



U.G Program (4 Years Honors)  
CBCS -2020-21

B Sc
Bio-Technology



## Syllabus and Model Question Papers



**TABLE OF CONTENTS**

S.No	Particulars	Page No.
1	Resolutions of the BOS	3
2	Details of paper titles & Credits	4
	a. Proposed combination subjects:	5
	b. Student eligibility for joining in the course:	5
	c. Faculty eligibility for teaching the course	5
	d. List of Proposed Skill enhancement courses with syllabus, if any	5
	e. Any newly proposed Skill development/Life skill courses with draft syllabus and required resources	5
	f. Required instruments/software/ computers for the course	5
	g. List of Suitable levels of positions eligible in the Govt/Pvt organizations	6
	h. List of Govt. organizations / Pvt companies for employment opportunities or internships or projects	6
	i. Any specific instructions to the teacher /paper setters/Exam-Chief Superintendent	6
3	Program objectives, outcomes, co-curricular and assessment methods	7
4	Details of course-wise syllabus for Theory and Lab	8
5	Model Question Papers for Theory and Lab	11
6	Details of Syllabus on Skill Enhancement courses and Model Question Papers for Theory and Lab	-

**Note:** BOS is to provide final soft copy in PDF and word formats and four copies of hard copies in bounded form to the office of Dean Academic affairs.



## 1. Resolutions of the Board of Studies

Meeting held on 22-01-2021 Time: 10:00 AM

At: N.T.R Convention Centre,

Adikavi Nannaya University, Rajamahendravaram

### Agenda:

1. Adoption of revised-common program structure and revising/updating course-wise syllabi (in the prescribed format) as per the guidelines issued by APSCHE
2. Adoption of regulations on scheme of examination and marks/grading system of the UG program
3. Preparation of Model question papers in prescribed format
4. List of equipment / software requirement for each lab/practical
5. Eligibility of student for joining the course
6. Eligibility of faculty for teaching the course
7. Any specific instructions to the teacher/paper-setter/student/ chief-superintendent/ paper-evaluator
8. List of paper-setters/paper evaluator with phone, email-id in the prescribed format

### Members present:

1. Dr A. Matta Reddy
2. Dr S. Murali Mohan
3. Sri Y. Ravi Chand

### Resolutions:

It is resolved to add three practical aspects in the following papers from II SEM and IV SEM

1. BT-201: Microbiology, Cell and Molecular Biology (practical added - Demonstration, use and care of microbial equipment is added)
2. BT-401 (i) Plant and Animal Biotechnology (practical added -cytology of callus)
3. BT-401 (ii) Environmental & Industrial Biotechnology (practical added -Production of citric acid by submerged fermentation)



**ADIKAVI NANNAYA UNIVERSITY :: RAJAHMAHENDRAVARAM**  
**B.Sc Biotechnology Syllabus (w.e.f 20-21 A.Y)**

UG Program (4 years Honors) Structure (CBCS)

2020-21 A. Y., onwards

**BACHLOR OF SCIENCE**

(3<sup>rd</sup> and 4<sup>th</sup> year detailed design will be followed as per APSCHE GUIDELINES)

Subjects/ Semesters	I		II		III		IV		V		VI				
	H/W	C	H/W	C	H/W	C	H/W	C	H/W	C	H/W	C			
<b>Languages</b>															
English	4	3	4	3	4	3									
Language (H/T/S)	4	3	4	3	4	3									
Life Skill Courses	2	2	2	2	2+2	2+2									
Skill Development Courses	2	2	2+2	2+2	2	2									
<b>Core Papers</b>															
M-1	C1 to C5	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1				
M-2	C1 to C5	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1				
M-3	C1 to C5	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1	4+2	4+1				
M-1	SEC (C6,C7)										4+2	4+1			
M-2	SEC (C6,C7)										4+2	4+1			
M-3	SEC (C6,C7)										4+2	4+1			
<b>Hrs/ W (Academic Credits)</b>		30	25	32	27	32	27	36	30	36	30	0	12	4	4
Project Work															
<b>Extension Activities (Non Academic Credits)</b>															
<b>NCC/NSS/Sports/Extra Curricular</b>										2					
<b>Yoga</b>						1			1						
Extra Credits															
<b>Hrs/W (Total Credits)</b>		30	25	32	27	32	28	36	33	36	30	0	12	4	4

M= Major; C= Core; SEC: Skill Enhancement Courses



**ADIKAVI NANNAYA UNIVERSITY :: RAJAHMAHENDRAVARAM**  
**B.Sc Biotechnology Syllabus (w.e.f 20-21 A.Y)**

**Marks & Credits distribution: UG-Sciences**

Sl. No	Course type	No. of courses	Each course teaching Hrs/wk	Credit for each course	Total credits	Each course evaluation			Total marks
						Conti-Assess	Univ-exam	Total	
1	English	3	4	3	9	25	75	100	300
2	S.Lang	3	4	3	9	25	75	100	300
3	LS	4	2	2	8	0	50	50	200
4	SD	4	2	2	8	0	50	50	200
5	Core/SE -I	5+2	4+2	4+1	35	25	75+50	150	1050
	Core/SE -II	5+2	4+2	4+1	35	25	75+50	150	1050
	Core/SE -III	5+2	4+2	4+1	35	25	75+50	150	1050
6	Summer-Intern	2		4	8		100	200	200
7	Internship/ Apprentice/ on the job training	1		12	12		200	200	200
		<b>38</b>			<b>159</b>				<b>4550</b>
8	<b>Extension Activities (Non Academic Credits)</b>								
	NCC/NSS/Sports/ Extra Curricular			2	2				
	Yoga			2	1	2			
	Extra Credits								
	<b>Total</b>	<b>40</b>			<b>142</b>				



**DETAILS OF PAPER TITLES & CREDITS**

Sem	Course no.	Course Name	Course type (T/L/ P)	Hrs./ Week: Science :4+2	Credits : Science: 4+1	Max. Marks Cont/ Internal/Mid Assessment	Max.Marks Sem-end Exam	
I	1	Bio-molecules &Analytical Techniques	T	4	4	25	75	
		Bio-molecules &Analytical Techniques Lab	L	2	1	-	50	
II	2	Microbiology, Cell and MolecularBiology	T	4	4	25	75	
		Microbiology, Cell and MolecularBiology Lab	L	2	1	-	50	
III	3	Immunology and rDNA technology	T	4	4	25	75	
		Immunology and rDNA technology Lab	L	2	1	-	50	
IV	4	Plant and AnimalBiotechnology	T	4	4	25	75	
		Plant and AnimalBiotechnology Lab	L	2	1	-	50	
	5	Environmental &Industrial Biotechnology	T	4	4	25	75	
		Environmental &Industrial Biotechnology Lab	L	2	1	-	50	
V	6A	Techniques in Nursery Development	T	4	4	25	75	
		Techniques in Nursery Development Lab	L	2	1	-	50	
	7A	Hydroponics Cultivation	T	4	4	25	75	
		Hydroponics Cultivation Lab	L	2	1	-	50	
	<b>OR</b>							
	6B	Organic Farming	T	4	4	25	75	
		Organic farming Lab	L	2	1	-	50	
	7B	Biofertilizers and Biopesticides production	T	4	4	25	75	
		Bio fertilizers and Bio pesticides Production Lab	L	2	1	-	50	
	<b>OR</b>							
	6C	Apiculture	T	4	4	25	75	
		Apiculture Lab	L	2	1	-	50	
7C	Pearl Culture	T	4	4	25	75		
	Pearl CultureLab	L	2	1	-	50		

Note: \*Course type code: T: Theory, L: Lab, P: Problem solving

**Note 1:** For Semester–V, for the domain subject **BIO-TECHNOLOGY**, any one of the three pairs of SECs shall be chosen as courses 6 and 7, i.e., 6A & 7A or 6B & 7B or 6C & 7C. The pair shall not be broken (ABC allotment is random, not on any priority basis).

**Note 2:** One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate field skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the field



**ADIKAVI NANNAYA UNIVERSITY :: RAJAHMAHENDRAVARAM**  
**B.Sc Biotechnology Syllabus (w.e.f 20-21 A.Y)**

skills embedded in the syllabus citing related real field situations.

**Note 3:** To insert assessment methodology for Internship/ on the Job Training/Apprenticeship under the revised CBCS as per APSCHE Guidelines.

➤ **First internship (After 1st Year Examinations):** Community Service Project. To inculcate social responsibility and compassionate commitment among the students, the summer vacation in the intervening 1st and 2nd years of study shall be for Community Service Project (the detailed guidelines are enclosed).

➤ **Credit For Course: 04**

➤ **Second Internship (After 2nd Year Examinations):** Apprenticeship / Internship / on the job training / In-house Project / Off-site Project. To make the students employable, this shall be undertaken by the students in the intervening summer vacation between the 2nd and 3rd years (the detailed guidelines are enclosed).

➤ **Credit For Course: 04**

➤ **Third internship/Project work (6<sup>th</sup> Semester Period):**

During the entire 6<sup>th</sup> Semester, the student shall undergo Apprenticeship / Internship / On the Job Training. This is to ensure that the students develop hands on technical skills which will be of great help in facing the world of work (the detailed guidelines are enclosed).

➤ **Credit For Course:12**

- a. Proposed combination subjects: Biotechnology, Microbiology, Chemistry; Biotechnology, Biochemistry, Chemistry
- b. Student eligibility for joining in the course: Intermediate / 10+2 or any other equivalent course with Biology
- c. Faculty eligibility for teaching the course: M.Sc. Biotechnology
- d. List of Proposed Skill enhancement courses with syllabus, if any
- e. Any newly proposed Skill development/Life skill courses with draft syllabus and required resources
- f. Required instruments/software/ computers for the course (Lab/Practical course-wiserequired i.e., for a batch of 15 students)

Sem. No.	Lab/Practical Name	Names of Instruments/Software/ computers required with specifications	Brand Name	Qty Required
1	Bio-molecules & Analytical Techniques Lab	Photo Colorimeter, UV VIS Spectrophotometer, PH meter, Double Distillation unit	Elico/ Equiptronics	2



**ADIKAVI NANNAYA UNIVERSITY :: RAJAHMAHENDRAVARAM**  
**B.Sc Biotechnology Syllabus (w.e.f 20-21 A.Y)**

2	Microbiology, Cell and Molecular Biology Lab	Autoclave, Compound microscope, Gel Electrophoresis, PCR Machine, Gel Doc	Olympus microscope, Biorad PCR	1
3	Immunology and rDNA technology Lab	ELISA Kit, Water bath, Ice making machine,	Thermo	1
4	Plant and Animal Biotechnology	Lab Centrifuge, PCR Machine	Systronics	1
5	Environmental & Industrial Biotechnology Lab	Lab fermenter	Steri Fermenter	1

- g. List of Suitable levels of positions eligible in the Govt/Pvt organizations  
 Suitable levels of positions for these graduates either in industry/govt organization like., technical assistants/ scientists/ school teachers., clearly define them, with reliable justification

S.No	Position	Company/ Govt organization	Remarks	Additional skills required, if any
1	Project Assistant	CSIR Institutes/ other central and State Research laboratories	none	Job training/ certificate program/ apprentice
2	Trainee/Apprentice/Skilled Assistant/ Field Assistants	State/ Central Agricultural Research laboratories; Pharma/ Biotech	none	Certificate course

- h. List of Govt. organizations / Pvt companies for employment opportunities or internships or projects

S.No	Company/ Govt organization	Position type	Level of Position			
1	Pharma/Biotech companies	Research Assistant	-			
2	ICAR/CSIR institutes	Scientific Assistant/ Junior Scientist	-			

- i. Any specific instructions to the teacher /paper setters/Exam-Chief Superintendent





**Program objectives, outcomes, co-curricular and assessment methods**

<b>B Sc</b>	<b>Bio-Technology</b>
-------------	-----------------------

1. Aim and objectives of UG program in Subject:

The Biotechnology degree program provides students with robust science concepts and an application-oriented undergraduate education. The program is aimed to prepare students for employment opportunities in the biotechnology industry. In addition, students gain the in-depth knowledge and core set of skills that span across basic sciences, technology. This is a unique program in the State of Andhra Pradesh to integrate plant, animal, medical and environmental biotechnology into an undergraduate curriculum.

2. Learning outcomes of Subject:

The courses are strongly interdisciplinary in nature and they will give an insight into basic aspects of microbiology, immunology, molecular biology, biochemical, biophysical aspects and different application in medical, industrial biotechnology and environmental biotechnology

3. Recommended Skill enhancement courses: (Titles of the courses given below and details of the syllabus for 4 credits (i.e., 2 units for theory and Lab/Practical) for 5 hrs class- cum-lab work



#### 4. Details of course-wise Syllabus

<b>B Sc</b>	<b>Semester: I</b>	<b>Credits: 4</b>
<b>Course: 1</b>	<b>BIO-MOLECULES &amp; ANALYTICAL TECHNIQUES</b>	<b>Hrs/Wk: 4</b>

#### **Aim and objectives of Course:**

To ensure students gain knowledge about the structure, properties and functions of biomolecules and characterization of biomolecular using analytical techniques

#### **Learning outcomes of Course:**

The course will provide an insight into various aspects of basic aspects of biomolecules and different aspects of biophysical and biochemical techniques applied in the field of biology

#### **UNIT I:**

**Carbohydrates, Protein and Lipids:** Classification, structure, properties of carbohydrates. Classification, structure and properties of amino acids, peptide bond and peptides. Classification, structure (primary, secondary, tertiary, quaternary) and functions of proteins. Denaturation and renaturation of proteins. Classification structure and properties of saturated and unsaturated fatty acids. Structure and functions of glycolipids, phospholipids, and cholesterol.

#### **UNIT II:**

**Nucleic acid, Vitamins and Bioenergetics:** Structure and functions of DNA and RNA. Source, structure, biological role and deficiency manifestation of vitamin A, B, C, D, E and K. Free energy, entropy, enthalpy and redox potential. High energy compounds, Glycolysis, TCA cycle, Electron-Transport System and Oxidative Phosphorylation.

#### **UNIT III:**

**Centrifugation, Chromatography and Electrophoresis:** Basic principles of sedimentation and types of centrifugations. Principle, instrumentation and application of partition, absorption, paper, TLC, ion exchange, gel permeation, affinity chromatography. Introduction to HPLC, GCMS and LCMS. Basic principles and types of electrophoresis, factors affecting electrophoretic migration. PAGE (Native, SDS-PAGE). Introduction to 2D & Isoelectric Focusing.

#### **UNIT IV:**

**Spectroscopy, Microscopy and Laser Techniques:** Beer-Lambert law, light absorption and transmission. Extinction coefficient, Design and application of photoelectric calorimeter and UV-visible spectrophotometer. Introduction to crystallography and application. Types and design of microscopes - compound, phase contrast, fluorescent electron microscopy (TEM, SEM). Introduction to radioisotopes, measurement of radioactivity (scintillation counter and autoradiography).

#### **UNIT V:**

**Biostatistics:** Mean, median, mode, standard deviation, One-way Anova, Two-way Anova, t-test, F-test and chi-square.



**RECOMMENDED BOOKS:**

1. Outlines of Biochemistry, 5th Edition, (2009), Erice Conn & Paul Stumpf; JohnWiley and Sons, USA
2. Principles of Biochemistry, 4th edition, (1997), Jeffory Zubey; McGraw-Hill College, USA
3. Principles of Biochemistry, 5th Edition (2008), Lehninger, David Nelson & Michael Cox; W.H. Freeman and Company, NY
4. Fundamentals of Biochemistry, 3rd Edition (2008), Donald Voet & Judith Voet; John Wiley and Sons, Inc. USA
5. Biochemistry, 7th Edition, (2012), Jeremy Berg & Lubert Stryer; W.H.Freeman and Company, NY
6. Textbook of Biochemistry with Clinical Correlations, 7th Edition, (2010), Thomas M. Devlin; John Wiley and Sons, USA
7. Proteins: biotechnology and biochemistry, 1<sup>st</sup> edition, (2001), Gary Walsch; Wiley,USA
8. Biochemical Calculations, 2nd Ed., (1997), Segel Irvin H; John Wiley and Sons, NY
9. Biophysical Chemistry Principles & Techniques Handbook, (2003), A. Upadhyay, K. Upadhyay, and N. Nath
10. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001), Palmer Trevor, Publisher: Horwood Pub. Co., England.
11. Analytical Biochemistry, 3<sup>rd</sup> edition, (1998), David Holmes, H.Peck, Prentice-Hall,UK
12. Introductory Biostatistics, 1<sup>st</sup> edition, (2003), Chap T. Le; John Wiley, USA.
13. Methods in Biostatistics, (2002), B. K. Mahajan –Jaypee Brothers.
14. Statistical methods in biology, (1995), Bailey, N. T.; Cambridge university press



<b>B Sc</b>	<b>Semester: I</b>	<b>Credits: 01</b>
<b>Course: 1</b>	<b>BIO-MOLECULES &amp; ANALYTICAL TECHNIQUES LAB</b>	<b>Hrs/Wk: 02</b>

### Course 1: Bio-molecules & Analytical Techniques Lab

**Total Hours: 30**

**Credits: 1**

Details of Lab/Practical/Experiments/Tutorials syllabus:

1. Introduction to basic instruments (Principle standard operation procedure) demonstration and record.
2. Calculation of molarity, normality and molecular weight of compounds.
3. Qualitative analysis of carbohydrates (sugars)
4. Quantitative analysis of carbohydrates.
5. Quantitative estimation of protein - Lowery method.
6. Estimation of DNA by diphenylamine reagent.
7. Estimation of RNA by orcinol reagent.
8. Assay of protease activity.
9. Preparation of starch from potato and its hydrolyze by salivary amylase
10. preparation of standard buffer and pH determination.
11. Separation of amino acids by paper chromatography
12. eparation of lipids of TLC
13. garose gel electrophoresis
14. alculatation of mean, median and mode.

#### RECOMMENDED BOOKS:

1. An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu. Pvt.Ltd. New Delhi, India
2. Biochemical Methods, 1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
4. Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)
  - A. Measurable:
    1. Assignments on:
    2. Student seminars (Individual presentation of papers) on topics relating to:
    3. Quiz Programmes on:
    4. Individual Field Studies/projects:
    5. Group discussion on:
    6. Group/Team Projects on:
  - B. General
    1. Collection of news reports and maintaining a record of paper-cuttings relating to topics covered in syllabus
    2. Group Discussions on:
    3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
    4. Any similar activities with imaginative thinking.
5. Recommended Continuous Assessment methods:



**5. MODEL QUESTION PAPER (Sem-end. Exam)**

**UG DEGREE EXAMINATIONS**

**Semester: I**

**Course 1: Bio-molecules & Analytical Techniques**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks** **5 X 5M = 25M**  
**(Total 8 questions and at least two questions should be given from each unit)**

1. Denaturation and Renaturation of Proteins.
2. Structure and functions of cholesterol.
3. Entropy and Enthalpy.
4. High energy compounds.
5. Types of centrifugations.
6. Factors affecting electrophoretic migration.
7. Beer-Lambert's law.
8. Extinction coefficient.

**SECTION – B**

**Answer ALL the questions. Each question carries 10 marks** **5 X 10M = 50M**

9. a) Write about classification, structure and properties of amino acids  
(OR)  
b) Write about structure and classification of saturated and unsaturated fatty acids
10. a) Explain biological role and deficiency manifestations of vitamin – A, B, C, D, E and K  
(OR)  
b) Explain Glycolysis process with a flow chart
11. a) Explain gel filtration chromatographic technique  
(OR)  
b) Explain about UV VIS spectrophotometer
12. a) Describe the basic principles and types of electrophoresis  
(OR)  
b) Explain the measurements of radioactivity
13. a) Explain about One-way and Two-way ANOVA  
(OR)  
b) Define mean, median and mode with examples



**MODEL QUESTION PAPER  
UG DEGREE EXAMINATIONS**

**Semester: I**

**Course 1: Bio-molecules & Analytical Techniques Lab**

**Time: 3 hours**

**Max Marks: 50M**

1. Estimation of DNA by Diphenylamine method 20M
2. Write principle of paper chromatography and separate aminoacids 10M
3. A) Principles of qualitative analysis of carbohydrates 2- ½  
b) Find normality of a given compound with equation 2- ½
4. Spotter
  - 1) Spectrophotometer - 2- ½
  - 2) Centrifuge - 2- ½
5. Record 5 M
6. Viva 5 M



<b>B Sc</b>	<b>Semester: II</b>	<b>Credits: 4</b>
<b>Course: 2</b>	<b>MICROBIOLOGY, CELL AND MOLECULAR BIOLOGY</b>	<b>Hrs/Wk: 4</b>

**Aim and objectives of Course:**

To ensure students gain knowledge about the microbiology, cell and molecular biology aspects

**Learning outcomes of Course:**

The course will provide an insight into basic aspects of microbiology, cell and molecular biology

**Course Objectives:** To acquaint students with concepts of microbiology, cell and molecular biology. This course is aimed to give an understanding of the basics of microbiology, dealing types of microbes, classification and their characterization, structure and function of prokaryotic and eukaryotic cell organelles, cell division and basics of molecular biology including DNA replication, transcription, translation and regulation of gene expression.

**UNIT I:**

**Scope and Techniques of Microbiology:** History and contribution of Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming. Ultrastructure of bacteria and growth curve. Pure culture techniques. Sterilization techniques, principles and application of physical methods (autoclave, hot air oven, incineration), chemical methods and radiation methods. Simple, gram and acid-fast staining.

**UNIT II:**

**Microbial Taxonomy and Metabolism:** Concepts of microbial species and strains. Classification of bacteria based on morphology, nutrition and environment. General characteristics, transmission and cultivation of viruses. Structure and properties of plant (tobacco mosaic virus, TMV), animal (Newcastle disease virus, NDV), human (Human immunodeficiency virus, HIV) and bacterial viruses (T4 phage). Emerging and reemerging viruses (dengue virus), zoonotic viruses (rabies, SARS- CoV-2). Microbial production of penicillin. Bacterial toxins, tuberculosis, typhoid. Introduction to fungi, algae and cytoplasm.

**UNIT III:**

**Cell Structure and Functions:** Structure, properties and functions of cellular organelles (E.R, Golgibodies, Mitochondria, Ribosomes and Vacuoles) of eukaryotic cells. Cell cycle and cell division (mitosis and meiosis). Chemical composition and dynamic nature of the membrane, cell signaling and communication, endocytic pathways.

**UNIT IV:**

**DNA Replication, Repair and Regulation of Gene Expression:** DNA replication in prokaryotes and eukaryotes (semiconservative, dispersive, conservative, uni and bi-direction, rolling circle). Mechanism of DNA replication, enzymes and protein involved in DNA replication. DNA damage and repair. Regulation of gene expression in prokaryotes Lac and Trip operon concept.

**UNIT V:**

**Central Dogma of Molecular Biology:** Genome organization of prokaryotic and eukaryotic organisms. Genetic code, prokaryotic and eukaryotic transcription, enzymes involved in transcription. Post-transcriptional modification (Capping Poly adenylation) and splicing.

**Translation:** mechanism of translation in prokaryotic and eukaryotic cells (initiation, elongation, termination). Post-translational modification (glycosylation and phosphorylation).



**RECOMMENDED BOOKS:**

1. Microbiology–6th Edition, (2006), Pelczar M.J., Chan E.C.S., Krieg N.R.; The McGrawHill Companies Inc. NY
2. Prescott's Microbiology, 8th edition, (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton; McGrawHill Science Engineering, USA
3. Textbook of Microbiology, Anantnarayan and Paniker (2017)
4. Brock biology of microorganisms, 2003, Brock, T. D., Madigan, M. T., Martinko, J.M., & Parker, J.; Upper Saddle River (NJ): Prentice-Hall, 2003.
5. Genes XI, 11th edition, (2012), Benjamin Lewin; Publisher - Jones and Barlett Inc.USA
6. Molecular Biology of the Gene, 6th Edition, (2008), James D. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R.; Cold Spring Harbour Lab. Press, Pearson Pub.
7. Molecular Biology, 5th Edition, (2011), Weaver R.; McGraw Hill Science. USA
8. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi; Oxford University Press.
9. Molecular Biology: Genes to Proteins, 4th edition (2011), Burton E Tropp Jones& Bartlett Learning, USA.
10. Cell and Molecular Biology: Concepts and Experiments, 6th Edition, Karp, G. 2010.; John Wiley & Sons. Inc.
11. Cell and Molecular Biology, 8th edition. De Robertis, E.D.P. and De Robertis, E.M.F. 2006; Lippincott Williams and Wilkins, Philadelphia.
12. Cell Biology, (2017), De Robertis & De Roberis, Blaze Publishers & Distributors Pvt.Ltd.
13. The Cell: A Molecular Approach. 5th edition. Cooper, G.M. and Hausman, R.E. 2009. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
14. The World of the Cell, 7<sup>th</sup> edition, Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 Pearson Benjamin Cummings Publishing, San Francisco.
15. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Narosa Publishing House.





<b>B Sc</b>	<b>Semester: II</b>	<b>Credits: 1</b>
<b>Course: 2</b>	<b>MICROBIOLOGY, CELL AND MOLECULAR BIOLOGY LAB</b>	<b>Hrs/Wk: 2</b>

**Course 2: Microbiology, Cell and Molecular Biology Lab**

Total Hours: 30

Credits: 1

**List of Practical's:-**

1. Demonstration, use and care of microbial equipment
2. Cleaning and preparation of glassware
3. Preparation of nutrient agar medium for bacteria
4. Preparation of PDA medium for fungi
5. Sterilization techniques (autoclave, hot air oven, filter)
6. Isolation of bacteria from soil
7. Simple staining technique
8. Differential staining technique
9. Microbial counting by Haemocytometer
10. Identification of different bacteria
11. Motility test by hanging drop
12. Biochemical identification of bacteria
13. Preparation of pure culture by slab, slant, streak culture
14. Study of stages of mitotic cell division
15. Study of stages of meiotic cell division
16. Isolation of chloroplast
17. Extraction and isolation of DNA from bacteria.

**RECOMMENDED BOOKS:**

1. David A. Thompson. 2011. Cell and Molecular Biology Lab. Manual.
2. P.Gunasekaran. 2007. Laboratory Manual in Microbiology. New Age International.
3. D O Hall, S E Hawkins. 1974. Laboratory Manual of Cell Biology. British Society for Cell Biology, Published by Crane, Russia.
4. Mary L. Ledbetter. 1993. Cell Biology: Laboratory Manual. Edition: 2. Published by Ron Jon Publishing. Incorporated.
5. Gunasekaran, P. 2009. Laboratory Manual in Microbiology. 1st Edition. New Age International Publishers.
6. Dr. T. Sundararaj. Microbiology Laboratory Manual. 2005. Dr.A.L. MPGIBMS, University of Madras, Taramani, Chennai – 600 113.
7. James G. Cappuccino and Natalie Sherman. 2013. Microbiology: A Laboratory Manual. 10th Edition. Benjamin Cummings.
8. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.



Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on:
2. Student seminars (Individual presentation of papers) on topics relating to:
3. Quiz Programmes on:
4. Individual Field Studies/projects:
5. Group discussion on:
6. Group/Team Projects on:

B. General

1. Collection of news reports and maintaining a record of paper-cuttings relating to topics covered in syllabus
2. Group Discussions on:
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.

Recommended Continuous Assessment methods:



**MODEL QUESTION PAPER (Sem-end. Exam)**  
**UG DEGREE EXAMINATIONS**  
**Semester: II**  
**Course 2: Microbiology, Cell and Molecular Biology**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks. 5 X 5M = 25M**  
**(Total 8 questions and at least two questions should be given from each unit)**

1. Contributions of Leeuwenhoek
2. Simple staining
3. General characteristics of virus
4. Production of Penicillin
5. Mitochondria
6. Endocytic pathway
7. DNA repair
8. Post-transcriptional modifications

**SECTION – B**

**Answer ALL the questions. Each question carries 10 marks. 5 X 10M = 50M**

9. a) Give the ultra-structure of Bacteria and its growth curve with neat labelled diagram.  
(OR)  
b) Explain sterilization techniques.
10. a) Explain classification of bacteria based on different criteria.  
(OR)  
b) Explain the structure properties of animal cells.
11. a) Explain the cell cycle and cell division.  
(OR)  
b) Explain the structure and properties of cell organelles.
12. a) What is replication and explain the process of replication in eukaryotes  
(OR)  
b) What is Operon concept? Explain positive and negative control methods of lacoperon
13. a) Explain the process of transcription in eukaryotes  
(OR)  
b) Write a note on post-translational modifications in prokaryotes



**MODEL QUESTION PAPER  
UG DEGREE EXAMINATIONS**

**Semester: II**

**Course 2: Microbiology, Cell and Molecular Biology Lab**

**Time: 3 Hrs**

**Max Marks: 50M**

1. Write procedure for isolation of bacteria from soil and carryout the experiment  
20M
2. Write principle and procedure of simple staining and experiment 10M
3. Identify given spotters 5 x 2=10
  - a) HOT-air oven
  - b) Stages of meiosis
  - c) Types of bacteria based on shape
  - d) HIV
  - e) Okazaki fragments
4. Record 5M
5. VA-Voce 5M



<b>B Sc</b>	<b>Semester: III</b>	<b>Credits: 4</b>
<b>Course: 3</b>	<b>IMMUNOLOGY AND rDNA TECHNOLOGY</b>	<b>Hrs/Wk: 4</b>

**Aim and objectives of Course:**

To acquaint students with concepts of immunology and recombinant DNA technology. This course is aimed to give an understanding of the basics of immunology dealing cells and organs of the immune system, types of immune responses, antigen-antibody interactions, vaccines and tools, techniques and strategies and applications of genetic engineering.

**Learning outcomes of Course:**

The course will provide an insight into basic aspects of immunology and rDNA technology

**UNIT I:**

**Concepts, Cells and Organs of the Immune System:** Terminology, antigen, hapten, antibody (types), antigenicity, immunogenicity and types of immunity. Innate and adaptive immunity. Hematopoiesis, organs, tissues, cells and mediators of the immune system (primary and secondary lymphoid organs, lymphocytes and cytokines). Introduction to complement components, MHC. Basic concepts of humoral and cell-mediated immune response.

**UNIT II:**

**Vaccinology and Clinical Immunology:** Live, killed, attenuated, subunit and recombinant vaccines. Role and properties of adjuvants. Hybridoma technology, monoclonal antibodies and their application in immunodiagnosis. Antigen and antibody interactions - precipitation, agglutination, immune diffusion and ELISA. Introduction to hypersensitivity and autoimmunity.

**UNIT III:**

**Introduction, Tools and Techniques of rDNA Technology:** Introduction to rDNA technology, steps involved in cloning, tools of genetic engineering (Genes, Cloning vectors - plasmids and cosmids, Enzymes – restriction endonucleases and DNA Ligase, Hosts – bacteria and yeast). Principles and application of PCR. Southern, Northern and Western Blotting. Introduction to DNA sequencing (Sanger Sequencing) and Site-directed Mutagenesis.

**UNIT IV:**

**Cloning Strategies and Application of rDNA Technology:** rDNA library, construction, methods of transformation, recombinant selection and screening methods. Applications of rDNA technology in agriculture (transgenic plants, edible vaccines and antibodies) and medicine (disease diagnosis and DNA fingerprinting).

**UNIT V:**

**Bioinformatics:** Databases (PubMed, NCBI, EMBL and ExPASy), nucleotide and protein BLAST analysis, CLUSTAL W and phylogenetic tree construction. Introduction to omics (proteomics, genomics and transcriptomics). Introduction to nanotechnology.



**RECOMMENDED BOOKS:**

1. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
4. Immuno diagnostics, 1996, By S.C. Rastogi, Publ: New Age
5. Introduction to Immunology- 2002, C. V. Rao- Narosa Publishing House
6. Textbook of Biotechnology - 2007, By H.K. Das (Wiley Publications)
7. Principles of Gene Manipulation - 7<sup>th</sup> edition, 2006, By R.W. Old & S.B. Primrose, Publ: Blackwell
8. Molecular Biology & Biotechnology- 1996, By H.D. Kumar, Publ: Vikas
9. Molecular Biotechnology - 4<sup>th</sup> edition, 2010, G.R. Click and J.J. Pasternak, Publ:Panima
10. Genes and Genomes – 1991, By Maxine Singer and Paul Berg
11. Genes VII- 2000, By B. Lewin - Oxford Univ. Press
12. Molecular Biology - 4<sup>th</sup> Edition, 2008, By D. Freifelder, Publ: Narosa Publishing house New York, Delhi
13. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
14. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA.
15. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
16. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7<sup>th</sup> edition. Blackwell Publishing, Oxford, U.K.
17. Introduction to Bioinformatics – 2007, By V. Kothekar
18. Introduction to Bioinformatics – 2013, By Arthur M. Lesk
19. Bioinformatics: 2001, Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
20. Biological Sequence Analysis: 1<sup>st</sup> Edition, 1998, Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press
21. Bioinformatics tools and Resources – free online tools, software packages, Bioinformatics books and Journals, Bioinformatics web-portals



<b>B Sc</b>	<b>Semester: III</b>	<b>Credits: 1</b>
<b>Course: 3</b>	<b>IMMUNOLOGY AND rDNA TECHNOLOGY LAB</b>	<b>Hrs/Wk: 2</b>

**Course 3: Immunology and rDNA technology Lab**

Total Hours: 30

Credits: 1

**List of Practical: -**

1. Determination of Blood Groups
2. Pregnancy test
3. Widal test
4. Ocuteroloney immunodiffusion
5. Radial immune diffusion
6. ELISA
7. Production of antibodies (theory exercise)
8. Bleeding, separation of serum and storage
9. Lymphoid organs (theory exercise)
10. Isolation of plasmid DNA (alkaline lysis method)
11. Analysis of plasmid DNA by Agarose gel electrophoresis
12. Southern blotting (theory exercise)
13. PCR Amplification (theory exercise)

**Recommended books:**

1. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
2. Bioinformatics: 2004, A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience

Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on:
2. Student seminars (Individual presentation of papers) on topics relating to:
3. Quiz Programmes on:
4. Individual Field Studies/projects:
5. Group discussion on:
6. Group/Team Projects on:

B General

1. Collection of news reports and maintaining a record of paper-cuttings relating to topics covered in syllabus
2. Group Discussions on:
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.

Recommended Continuous Assessment methods:



**MODEL QUESTION PAPER (Sem-end. Exam)**

**UG DEGREE EXAMINATIONS**

**Semester: III**

**Course 3: Immunology and rDNA technology**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks. 5 X 5M = 25M**  
**(Total 8 questions and at least two questions should be given from each unit)**

1. MHC
2. Hematopoiesis
3. Properties of Adjuvants
4. Monoclonal Antibodies Applications
5. Sanger Sequencing
6. Principle of PCR
7. DNA Fingerprinting
8. Proteomics

**SECTION – B**

**Answer ALL the questions. Each question carries 10 marks. 5 X 10M = 50M**

9. a) Explain the different organs of immune system  
(OR)  
b) Write about immunity and explain the types of immunity
10. a) What is vaccine? Explain the different types of vaccines?  
(OR)  
b) Explain the different types of Ag-Ab reactions
11. a) Write about tools and steps involved in genetic engineering  
(OR)  
b) Explain blotting techniques
12. a) Write about applications of r-DNA technology in agricultural field  
(OR)  
b) What is transformation? Write about methods of transformation
13. a) Explain about nanotechnology and its importance  
(OR)  
b) Explain about protein BLAST method





**MODEL QUESTION PAPER**  
**UG DEGREE EXAMINATIONS**  
**Semester: III**

**Course 3: Immunology and rDNA technology Lab**

**Exam: 3 hrs**

**Max Marks: 50M**

- 
1. Write principle and procedure for isolation of plasmid DNA and carryout experiment 20M
  2. Determination of blood groups 10M
  3. Identify the spotters 5 x2  
=10M
    - 1) Lymphoid organs
    - 2) Cosmids
    - 3) ELISA
    - 4) BLA  
ST
    - 5) RIA
  4. Record 5M
  5. Viva-voce 5M



<b>B Sc</b>	<b>Semester: IV</b>	<b>Credits: 4</b>
<b>Course: 4</b>	<b>PLANT AND ANIMAL BIOTECHNOLOGY</b>	<b>Hrs/Wk: 4</b>

**Aim and objectives of Course:**

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation.

**Learning outcomes of Course:**

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

**UNIT I:**

**Plant tissue culture techniques & secondary metabolites production:** Plant tissue culture: to tipotency, media preparation – nutrients and plant hormones; sterilization techniques; establishment of cultures – callus culture, cell suspension culture ,applications of tissue culture-micro propagation; Somatic embryogenesis; synthetic seed production; protoplast culture and somatic hybridization - applications. Cryopreservation,Plant secondary metabolites- concept and their importance

**UNIT II:**

**Transgenesis and Molecular markers:** Plant transformation technology-- Agrobacterium mediated Gene transfer (Ti plasmid), hairy root features of Ri plasmid,Transgenic plants as bioreactors. Herbicide resistance – glyphosphate, Insect resistance- Bt cotton,,Molecular markers - RAPD, RFLP and DNA fingerprinting-principles and applications.

**UNIT III:**

**Animal tissue culture techniques:** Animal cell culture: cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, cell lines,stem cell cultures; Tests: cell viability and cytotoxicity, Cryopreservation. Transfection methods (calcium phosphate precipitation, electroporation, Microinjection) and applications.

**UNIT IV:**

**Transgenic animals & Gene Therapy:** Production of vaccines, diagnostics, hormones and other recombinant DNA products in medicine (insulin,somatostatin, vaccines),IVF, Concept of Gene therapy, Concept of transgenic animals – Merits and demerits -Ethical issues in animal biotechnology.

**UNIT V:**

**Bioethics, Biosafety and IPR:** Bioethics in cloning and stem cell research, Human and animal experimentation, animal rights/welfare. Bio safety-introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GLP,GMP, Introduction to IP-Types of IP: patents, trademarks & copyright



**RECOMMENDED BOOKS :**

1. Introduction to Plant Tissue Culture, M.K. Razdan, 2003, Science Publishers
2. Plant Tissue Culture, kalyan Kumar De, 199 M7, New Central Book Agency
3. Biotechnology – By U. Satyanarayana ;1997
4. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects By Y.P.S. Bajaj and A. Reinhard ,2001
5. Introduction to Plant Tissue Culture, M. K. Razdan, 2003, Science Publishers
6. A Textbook of Biotechnology, R C Dubey, S. 2014, Chand Publishing
7. Elements of Biotechnology, P. K. Gupta, 1994, Rastogi Publications
8. Daniel R. Marshak, Richard L. Gardner, David Gottlieb “Stem cell Biology” edited by Daniel 2001, Cold Spring Harbour Laboratory press, New York
9. M.M. Ranga, Animal Biotechnology; Agrobios (India) ,2006.



<b>B Sc</b>	<b>Semester: IV</b>	<b>Credits: 1</b>
<b>Course: 4</b>	<b>PLANT AND ANIMAL BIOTECHNOLOGY LAB</b>	<b>Hrs/Wk: 2</b>

**Course 4: Plant and Animal Biotechnology Lab**

**Total Hours: 30**

**Credits: 1**

**List of Practical's:**

1. plant culture media and composition of MS media
2. Raising of aseptic seedlings
3. Induction of callus from different explants, cytology of callus
4. Plant propagation through Tissue culture (shoot tip and Nodal culture)
5. Establishing a plant cell culture (both in solid and liquid media)
6. suspension cell culture
7. Cell count by hemocytometer.
8. Establishing primary cell culture of chicken embryo fibroblasts.
9. Animal tissue culture – maintenance of established cell lines.
10. Animal tissue culture – virus cultivation.
11. Estimation of cell viability by dye exclusion (Trypan blue).
12. ELISA – Demonstration

**RECOMMENDED BOOKS:**

1. R. Ian Freshney, “Culture of animal cells – A manual of basic techniques” 4<sup>th</sup> edition, John Wiley & Sons, 2000, Inc, publication, New York
2. Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan, 1998

Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

A. Measurable:

1. Assignments on:
2. Student seminars (Individual presentation of papers) on topics relating to:
3. Quiz Programmes on:
4. Individual Field Studies/projects:
5. Group discussion on:
6. Group/Team Projects on:

B. General

1. Collection of news reports and maintaining a record of paper-cuttings relating to topics covered in syllabus
2. Group Discussions on:
3. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
4. Any similar activities with imaginative thinking.

Recommended Continuous Assessment methods:



**MODEL QUESTION PAPER (Sem-end. Exam)**  
**UG DEGREE EXAMINATIONS**  
**Semester: IV**  
**Course 4: Plant and Animal Biotechnology**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

**(Total 8 questions and at least two questions should be given from each unit)**

1. Micro propagation
2. Cryopreservation
3. RAPD
4. Ti-Plasmid
5. Somatic embryogenesis
6. Cell lines
7. IVF
8. Animal rights

**SECTION – B**

**Answer ALL the questions. Each question carries 10 marks.**

**5 X 10M = 50M**

9. a) What are metabolites and explain different plant secondary metabolites  
(OR)  
b) Explain different types of cultures
10. a) Explain the herbicide and insecticide resistance in transgenesis process  
(OR)  
b) What are transgenic plants? Write a note on transgenic plants as bioreactors
11. a) What are cell cultures and explain different types of cell cultures  
(OR)  
b) What is transfection and explain different methods of transfection
12. a) Write a note on transgenic animals with merits and demerits  
(OR)  
b) Write about recombinant DNA products in medicine
13. a) Explain about human and animal experimentation  
(OR)  
b) Explain about biosafety and different levels in biosafety



**UG DEGREE EXAMINATIONS**  
**Semester: IV**  
**Course 4: Plant and Animal Biotechnology Lab**

**Time: 3Hrs**

**Max Marks: 50M**

- 
- |  |             |
|--|-------------|
| 1. Write procedure for process of callus induction from different explants | 20M         |
| 2. Suspension cultures   | 10M         |
| 3. Spotters  | 2 x 5 = 10M |
| 1) RFLP  |             |
| 2) Bt-Cotton   |             |
| 3) Bioreactor  |             |
| 4) Plasmid   |             |
| 5) Chick embryo fibroblast   |             |
| 4. Record  | 5M          |
| 5. Viva  | 5M          |



<b>B.Sc</b>	<b>Semester: IV</b>	<b>Credits: 4</b>
<b>Course: 5</b>	<b>ENVIRONMENTAL &amp; INDUSTRIAL BIOTECHNOLOGY</b>	<b>Hrs/Wk: 4</b>

**Aim and objectives of Course:**

This course aims to introduce fundamentals of Environmental Biotechnology. The course will also give an insight in introducing major groups of microorganisms and their industrial applications.

**Learning outcomes of Course:**

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

**UNIT I:**

**Pollution Types and Control:** Environmental Biotechnology-Environmental Pollution: Types of pollution, air pollution & its control through Biotechnology, Biofilters, Bioscrubbers, Biotrickling filter. Water pollution and its management: Measurement of water, pollution, sources of water pollution. Microbiology of waste water treatment, aerobic processes, activated sludge, oxidation ponds, trickling filters, and rotating biological contactors. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors.

**UNIT II:**

**Bioremediation:** Biodegradation and Bioremediation – Concepts & principles of Bioremediation, Bioremediation of Hydrocarbons and its applications Degradation of pesticides and other toxic chemicals by microorganism. Role of genetically Engineered microbes, Concept of Phytoremediation, , environmental safety guidelines.

**UNIT III:**

**Biofuels:** Biofuels-biogas, microbial groups involved in biogas production & interactions, factors affecting biogas production, Biofertilizers, Vermiculture.

**UNIT IV:**

**Basic principles of Microbial technology:** Industrially important microbes, its screening, selection and identification. Maintenance and preservation of industrially important microbial cultures. Strain Improvement, Basic concepts of fermentation; Design of fermenter and applications.

**UNIT V:**

**Commercial Production of Microbial products:** Microbial technology products and applications; Microbial production of Organic acids (Lactic acid, citric acid), Amino acids (Glutamic acid, Aspartic acid and Lysine). Fermentation by microbes for food additives: dairy products (Cheese, Yogurt), beverages (Beer, Wine) and antibiotics (Streptomycin, Pencillin)



**RECOMMENDED BOOKS :**

1. K. Vijaya Ramesh, Environmental Microbiology, 2004,MJP Publishers, Chennai.
2. A.G. Murugesan, C. Raja Kumari, Environmental Science & Biotechnology - Theory & Techniques, 2005,MJP Publishers
3. Environmental microbiology by Raina M.Maier Ian L.Pepper &Charles P.Gerba,2000,Academic press.
4. Environmental Chemistry, A.K. De. Wiley Eastern Ltd.,2001, New Delhi
5. Introduction of Biodeterioration, D. Allsopp and K.J. Seal, ELBS/Edward Arnold,2008
6. Power un seen: How microbes rule the world. By Dixon, B. Freeman/ Spectrum, 1994,Oxford.
7. Environmental Microbiology. By. Mitchell. R. Wiley,1992, New York
8. Introduction to Environmental Sciences, Y. Anjaneyulu ,2004, BS Publications
9. Industrial Microbiology by A.H.Patel,2009
10. Prescott & Dum (2002) Industrial Microbiology, Agrabios (India) ,2005,Publishers
11. Creueger W. & Crueger A.A Text of Industrial Microbiology,2000, 2nd Edition,Panima Publishers corp.





<b>B.Sc</b>	<b>Semester: IV</b>	<b>Credits: 1</b>
<b>Course: 5</b>	<b>ENVIRONMENTAL &amp; INDUSTRIAL BIOTECHNOLOGY LAB</b>	<b>Hrs/Wk: 2</b>

**Course-5: Environmental & Industrial Biotechnology Lab**

Total Hours: 30

Credits: 1

**List of Practicals:**

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water
3. Determination of Hardness and alkalinity of water sample.
4. Determination of dissolved oxygen concentration of water sample
5. Determination of biological oxygen demand of sewage sample
6. Determination of chemical oxygen demand (COD) of sewage sample.
7. Isolation of industrially important microorganisms from soil.
8. Isolation of amylase producing organisms from soil.
9. Production of  $\alpha$  – amylase from Bacillus Spp. by shake flask culture.
10. Production of alcohol or wine using different substrates.
11. Production of citric acid by submerged fermentation
12. Estimation of citric acid by titrimetry.

B. Recommended Co-curricular activities: (Co-curricular Activities should not promote copying from text book or from others' work and shall encourage self/independent and group learning)

C. Measurable:

7. Assignments on:
8. Student seminars (Individual presentation of papers) on topics relating to:
9. Quiz Programmes on:
10. Individual Field Studies/projects:
11. Group discussion on:
12. Group/Team Projects on:

D. General

6. Collection of news reports and maintaining a record of paper-cuttings relating to topics covered in syllabus
7. Group Discussions on:
8. Watching TV discussions and preparing summary points recording personal observations etc., under guidance from the Lecturers
9. Any similar activities with imaginative thinking.

C. Recommended Continuous Assessment methods:



**MODEL QUESTION PAPER ( Sem End)**  
**UG DEGREE EXAMINATIONS**  
**Semester: IV**  
**Course-5: Environmental & Industrial Biotechnology**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

**(Total 8 questions and at least two questions should be given from each unit)**

1. Air pollution
2. Oxidation ponds
3. Hydro carbons applications
4. Phytoremediation
5. Biofertilizers
6. Vermiculture
7. Fermenter applications
8. Streptomycin

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

9. a) Explain the microbiology of waste water treatment  
(OR)  
b) Explain about biofertilizers and their application
10. a) Explain biodegradation and bioremediation processes  
(OR)  
b) Write about role of genetically engineered microbes
11. a) Write about biogas production  
(OR)  
b) Write about factors affecting biogas production
12. a) Explain about preservation of industrial microbial cultures  
(OR)  
b) Explain design and process of fermentation with an example
13. a) Explain about microbial production of organic acids  
(OR)  
b) What are food additives and explain the process of fermentation for food additives



**MODEL QUESTION PAPER**  
**UG DEGREE EXAMINATIONS**  
**Semester: IV**

**Course-5: Environmental & Industrial Biotechnology Lab**

**Time: 3 Hrs**

**Max Marks: 50M**

- 
- |  |             |
|--|-------------|
| 1. Write procedure for BOD determination and carryout experiment | 20M         |
| 2. Write procedure for determination of hardness of water        | 10M         |
| 3. Spotters  | 2 x 5 = 10M |
| 1) Fermenter   |             |
| 2) Principle of wine preparation                                 |             |
| 3) Identify given product from the spotter                       |             |
| 4) Biodegradation principle                                      |             |
| 5) Identify structure of amino acid                              |             |
| 4. Record  | 5M          |
| 5. Viva  | 5M          |



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 4</b>
<b>Course: 6A</b>	<b>Techniques in nursery development</b>	<b>Hrs/Wk: 4</b>

**Learning outcomes:**

Students after successful completion of the course will be able to

1. Understand different types of nurseries
2. Identify various facilities required to set up of a nursery
3. Understood expertise related to various practices in a nursery
4. Acquire skills to get an employment or to become an entrepreneur.

**II. Syllabus:** (Total 90 hrs. (including Teaching, Lab, Field Training and unit tests etc.)

**UNIT I: Introduction to Nursery**

(10h)

Definition, objectives and importance. Basic requirements for a nursery layout and components of a good nursery. Types of nurseries. Bureau of Indian standards (BIS - 2008) related to nursery.

**UNIT II: Nursery inputs**

(10h)

Tools, implements and containers. Nursery media. Electricity, equipment and machinery management. Types of nursery beds and their preparations. Precautions and maintenance of nursery beds.

**UNIT III: Seeds and Propagules**

(10h)

Selection of seed and different sowing methods. Use of different plant parts for vegetative propagation to raise nursery. Different techniques of vegetative propagation.

**UNIT IV: Management Practices**

(10h)

Routine seasonal operations in a nursery. Supply of water, nutrients and removal of weeds. Identification of pests and diseases, control and prevention methods.

**UNIT V: Grafting techniques**

(10h)

Introduction to grafting, definition, types and tools for grafting. Steps involved in simple, splice graft, tongue graft, Whip graft, cleft graft and wedge graft. Grafting of horticultural & floricultural crops and applications.

**REFERENCES:**

1. Ratha Krishnan, M., *et al.* (2014) Plant Nursery
2. Management: Principles and Practices, Central Arid Zone Research Institute – ICMR, Jodhpur, Rajasthan.
3. Vikas Kumar, Anjali Tiwari, Practical manual of Nursery management, Agri – biotech Press, New Delhi.
4. Tarai Ranjan Kumar, (2020) Plant propagation and nursery management, New India Publishers.
5. P.K.Ray, (2020) Essentials of plant nursery management.
6. P.K.Ray, (2012) How to start and operate a Plant Nursery.



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 1</b>
<b>Course: 6A</b>	<b>Techniques in nursery development Lab</b>	<b>Hrs/Wk: 2</b>

### **Practical syllabus: Techniques in Nursery Development**

#### **Skill outcomes:**

On successful completion of the practical course, student shall be able to

1. List out different types of nurseries and beds.
2. Identify the nursery tools, implements and containers.
3. Develop skill on potting media preparation and plant production.
4. Learn the technique of establishing cutting, layering, grafting etc

#### **Practical syllabus:**

1. Demonstration of different types of nurseries
2. Handling of nursery tools, equipment and types of containers
3. Laying of nursery bed with soil and compost
4. Seed collection, treatment and rising of seedlings on nursery bed
5. Handling of grafting and layering techniques in the nursery
6. Watering, weeding and management of nursery
7. Maintaining of the seedlings / cuttings in the nursery

#### **Co-curricular activities:**

**a) Mandatory:** (Training of students by teacher on field related skills: 15hrs)

1. **For teachers:** Training of students by teacher in laboratory and field for a total of 15hrs on nursery types and infrastructure of a nursery. Presowing treatment and seed sowing methods. Plucking, transplantation, layering and grafting methods
2. **For students;** Visit to local nursery farm, observing the crop growth raised in nurseries. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report: 05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

#### **b) Suggested co-curricular activities:**

1. Visit to local nurseries
2. Learning techniques of basic tools and instruments handling related to field work
3. Sowing of seeds by adopting different methods, grafting and layering techniques
4. Training of students by related subject experts
5. Attending special lectures, group discussions and seminars on related topics
6. Preparation of videos on nursery media preparation and application



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V (Skill Enhancement Course -Elective)**  
**Course 6A: Techniques in Nursery Development**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Write about different types of Nursery
- 2) Describe about importance of Nursery
- 3) Nursery Media
- 4) Nursery bed
- 5) Write about selection of seeds for nursery
- 6) What is vegetative propagation
- 7) Write about nursery tools
- 8) Write about cleft graft

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 9) a) Write about basic requirements for a nursery layout and components of a good nursery?  
(OR)  
b) Write about different types of nursery beds and their preparations?
- 10) a) Write about precautions and maintenance of nursery beds?  
(OR)  
b) Write about selection of seed and different sowing methods?
- 11) a) Write about different techniques of vegetative propagation?  
(OR)  
b) Write about identification of pests and diseases, control and prevention methods?
- 12) a) What is grafting, describe about and tools for grafting?  
(OR)  
b) Write about routine seasonal operations in a nursery?
- 13) a) Write about steps involved in simple, splice graft, tongue graft, Whip graft, cleft graft and wedge graft  
(OR)  
b). Write about grafting of horticultural & floricultural crops and various applications?



ADIKAVI NANNAYA UNIVERSITY :: RAJAHMAHENDRAVARAM  
B.Sc Biotechnology Syllabus (w.e.f 20-21 A.Y)

**Suggested Question Paper Model for Practical Examination**  
Semester – V/ Biotechnology Course – 6 A (Skill Enhancement Course)  
**Techniques in Nursery Development**

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

- |   |              |
|---|--------------|
| 1. Perform the pre-treatment method for given seed 'A'                      | 8 M          |
| 2. Identify the graft and perform grafting 'B'                              | 8 M          |
| 3. Demonstration of handling of nursery tools, equipment and containers 'C' | 12 M         |
| 4. Scientific observation and data analysis                                 | 4 x 3 = 12 M |
| A. Whip graft/photograph  |              |
| B. Propagule / photograph   |              |
| C. Nursery container/ photograph  |              |
| D. Sucker/photograph  |              |
| 5. Record + Viva-voce   | 6+4 = 10 M   |



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 4</b>
<b>Course: 7A</b>	<b>Hydroponics cultivation</b>	<b>Hrs/Wk: 4</b>

**Learning outcomes:**

Students after successful completion of the course will be able to

1. Understand the concept of hydroponics
2. Acquire the knowledge on soilless cultivation system
3. Prepare media for hydroponics cultivation
4. Learn the hydroponic cultivation technique

**Syllabus:** (Total 90 hrs. including Teaching, Lab, Field Training and unit tests etc.)

**UNIT I: Introduction to Soilless culture**

(10h)

Definition, History and origin of soilless culture, Present status of hydroponics-contrasts with soil based culture, Applications & future developments.

**UNIT II: Macronutrients, micronutrients**

(10h)

Functions and effect on plants, deficiency symptoms of the following essential minerals N, P, Mg, Ca, K, S, Fe, Mn, Cu, Zn, B, Mo, Physical factors, light (Quantity, energy, photoperiodism etc), Temperature (Heating and cooling), Humidity, CO<sub>2</sub>, ppm, pH and TDS.

**UNIT III: Cultural conditions**

(10h)

Plant nutrition. Inorganic salts (fertilizers) major and minor nutrients formulating, monitoring and analysing. Selection of fertilizers, media used for hydroponics-expanded clay, rock wool, coir, perlite, pumice, vermiculite, sand gravel etc. Weed management, diseases and pest control.

**UNIT IV: Techniques in hydroponics**

(10h)

Static solution culture, continuous-flow solution culture and aeroponics.

**UNIT V: Cultivation of crop plants by hydroponics**

(10h)

Passive sub-irrigation, Ebb and flow or flood and chain irrigation. Deep water culture protocols for –Tomato cultivation through Dutch bucket method, chilly cultivation through NFT system, Spinach through raft System and measurements of yield.

**REFERENCES:**

1. Keith Roberto, *How to Hydroponics*. The future Garden Press New York.4<sup>th</sup> Edition
2. Howard M. Resh. *Hobby Hydroponics*. CRC Press, USA.
3. Prasad S and Kumar U. *Green House management for Horticultural crops*. Agro-Bios India.
4. Dahama A.K. *Organic Farming for Sustainable Agriculture*. Agrobios, India
5. Subba Rao N.S. (1995). *Biofertilizers in Agriculture and Forestry*. Oxford and IBH Publishing Company. Pvt. Ltd New Delhi.





<b>B. Sc</b>	<b>Semester -V (Skill Enhancement Course -Elective)</b>	<b>Credits: 1</b>
<b>Course: 7A</b>	<b>Hydroponics cultivation Lab</b>	<b>Hrs/Wk: 2</b>

### Practical syllabus: Hydroponics cultivation

#### Skill outcomes:

On successful completion of the practical course student shall be able to

1. List out macronutrients, micronutrients- functions and effect on plants, deficiency symptoms.
2. Demonstrate the importance of temperature and light in hydroponics
3. Develop skill of media production for Hydroponics cultivation
4. Equip with the skill of weed management, diseases and pest management

#### Practical syllabus:

1. Handling of tools required for hydroponic set up
2. Preparation of macronutrients and micronutrients solutions/stock cultures
3. Preparation of different media for hydroponic system.
4. Evaluating the effect of bio fertilizers on hydroponic cultivation
5. Weeding management techniques - demonstration
6. Demonstration of pests and diseases control and prevention methods
7. Cultivation of tomato by hydroponic system
8. Cultivation of chilli through hydroponic cultivation

#### Co-curricular activities:

a) **Mandatory:** (Training of students by teacher on field related skills:15hrs)

1. **For teachers:** Training of students by teacher in laboratory and field for a total of 15hrs on soilless culture system. Demonstrating importance of nutrients/light/temperature for successful hydroponic cultivation.
2. **For students:** Visit to local Hydroponics cultivation farm, observing the crop growths. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report: 05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

#### b) Suggested co curricular activities:

1. Visit to local hydroponics cultivation farm
2. Learning techniques of basic tools and instruments handling related to hydroponics
3. Training of students by related subject experts
4. Preparation of videos on media preparation and application in hydroponics
5. Attending special lectures, group discussions and seminars on related topics



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V (Skill Enhancement Course -Elective)**  
**Course 7A: Hydroponics cultivation**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Write about soilless culture?
- 2) Write about functions of macronutrients in plants?
- 3) Describe about photoperiodism?
- 4) Aeroponics?
- 5) Write about selection of fertilizers in hydroponics?
- 6) Deep water culture protocols for tomato cultivation?
- 7) Write about chilly cultivation through NFT system?
- 8) Write about spinach through raft System?

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 9) a) Write about History and origin of soilless culture?  
(OR)  
b) Write about present status of hydroponics-contrasts with soil-based culture?
- 10) a) Write about functions, effects and deficiency symptoms of the essential minerals in plants?  
(OR)  
b) Write about importance of physical factors on plants?
- 11) a) Write about selection of fertilizers, media used for hydroponics?  
(OR)  
b) Write about major and minor nutrients formulating and monitoring in hydroponics?
- 12) a) Write about different techniques used in hydroponics?  
(OR)  
b) Write about weed management, diseases and pest control?
- 13) a) Write about various irrigation techniques implemented in hydroponics?  
(OR)  
b) Write about Applications & future developments in hydroponics?



**Suggested Question Paper Model for Practical Examination**  
Semester – V/ Biotechnology Course – 7 A (Skill Enhancement Course)  
**Hydroponics cultivation**

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

1. Demonstrate the preparation of macronutrients and micronutrients stock solutions for hydroponics cultivation 'A' 8 M
2. Establish hydroponic set up with given tools 'B' 8 M
3. Prepare complete media for effective hydroponic cultivation 'C' 12 M
4. Scientific observation and data analysis 4 x 3 = 12 M
  - A. Chilli cultivation /photograph
  - B. Tomato cultivation / photograph
  - C. Zinc deficiency symptom / photograph
  - D. Static solution culture /photograph
5. Record + Viva-voce 6+4 = 10 M



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 4</b>
<b>Course: 6B</b>	<b>Organic Farming</b>	<b>Hrs/Wk: 4</b>

### Learning outcomes

Students after successful completion of the course will be able to

1. Understand the soil profile and nutrients in soil
2. Appreciate the importance of organic manure and bio fertilizers
3. Produce vermi compost, farmyard manure from bio waste
4. Acquire skill on isolation and maintenance of bio fertilizers

**Syllabus:** (Total 90 hrs. (including Teaching, Lab, Field Training and unit tests etc.)

#### UNIT I: Soil: (10h)

Definition, soil formation, composition and characteristics. Types of soils. Distribution of soil groups in India. Acidic, Alkaline and heavy metal contaminated soil. Methods of reclamation. Effects of chemical dependent farming on yield and soil health.

#### UNIT II: Plant Nutrition (10h)

Macro and micro nutrients, functions of nutrients in plant growth and development. Nutrient uptake and utilization by plant. Types of fertilizers. Organic, inorganic and bio fertilizers. Chemical fertilizer. Advantages & disadvantages of their use. Importance of organic and bio fertilizers.

#### UNIT III: Organic Farming (10h)

Definition, concept, benefits. Integrated farming system (combination of organic and inorganic). Mixed farming system. Concept of different cropping systems in relation to organic farming, Inter cropping, crop rotation. Organic farming process. Organic fertilizers, crop nutrients and effective microorganisms in Organic farming.

#### UNIT IV: Organic compost (10h)

Definition, types of compost, farm yard compost, green leaf compost, animal husbandry, animal housing, animal feeding, animal health, breeding goals.

Vermi compost: Introduction, vermi composting material, species of earthworms, small scale, large scale composting process. Vermi castings, harvesting, processing and drying. Nutrient content of vermi compost. Field application methods.

#### UNIT V: Biofertilizers (10h)

Introduction, status and scope. Structure and characteristic features of bacterial bio fertilizers- *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*. Cynobacterial biofertilizers- *Anabaena*, *Nostoc*, *Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Mechanism of nitrogen fixation and phosphorus solubilization.

### REFERENCES:

1. Principles of Organic Farming:: by E Somasundaram,D Udhaya Nandhini,M Meyyappan ;2021
2. Organic farming in India:: by Arpita Mukherjee; 2017
3. Biofertilizer and biocontrol agents for agriculture;; by AM Pirttilä · 2021
4. Trends in Organic Farming in India;; by S. S. Purohit, 2006
5. Biofertilizers for Sustainable Agriculture and Environment;; by Bhoopander Giri Ram Prasad, Qiang-Sheng Wu, Ajit Varma; 2019



<b>B. Sc</b>	<b>Semester -V (Skill Enhancement Course -Elective)</b>	<b>Credits: 1</b>
<b>Course: 6B</b>	<b>Organic Farming Lab</b>	<b>Hrs/Wk: 2</b>

### Practical syllabus: Organic farming

#### Skill outcomes:

On successful completion of the practical course, student shall be able to

1. Estimate NPK levels in the soil
2. Demonstrate the collection and processing of raw material
3. Develop skill of vermi compost production
4. Learn the technique of establishing organic farms
5. Equip with the skill of preparation of microbial media

#### Practical syllabus:

1. Collection of different soil samples
2. Qualitative estimation of nitrogen, phosphorus and potassium in soil samples
3. Collection of fruit, vegetable and other domestic waste
4. Preparation of compost beds and introducing earthworms
5. Collection of vermi castings
6. Sieving, drying and packing of vermi compost
7. Visit to animal shed and observing farm yard manure production
8. Preparation of media and isolation of bio fertilizers

#### Co-curricular activities:

a) **Mandatory:**(Training of students by teacher on field related skills;15hrs)

1. **For teacher;** Training of students by teacher in laboratory and field for a total of 15hrs on soil sample collection, NPK analysis, collection of biodegradable waste, vermi composting, collection of castings, processing, drying& packing. In addition teacher should demonstrate the media preparation, sterilization, and isolation of microorganisms from soil.
2. **For students:** Visit to local organic farm, collection of earthworms, observing the crop growth raised in organic farms. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report:05
4. Suggested format for field work report: Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE)

b) **Suggested co-curricular activities:**

1. Comparing mineral content in different agricultural soil
2. Learning techniques of basic instruments handling related to field work
3. Preparation of videos on compost preparation and application
4. Visit to local organic fields
5. Attending special lectures, group discussions and seminars on organic farming



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V** (Skill Enhancement Course -Elective)  
**Course 6B: Organic Farming**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Soil contamination
- 2) Reclamation
- 3) Biofertilizers
- 4) Intercropping
- 5) Animal husbandry
- 6) Vermi casting and harvesting?
- 7) Cyanobacterial biofertilizers
- 8) Fungal biofertilizers

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 9) a) Define soil? Write about soil formation, composition and characteristics?  
(OR)  
b) Write about effects of chemical dependent farming on yield and soil health?
- 10) a) What are macro and micro nutrients? Discuss about their functions in plant growth and development?  
(OR)  
b) What are fertilizers? Discuss about different types of fertilizers?
- 11) a) What is integrated farming? Discuss about integrating farming in detail?  
(OR)  
b) Write in detail about different cropping systems?
- 12) a) Discuss in detail about various types of organic compost?  
(OR)  
b) What is vermi composting? Write about small scale and large scale vermi composting?
- 13) a) Discuss in detail about various bacterial biofertilizers?  
(OR)  
b) Discuss in detail about mechanism of nitrogen fixation and phosphorus solubilization?



**Suggested Question Paper Model for Practical Examination**  
Semester – V/ Biotechnology Course – 6B (Skill Enhancement Course)  
**Organic Farming**

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

- 
- |   |              |
|---|--------------|
| 1. Estimate the pH of soil in given sample 'A'            | 8 M          |
| 2. Estimate the nitrogen content in given soil sample 'B' | 8 M          |
| 3. Perform streak plate technique for isolation 'C'       | 12 M         |
| 4. Scientific observation and data analysis               | 4 x 3 = 12 M |
| A. Identify different earth worm species /photograph      |              |
| B. Sieving and processing of vermi compost - photograph   |              |
| C. VAM identification                                     |              |
| D. Farmyard manure  |              |
| 5. Record + Viva-voce                                     | 6+4 = 10 M   |



<b>B. Sc</b>	<b>Semester -V (Skill Enhancement Course -Elective)</b>	<b>Credits: 4</b>
<b>Course: 7B</b>	<b>Biofertilizers and Biopesticides production</b>	<b>Hrs/Wk: 4</b>

**Learning outcomes:**

On successful completion of the practical course, student shall be able to

1. Understand the importance of bio fertilizers for sustainable agriculture.
2. Appreciate the role of VAM in P solubilization
3. Define bio pesticide and its nature
4. Produce bio fertilizers and bio pesticides on large scale
5. Able to prepare inoculums for field application

**Syllabus:** (Total 90 hrs (including Teaching, Lab, Field Training and unit tests etc.)

**UNIT I: Bio fertilizers** (10h)

Introduction, history, concept, scope of bio fertilizers in India. Classification, microorganisms used as bio fertilizers. Bacterial, fungal and algal bio fertilizers. Symbiotic and a symbiotic microorganisms. Mechanism of nodulation and nitrogen fixation.

**UNIT II: Mycorrhizal bio fertilizers** (10h)

Importance, types, characteristic features of ecto and endo mycorrhiza. Mechanism of phosphorus solubilization. Uptake of phosphates by the roots. Consortium based inoculums and significance.

**UNIT III: Bio pesticides** (10h)

Definition, concept, history, scope and importance of biopesticides. Classification - botanicals, bacterial, fungal and viral based biopesticides. Mechanism of action of *Bacillus thuringiensis* and *Trichoderma viridae* as bio control agents.

**UNIT IV: Mass production techniques** (10h)

Media, types, preparation. Methods of isolation, streak plate, spread plate and pour plate techniques, purification and identification of microorganisms used as bio fertilizers and bio pesticides. Mass production and packing techniques.

**UNIT V:Field application methods** (10h)

Preparation of carrier based inoculum. Sphagnum, peat, vermiculite as inoculums carriers. Dosage standardisation. Seed treatment, foliar application, root dressing and soil application techniques. Storage and maintenance of inoculum.

**REFERENCES:**

1. Biofertilizers: Commercial Production Technology and Quality Control, 2017 by Dr. P.Hyma
2. Biofertilizers Technology, 2010, by S.Kaniyan, K.Kumar and K. Govinda rajan
3. Biofertilizers for Sustainable Agriculture, 2017; by Arun K Sharma
4. Advances In Plant Biopesticides 2021, by Dwijendra Singh, Springer India
5. A Textbook of Integrated Pest Management, 2013by Ram Singh & Vikas Jindal G.S. Dhaliwal





<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 1</b>
<b>Course: 7B</b>	<b>Biofertilizers and Biopesticides production Lab</b>	<b>Hrs/Wk: 2</b>

### Practical syllabus: Bio fertilizers and Bio pesticides Production

#### Skill outcomes:

On successful completion of the practical course, student shall be able to

1. Prepare bacterial and fungal media
2. Isolate and identify symbiotic and free living nitrogen fixing bacteria
3. Isolate fungal bio control agents from soil samples.
4. Develop skill for large scale production of micro organisms

#### Practical syllabus:

1. Preparation of Nutrient agar, YEMA, and PDA media
2. Isolation of *Rhizobium* from root nodules
3. Isolation of *Azotobacter* from soil samples
4. Isolation of *Trichoderma*
5. Gram staining of bacteria
6. VAM root staining
7. Raising of legume seedlings with *Rhizobium* treatment
8. Visit to commercial bio control units and Krishi seva Kendra

#### Cocurricular activities:

a) **Mandatory:** (Training of students by teacher on field related skills: 15hrs)

1. **For teacher:** Training of students by teacher on preparation of different microbial media, isolation techniques – streak plate , spread plate, pour plate, Grams staining of bacteria , VAM and Trichoderma observation. Preparation of Rhizobium inoculum and application to legume seedlings.
2. **For students:** Raising of seedlings of Leguminaceae species, maintaining of the seedlings in nursery/green house. Comparing the growth of seedlings treated with biofertilizer and chemical fertilizer. Visit to Bio fertilizer and Bio pesticides commercial lab. Submission of field work report of 10 pages in the prescribed format.
3. Maximum marks for field work report:05
4. Suggested format for field work book; Title page, student details, content page, introduction, work done, findings, conclusion and acknowledgements.
5. Unit test (IE).

b) **Suggested co-curricular activities;**

1. Training of students by the industrial experts
2. Identification and collection of botanical pesticides
3. Assignments/seminars/group discussion /quiz on bio fertilizers and bio pesticides
4. Preparation of videos, charts on inoculum development and field application
5. Attending invited guest lectures on the concern topics.
6. Learn field application techniques of biofertilizers and biopesticides



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V** (Skill Enhancement Course -Elective)  
**Course 7B: Biofertilizers and Biopesticides production**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Bacterial biofertilizers
- 2) Symbiotic microorganisms
- 3) Micorrhiza
- 4) Phosphates uptake
- 5) *Bacillus thuringiensis*
- 6) Microbiological media
- 7) Seed treatment
- 8) Storage of inoculum

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 1) a) Write about scope and importance of biofertilizers?  
(OR)  
b) Write in detail about mechanism of nodulation and nitrogen fixation?
- 2) a) Write about importance and characteristic features of ecto and endo mycorrhiza?  
(OR)  
b) Write about mechanism of phosphorus solubilization in plants?
- 3) a) What is biopesticide? Discuss in detail about different types of biopesticides?  
(OR)  
b) Write about mechanism of action of *Bacillus thuringiensis* and *Trichoderma viridae* as bio control agents
- 4) a) Write about different methods of isolating microorganisms?  
(OR)  
b) Discuss in detail about mass production and packing techniques?
- 13) a) Discuss in detail about various carrier-based inoculums?  
(OR)  
b) write about different field application techniques?



Suggested Question Paper Model for Practical Examination  
Semester – V/ Biotechnology  
Course – 7B (Skill Enhancement Course)

**Bio fertilizers and Bio pesticides Production**

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

1. Identify the given microbial sample based on morphological characteristics 'A' 8 M
2. Identify the given culture based on microscopic observation 'B' 8 M
3. Perform the section cutting of root nodule 'C' 12 M
  
4. Scientific observation and data analysis 4 x 3 = 12 M
  - A. Identify the given algal fertilizer /photograph
  - B. Identify the fungal biofertilizer - photograph
  - C. VAM identification
  - D. Seed treatment
  
- Record + Viva-voce 6+4 = 10 M=



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 4</b>
<b>Course: 6C</b>	<b>Apiculture</b>	<b>Hrs/Wk: 4</b>

### Learning outcomes

Students after successful completion of the course will be able to

1. Understand the basic concepts of Apiculture.
2. Obtain the elementary knowledge of different species and races of honey bees
3. Appreciate the importance of health and hygiene in Bee keeping
4. Maintain the Bee hives in a scientific way

**Syllabus:** (Total Hours: 90 including Teaching, Lab, Field Training and unit tests etc.)

### UNIT I: Biology of Bees

**10 hrs**

History, Classification and Life Cycle of Honey Bees. Social Organization of Bee Colony.

### UNIT II: Rearing of Bees

**10 hrs**

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth. Methods of Extraction of Honey (Indigenous and Modern).

### UNIT III: Diseases and Enemies

**10 hrs**

Bee Diseases and Enemies. Control and Preventive measures.

### UNIT IV: Economy and Entrepreneurship

**10 hrs**

Products of Apiculture Industry and its Uses (Honey, Bee Wax, Propolis) and Pollen.

### UNIT V: Entrepreneurship in Apiculture

**10 hrs**

Bee Keeping Industry: Present and future, Role of Bees in cross pollination in horticulture and agriculture. Prospects of apiculture as self-employment venture.

### REFERENCES:

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Graham, J M (1992) The hive and the honey bee. Dadant and Sons, Hamilton, Illinois.
3. Mishra R.C. (1995) Honey bees and their management in India. ICAR Publication New Delhi.
4. Singh, S. (1971) Beekeeping in India, ICAR publication..
5. Bisht, D.S. (2004). Agricultural Development in India, Anmol Pub. Pvt. Ltd.
6. Singh S.(1964). Beekeeping in India, Indian council of Agricultural Research, NewDelhi
7. Mehrotra, K.N. Bisht, D.S. (1981). Twenty-five years of apiculture research at IARI. Apiculture in relation to agriculture.



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 1</b>
<b>Course: 6C</b>	<b>Apiculture Lab</b>	<b>Hrs/Wk: 2</b>

### Practical Syllabus: Apiculture

#### Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Maintain the Bee hives in a scientific way.
2. Clean & Maintain Bee Boxes
3. Use of other tools required in Bee Keeping
4. Building and division of colony
5. Understand the methodologies of extracting, preservation and marketing of honey and other products of honey bee

#### Practical syllabus

1. Handling of tools and techniques for Apiculture
2. To study the morphological and anatomical characteristics of queen and worker bees
3. Identification of different species of honey bees
4. Preparation of honey bee trays for beekeeping, maintenance and colony inspection
5. Extraction of honey and bee wax
6. Processing of honey, packing and storing
7. Identification of honey adulteration

#### Co-Curricular Activities

##### a) **Mandatory:** (*Training of students by teacher on field related skills: 15 hrs*)

1. For Teacher: Training of students by teacher in laboratory and field for a total of 15 hours in Preparation of honey bee trays for beekeeping, maintenance and colony inspection. Extraction, processing, packing and storing of honey and bee wax
2. For Student: Individual visit to an Apiculture facility or related field or to a laboratory in a university/research organization/private sector and study of Apiculture practices. Submission of a hand-written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements.
5. Unit tests (IE).

##### b) **Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like Identification of flora and location of site, procurement of bee box and other tools, building & division of comb and colony, manage insects and diseases and nuisance in bee hives, knowledge of the scientific methods of bee keeping)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques on bee keeping.
5. Collection of material/figures/photos related to products of Apiculture, writing and organizing them in a systematic way in a file.
6. Visits to Apiculture facilities, firms, research organizations etc.
7. Invited lectures and presentations on related topics by field/industrial experts.



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V (Skill Enhancement Course -Elective)**  
**Course 6C: Apiculture**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Apiculture
- 2) Drones
- 3) Langstroth
- 4) Modern bee keeping
- 5) Propolis
- 6) Bee wax
- 7) Role of bees in agriculture
- 8) Bee pollination

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 9) a) Write about history, classification and Life Cycle of Honey Bees?  
(OR)  
b) Discuss in detail about Social Organization of Bee Colony?
- 10) a) What is apiary? Write about different types of beehives?  
(OR)  
b) Discuss about indigenous and modern methods of Extraction of Honey?
- 11) a) Write in detail about bee diseases, control and preventive measures?  
(OR)  
b) Write about Products of Apiculture Industry and their Uses?
- 12) a) Write about harvesting and processing of bee products?  
(OR)  
b) Discuss about bee keeping industry: present and future
- 13) a) Write about role of bees in cross pollination in horticulture and agriculture?  
(OR)  
b) Discuss about prospects of apiculture as self-employment venture?



**Suggested Question Paper Model for Practical Examination**

Semester – V/ Biotechnology

Course – 6C (Skill Enhancement Course) Apiculture

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

1. Identification of different species of honey bees ‘A’ 8 M
2. Demonstration of use of different boxes and other tools in Bee Keeping ‘B’ 8 M
3. Methods of harvesting, processing and preservation of honey ‘C’ 12 M
  
4. Scientific observation and data analysis 4 x 3 = 12 M
  - A. Identify tools for Apiculture / photograph
  - B. Identification of morphological and anatomical characteristics of queen and worker bees / photograph
  - C. Identify Common pests that attack honey bees and hives / photograph
  - D. Building of comb and colony / photograph

Record + Viva-voce 6+4 = 10 M



<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 4</b>
<b>Course: 7C</b>	<b>Pearl Culture</b>	<b>Hrs/Wk: 4</b>

### Learning outcomes

Students after successful completion of the course will be able to

1. Understand the basic concept of pearl culture.
2. Obtain the elementary knowledge regarding the Anatomical and Physiological aspects of fresh water oysters.
3. Acquaint with the various types of implantation methods and pearl culture surgery techniques.
4. Acquire skill on production of pearl and its marketing for economic gain

**Syllabus:** (Total Hours: 90 including Teaching, Lab, Field Training and unit tests etc.)

### UNIT I: Overview of Pearl oyster (10h)

Biology of Pearl oyster: Pearl producing molluscs. Morphology and anatomy of Pearl oyster, Life cycle of pearl oyster.

### UNIT II: Process of Pearl formation (10h)

Structure and Histology of mantle. Natural Process of Pearl formation. Chemical composition of Pearls. Economic importance of pearls.

### UNIT III: Pearl oyster culture (10h)

**Pearl oyster culture** Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls. Pearl culture techniques -Rafts, long lines, Pearls oyster baskets, under water platforms, mother oyster culture/Collection of oysters, rearing of oysters, Environmental parameters.

### UNIT IV: Pearl Oyster surgery (10h)

Selection of Oyster, Graft tissue preparation, Nucleus insertion, Conditioning for surgery, Post-operative culture, harvesting of pearl, clearing of pearl.

### UNIT V: Pearl culture Economy (10h)

Diseases and Predators of Pearl oysters' Present status, prospects and problems of pearl industry in India.

### REFERENCES:

1. Haws Maria (2002). The basics of pearl farming: a Layman's manual: (U.S.A). CTSA publications.
2. Alexander E .Farn (1986) pearls :(U.S.A.).Butterworth Heinemann publications.
3. Le Jia Li (2014) new technologies to promote freshwater pearl culture (China) Ocean Press publications.
4. Bardach, J.E.W (1972) Aquaculture farming and husbandry of freshwater and Sorting of Pearl. Marketing and economics concerned with Pearl Culture. Generation marine organisms
5. David Dobilet (1995) Pearl farming (Australia) Nat Geographic Mag publication
6. Yuan Cha Da (2014) Environmental effects Pearl farming (China) Jiangxi People publishing house.





<b>B. Sc</b>	<b>Semester -V</b> (Skill Enhancement Course -Elective)	<b>Credits: 1</b>
<b>Course: 7C</b>	<b>Pearl Culture Lab</b>	<b>Hrs/Wk: 2</b>

### Practical Syllabus: Pearl Culture

#### Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Execute pre- pearl culture activities
2. Learn the technique of surgical operation
3. Develop skill of Post operation activities
4. Implement culture activities
5. Perform pearl harvesting

#### Practical syllabus:

1. Technique for measurement of soil and water
2. Culture technique of microorganism for pond maintenance. Surgical techniques
3. Graft tissue preparation, implantation techniques, post operation care
4. Designed pearl culture techniques, bleaching, collection of pearls, cleaning of pearls
5. Sorting of pearls, marketing of pearls.

#### Co-Curricular Activities

**a) Mandatory:** (*Training of students by teacher on field related skills: 15 hrs*)

1. **For Teacher:** Training of students by teacher in laboratory and field for a total of 15 hours on construction of pearl farm, collecting oysters, seeding, caring the oyster and harvesting
2. **For Student:** Individual visit to a pearl culture facility or related field or to a laboratory in a university/research organization/private sector and study of pearl culture practices. Submission of a hand-written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements.
5. Unit tests (IE).

#### **b) Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying tools in pearl culture and their handling, operational techniques with safety and security, IPR)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in pearl culture.
5. Collection of material/figures/photos related to products of pearl culture, writing and organizing them in a systematic way in a file.
6. Visits to pearl culture facilities, firms, research organizations etc.
7. Invited lectures and presentations on related topics by field/industrial experts.



**MODEL QUESTION PAPER ( Sem End)**  
**B. Sc DEGREE EXAMINATIONS**  
**Semester -V (Skill Enhancement Course -Elective)**  
**Course 7C: Pearl Culture**

**Time: 3 Hrs**

**Max Marks: 75M**

**SECTION – A**

**Answer any FIVE questions. Each question carries 5 marks.**

**5 X 5M = 25M**

- 1) Pearl oyster
- 2) Mantle histology
- 3) Chemical composition of pearl
- 4) Artificial production of pearl
- 5) Rafts
- 6) Selection of oyster
- 7) Post operative culture
- 8) Diseases of pearl oysters

**SECTION – B**

**Answers ALL the following five questions.**

**5X10= 50M**

- 9) a) Write in detail about biology of pearl producing molluscs?  
(or)  
b) Write about life cycle of pearl oyster?
- 10) a) Discuss about natural process of pearl formation?  
(or)  
b) Write about economic importance of pearls?
- 11) a) Discuss in detail about pearl oyster culture techniques?  
(or)  
b) Write about collection and rearing of oysters and also discuss about environmental parameters involved in pearl oyster culture?
- 12) a) Discuss in detail about various aspects of pearl oyster surgery?  
(or)  
b) Write in detail about harvesting and cleaning of pearls?
- 13) a) Write in detail about diseases and predators of pearl oysters?  
(or)  
b) Discuss about present status, prospects and problems of pearl industry in India?



**Suggested Question Paper Model for Practical Examination**

Semester – V/ Biotechnology

**Course – 7C (Skill Enhancement Course) Pearl Culture**

**Max. Time: 3 Hrs.**

**Max. Marks: 50**

1. Identify pearl producing oyster, preparation of nuclei 'A' 8 M
2. Prepare graft tissue, perform surgical implantations. 'B' 8 M
3. Implantation of live graft pieces into the mantle of mussel 'C' 12 M
  
4. Scientific observation and data analysis 4 x 3 = 12 M
  - A. Pearl culture surgical instruments /photograph
  - B. Identification of Pearl/ photograph
  - C. Classification of pearls / photograph
  - D. Biomineralisation of pearls /photograph
5. Record + Viva-voce 6+4 = 10 M