Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

SU/BOS/Science/06 **Date: 01/01/2024**

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.

Subject: Regarding syllabi of B.Sc. Part-III (Sem. V & VI) as per NEP-2020 (1.0) degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of B.Sc. Part-III (Sem. V & VI) as per NEP-2020 (1.0) degree programme under the Faculty of Science and Technology.

B.Sc.-III (Sem. V & VI) as per NEP-2020 (1.0)			
1.	Mathematics	12.	Computer Science (Opt)
2.	Statistics	13.	Computer Science (Entire)
3.	Physics	14.	Information Technology (Entire)
4.	Microbiology	15.	Food Science and Technology (Entire)
5.	Industrial Microbiology	16.	Food Science
6.	Electronics	17.	Food Science and Quality Control (Entire)
7.	Chemistry	18.	Food Technology &Management (Entire)
8.	Sugar Technology (Entire)	19.	Biochemistry
9.	Geology	20.	Biotechnology (Optional/Vocational)
10.	Zoology	21.	Biotechnology (Entire)
11.	Botany	22.	Environmental Science (Entire)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2024-2025 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020(Online Syllabus)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2024 & March/April 2025. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

SHIVAJI UNIVERSITY, KOLHAPUR.

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Revised Syllabus For

B.Sc. III Biotechnology
(Optional/Vocational)

(Faculty of Science & Technology)

Paper-IX,X,XI,XII-(Semester-V)

and

Paper-XIII,XIV,XV,XVI-(Semester-VI)

(NEP-2020) CBCS Syllabus to be implemented from June,2024 onwards

ii) Structure of B.Sc. Programme Sem V&VI

Sr. No.	Subject Title	TEACHING SCHEME						EXAMINATION SCHEME								
		THEORY			PRACTICAL			THEORY						PRACTICAL		
								Internal		University						
		Credits	No. of lectures	Hours	Credits	No. of lectures	Hours	Max Marks	Min Marks	Hours	Max Marks	Min Marks		Hours	Max Marks	Min Marks
1	DSE-E	**2**	3	2.4				10	4	2	40	**14**				
2	DSE-E	**2**	3	2.4				10	4	2	40	**14**				
3	DSE-E	**2**	3	2.4	**8**	**20**	**16**	10	4	2	40	**14**		**PRACTICAL EXAMINATION IS ANNUAL**		
4	DSE-E	**2**	3	2.4				10	4	2	40	**14**				
5	AECC-E	**4**	4	3.2				10	4	2	40	**14**				
6	SEC-V	Any one from pool of courses			**2**	---	---	---	---					**2**	**50**	**18**
	TOTAL	**12**	**16**	**12.8**	**10**	**20**	**16**	**50**			**200**					
SEMESTER–VI (Duration–6 Months)																
1	DSE-F	**2**	3	2.4				10	4	2	40	**14**				
2	DSE-F	**2**	3	2.4				10	4	2	40	**14**		**As per BOS Guide-Lines**	**200**	**70**
3	DSE-F	**2**	3	2.4	**8**	**20**	**16**	10	4	2	40	**14**				
4	DSE-F	**2**	3	2.4				10	4	2	40	**14**				
5	AECC-E	**4**	4	3.2				10	4	2	40	**14**				
6	SEC-VI	Any one from pool of courses			**2**	---	---							**2**	**50**	**18**
	TOTAL	**12**		**12.8**	**10**		**16**	**50**			**200**					
	GRAND TOTAL	**24**	**32**	**25.6**	**20**	**40**	**32**			**400**	**800**					

- Student contact hours per week: 28.8 Hours (Min)
- Total Marks for B.Sc.-III (Including English): **800**
- Theory and Practical Lectures: 48 Min. Each
- Total Credits for B.Sc.-III (Semester V&VI): **44**
- **DSE-Discipline Specific Elective.** A candidate shall select one course (subject) from the three Courses (Subjects)selected at B.Sc.–II. Select any 4 pairs of papers from DSE-E1 to DSE-E84 for Sem –V and DSE- F1 to DSE-F84 for Sem-VI
- **AECC**-Ability Enhancement Compulsory Course (E & F): English for communication
- ***There shall be separatee passing for internal, theory and practical examinations.***
- ***Practical Examination shall be conducted annually for 200 marks, and minimum 70 marks are required for passing.***
- ***University semester end exam shall be of 40 marks per paper and minimum 14 marks are required for passing.***
- ***Minimum 4 marks are required for passing out of 10 for Internal Examination of each paper.***
- ***Examination of SEC shall be either theory or practical depending upon type of SEC.***

Class	B. Sc. - I	B. Sc. - II	B. Sc. - III	Total
Marks	1200	1100	800	3100
No. of Credits	60	56	44	160

Nature of Question Paper for B.Sc. Part – I, II & III (40 + 10 Pattern) according to Revised Structureas Per NEP – 2020 to be implemented from academic year 2022-23

Maximum Marks: 40

Duration: 2 hrs

Q. 1 Select the most correct alternate from the following [8]

i) to viii) MCQ one mark each with four options

A)

B)

C)

D)

Q.2 Attempt any TWO of the following [16]

A)

B)

C)

Q. 3 Attempt any FOUR of the following [16]

a)

b)

c)

d)

e)

f)

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A] Ordinance and Regulations: (As applicable to Degree Course)

B] Shivaji University, Kolhapur
Revised syllabus for Bachelor of Science

1. TITLE: Subject-Biotechnology (Optional/Vocational)
Optional under the Faculty of Science

2. YEAR OF IMPLEMENTATION :-Revised Syllabi (As per NEP 2020) will be implemented from June 2024 onwards.

3. PREAMBLE:-

[Note: - The Board of Studies should briefly mention foundation, core and applied components of the course/paper. The student should get into the prime objectives and expected level of study with required outcome in terms of basic and advance knowledge at examination level.**]**

4. GENERAL OBJECTIVES OF THE COURSE:
(as applicable to the Degree concerned) Objectives :-

1) To impart knowledge of Science is the basic objective of education.
2) To develop scientific attitude is the major objective to make the students open minded, critical, curious.
3) To develop skill in practical work, experiments and laboratory materials and equipment's along with the collection and interpretation of scientific data to contribute the science.
4) To understand scientific terms, concepts, facts, phenomenon and their relationships.
5) To make the students aware of natural resources and environment.
6) To provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.

7) The students are expected to acquire knowledge of plant and related subjects so as to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.
8) To develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self reliant and sufficient.
9) To create the interest of the society in the subject and scientific hobbies, exhibitions and other similar activities.

5. DURATION

The course shall be a fulltime course.

6. PATTERN : -

Pattern of examination will be semester.

7. FEE STRUCTURE : -

As per Government / University rules

1) Refer brochure and prospectus of concern affiliated college/institute to Shivaji University, Kolhapur.
2) Other fee will be applicable as per rules and norms of Shivaji University, Kolhapur.

8. ELIGIBILITY FOR ADMISSION:

As per guidelines obtained from Shivaji University, Kolhapur by following rules and regarding reservations by Govt. of Maharashtra

9. MEDIUM OF INSTRUCTION:

The medium of instruction shall be in English.

10. STRUCTURE OF THE COURSE –

B. Sc. III Biotechnology (Optional/Vocational)

THIRD YEAR (SEMESTER V / VI) (NO. OF PAPERS 8)

SHIVAJI UNIVERSITY, KOLHAPUR

B. Sc- III. Biotechnology

(Optional/Vocational)

Semester-V and VI

Semester V- (Theory)			
Paper No.	**Title of Paper**	**Theory**	**Internal**
Paper- IX	Biochemical Techniques	**40**	**10**
Paper-X	Animal Cell Culture	**40**	**10**
Paper-XI	Bioprocess Engineering	**40**	**10**
Paper-XII	Fermentation technology	**40**	**10**
Semester-VI (Theory)			
Paper No.	**Title of Paper**	**Theory**	**Internal**
Paper-XIII	Plant Biotechnology	**40**	**10**
Paper-XIV	Environmental Biotechnology	**40**	**10**
Paper-XV	Cell Metabolism and Virology	**40**	**10**
Paper-XVI	Gene biotechnology and Bioinformatics	**40**	**10**
Practical's			
Practical-I	Techniques in Plant and Environmental Biotechnology	**50**	--------
Practical-II	Techniques in Microbiology and Bioinformatics.	**50**	--------
Practical-III	Project (Opt.) / Project and Onthe Job training (For-Voc.)	**50**	-------
Practical-IV	Entrepreneurship and Study tour Report	**50**	---------

11. SCHEME OF TEACHING AND EXAMINATION : -

[The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

THIRD YEAR-SEMESTER–V/VI : Biotechnology (Optional/Vocational) Scheme of Teaching and Examination

Sr. No.	Subject/Paper	Teaching Scheme (Hrs/Week)				Examination Scheme (Marks)		
		L	T	P	Total	Theory	Term Work	Total
	Semester-V							
1	Paper-IX	03	-	-	03	40	10	50
2	Paper-X	03	-	-	03	40	10	50
3	Paper -XI	03	-	-	03	40	10	50
4	Paper-XII	03	-	-	03	40	10	50
5	AECC-E	04			04	40	10	50
6	SEC-V							50
	Semester-VI							
1	Paper-XIII	03	-	-	03	40	10	50
2	Paper-XIV	03	-	-	03	40	10	50
3	Paper-XV	03	-	-	03	40	10	50
4	Paper-XVI	03	-	-	03	40	10	50
5	AECC-E	04			04	40	10	50

6	SEC-VI							50
	Practical- I (annual)	-	-	04	04	-	-	50
	Practical- II (annual)	-	-	04	04	-	-	50
	Practical-III (annual)	-	-	04	04	-	-	50
	Practical -IV (annual)	-	-	04	04	-	-	50
	Total	32	-	16		-	-	800

12. SCHEME OF EXAMINATION :-

The examination shall be conducted at the end of each term for semester pattern.

- The theory paper shall carry 40 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 40 marks.
- The internal evaluation for each paper shall carry 10 marks. (Semester V: Group activity and Semester VI: Case study/Oral examination)
- Question paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

13. STANDARD OF PASSING:-

As prescribed under rules and regulation for each degree.

14. NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING:

Q.1. Multiple choices questions (8-questions) --- 8 Marks

Q. 2. Attempt **any two** of the following (out of three).

(Essay type / Broad answer questions) ---- 16Marks

Q. 3. Write short notes (**any four**) (out of six). 16Marks

15. EQUIVALENCE IN ACCORDANCE WITH TITLES AND CONTENTS OF PAPERS- (FOR REVISED SYLLABUS)

(Introduced from June 2024 onwards)

Old Syllabus (Semester pattern)		Revised Syllabus (Semester pattern)		
Paper No.	**Title of Old Paper**	**Semester No.**	**Paper No.**	**Title of New Paper**
IX	Biochemical Techniques	Semester- V	IX	Biochemical Techniques
X	Animal Cell Culture		X	Animal Cell Culture
XI	Bioprocess Engineering		XI	Bioprocess Engineering
XII	Fermentation Technology		XII	Fermentation Technology
XIII	Plant Biotechnology	Semester- VI	XIII	Plant Biotechnology
XIV	Environmental Biotechnology		XIV	Environmental Biotechnology
XV	Cell Metabolism and Virology		XV	Cell Metabolism and Virology
XVI	Gene Biotechnology and Bioinformatics		XVI	Gene Biotechnology and Bioinformatics

16. SPECIAL INSTRUCTIONS, IF ANY

SEMESTER-V

Biotechnology (Optional/Vocational)

DSE-E Paper IX: Biochemical Techniques

Course Outcomes:
Paper IX:

After successful completion of the course, the students will be able

1. To understand the principle and types of centrifugations.
2. To understand principle, methods and applications of chromatography.
3. To understand Electrophoresis of nucleic acid and protein.
4. To understand methods of measurement of radioactivity.

Topic No.	Topic	No.of Lectures
	Credit -1	30
	1.1 Cell disruption methods-Grinding, abrasive presses, Enzymatic method, sonication. **1.2** Centrifugation **1.2.1** Introduction and basic principle of Sedimentation **1.3** Types of centrifuges **1.3.1** Centrifugation- Differential Centrifugation, density gradient Centrifugation **1.4** Separation of proteins by precipitation- **1.4.1** Salt precipitation - Salting out by Ammonium sulphate. **1.4.2** Organic solvent precipitation **1.5** Dialysis **1.6** Chromatographic methods – Principle, methodology and applications of **1.6.1** Gel Filtration method **1.6.2** Ion exchange chromatography **1.6.3** Affinity chromatography **1.6.4** Gas chromatography mass spectroscopy (GCMS) **1.6.5** High Performance Liquid chromatography(HPLC)	15

	Credit -2	
	2.1 Electrophoresis- Introduction, general principle supporting media- (Agarose. poly acryl amide gel) **2.2** Electrophoresis of nucleic acid **2.2.1** Agarose gel electrophoresis of DNA **2.2.2** DNA sequencing gel **2.2.3** Pulsed field gel electrophoresis **2.3** Electrophoresis of protein **2.3.1** SDS-PAGE electrophoresis-Methodology, gel staining and Applications **2.3.2** Isoelectric focusing **2.4** Tracer technique. **2.4.1** Introduction- Radioactivity, radioisotopes, types of radiation (α, β, γ), half-life period of radioactivity **2.5** Methods of measurement of radioactivity **2.5.1** Gas ionization **2.5.2** Solvent excitation - Liquid scintillation counter **2.5.3** Autoradiography **2.6** Applications of radioisotopes in biological systems	15

References :-

1. Practical Biochemistry principles and techniques – Wilson & Walkar (edi.VI)
2. Protein purification –Robert Scoop
3. Biophysical Chemistry –Nath Upadhyay
4. Textbook of Biotechnology- R.C.Dubey
5. Textbook of Biotechnology- B.D.Singh

DSE-E Paper X: Animal Cell Culture

Course Outcomes:
Paper X:

After successful completion of the course, the students will be able

1. To understand characteristic of animal cell culture.
2. To understand the develop, test and make new products such as monoclonal antibodies.

3. To understand developing DNA-based diagnostics and genetically engineered vaccines for animals
4. To know developing embryo -transfer technology, cloning, transgenic animals.

Topic No.	Topic	No.of Lectures
	Credit -1	30
	1.1 Introduction to Animal Cell Culture **1.2** Characteristics of Animal Cell Culture **1.3** Substrates for Cell Growth **1.4** Culture media and their properties – Nature, Synthetic **1.4.1** Serum containing media **1.4.2** Serum Free Media **1.4.3** Balanced Salt Solution (BSS) **1.4.4** Growth factor promoting proliferation of Animal Cell – EGF, FGF, PDGF, IL – 1, IL – 2, NGF, Erythropoietin **1.5** Sterilization f Glass ware, agents, Culture media. **1.5.1** Contamination in ATC **1.5**.2 Lab. Organization and equipment's in ATC – Positive press unit, Air Sedimentation shower etc. **1.6** Equipment's used in Animal cell culture – Laminar Air Flow, Homogenizer, Haemocytometer, inverted microscope, CO2 incubator **1.7** Basic Techniques of Animal Cell Culture **1.7.1** Isolation of Tissue **1.7.2** Desegregation **1.7.3** Measurement of cell viability **1.7.4** Maintenance of cell Culture **1.8** Cell lines – Types of Cell lines- Primary, Secondary, Established **1.9** Scale up of Animal Cell Culture **1.9.1** Bioreactors of Animal Cell Culture **1.9.2** Roller Bottle **1.9.3** Cytotoxicity – Assay techniques (e.g- Anticancer effect of phytochemical) and applications	15
	Credit -2	

	2.1 Organ Culture- Types of organ culture (Organotypic and Histotypic culture) **2.2** Stem cell culture **2.2.1** Types and Applications of stem cells **2.3** Applications of Animal cell culture **2.3.1** In Transplantation stem cells **2.3.2** Monoclonal antibody production **2.3.3** Culture based vaccine **2.3.4** Valuable recombinant products **2.3.5** Cloning **2.3.6** Cell synchronization **2.4** Transfection of Animal cells Electroporation, microinjection, liposome mediated, gene gun method, virus mediated. **2.5** Selection of transfected cells- Using selective markers-NPT-II, TK, DHFR, XGPRT **2.6** Karyotyping **2.7** Transgenic Animals **2.7.1** Production of Transgenic Animals-sheep, mice. **2.7.2** Applications of Transgenic Animals **2.8** Bioethics of Animal Genetic Engineering	15

References:

1. Animal cell culture- Fresheny.
2. Biotechnology – B.D.Singh.
3. Biotechnology- R.C.Dubey.
4. Gene Biotechnology- S.N.Jogdand.

DSE-E Paper XI: Bioprocess Engineering

Course Outcomes:
Paper XI:

After successful completion of the course, the students will be able

1. To understand design, and processes for the bioprocessing and biotechnology industries.
2. To understand maintenance of industrially important microorganisms.
3. To understand the scale up and strain improvements methods.

4. To understand different methods in downstream processing.

Topic No.	Topic	No.of Lectures
	Credit- I	30
1.	**1.1** Basic design of fermenter **1.1.1** Construction material used for fermenter **1.1.2** Accessories associated with fermenter **1.2** Types of fermenters- tube tower fermenter, bubble cap fermenter, fluidized bed fermenter, air lift fermenter **1.3** Fermentation media **1.4** Sterilization of fermentation media, equipment and air **1.5** Screening of industrially important microorganisms **1.5.1** Primary screening **1.5.2** Secondary screening **1.6** Strain improvement by **1.6.1** Mutation **1.6.2** Genetic engineering **1.6.3** genetic recombination **1.7** Preservation of industrially important microorganisms- Culture collection centers in India – NCIM	15
	Credit-II	
2.	**2.1** Scale up Bench studies, pilot studies, industrial scale **2.2** Building of inoculum (pitching) **2.3** Introduction of Computer application in fermentation technology **2.4** Types of fermentations **2.4.1** Continuous fermentation **2.4.2** Batch fermentation **2.4.3** Solid state fermentation **2.5** Downstream processing- Centrifugation, Distillation, Solvent extraction, Filtration, Ultrafiltration, precipitation, Ion exchange chromatography, gel filtration, affinity chromatography, Crystallization and drying **2.6** Assays **2.6.1** Physico – chemical assays - gravimetric, spectrophotometric, Chromatographic **2.6.2** Microbiological assays – Diffusion assay, turbidometric assay, metabolic response assay, end point determination assay, enzymatic assay	15

References:

1. Comprehensive Biotechnology volume 3 – Murray Moo- Young
2. Basic Biotechnology- Colin Ratledge & Bijon Kritinsen, cambridge university press, UK
3. Industrial Microbiology - casida
4. Principles of Fermentation technology-Whittekar
5. Industrial Microbiology- Prescott & dunns
6. Industrial Microbiology- A.H.Patel
7. Industrial Microbiology-Pepler & Perlman

DSE-E Paper XII: Fermentation Technology

Course Outcomes:
Paper XII :

After successful completion of the course, the students will be able

1. To understand the different fermentation methods.
2. To understand the fermentation economics.
3. To understand introduction and process or patenting
4. To understand trademarks, trade secrets, copyrights.

Topic No.	Topic	No.of Lectures
	Credit I	30
	1.1 Specific fermentations **1.1.1** Organic acid -Citric acid **1.1.2** Amino acid -Lysine 1.**1**.3 Vinegar **1.1.4** Antibiotic -Penicillin **1.1.5** Vitamin-Vitamin B12 **1.1.6** Enzyme Amylase -koji method **1.1.7** Therapeutic agent -L-asparginase **1.1.8** Single cell protein-Spirulina	15
	Credit II	
	2.1 Alcoholic beverages -Wine -Types -White and Red, Beer Fermentation **2.2** Cheese Fermentation - Cheedar **2.3** Xanthan gum Fermentation **2.4** Lacic acid fermentation **2.5** Fermentation economics **2.6** IPR-introduction (Patents -Introduction, Criteria and process for patenting, Trademark, Trade secrets, Copyrights).	15

References-

1. Comprehensive Biotechnology volume 3 – Murray Moo- Young

2. Basic Biotechnology- Colin Ratledge & Bijon Kritinsen, cambridge university press ,UK

3. Industrial Microbiology - casida

4. Principles of Fermentation technology-Whittekar

5. Industrial Microbiology- Prescott &duns

6. Industrial Microbiology- A.H.Patel

7. Industrial Microbiology-Pepler & Perlman

DSE-F Paper XIII: Plant Biotechnology

Course Outcomes:

Paper XIII:

1: Understand basic concepts with the brief history and practical applications of plant cell cultures.

2: Understand meristem culture and clonal propagation, its importance, applications and limitations.

3: Get the brief idea about the protoplast culture, somatic hybridization along with the practical applications of organ and tissue culture.

4: Understand the concepts and protocols of callus culture, embryogenesis, organogenesis artificial seeds and embryo culture with its advantages and disadvantages.

5: Learn about the haploid production, endosperm culturing suspension cultures and somaclonal variations

Topic No.	Topic	No. of Lectures
1	**Credit I**	15
	1.1 Cell culture – Concept, Introduction, History. **1.2** Laboratory organization **1.3** Tissue culture media, Aseptic manipulation **1.4** Callus culture technique – Introduction, principle, protocol, factors affecting, morphology, applications, limitations. **1.5** Suspension culture technique - Different types, growth measurement applications, limitations. **1.6** Micropropagation stages and pathway **1.7** Somatic embryogenesis - Introduction, principle, protocol, factors, affecting, importance. **1.8** Embryo culture - Introduction, principle, protocol, applications. **1.9** Artificial seeds - Introduction, method, importance.	
2	**Credit II**	15

	2.1 Organogenesis - Introduction, principle, protocol, factors affecting, applications. **2.2** Anther and pollen culture - Development of androgenic haploids, applications, advantage of pollen culture over anther culture. **2.3** Somaclonal variation - Introduction, selection and isolation of variants. **2.4** Protoplast culture - Introduction, principle, isolation, culture methods, importance. **2.5** Somatic hybridization – Protoplast fusion techniques, selection of hybrids-biochemical complementation, visual and morphological methods, cybrid production.	

References-

1. Introduction to plant tissue culture- M. K. Razdan
2. Plant tissue culture – Theory & practice- S. S. Bhojwani & M. K. Razdan
3. Crop improvement in biotechnology- H. S. Chawla
4. Plant tissue culture- Kalyankumar dey
5. Textbook of biotechnology- R. C. Dubey
6. Plant tissue culture- U. Kumar.
7. Biotechnology- B. D. Singh

DSE-F Paper XIV: Environmental Biotechnology

Course Outcomes:
Paper XIV:

1: Understand environmental aspects of conventional and non-conventional fuels and advantages of modern fuels over the conventional fuels.

2: Get an insights of greenhouse effect, global warming, ozone depletion, UV radiations and acid rain.

3: Learn waste water treatments at various levels using different techniques.

4: Understand the concepts and significance of bioremediation, bio pesticides, bio-augmentation, bio sorption, bioleaching phytoremediation and microbial enhancement in oil recovery.

5: Learn different biofertilizers and their methods of field application.

Topic No.	Topic	No. of Lectures
1	**Credit I**	15
	1.1 Conventional and non-conventional fuels and their environmental impacts **1.2** Modern fuels **1.2.1** Methanogenesis and biogas production. **1.2.2** Biohydrogen production **1.2.3** Bioethanol production and Gasohol experiment **1.2.4** Biodisel **1.3** Global environmental problems **1.3.1** Greenhouse effect and global warming **1.3.2** Ozone depletion **1.3.3** UV radiations **1.3.4** Acid rain **1.4** Types of wastes **1.5** Solid waste management **1.5.1** Types of solid waste (hazardous and non-hazardous) **1.5.2** Treatment and disposal **1.6** Waste water treatment **1.6.1** Methods of treatment- a) Primary - (screening, grinding, grit removal. flocculation, sedimentation, flotation, equalization, coagulation, clarification) b) Secondary- (Aerobic-Trickling filters, activated sludge processes, stabilization ponds) (Anaerobic Up flow anaerobic sludge blanket reactors) c) Tertiary Chemical precipitation. **1.6.2** Disposal & recycling of treated waste water.	
2	**Credit II**	15
	2.1 Bioremediation **2.2** Definition & types (in situ and ex-situ) **2.3** Bioremediation of hydrocarbons, dyes, heavy metals, pesticides. **2.3.1** Bioremediation for Agriculture- Composting and vermicomposting.	

	2.4 Biopesticides – Concept, Advantages - Bacterial biopesticides (Bacillus thuringiensis), fungal biopesticides (Trichoderma viride) **2.5** Bioaugmentation **2.6** Biosorption **2.7** Bioleaching (Bioleaching of Copper & Uranium) **2.8** Microbial enhancement of oil recovery **2.9** Biofertilizers - Rhizobial inoculants, Azotobacter inoculants, Azospirillum inoculants, Cyanobacterial inoculants, Phosphate solubilizing bacteria, VAM, Frankia, Azolla	

References:

1. Environmental biotechnology- Indu Shekhar Thakur.
2. Environmental biotechnology- Chatterjee.
3. Environmental biology-Verma & Agarwal.
4. Environmental chemistry-B. K. Sharma.
5. Environmental Pollution- Peavy & Rowe.
6. Environmental problems & solutions- Asthana & Asthana.
7. Environmental science- Siago Canninhham.
8. Environmental biotechnology-S. N. Jogdand.
9. Water engineering- Treatment dispose & reuse-Metcalf & Eddy.
10. Environmental Biotechnology-C. S. K Mishra & Juwarkar

DSE-F Paper XV: Cell Metabolism and Virology

Course Outcomes:
Paper XV:

1: Understand in general the concepts and terminologies of metabolism and different metabolic pathways.
2: Understand carbohydrate metabolism, lipid metabolism pathways.
3: Learn the important steps of urea cycle
4: Understand protein and nucleotide metabolism.
5: Learn the structure of viruses, mode of reproduction, isolation and cultivation of plant and animal viruses.

Topic No.	Topic	No. of Lectures
1	**Credit I**	**15**
	1.1 General Metabolism- Introduction, Definition, Reactions of Metabolic Pathways **1.2** Glycogen metabolism – Glycogenesis, Glycogenolysis **1.3** Lipid Metabolism **1.3.1** Biosynthesis of Saturated Fatty acid- Palmitic Acid **1.3.2** β-Oxidation of Fatty acid - Palmitic Acid **1.3.3** Cholesterol Biosynthesis **1.3.4** Cholesterol Degradation **1.4** Protein Metabolism **1.5** Urea Cycle- Reactions & Significance **1.6** Nucleotide Metabolism	
2	**Credit II**	**15**
	2.1 Virology- Introduction, types on the basis of host and nucleic acid **2.2** General Characteristics of Viruses **2.3** General Structures of Viruses- TMV, Adeno virus, T4 Bacteriophage **2.4** Reproduction of Viruses- Adeno virus, Bacteriophages T4, λ-Phage **2.5** Animal viruses – Classification, life cycle, effect in animal cell **2.6** AIDS – Structure of HIV, life cycle, therapeutic agents **2.5** Isolation & Cultivation of Plant & Animal Viruses- Tissue culture & Embryonated Eggs **2.6** Prions - concept	

References:

1. Biochemistry – Lubert Strayer.
2. Principles of Biochemistry- Lehninger.
3. Virology- Luria & Delbruck. 4. Fundamentals of Biochemistry- J. L. Jain and S. Chand
4. Life Sciences – Pranav Kumar

DSE-F Paper XVI: Gene Biotechnology and Bioinformatics

Course Outcomes:
Paper XVI:

1: Learn basic techniques of gene biotechnology along with the concepts of gene markers, minisatellites, DNA fingerprinting.
2: Understand gene targeting, human gene therapy, and antisense therapy.
3: Learn basic concepts of bioinformatics and databases of different biomolecules.
4: Learn about genomics, proteomics and major concepts and applications.
5: Understand various structural databases

Topic No.	Topic	No. of Lectures
1	**Credit I**	15
	1.1 Techniques in gene biotechnology - 1.1.1 DNA finger printing (DNA profiling) - Introduction 1.1.2 Genetic markers-RFLP, RAPD, AFLPUses of Minisatellites & Microsatellites 1.1.3 Multi-locus and single locus probes 1.1.4 Chromosome walking and jumping **1.2** Gene targeting **1.3** Human gene therapy - Introduction 1.3.1 Types of gene therapy - (a) Somatic (b) Germ Line (c) Enhancement (d) Eugenic genetic engineering 1.3.2 Limitations and requirement in gene therapy **1.4** Antisense therapy- Introduction, principle, applications	

2	Credit II	15
	2.1 Introduction to Bioinformatics - History 2.2 Information Resources - Introduction, aim and objectives - National Centre for Biotechnology Information (NCBI), National Library of Medicine (NLM), National Institute of Health (NIH) and EBI, Sequence retrieval system (SRS) – Entrez, Literature database - PubMed 2.3 Genomics - 2.3.1 Human Genome Project (HGP)- Goal, applications and final draft of HGP 2.3.2 Genome databases - Introduction, Databases, Nucleic acid sequence database, Gene Bank, EMBL, DDBJ 2.4 Proteomics: - Introduction to amino acids and protein, Proteome, Protein structure 2.4.1 Primary protein sequence databases- SWISS-PROT, PIR, MIPS, NRL-3D, TrEMBL 2.4.2 Secondary protein sequence databases - PROSITE, PROFILE, PRINT, pfam, BLOCK, IDENTIFY 2.4.3 Structural databases - Introduction, Difference between Primary structure and 3D structure, Protein databank (PDB), - Molecular modeling databank (MMDB), CATH, SCOP	

References:

1. Gene Biotechnology -S. N. Jogdand

2. Gene Manipulation – Old and Primrose

3. Introduction to Bioinformatics – Rastogi. 4. Introduction to Bioinformatics- T. K. Attwood

4. Bioinformatics methods and applications by S. C. Rastogi, N. Mendiratta, P. Rastogi

5. Principle of bioinformatics by p. shanmughave

Practical- I: Techniques in Plant and Environmental Biotechnology

Sr. no	Name of the Practical	Minor/ Major Expt.
1	Preparation of stock Solutions & media.	Minor
2	Callus culture technique- Initiation of culture, callus morphology	Major
3	Initiation of anther culture	Minor
4	Synthetic seed production	Minor
5	Initiation of micropropagation-Shoot tip or axillary bud culturetechnique	Major
6	Determination of BOD of sewage	Major
7	Determination of COD of sewage	Minor
8	Isolation of *Rhizobium* from root nodules	Major
9	Isolation of PSB from soil	Major
10	Isolation of *Azotobacter* from soil	Major
11	Isolation of *Xanthomonas* from infected citrus fruits.	Major

Practical-II: Techniques in Microbial, Biochemical Technology and Bioinformatics

Sr. no	Name of the Practical	Minor/ Major Expt.
1	Bioassay of penicillin	Major
2	Bioassay of Vitamin B-12	Major
3	Immobilization of yeast (*Saccharomyce scerevisiae*) cells, production of ethanol by using immobilized yeast cells and determination of alcohol content by specific gravity method	Minor
4	Screening of Amylase Producers from Soil, Production of bacterial amylase by submerged culture method & estimation of amylase by DNSA method	Major
5	Production of Xanthan gum using Xanthomonas.	Major
6	Estimation of citric acid by Titrimetric method	Minor
7	Isolation of Vit-B12 requiring mutants.	Major
8	Determination of molecular weight of DNA	Minor
9	Browsing and understanding NCBI Web page,Introduction to literature database- PubMed	Minor
10	Exploring protein sequence database-Introduction	Minor

	proteindatabank(PDB) &RasMol to visualize 3D structure of protein	
11	Exploring Nucleic acid sequence database,Understanding Human genome project	Minor
12	Purification of proteins by gel filtration-chromatography	Minor
13	Purification of Proteins by Ion exchange chromatography.	Minor
14	Transformation of *E. coli*.	Major
15	Isolation of *E. coli* phages	Major
16	Demonstration Polymerase chain reaction	
17	Demonstration Southern Blotting	
18	Demonstration SDS-PAGE	

Practical-III:

Project

Practical-IV:

Entrepreneurship and Study Tour Report

Practical Examination:-

A) The practical examination will be conducted on three (3) consecutivedays for not less than 4 1/2 hours on each day of the practical exanimation.

B) Each candidate must produce a certificate from the Head of the Department in his/her college stating that he/she has completed in a satisfactory manner the practical course on the guidelines laid down from time to time by Academic Council on the recommendation of Board of studies and has been recorded his/her observations in the laboratory journal and written a report on each exercise performed. Every journal is to be checked and signed periodically by a member teaching staff and certified by the Head of the Department at the end of year. Candidates are to produce their journal at the time of practical examination. Candidates have to visit at least two (2) places of Biotechnological interest (Pharmaceutical industry, Dairy,

Research institutes etc.) and satisfactorily complete project work, job training, and entrepreneurship as per syllabus. The report of the same should be duly certified by the Head of the Department and submit the respective reports at the time of examination.

Note:- At least 80% Practicals should be covered in practical Examination.

Practical Question paper pattern:

Practical I: Techniques in Plant and Environmental Biotechnology

Q.1 Major Experiment	20 Marks
Q.2 Minor Experiment	10 Marks
Q.3 Spotting	10 Marks
Q.4 Journal	5 Marks
Q.5 Oral	5 Marks

Practical II: Techniques in Microbiology and Bioinformatics

Q.1 Major Experiment	20 Marks
Q.2 Minor Experiment	10 Marks
Q.3 Spotting	10 Marks
Q.4 Journal	5 Marks
Q.5 Oral	5 Marks

Practical III:-

Project -50 Marks

Project report- 30 Marks

Presentation – 10 Marks

Oral – 10 marks

Practical IV:

Entrepreneurship - 35 Marks

Entrepreneurship report – 25 Marks

Presentation – 5 Marks

Oral – 5 Marks

Study Tour Report – 15 Marks