes: Students will be able to…

1) explain vertebrates immune system.
2) discuss types and mechanisms of defense.
3) describe cells and organs of the immune system.
4) illustrate antigen and antibody reaction.

Module	Title and Contents	Hrs
Module -1:	**Overview of Immune System** **1.1** Introduction:- Introduction and history of vertebrates immune system Classification of immune system **1.2** Innate (Specific and non-specific) **1.3** Acquired (Active and Passive)	08
Module -2:	**Introduction to Cells and Organs of Immune System** **2.1** Cells of the immune system. **2.2** Broad categories of leukocytes -their role and properties. **2.3** B-lymphocytes. **2.4** T-Cells –subsets of other cells (Antigen presenting cell, Null cell, Natural killer cell.) **2.5** Organs of the immune system –primary and secondary lymphoid organs –structure and their role	07
Module -3:	**Antigen and Antibody** **3.1** Antigen- Definition, Nature, types of antigens, factors affecting Antigenicity **3.2** Antibody-Definition ,Nature, Basic structure of immunoglobulin **3.3** Major human immunoglobulin classes (Their properties and functions).	08
Module -4:	**Immune Response** **4.1** Immune response- Primary and secondary immune response. **4.2** Antigen Antibody reactions –Principle and applications of agglutination, b)precipitation c)complement fixation d) ELISA e) neutralization **4.3** Parasitic immunology:-Immune response against Bacterial infection with reference to suitable example.	08

Reference Books:-

1) Ananthanarayan, R., and C.K.J. Paniker. 2018. Textbook of Microbiology. 9th ed. Universities Press (India) Pvt. Ltd.
2) Delves, P.J., Dennis, and Ivan M. Roitt. 2017. Essential Immunology. 13th ed.
3)Fatima, D., and N. Arumugam. 2014. Immunology. Saras Publication.
4) Heinen, E., M.P. Defresne, J. Boniver, and V. Geenen. 2012. In Vivo Immunology.
5) Kindt, T.J. 2006. Kuby's Immunology. 8th ed. W.H. Freeman & Co Ltd.
6) Kumar, Arvind. 2013. Textbook of Immunology. New Delhi: TERI.
7) Male, David, Jonathan Brostoff, David Roth, and Ivan Roitt. 2012 Immunology. 8th ed.
8)Reddy, K. Rajeshwar. 2012. Textbook of Immunology. 3rd ed.
9) Snyder, L., J.E. Peters, T.M. Henkin, and W. Champness. 2020. Molecular Genetics of Bacteria. 5th ed. ASM Press.
10) Stanier, R.Y., E.A. Adelberg, and J.L. Ingraham. 1999. General Microbiology. 5th ed.

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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Board of Studies in Biotechnology

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

Name of the Course:BBTP 246 -Laboratory exercise based on Genetics & Immunology

Course Objectives: Students should be able to…

1) understand mendelian genetics concept with numerical examples
2) study the basic concepts of hardness of water sample.
3) understand antigen antibody reactions..
4) study serological tests.

Course Outcomes: Students will be able to…

1) describe the karyotyping experiments.
2) explain the concept of mendelian inheritance with numerical.
3) analyze antigen antibody reactions.
4) demonstrate serological tests.

Sr. No.	Laboratory exercise based on Genetics & Immunology	Hrs
1.	Isolation of Lac negative mutants of *E. coli* by visual detection method (Media preparation & Maintenance of *E.coli culture*)	60
2.	Isolation of Lac negative mutants of *E. coli* by visual detection method (UV treatment & Incubation)	
3.	Isolation of streptomycin resistant mutants by gradient plate technique (Media preparation & Maintenance of *E.coli culture*)	
4.	Isolation of streptomycin resistant mutants by gradient plate technique (UV treatment and Gradient preparation of *Streptomycine*)	
5.	U.V survival curve of *E.coli* (Media preparation & Maintenance of *E.coli culture*)	
6.	U.V survival curve of *E.coli* (UV treatment and obtaining survival curve)	
7.	Study of problems based on Mendelian Inheritance -Monohybrid cross	
8.	Study of problems based on Mendelian Inheritance -Dihyhybrid cross	
9.	Study of problems based on Mendelian Inheritance- Test cross	
10.	Study of problems based on linkage.	
11.	laboratory safety practices for immunology	
12.	To study antigen -antibody reaction by Quantitative Widal test.	
13.	To study Radial immunodiffusion Assay.	
14.	To study Qualitative Immuno electrophoresis.	
15.	To study Double Immunodiffusion Technique.	
16.	To study Enzyme linked immunosorbent assay ELISA-dot ELISA	
17.	To study Rapid Plasma Reagin (RPR) card test	
18.	Qualitative analysis of human chorionic gonadotropin hormone(HCG)	
19.	Diagnostic test for Rheumatoid arthritis (RA test).	
20.	Demonstration of antigen-antibody interaction: Ouchterlony method	

Reference Books:-

1) Balakrishnan, Senthilkumar. 2017. Practical Immunology: A Laboratory Manual. 1st ed. Academic Publishing.
2) Goldsby, Richard A., T.J. Kindt, and B.A. Osborne. 2007. Kuby's Immunology. 6th ed. W.H. Freeman and Company, New York.
3) Joshi, Sunita. 2016. A Laboratory Manual of Genetics. IK International Publishing House.
4) Kaliaperumal, Karthik, SenbagamDuraisamy, and SenthilkumarBalakrishnan. 2017. Practical Immunology: A Laboratory Manual.
5) Kumar, Yogesh. 2024. A Handbook of Immunology and Immunological Techniques.
6) Myers, L. Richard. 1989. Immunology: A Laboratory Manual. 1st ed. William C Brown.
7) Panigrahi, Kaushik Kumar. 2019. Practical Manual on "Fundamentals of Genetics" (PBG-121). Odisha University of Agriculture & Technology.
8) Ray, Dennis, and Shotwell, Mark. 2018. Genetics Laboratory Manual. 3rd ed. Kendall Hunt Publishing.
9) Richard, C., and Geoffrey S. 2009. Immunology. 6th ed. Wiley Blackwell Publishing.
10) Tobili, Y., and Sam-Yellowe. 2022. Immunology: Overview and Laboratory Manual.

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

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Programme: B.Sc. II	**Semester** - IV
Type :Vocational and Skill based Course	**Marks:** 50
Credits : 2	**From:** A. Y. 2025-26

Name of the Course:BBTPVSC 2 -Lab exercise based on Tools and Techniques of Biotechnology in Nursery Management

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 grafting

Course Outcomes: Students will be able to…

1) explain nursery management.
2) apply the technique of different tools used in nursery management
3) analyze various techniques for nursery management
4) illustrate the demonstrate techniques used in grafting

Sr. No.	Lab exercise based on Tools and Techniques of Biotechnology in Nursery Management (Any Fifteen)	Hrs
1.	To study criteria for nursery site selection	60
2.	Preparation and application of potting media.	
3.	To study presowing treatments	
4.	To study intermediate nursery management operations	
5.	Calculation of nursery area and seedlings quantity	
6.	To study economics of nursery to plantation establishment	
7.	To study seed sowing methods in nursery	
8.	To study importance of macro and micro nutrients, phytohormones, growth factors in Nursery technology.	
9.	To study extension of shelf life of fruits and flowers	
10.	Identification of organic manures and chemical fertilizers used in nursery.	
11.	To study seed Certification procedures	
12.	To know seed collection timing, location and quantity of seed and method of seed collection	
13.	To demonstrate stump preparation and planting	
14.	To preparation and application for production by planning for bare root and containerized nursery plantation	
15.	To preparation and application nursery management calender	
16.	To know sowing methods for different seed size	
17.	To know technique of pricking and transplanting from mother beds	
18.	To identify natural seed production areas and plant artificial seed production areas for abundant seed production	
19.	To study methods of irrigation and drainage for the cultivation of plants.	
20.	To study nursery management practices for healthy propagule production.	

Reference Books:-

1) Central Arid Zone Research Institute–ICMR. 2015. Management: Principles and Practices. Jodhpur, Rajasthan.
2) Hammond, J., P. McGarvey, and V. Yusibov. 2000. Plant Biotechnology. Springer Verlag. New York.
3) Krishnan, M. Ratha, et al. 2014. Plant Nursery. ICAR - Central Arid Zone Research Institute. Jodhpur.
4) Kumar, TaraiRanjan. 2020. Plant Propagation and Nursery Management. New India Publishers.
5) Kumar, Vikas, and Anjali Tiwari. 2018. Practical Manual of Nursery Management. Agri–Biotech Press. New Delhi.
6) Ray, P.K. 2012. How to Start and Operate a Plant Nursery. Scientific Publishers.
7) Ray, P.K. 2020. Essentials of Plant Nursery Management. Scientific India Publisher.
8) Razdan, M. K. 2004. Introduction to Plant Tissue Culture. 2nd ed. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
9) Smith, Miranda June. 2021. Plant Propagator's Bible: A Step-by-Step Guide to Propagating Every Plant in Your Garden. Annotated ed. Cool Springs Press.
10) Trigiano, R. N., and D. J. Gray, eds. 2010. Plant Tissue Culture, Development and Biotechnology. CRC Press. London, UK.

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 II	**Semester** - IV
Type :SEC (Skill Enhancement Course)	**Marks:** 25
Credits : 1	**From:** A. Y. 2025-26

Name of the Course: BBTTSEC2 Application in Hydroponics

Course Objectives: Students should be able to…

1) introduce the basic principles and types of hydroponic systems.
2) develop understanding of essential plant nutrients and nutrient solution management.
3) provide hands-on knowledge of designing and operating small- to medium- scale hydroponic setups.
4) train students in selecting suitable crops and managing their growth in soilless systems.

Course Outcomes: Students will be able to…

1) explain the principles, types, and advantages of various hydroponic systems.
2) prepare and manage balanced nutrient solutions for different crop requirements.
3) design and assemble a functional hydroponic unit using appropriate materials and equipment.
4) identify suitable crops for hydroponic cultivation and manage their complete growth cycle.

Module	Title and Contents	Hrs
Module -1:	**Crop Management and Cultivation Techniques in Hydroponics** **1.1** Selection of Suitable Crops for Hydroponic Systems (e.g., leafy greens, tomatoes, cucumbers, herbs),Germination and Transplanting Techniques **1.2** Plant Spacing and Density for Optimal Yield, Pruning, Trellising, and Plant Support Systems, Pollination Techniques in Controlled **1.3** Environments Harvesting Methods and Post-Harvest Handling, Managing Growth Cycles and Succession Planting	07
Module -2:	**Pest, Disease, and Environmental Management in Hydroponics** **2.1** Common Pests and Diseases in Soilless Systems (e.g., aphids, powdery mildew, root rot) **2.2** Integrated Pest Management (IPM) Approaches for Hydroponics, **2.3** Use of Biological Control Agents,Sterilization and Hygiene Practices,Monitoring **2.4** Tools: Yellow Sticky Traps, Nutrient Solution Testing, Infrared Thermometers,Role of Sensors and Automation in Environment Control (Temperature, Humidity, CO_2)	08

Reference Books:-

1) Bhattacharjee, S.K. (2006).Advances in Protected Cultivation. Pointer Publishers
2) Jensen, M.H., &Malter, A.J. (1995).Protected Agriculture: A Global Review. World Bank Technical Paper.
3) Kratky, B.A. (2004).A Suspended Pot, Non-Circulating Hydroponic Method for Commercial Production of Leaf Lettuce in Greenhouses. University of Hawaii.
4) Nelson, R. (2018).Greenhouse Operation and Management (8th Edition). Pearson Education.
5) Patel, R.M. (2020).Hydroponics Farming in India – Step by Step Guide. NIPA Publishers.
6) Raviv, M., &Lieth, J.H. (2008).Soilless Culture: Theory and Practice. Elsevier.
7) Resh, H.M. (2013).Hydroponic Food Production: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower. CRC Press.
8) Savvas, D., &Passam, H.C. (2002).Hydroponic Production of Vegetables and Ornamentals. Embryo Publications.
9) Treftz, C., &Omaye, S.T. (2015).Hydroponics: Potential for augmenting sustainable food production in non-arable regions.Nutrition& Food Science, 45(5), 672–684.
10) Tyagi, S.K., & Gaur, A. (2019).Hydroponics – A New Dimension in Modern Agriculture.Agrotech Publishing Academy, Udaipur

Evaluation Pattern:

Total Marks: 25	
Internal Continuous Evaluation: ● Internal Work -1: CCE1 – 5 Marks ● Internal Work -2 CCE 2 – 5 Marks	**End Semester Examination:** ● Question -1 : 15 Marks

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Programme: B.Sc. II	**Semester** - IV
Type :SEC: Skill Enhancement Course	**Marks:** 25
Credits : 1	**From:** A. Y. 2025-26

Name of the Course-BBTPSEC 2:Application in Hydroponics

Course Objectives: Student should be able to…

1) understand successful cultivation of crops using hydroponics techniques.
2) know basic farming practices; and some experience in crop farming.
3) learn to apply techniques for production of sustainable hydroponic and greenhouse crops.
4) aware to harvest the plant which is cultivated in hydroponics.

Course Outcomes: Students will be able to…

1) explain nursery management.
2) apply the technique of different tools used in nursery management
3) analyze various techniques for nursery management
4) illustrate the demonstrate techniques used in grafting

Sr. No.	Application in Hydroponics (Any Eight)	Hrs
1.	Cultivation of spinach using hydroponics technique	30
2.	Production of tomato using hydroponics technique	
3.	Cultivation of potato using hydroponics techniques.	
4.	Cultivation of Fenugreek using hydroponics technique	
5.	Production of mint using hydroponics technique	
6.	Production of brinjal using hydroponics technique	
7.	Production of cucumber using hydroponics technique	
8.	Cultivation of Taro using hydroponics technique	
9.	Study harvesting of fruit vegetables.	
10.	Study harvesting of leafy green vegetables.	

Reference Books:-

1) Anon. 2009. Hydroponics: Soil-less Culture Book. Department of Agriculture, Ministry of Agriculture. Pp. 1-45.
2) Dahama, A.K. 2002. Organic Farming for Sustainable Agriculture. 2nd ed., reprint. Agrobios India. ISBN 8177540580.
3) Jones, Dr. J. Benton. 2004. Hydroponics: A Practical Guide for the Soilless Grower. 2nd ed. CRC Press. ISBN 9780849331671438. Pp. 84.
4) Pardossi, A., G. Carmassi, C. Diara, L. Incrocci, R. Maggini, and D. Massa. 2011. Fertigation and Substrate Management in Closed Soilless Culture. Dipartimento di BiologiadellePianteAgrarie, Università di Pisa, Pisa. Pp. 1-63.
5) Prasad, S., and R.J. Kumar. 2005. Greenhouse Management for Horticultural Crops. Agro-Bios India. ISBN-13: 978-8177541243.
6) Resh, Howard M. 2003. Hobby Hydroponics. 1st ed. CRC Press. USA.
7) Roberto, L. Keith. 2003. How to Hydroponics. 4th ed. The Future Garden Press, New York.
8) Sabir, Naved, Balraj Singh, M. Hasan, R. Sumitha, SikhaDeka, R.K. Tanwar,D.B. Ahuja, B.S. Tomar, O.M. Bambawale, and E.M. Khah. 2010. Good Agricultural Practices (GAP) for IPM in Protected Cultivation. Tech. Bull. No. 23, National Centre for Integrated Pest Management, New Delhi 110 012 INDIA. Pp. 1-16.
9) Subbarao, N.S. 1999. Biofertilizers in Agriculture and Forestry. Oxford and IBH Publishing Company Pvt. Ltd. New Delhi.
10) Van der Lugt, Geerten, HarmenTjallingHolwerda, KatjaHora, Griselli Durant, Mauricio Uribe, Camila Miranda, Marcel Bugter, and Peter de Vries. 2016. Nutrient Solution for Greenhouse Crops. Pp. 1-94.

Evaluation Pattern:

Total Marks: 25

Internal Continuous Evaluation:	**End Semester Examination:**
● Internal Work -1: CCE1 – 5 Marks ● Internal Work -2 CCE 2 – 5 Marks	● Question -1 : 15 Marks

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

Name of the Course: BBTTVEC-II- Environmental awareness for Biotechnologist

Course Objectives: Students should be able to…

1) understand the environmental issues.
2) relate those laws made to safe guard the environment.
3) know the importance of sustainable development.
4) correlate knowledge of sustainable development with plant sciences.

Course Outcomes: Students will be able to…

1) explain the causes of environmental issues
2) discuss concepts related to environmental laws and ethics.
3) discuss the sustainable development goals.
4) compare and analyze the importance of plant sciences in meeting the sustainable development goals.

Module	Title and Contents	Hrs
Module -1:	**Environmental issues** **1.1** Pollution (Air, Water and Land) **1.2** Fresh-water overuse **1.3** Natural disasters **1.4** Fuel and Energy shortage due to overuse **1.5** Increase in wasteland **1.6** Biodiversity loss **1.7** Global warming and climate change (Causes and intensity of the problem)	09
Module -2:	**Environmental laws and ethics** **2.1** Environmental Protection Act **2.2** Wildlife Protection Act **2.3** Forest Conservation Act **2.4** Prevention and Control of Pollution Act (Air, water and Land) **2.5** From unsustainable to sustainable development **2.6** Responsibilities of an Environmentally aware citizen	07
Module -3:	**Sustainable goals** **3.1** 17 global sustainable goals	07
Module -4:	**Role of Biotechnology in meeting the sustainable development goals.** **4.1** Examples and case studies	07

Reference Books:-

1) Aagarwal,S.K. 2005. Advanced Environmental Biotechnology. Ashish Publishing House.
2) C.K., Ramesh, and Ajay Singh. 2013. Biotechnology for Environmental Management and Resource Recovery. Springer, India, Private Ltd.
3) H., Salvatore. 2020. Environmental Biotechnology: Principles and Applications. White Press Academic Publications.
4) Joshi, Navneet, Sharma K.C., and Sharma M. 2012. Environmental Biotechnology. LAP Lambert Academic Publishing.
5) K., Garima. 2015. Applied Environmental Biotechnology: Present Scenario and Future Trends. Springer Publications.
6) Kumar, Rajan, and Satya S.S. 2020. Environmental Biotechnology: A New Approach. Daya Publishing House.
7) M., Sukanta, ShiveshPratap S., and Yugendra Kumar L. 2009. Emerging Trends in Environmental Biotechnology. Taylor & Francis Ltd.
8) Rawat, Hemant. 2024. Environmental Biotechnology. 1st ed. Oxford Book Company.
9) S., Ranbir C., Naveen Kumar A., and Richa K. 2019. Environmental Biotechnology: For Sustainable Future. 1st ed. Springer.
10) Y., Eric. 2015. Environmental Biotechnology: Principles and Applications. Delve Publications.

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