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 2024-2025

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:** 2024-25
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 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.

4. **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

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:**

a. Semester I:

Theory: 2 major + 2 minor + 2 VSEC

Practical's: 4+2=06 Papers

b. Semester II:

Theory: 2 major + 2 minor + 2 VSEC

Practical's: 4+2=06 Papers

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	Cell Biology	2	BBTT 235	Developmental Biology	2	BBTTOE	–	–	BBTPVSC1	Lab exercise in Basics of Biotechnology in Nursery Management	2	BBTPSEC2	Advances in Hydroponics	2	BBTTAEC1 : English for communication I (2)	BBTTVEC2 : Environmental Awareness for Biotechnologist (2)		22
	BBTT 232	Genetics	2	BBTP 236	Lab exercise based on Developmental Biology	2	BBTTOE	–	–							BBTTAEC2 : English for communication II (2)			
	BBTP 233	Lab exercise based on cell biology & Genetics	4				BBTTOE	–	–										
IV	BBTT 241	Immunology	2	BBTT 245	Environmental Biotechnology	2	BBTTOE	–	–	BBTPVSC2	Lab exercise based on Tools and Techniques of Biotechnology in nursery management	2	BBTPSEC3	Applications in Hydroponics	2	English for communication III (2)		BBTTCC2: Art of Public speaking (2)	22

	BBTT 242	Molecular Biology	2	BBTP 246	Lab exercise based on Environmental Biotechnology	2	BB TT OE	–	–-							English for communication IV (2)			
	BBTP 243	Lab exercise based on Immunology and Molecular Biology.	4																

VSC: Vocational and Skill based course, SEC: Skill Enhancement Course

Semester III

Major Course

BBTT 231: Cell Biology

Course Objectives: The 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.

Credits 02	**BBTT 231: Cell Biology**	**No. of hrs.**
Unit I	**Membrane Transport And Its Types**	**O8**
	1.1 cell,cell membrane . 1.2 Passive transport- simple diffusion, facilitated diffusion, osmosis. 1.3 Active transport- primary and secondary transport, Sodium potassium pump, Calcium pump, ATPase pump. 1.4 Bulk transport -endocytosis and exocytosis, pinocytosis.	
Unit II	**Cell Division Cycle**	**07**
	2.1 Introduction, definition, phases of cell cycle. 2.2 Control of cell cycle and its checkpoints. 2.3 Molecular events of cell cycle- CDK and cyclins, s-phase, CDK cyclins Complex, M-phase CDK cyclins complex, anaphase promoting complex. 2.4 Programmed cell death, Necrosis	
Unit III	**Cell Signaling**	**07**
	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. 3.4 Signaling through G-protein linked receptors - IP3 and DAG Pathway	
Unit IV	**Secretory Pathway And Protein Trafficking**	**08**

	4.1 Secretary pathway 4.2 ER associated ribosomal translation 4.3 Co-translational transport of nascent polypeptide chain to ER lumen. 4.4 Transport of proteins to- mitochondria, chloroplast, peroxisomes, nucleus, Golgi apparatus	

Course Outcomes: The 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, tumor suppressor genes.

Reference Books:

1. *N.V.B . De Robertis,* cell and molecular biology,2023

2. *V. B. Rastogi* , cell biology Unknown Binding – Big Book,2021

3. *H. Lodish*,Molecular biology & cell biology, W H Freeman & Co; 9th edition, 2021

4. *E.D.P. De Robertis* ,Cell And Molecular Biology– 8th edition, 2017

5. *N Arumugam , R.P Meyyan,* Cell Biology, Molecular Biology, Genetics, Evolution and Ecology (Vol.1), 2014

6. *G. Karp,*Cell biology, Wiley publication; 7th edition, 2013

7. *B. Levin* ,Gene XI, Publisher- Jones & Barlett Inc. USA , Genes 7th, 8th , 9th, 10th 11th edition, 2012

8.*C. B. Powar,* Cell Biology, Himalaya Publishing House, 3rd edition ,2010

9. *P.S. Varma & Agarwal, S Chand,* ell biology-Genetics, molecular biology, Reprint Edn. 2006 edition, 2004

10. *B Alberts, A Johnson, J Lewis,* Molecular biology of cell, Garland Science, 5th edition, 2002

BBTT 232 –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.

Credits 02	**SEMESTER-III** **BBTT 232: Genetics**	**No. of hrs.**
Unit I	**Mendelian Genetics**	**07**
	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	
Unit II	**Linkage and Crossing Over**	**08**
	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).	
Unit III	**Cytogenetics**	**07**
	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.	
Unit IV	**Microbial Genetics**	**08**
	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.	

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.

Reference Books :

1.*Daniel L. Hartl*, "Essential Genetics:A Genomics Perspective."Jones & Bartlett Learning, 2018.

2.*Leland H. Hartwell, Michael L. Goldberg, Janice A. Fischer, and Leroy Hood "*Genetics: From Genes to Genomes" McGraw-Hill Education,2017.

3.*Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll, and John Doebley*"Introduction to Genetic Analysis" W.H. Freeman, 2015.

4. *D. Peter Snustad and Michael J. Simmons*"Principles of Genetics" Wiley, 2015.

5. *Strickberger Monroe,* Genetics,New Delhi Pearson Publishers, 3rd edition, 2015.

6.*James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick* "Molecular Biology of the Gene"Cold Spring Harbor Laboratory, 2014.

7.*Snyder Larry, Peters Joseph, Henkin Tino and Champness Wendy,* Molecular Genetics of Bacteria,John Wiley & Sons, Washington, DC, USA, 4 th edition, 2013.

8.*Verma P S, Agarwal V K,* Cell biology,Genetics,Molecular Biology,Evolution and Ecology, S.Chand publication 1st edition, 2013.

9.*David Clark,Nanette Pazdernik,*Molecular Biology,Academic Press Cell,2nd edition, 2012.

10.*Maloy Stanley, Cronan John, Freifelder David,* Microbial Genetics - Boston : Jones and Bartlett Publishers 2nd edition, 2008.

BBTP 233 : Laboratory Exercise Based on Cell Biology and Genetics

Learning Objectives: The students should be able to…

1. Understand the micrometry
2. Study the different techniques of Membrane permeability.
3. Perform isolation of lac negative mutants of E.coli.
4. Understand mendelian genetics concept with numerical examples.

Credits 04	**SEMESTER-III** **BBTP 233: Laboratory Exercise Based on Cell Biology and Genetics**	**No. of practicals hours**
1.	Measurement of size of plant cell by micrometry	3
2.	Effect of temperature on membrane permeability of cells.	3
3.	Measurement of size of pollen grain by micrometry	3
4.	Isolation of chloroplast	3
5.	Study of methodology of cell lyses.	3
6.	Estimation of amount of chlorophyll present in the leaf disc	3
7.	Study of mitosis and preparation of slides and identification of Anaphase	3
8.	Measurement of size of Bacteria cell by micrometry	3
9.	Study of Meiosis and preparation of slides and identification of different stages.	3
10.	Study of plasmolysis in Leaf plant cell.	3
11.	Effect of organic solvent on membrane permeability of cells.	3
12	Study of Deplasmolysis in Leaf plant cell .	3
13	Study of mitosis and preparation of slides and identification of Metaphase	3
14	Isolation of Mitochondria	3
15	Study of mitosis and preparation of slides and identification of Telophase	3
16	Preparation of Blood Smear	3

17	Study of mitosis and preparation of slides and identification of Prophase	3
18	study of cell disruption by thermolysis	3
19	preparation of Permanent slide	3
20	study of cell disruption by detergent	3
21	Isolation of Lac negative mutants of *E. coli* by visual detection method (Media preparation & Maintenance of *E.coli culture*)	3
22	Isolation of Lac negative mutants of *E. coli* by visual detection method (UV treatment & Incubation)	3
23	Isolation of streptomycin resistant mutants by gradient plate technique (Media preparation & Maintenance of *E.coli culture*)	3
24	Isolation of streptomycin resistant mutants by gradient plate technique (UV treatment and Grandient preparation of Streptomycine)	3
25	U.V survival curve of *E.coli* (Media preparation & Maintenance of *E.coli culture*)	3
26	U.V survival curve of *E.coli* (UV treatment and obtaining survival curve)	3
27	Study of problems based on Mendelian Inheritance -Monohybrid cross	3
28	Study of problems based on Mendelian Inheritance -Dihyhybrid cross	3
29	Study of problems based on Mendelian Inheritance- Test cross	3
30	Study of problems based on linkage .	3
31	Study of problems based on crossing over.	3
32	Study of normal human (Male and female) karyotype with charts / photographs	3
33	Study of karyotype by using photograph (Rearrangement of the chromosomes) -Autosomic disorders	3
34	Study of karyotype by using photograph (Rearrangement of the chromosomes) -Allosomic disorders	3
35	Study of chromosomal aberration- (Structural changes) with Charts/ Photographs or models.	3

36	Study of chromosomal aberration- (Numerical changes) with Charts/ Photographs or models.	3
37	Study of plasmid with chart/ model	3
38	Study of bacterial recombination with chart and photograph	3
39	Study of bacterial transformation with chart and photograph	3
40	Study of bacterial transduction with chart and photograph	3

Learning Outcomes: The students will be able to…

1. Apply knowledge of isolation techniques for various organelles.
2. Demonstrate the different techniques of Membrane permeability.
3. Describe the karyotyping experiments.
4. Explain the concept of mendelian inheritance with numerical.

Reference Books:

1. *Kaushik Kumar Panigrahi* , Practical Manual on "Fundamentals of Genetics" (PBG-121) Publisher: Odisha University of Agriculture & Technology,2019

2.*Ray Dennis and Shotwell Mark,* Genetics Laboratory manual .- Kendall Hunt Publishing, 3rd edition ,2018

3.*Sunita Joshi,* A Laboratory manual of Genetics IK Internationational publishing house, 2016 .

4.*G Karp,* Cell biology, Wiley publication; 7th edition ,2013

5.Jeffrey C (2010) Laboratory Fundamentals of Microbiology , Jones and Bartlett Publishers, Inc; 9th edition

6. *L. H .Pentz* , Cell Biology Laboratory Manual Spiral-bound – Import,2009

7.H.*William . Heidcamp,* Experimental Cell Biology Laboratory Manual Heidcamp publication,1992

8.*D.Jerry . Berlin, K. Hunt* Cell biology Laboratory Mannual, 1987

9.Atlas, Macmillan Basic and Practical Microbiology ,1986

10. *F. J. Baker, Butterworth,* Bacteriological techniques Co Publishers Ltd; 2nd Revised edition ,1967

Minor Subjects

BBTT 235: 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.

Credits 02	**SEMESTER III** **BBTT 235- Developmental Biology**	**No. of hours per unit**
Unit I	**Plant Embryology**	8
	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	
Unit II	**Pollen germination and Meristem organization**	7
	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.	
Unit III	**Animal embryology**	8

	3.1 Gametogenesis, gametes and fertilization in Animals: Gametogenesis in animals, Types of eggs and sperms in animals, Fertilization in animals. 3.2 Early development in animals: Types and patterns of cleavages in animals, Blastulation, gastrulation in chick up-to the Formation of three germ layers 3.3 embryonic induction, 3.4 Foetal membranes, Types and significance of placenta.	
UNIT - IV	**Differentiation and Regeneration:**	7
	4.1 Differentiation: Differentiation, Dedifferentiation, Redifffrentitation, Commitment, Transdifferentiation, Developmental Plasticity. 4.2 Regeneration: Definition, mechanism, factors affecting 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.

Reference Books:

1. *N. Arumugam*, Developmental biology, Saras publications, first edition, 2019

2. *S.S.Bhojawani and S.P Bhatnagar* , The Embryology of Angiosperm,Vikas publications ,II nd Edition ,9 July 2018

3. *Subramurti*, Text book of Bryophytes, Pteridophytes , Gymnosperm, and Paleobotany-, I K International Publishing House Pvt. Ltd.30 December 2013

4. *P Maheswari, Nabu* ,An Introduction to the Embryology of Angiosperm, II nd edition 2011

5. *Patten by Carlson*, Foundations of Embryology, McGraw Hill publication, 6th edition, 16 January 2003

6. *Richard Twyman* , Instant notes of developmental biology, Taylor & Francis publications, 1st edition ,15 June 2000

7. *Scott Gilbert*-, Developmental biology, 6 th edition ,2001

8. *P.S. Verma and V K. Agarwal*, Developmental biology, S.Chand publication, II nd edition,2000

9. *S.N Pandey, A. Chadha*, , Plant Anatomy and Embryology, S Chand, Ist edition .1 may 1997

10. *E. Arnold & E.Cutter*, Plant Anatomy, 1970

BBTP 236: Laboratory exercises in Developmental Biology (Plant and animal)

Course Objectives: students will be able to...

1. Study the concept of plant and animal embryology.
2. Understand different developmental stages in plants and animals
3. Study the different methods of Dissection, staining, Mounting etc.
4. Perform Pollen germination incompatibility.

Credits 02	**Semester III** **BBTP 236: Laboratory exercises in Developmental Biology (Plant and animal)**	**No. of practical hours**
1	Methods of studying plant development a.Dissection b. Sectioning	3
2	Methods of studying plant development a.Staining b. Mounting	3
3	Methods of studying plant development a. Maceration	3
4	Study of apices and meristem –Root apical meristem. .	3
5	Study of apices and meristem –Shoot apical meristem.	
6	Microsporogenesis : anther squash technique Development of male gametophytes	3
7	Microsporogenesis : anther squash technique Development of female gametophytes	3
8	Developmental stages during plant embryogenesis in monocots	3
9	Developmental stages during plant embryogenesis in dicots	3
10	Dissection of seed and excision of young embryo and endosperm (monocotyledon)	3

11	Dissection of seed and excision of young embryo and endosperm (dicotyledon)	3
12	Study of ultrastructure of Sperm and Ovum of Mammal.	
13	Study of different types of eggs.	3
14	Study of holoblastic cleavage and its types with the help of Slide / Photograph / Chart / Model.	3
15	Study of meroblastic cleavage and its types with the help of Slide / Photograph / Chart / Model.	3
16	Study of staging & staining of Chick embryos with whole mount slides (18 h)	3
17	Study of staging & staining of Chick embryos with whole mount slides (24 h)	3
18	Study of staging & staining of Chick embryos with whole mount slides (48 h)	3
19	Study of staging & staining of Chick embryos with whole mount slides (72 h)	3
20	To study the types of placenta in animals with charts and photographs	3

Course outcomes: Students should be able to...

1. Explain different developmental stages in plants and animals.
2. Describe plant and animal embryology.
3. Describe different developmental stages in plants and animals
4. Perform different methods of Dissection, staining, Mounting etc.

Reference Books:

1. *P Maheswari, Nabu* ,An Introduction to the Embryology of Angiosperm, II nd edition, 2011

2. SRM university ,Animal cell and tissue culture manual, 2002

3. *Richard Twyman* , Instant notes of developmental biology, Taylor & Francis publications, 1st edition,15 June 2000

4. *S.N. Pandey, A. Chadha*,Plant Anatomy and Embryology, S Chand, Ist edition, 1 may 1997

5. *R. Ian Freshney and R. Alan*, Culture of Animal Cells ,Liss. Inc. 1987

6. *R. Pollack*,Readings in Mammalian cell culture , Cold Spring Harbour Laboratory , II nd edition. 1981

7. *R.Crowe, H. Ozer and Dr. Rifkin*, Experiments with Normal and Transformed cells, Cold Spring Harbour Laboratory ltd.1978

8. *R. Pollack and S. Pfeiffer*, Animal Cell Culture ,Cold Spring Harbour Laboratory ,Ist edition .1971

9. *Edward Arnold & E.Cutter*, 1970, Plant Anatomy .

10. *D. J. Merchant., R.H. Kahn and W. H. Murphy*, Hand Book of cell and organ culture, Burgess Publishing Company, IInd edition. 1969

VSEC Course

VSC (Vocational and Skill based Course)

BBTPVSC 1:Lab Exercise In Basics Of Biotechnology In Nursery Management

Course Objectives: The 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

Credits 02	**SEMESTER-IV** **BBTPVSC 1: Lab. Exercise in basics of biotechnology in nursery management**	**No. of practicals hours**
1.	Demonstration of different types of nurseries	3
2.	Handling of nursery tools, equipment and types of containers	3
3.	Preparation of biofertilizer-Azatobater	3
4.	Preparation of biofertilizer-Rhizobium	3
5.	Preparation of biofertilizer- PSB(Phosphate solubalizing bacteria)	3
6.	Preparation of compost - cow dung slurry	3
7.	Preparation of compost - Vermicompost	3
8.	Preparation of Green mannure	3
9.	To study Application of Biopesticide in nursery management	3
10.	Aseptic seed generation	3
11.	Micropropogation stage I Initiation of micropropogation shoot axillary bud culture	3

12.	Micropropogation stage II-Subculture and multiplication of culture	3
13.	Micropropogation stage III- Rooting- invitro and ex vivo	3
14.	Micropropogation stage IV- Acclimatization and hardening	3
15.	Watering, weeding and management of nursery	3
16.	Seed collection, treatment and rising of seedlings on nurserybed	3
17.	Handling of grafting and layering techniques in the nursery	3
18.	Maintaining of the seedlings / cuttings in the nursery	3
19.	To study the technique pricking and transplanting from mother bed	3
20.	To study the propagation technique and management practices in nursery	3

Course Outcomes: The 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 .

Reference Books:

1.*Dr.H.Panda*, Biofertilizer and organic farming,nir project consultancy services, 2023

2. *Priya Lokare* Plant Nursery Development & Management An Innovative Way of Self Employment Notion Press 1st edition 2022

3. *C. Rajamanickam, A. Subbiah, J. Rajangam et. Al*, Principles & Practices of Plant Propagation and Nursery Management,2021

4. *Pauline pears*, organic book of compost easy and natural technique to feed your garden,paperback import,edition 2020

5. *P.K.Ray*,Essentials of plant nursery management, 2020.

6. *Deepa H. Dwivedi, Navaldey Bharti,* A Handbook For Skill Development Nursery Management, 2019

7. *Vikas Kumar*, Anjali Tiwari, Practical manual of Nursery management 2018

8.*Ratha Krishnan, M.,et al.*, Plant Nursery, P. Ratha Krishnan Rajwant K. Kalia J.C. Tewari 2014

9. *M.M. Roy* Central Arid Zone Research Institute ISO 9001 : 2008 (Indian Council of Agricultural Research Plant Nursery Management: Principle and Practices 2014

10. *P.K.Ray*, How to start and operate a Plant Nursery 2012

SEC (Skill Enhancement Course)

BBTPSEC2 : Advances 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 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

Credits 02	**BBTPSEC2 Advances in Hydroponics**	**No. of practicals hours**
1.	Study the use of hydroponics clay pebbles	3
2.	Study of Plant selection for hydroponic gardening	3
3.	Study the cleaning of hydroponics clay pebbles.	3
4.	Study how to prevent algae growth in hydroponics	3
5.	Study of changing water in hydroponics system	3
6.	Study of managing insect in hydroponics system	3
7.	Study of managing diseases in hydroponics system	3
8.	Study the separate pebbles and water	3
9.	Preparation of seedling for hydroponics.	3
10.	Study Deep water culture systems.	3
11.	Study Wick systems.	3
12.	Study Nutrient film technique systems.	3
13.	Study Ebb and flow systems	3
14.	Study the Mineral Requirements of Plants	3
15.	Study Drip systems.	3
16.	Study the clean and sanitize the NFT system	3

17.	Study of managing pest in hydroponics system	3
18.	Study the safety in hydroponics	3
19.	Study Aeroponic system	3
20.	Study change the nutrient solution in the NFT system	3

Course Outcomes: Students will be able to…

1. Establish a Hydroponics set up.

2.Run a Hydroponics set up for crop cultivation.

3.Aquire the basics of several common hydroponic systems.

4.Evaluate crop quality/performance, and diagnose and correct/prevent common plant nutritional and physiological disorders

Reference Books:

1.G*eerten van der Lugt, Harmen Tjalling Holwerda, Katja Hora, Griselli Durant, Mauricio Uribe, Camila Miranda , Marcel Bugter and Peter de Vries*. . Nutrient solution for Greenhouse Crops. Pp 1-94,2016

2.*Pardossi A., Carmassi G., Diara C., Incrocci L., Maggini R., Massa D* Fertigation and Substrate Management in Closed Soilless Culture. Dipartimento di Biologia delle Piante Agrarie, Università di Pisa, Pisa, Pp 1-63,2011

3. *Naved Sabir, Balraj Singh, M. Hasan, R. Sumitha, Sikha Deka, R.K. Tanwar, D.B. Ahuja , B.S. Tomar, O.M. Bambawale & E.M. Khah* Good Agricultural Practices (GAP) for IPM in Protected Cultivation. 2010. Tech. Bull. No. 23, National Centre for Integrated Pest Management,New Delhi 110 012 INDIA, Pp 1-16, 2010

4. *Anon,* Hydroponics. Soil-less Culture Book. Department of Agriculture. Ministry of Agriculture. Pp 1-45, 2009

5.*Prasad S and Kumar,* rJ- Green House management for Horticultural crops . Agro-Bios India.ISBN-13. 978-8177541243,2005

6. *Dr. J. Benton Jones,* Hydroponics: A Practical Guide for the Soilless Grower (2nd Edition), ISBN 9780849331671438 Pages 84 B/W Illustrations Published by CRC Press,2004
7.*L Keith Roberto* , How to Hydroponics . The future Garden press New york.4s Edition, 2003

8. *Howard M. Resh*, Hobby Hydoponics. CRC press. USA Edition. 1st. Publisher. CRC Press. 2003

9. *Dahama A.K.* Organic Farming for Sustainable Agriculture. Agrobios,IndiaEdition, 2, reprint ; Publisher, Agrobios (India), ISBN 8177540580,2002

10.*Subbarao N. S.* .Biofertilizers in Agricurtuie and Forestrv. oxford and IBH Publishing Company. Pvt. Ltd New Delhi,1995

VEC Syllabus

BBTTVEC-II: Environmental awareness for Biotechnologist

Course Objectives: The students should be able to:

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

Credits (02)	**VEC Course -II (BBT-VEC-II): Environmental Awareness for Plant Scientist**	**No. of hours per unit**
Unit I	**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), 1.8 role of _____(subject) in creation of environmental issues	**10**
Unit II	**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**

Unit III	**Sustainable Development Goals**	**07**
	17 global sustainable goals	
Unit IV	**Role of Biotechnology in meeting the sustainable development goals.**	**06**
	Examples and case studies	

Course Outcomes: The 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.

References Books:

1. Ranbir C. S., Naveen Kumar A., Richa K., Environmental Biotechnology: For Sustainable Future, Springer; 1st ed. 2019

2. Hemant Rawat, Environmental Biotechnology, Oxford Book Company, 1st edition, 2024

3. Eric Y., Environmental Biotechnology: Principles and applications, Delve publications, 2015

4. Ramesh C.K., Ajay Singh, Biotechnology for Environmental management and resource recovery: Springer, India, Private Ltd; 2013th edition

5. Sukanta M., Shivesh pratap S., Yugendra Kumar L., Emerging Trends in Environmental Biotechnology, Taylor & Francis Ltd. 2009

6. Garima K., Applied Environmental Biotechnology: Present Scenario and Future Trends: SpringerPublications; 2015th edition

7. Rajan Kumar, Satya S.S. Environmental Biotechnology: A New Approach: Daya Publishing House (1 January 2020)

8. Salvatore H., Environmental Biotechnology Principles and applications: White Press Academic Publications 2020

9. S.K. Aagarwal, Advanced Environmental Biotechnology: Ashish Publishing House, 2005 edition

10. Navneet Joshi, Sharma K.C. Sharma M., Environmental Biotechnology, LAP Lambert Academic Publishing, 2012.

SEMESTER IV

Major Course

BBTT 241: Immunology

Learning Objectives: The 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.

Credits 02	**SEMESTER IV** **BBTT 241: Immunology**	**No. of hrs . 30**
Unit I	**Overview of Immune System-**	**07**
	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)	
Unit II	**Introduction to Cells and Organs of Immune System**	**08**
	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.	
Unit III	**Antigen and Antibody**	**07**
	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).	
Unit IV	**Immune Response**	**08**

	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.	

Course Outcomes - Students should 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.

Reference Books:

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

BBTT 242: Molecular Biology

Course Objectives: The students should be able to…

1. Aware of 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

Credits 02	**SEMESTER-IV** **BBTT 242: Molecular Biology**	**No. of hrs**
Unit I	**Experimental Evidences for DNA**	**05**
	1.1Experimental Evidences for DNA as a genetic material: Griffith's Exp. Avery, Macleod, McCarty Exp.,Blender Exp. 1.2RNA As a genetic material. (Gierer and Schram expt.)	
Unit II	**DNA Replication and Repair**	**09**
	2.1 DNA Replication: Semi conservative model of replication (M.S Expt.) 2.2 Variation in prokaryote and Eukaryote polymerases. 2.3 Mechanism of DNA replication and regulation in brief. 2.4 D loop model, Rolling circle model 2.5 DNA damage and types of DNA damage in brief –Base substitution, Frameshift mutation, Chemical damage, Physical breakdown 2.6 DNA repair mechanisms and types in brief - Excision repair, Mismatch repair, SOS repair, Photo reactivation, Recombination repair	
Unit III	**Transcription and Regulation of Gene Expression**	**09**
	3.1RNA polymerase, Transcription in prokaryote and Eukaryote. 3.2 Transcription (Initiation, Elongation, termination) 3.3 Post transcriptional Modification - Capping, splicing, and RNA editing, polyadenylation 3.4 Developmental and environmental regulation of gene expression: i) Lac operon ii) Tryptophan operon 3.5Regulation of gene expression: Promoter, Enhancers, Activators, Repressor, Co repressors	
Unit IV	**Translation**	**07**
	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	

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

Reference Books:

1. *A. Nadeem., F Hassan., M. Javed,* Introduction to Molecular Genomics, Bentham Science Publishers, 2021
2. *N. Craig, R. Green, C. Greider, O. Cohen*, Molecular Biology Principles of Genome Function 2nd Edition, OUP Oxford, 2014
3. *B. Lewin*, Genes XI, 11th edition, Publisher - Jones and Barlett Inc. USA, 2012
4. *R. Weaver,* Molecular Biology, 5th Edition, McGrew Hill Science. USA, 2011
5. *B. E., Tropp, Jones Bartlett,* Molecular Biology: genes to proteins, 4th edition Learning, USA, 2011
6. *K. Wilson, J. Walker*. Principles and Techniques of Biochemistry and Molecular Biology 7th Edition Cambridge University Press, 2010
7. *J. K. Pal and S. Ghaskadbi*, Fundamentals of Molecular Biology, Oxford University Press, 2009
8. *J. D. Watson, T. Baker, S. P. Bell, A. Gann , M. Levine, R. Lodwick,*. Molecular Biology of the Gene, 6th Edition,. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA, 2008
9. *R. M. Twyman , W. Wisden,* Advanced Molecular Biology: A Concise Reference BIOS Scientific, 1998
10. *T A Brown,* A practical approach, Essential molecular biology, vol. I, IRL press, Oxford, 1995

BBTP 243: Lab exercise based on Immunology and Molecular Biology

Course Objectives: The students should be able to…

1. Understand antigen antibody reactions..
2. Study serological tests.
3. Know process of DNA isolation
4. Learn the technique of RNA isolation

Credits: 04	**SEMESTER-IV** **BBTP 243: Lab exercise based on Immunology & Molecular Biology**	**No. of contact hrs 120**
1.	laboratory safety practices for immunology	3
2.	To study antigen -antibody reaction by Quantitative Widal test.	3
3.	To study Radial immunodiffusion Assay.	3
4.	To study Qualitative Immunoelectrophoresis.	3
5.	To study Double Immunodiffusion Technique.	3
6.	To study Enzyme linked immunosorbent assay ELISA-dot ELISA	3
7.	To study Rapid Plasma Reagin (RPR) card test	3
8.	Qualitative analysis of human chorionic gonadotropin hormone (HCG)	3
9.	Diagnostic test for Rheumatoid arthritis (RA test).	3
10.	Demonstration of antigen-antibody interaction: Ouchterlony method	3
11.	Determination of clotting time of given human blood samples.	3
12.	To determine the blood group of a given blood sample using agglutination Assay.	3
13.	To study rocket immunoelectrophoroesis.	3
14	To study total WBC count (Heamocytometer)	3
15	Estimation of Haemoglobin (HB)	3
16	Collection of blood and separation of serum from human blood	3
17	Collection of blood and separation of serum from animal blood	3
18	Case study 1: Any bacterial (T.B/Pneumonia) disease – Introduction, Mode of Infection, Epidemiology and preventive measures etc.	3

19	Case study 2: Any Viral (Covid -19) disease – Introduction, Mode of Infection, Epidemiology and preventive measures etc.	3
20	Visit to a serological or diagnostic laboratory	3
21	Good laboratory practices for molecular biology	3
22	Preparation of percent solutions	3
23	Preparation of Normal solutions	3
24	Preparation of acetate buffer of acidic pH	3
25	Preparation of acetate buffer of basic pH	3
26	Preparation of phosphate buffer	3
27	To isolate bacterial genomic DNA,	3
28	To isolate Eukaryotic DNA from - Plant Material	3
29	To isolate Eukaryotic DNA from - Animal Material	3
30	To prepare agarose gel.	3
31	Qualitative analysis of DNA by agarose gel electrophoresis,	3
32	To isolate RNA from animal sample	3
33	To isolate RNA from plant sample	3
34	Separation of RNA by using denaturing gel electrophoresis	3
35	To isolate Plasmid from E.coli.	3
36	To perform Restriction digestion of DNA /Plasmid	3
37	To determine the melting temperature of DNA.	3
38	To perform native PAGE	3
39	To perform SDS- PAGE	3
40	Plasmid isolation by alkaline lysis methods.	3

Course Outcomes: Students should be able to…

1. Analyze antigen antibody reactions.
2. Demonstrate serological tests.
3. Isolate of DNA from plant, bacteria, animal sources
4. Perform isolation of RNA from various sources

Reference Books:

1. *Dr. Yogesh Kumar*, A Handbook of Immunology and Immunological Techniques,2024
2. *Y. Tobili, Sam-Yellowe,* Immunology: Overview and Laboratory Manual, 2022
3. *Karthik Kaliaperumal, Senbagam Duraisamy, Senthilkumar Balakrishnan*, Practical Immunology, A Laboratory Manual, 2017
4. *Senthilkumar Balkrishnan, Lap Lambert,* Practical immunology A Laboratory Manual, Academic Publishing, 1 st edition, 2017
5. *Loose,* Molecular Biology of the Cell 6th edition Leaf Garland Science, 2014
6. *R.Weaver,* Molecular Biology, 5th Edition, McGrew Hill Science. USA, 2011
7. *B.E.Tropp, Jones & Bartlett,* Molecular Biology, genes to proteins, 4th edition Learning, USA, 2011
8. *K. Wilson, J. Walker,* Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition Cambridge University Press, 2010
9. *L.Richard Myers. William C Brown,* Immunology A laboratory Manual, Pub 1st edition, 1989
10. *G.D.Fasman*, Practical Handbook of Biochemistry and Molecular Biology Hardcover, Important, 1989

Minor Subjects

BBTT 245 : Environmental Biotechnology

Course Objectives: The students should be able to…

1.Understand concept of Environmental Biotechnology

2. Study of Environmental Impact Assessment.

3. Imbibe strategies for Environmental Survey for different approaches.

4. Know various effluent treatment systems.

Credits 2	**BBTT 245: Environmental Biotechnology**	**No. of hrs.**
Unit I	**Environmental Toxicology**	**08**
	1.1 Definition, classification and concept 1.2 Pesticide Toxicity –Classification (Organic and Inorganic) 1.3 Mode of action of toxicants (Metals, organophosphates, carbamates and mutagens) 1.4 Bioconcentration, Bioaccumulation, Biomagnification, Potentiation and Synergism 1.5 Control of Toxic effects- Biotransformation and excretion, Toxicants removal techniques with examples	
Unit II	**Bioremediation Techniques**	**07**
	2.1 Introduction of bioremediation, Definition, Principle, In situ and Ex situ Bioremediation, Bioremediation of waste waters 2.2 Activated Sludge Process, Solid Waste Treatment, Slurry Phase Treatment 2.3 Agricultural Bioremediation- Microbial Composting, Biogas, Land Farming and Pest Control 2.4 Bioremediation of Industrial wastes, Xenobiotics	
Unit III	**Biogeochemical Cycle**	**08**
	3.1 Carbon cycle (Types of Carbon cycle -Marine carbon cycle, terrestrial carbon cycle), 3.2 Nitrogen cycle, Sulphur cycle, Phosphorus cycle- Significance and importance of cycles 3.3 Bio augmentation and Bio filtration 3.4 Environmental Impact Assessment (EIA)	
Unit IV	**Waste Water Treatment**	**07**

	4.1 Introduction, sources of water pollution, 4.2 Stages of waste water treatment -Preliminary, Primary, Secondary – Aerobic and anaerobic treatment, Tertiary treatment. 4.3 Waste water treatment for industry water recycling process (dairy, distillery, sugar industry)	

Learning Outcomes: Student will be able to…

1. Discuss recycling, and remediation methods of different pollutants.
2. Apply the technique of remediation method for pollution control.
3. Analyze various techniques for Environmental Impact Assessment
4. Describe the effluent treatment system.

Reference Books:

1. *Eugene Odum*, Fundamentals of Ecology, Cengage India Private Limited; 5th edition 2017
2. *P. S. Verma and V. K. Agerwal*, Environmental Biology, S. Chand publishing 2nd Edition, 2015
3. *B. K. Sharma*, Environmental Chemistry, Krishna Prakashan Media (P) Ltd. 2nd Edition,2014.
4. *U. Satyanarayan*, Biochemistry, Elsevier Publication 4th Edition, 2013.
5. *A. K. Chattergy*, Environmental Biotechnology, Prentice Hall India Learning Private Limited; 3rd edition, 2011.
6. *Ajay kumar Bhagi, G. R. Chatwal*, Environmental Chemistry, Himalaya Pub. house, Mumbai, 2010.
7. *D. K. Asthana and M. S. Asthana*, Environmental problems and solution, S. Chand Publishing, 2005.
8. *H. D. kumar*, General Ecology, S.Chand (G/L) & Company Ltd, 1997
9. *L. Perry McCarty and Bruce E Rittmann*, Environmental Biotechnology -principles and applications, ENglish Publications, 1996.
10. *R.C. Dubey*, A text book of Biotechnology, S. Chand Publications, 1993

BBTP 246 : Lab exercise in Environmental Biotechnology

Course Objectives: The students should be able to…

1. Understand the basic concepts of Hardness of water sample.
2. Learning the Biological oxygen Demand test is an important water quality parameter.
3. Study the physico-chemical properties of water samples – pH, TDS, Total hardness, BOD, COD.
4. Aware the water analysis techniques

Credit 02	**BBTP 246: Lab exercise in Environmental Biotechnology**	**No. of contact hrs**
1.	Determination of total hardness of water sample.	3
2	Determination of permanent hardness of water sample	3
3	Estimation of BOD of water sample.	3
4	Determination of TDS of water	3
5	Study of the effect of heavy metal on growth of plants	3
6	Study of the effect of heavy metal on growth of organisms.	3
7	Estimation of COD of water sample.	3
8	Routine bacteriological analysis of water Presumptive, Confirmatory ,Completed	3
9	Bacterial examination of water by MPN Test	3
10	Study the IMVIC Test	3
11	Isolation of Micro organisms from waste water resources	3
12	Visit to commercial ETP plant	3
13	Study the effectiveness of biofertilizers with chemical fertilizers.	3
14	Study of all the biotic components of any simple ecosystem- natural pond or terrestrial ecosystem	3
15	Study of all the abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem	3

16	Study of all the biotic components of any simple ecosystem-human modified ecosystem	3
17	Study of all the abiotic components of any simple ecosystem- human modified ecosystem	3
18	Study any five endangered/ threatened species	3
19	Case Study on Environmental Impact Assessment	3
20	Case Study on waste water treatment for industry water recycling process	3

Learning Outcomes: Students will be able to …

1. Analyze physico-chemical properties of water samples such as pH, TDS, Total hardness, BOD, COD.
2. Perform techniques for water analysis and water quality parameters.
3. Analyze the skill developments of students to work in commercial Environmental Biotechnology laboratory.
4. Demonstrate the evaluation of hardness of water.

Reference Books:

1. *Supriya Dash,* Practical Biochemistry (Principle and protocols) HrudayanathThatoi , Dreamtech Press, 2nd edition - 2021
2. *G. Swarajya Lakshmi*, Environmental Science - A practical Manual, BS Publications, 2011
3. *D.K.Maheshwari*,Practical microbiology, S. Chand Publications, 5th edition - 2013
4. *K.R.Aneja,* Laboratory manual of Microbiology and Biotechnology, medtech scientific pub. 2nd edition-2018
5. *Hans joachim jordening, Josef winter*, Environmental Biotechnology: concepts & applications, Wiley Blackwell, 1st edition, 2004
6. *B. C. bhattacharyya & Rintu Banerjee*, Environmental Biotechnology, Oxford University Press, 2007
7. *V. Kumaresan, N. Arumugam,* Environmental Biotechnology, Saras Publication, 2014
8. *Indu Shekhar Thakur,* Environmental Biotechnology : Basic Concepts & Applications, I K International Publishing House Pvt. Ltd; 2nd Revised edition,2013
9. *T. Srinivas,* Environmental Biotechnology, new age publishers; First Edition,2008
10. *S. K. Agarwal* , Environmental Biotechnology, A. P. H. Publishers,1999

Vocational and Skill based Course

BBTPVSC 2 : Lab exercise based on Tools and Techniques of Biotechnology in Nursery Management

Course Objectives: The students 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

Credits 02	**SEMESTER-IV** **BBTPVSC 2 : Lab exercise based on Tools and Techniques of Biotechnology in nursery management**	**No. of Practical hours**
1	To study Learning techniques of basic tools and instruments handling related to field work	3
2	To study . Preparation of nutrient media.	3
3	To study Establishment of callus culture.	3
4	To study Organogenesis in callus cultures	3
5	To study Test tube plants	3
6	To study Micro propagation.	3
7	. To Study Isolation of plant secondary metabolites.	3
8	To study Importance of macro and micro nutrients, phytohormones, growth factors in Nursery technology.	3
9	To Study Extension of shelf life of fruits and flowers	3
10	To Visit to local nurseries	3
11	To Study Seed Certification procedures	3
12	To know seed collection timing, location and quantity of seed and method of seed collection	3

13	To Study seeds extraction by using different methods	3
14	To prepare for production by planning for bare root and containerized nursery plantation	3
15	To identify ideal site and bed preparation in nursery	3
16	To know sowing methods for different seed size	3
17	To know technique of pricking and transplanting from mother beds	3
18	To identify natural seed production areas and plant artificial seed production areas for abundant seed production	3
19	To know the propagation techniques and management practices in nursery	3
20	Preparation of videos on nursery media preparation and application	3

Course Outcomes: Students should be able to…

1. Explain nurseryManagement.
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

Reference Books:

1. *Miranda Smith June*, Plant Propagator's Bible: A Step-by-Step Guide to Propagating Every Plant in Your Garden Cool Springs Press; Annotated edition 2021

2. *Tarai Ranjan Kumar*, Plant propagation and nursery management, New India Publishers. 2020

3. *P.K.Ray*, Essentials of plantnursery management. Scientific India Publisher.2020

4. *Vikas Kumar, Anjali Tiwari,* Practical manual of Nursery management, Agri – biotech Press, New Delhi. 2018

5. Management: Principles and Practices, Central Arid Zone Research Institute– ICMR, Jodhpur, Rajasthan. 2015

6. *Ratha Krishnan*, M.,et al. Plant Nursery ICAR - Central Arid Zone Research Institute, Jodhpur 2014

7. *Trigiano, R.N., D.J. Gray* (Eds) . Plant tissue culture, development and biotechnology, CRC Press, London, UK 2010

8. *P.K.Ray,* How to start and operate a Plant Nursery Scientific Publishers 2012

9. *Razdan, M. K.* Introduction to Plant Tissue Culture. 2nd ed. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi 2004

10. *Hammoond, J., McGarvey, P. and Yusibov, V.* Plant Biotechnology. Springer Verlag, New York. 2000

11. *Phillipson J.D* Plants as source of valuable products. In:B.V. Charlwood, and M.J.C. Rhodes (eds.), Secondary Products from Plant Tissue Culture. Oxford: Clarendon Press, UK 1990

12. *Holden RR, Holden MA, Yeoman MM* The effects of fungal elicitation on secondary metabolism in cell cultures of Capsicum frutescens. In: Robins RJ, Rhodes MJC, editors. Manipulating secondary metabolism in culture. Cambridge England: Cambridge University Press, UK 1988

SEC: Skill Enhancement Course

BBTPSEC 3 :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 are cultivated in hydroponics.

Credits 02	**BBTPSEC 3 : Application in Hydroponics**	**No. hours required per practicals**
1.	Cultivation of spinach using hydroponics technique	3
2.	Production of tomato using hydroponics technique	3
3.	Cultivation of potato using hydroponics techniques.	3
4.	Cultivation of Fenugreek using hydroponics technique	3
5.	Production of mint using hydroponics technique	3
6.	Production of brinjal using hydroponics technique	3
7.	Production of cucumber using hydroponics technique	3
8.	Cultivation of Taro using hydroponics technique	3
9.	Study harvesting of fruit vegetables.	3
10.	Study harvesting of leafy green vegetables.	3
11.	Study the nutrient solution preparation	3
12.	Demonstrate how to germinate seeds in a moist paper towel or directly in a growing medium like rockwool cubes.	3
13.	Study transplanting seedlings	3
14.	Demonstrate how to regularly check and top up the nutrient solution reservoir, ensuring plants receive an adequate supply of water and nutrients.	3

15.	Demonstrate how to measure and adjust pH and electrical conductivity in the nutrient solution to maintain optimal levels for plant growth.	3
16.	Study how to regularly check and top up the nutrient solution reservoir, ensuring plants receive an adequate supply of water and nutrients.	3
17.	Explain the importance of pruning and training plants to promote healthy growth and maximize yield in a hydroponic system.	3
18.	Study and management of fungal diseases hydroponics plantlets.	3
19.	Study and management of Bacterial diseases hydroponics plantlets.	3
20.	Study deep water culture (DWC) Setup	3

Course Outcomes: Students will be able to….

1. Cultivate the different plants in hydroponics.

2.Run a Hydroponics set up for crop cultivation.

3.Acquire the basics of transplanting seedlings

4. Diagnose and correct/prevent common plant nutritional and physiological disorders

Reference Books:

1.G*eerten van der Lugt, Harmen Tjalling Holwerda, Katja Hora, Griselli Durant, Mauricio Uribe, Camila Miranda , Marcel Bugter and Peter de Vries*. . Nutrient solution for Greenhouse Crops. Pp 1-94,2016

2. *APardossi .,G. Carmassi , C.Diara .,L. Incrocci , R.Maggini, Massa D* Fertigation and Substrate Management in Closed Soilless Culture. Dipartimento di Biologia delle Piante Agrarie, Università di Pisa, Pisa, Pp 1-63,2011

3. *Naved Sabir, Balraj Singh, M. Hasan, R. Sumitha, Sikha Deka, R.K. Tanwar, D.B. Ahuja , B.S. Tomar, O.M. Bambawale & E.M. Khah* Good Agricultural Practices (GAP) for IPM in Protected Cultivation. 2010. Tech. Bull. No. 23, National Centre for Integrated Pest Management,New Delhi 110 012 INDIA, Pp 1-16, 2010

4. *Anon,* Hydroponics. Soil-less Culture Book. Department of Agriculture. Ministry of Agriculture. Pp 1-45, 2009

5.*Prasad S and Kumar,* rJ- Green House management for Horticultural crops . Agro-Bios India.ISBN-13. 978-8177541243,2005

6. *Dr. J. Benton Jones,* Hydroponics: A Practical Guide for the Soilless Grower (2nd Edition), ISBN 9780849331671438 Pages 84 B/W Illustrations Published by CRC Press,2004
7.*L Keith Roberto* , How to Hydroponics . The future Garden press New york.4s Edition, 2003

8. *Howard M. Resh*, Hobby Hydoponics. CRC press. USA Edition. 1st. Publisher. CRC Press. 2003

9. *Dahama A.K.* Organic Farming for Sustainable Agriculture. Agrobios,IndiaEdition, 2, reprint ; Publisher, Agrobios (India), ISBN 8177540580,2002

10.*Subbarao N. S.* .Biofertilizers in Agricurtuie and Forestrv. oxford and IBH Publishing Company. Pvt. Ltd New Delhi,1995