

SHIVAJI UNIVERSITY, KOLHAPUR



A' Re -accredited by NAAC

with C.G.P.A.-3.16 CBCS

Syllabus for B. Sc. -III

Biotechnology

To be implemented from June, 2020

SHIVAJI UNIVERSITY, KOLHAPUR

B. Sc- III.

Biotechnology

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

Practicals

No.	Title	Marks
Practical-I	Techniques in Plant and Environmental Biotechnology	50
Practical-II	Techniques in Microbial, Biochemical Technology and Bioinformatics	50
Practical-III	Project	50
Practical-IV	Entrepreneurship and Study tour report	50

Equivalence for theory papers

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

Paper No-IX- Biochemical Techniques.

Topic No.	Topic	No of Lectures
	Credit I	22
1	1.1 Cell disruption methods-Grinding, abrasive, presses, Enzymatic method, sonication. 1.2 Centrifugation-Introduction,basic principle of sedimentation, Types of centrifuges- Differential centrifugation, Density gradient centrifugation . 1.3 Separation of proteins by precipitation- 1.3.1 Salt precipitation - Salting out by Ammonium sulphate. 1.3.2 Organic solvent precipitation 1.4 Dialysis 1.5 Chromatographic methods – Principle, methodology and applications of 1.5.1. Gel Filtration method 1.5.2 Ion exchange chromatography 1.5.3 Affinity chromatography 1.5.4 Gas liquid chromatography (GLC) 1.5.6 High Performance Liquid chromatography(HPLC)	
	Credit II	23
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,RNA 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 and applications 2.3.2 Isoelectricfocusing 2.4 Tracer technique. 2.4.1 Introduction – Radioactivity, radioisotopes, types of radiation (α , β , γ), half-life period of radioisotope 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	

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

Paper X–Animal Cell Culture

Topic No.	Topic	No of Lectures
1	Credit I	22
	<ul style="list-style-type: none">1.1 Introduction to Animal Cell Culture1.2 Characteristics of Animal Cell Culture1.3 Substrates for Cell Growth1.4 Culture media & their properties.- Natural, Synthetic<ul style="list-style-type: none">1.4.1 Serum containing media1.4.2 Serum Free Media1.4.3 Balanced Salt Solution (BSS)1.4.4 Growth factors promoting proliferation of Animal Cell- EGF, FGF, PDGF, IL-1, IL- 2,NGF,Erythropoetin1.5 Sterilization of Glass ware, Reagents ,Culture media.<ul style="list-style-type: none">1.5.1- contamination in ATC1.5.2- Lab.Orgnization &equipment's in ATC- Positive press unit, Air shower etc.1.6 Equipment's used in Animal Cell culture – Laminar Air Flow, Homogenizer, Haemocytometer, Inverted microscope, CO₂ Incubator1.7 Basic Techniques of Animal Cell Culture<ul style="list-style-type: none">1.7.1 Isolation of Tissue,1.7..2 Desegregation1.7.3 Measurement of cell viability,1.7.4 Maintenance of cell Culture.1.8 Cell lines-Types of Cell lines- Primary, Secondary, Established1.9 Scale up of Animal Cell Culture-<ul style="list-style-type: none">1.9.1 Bioreactors of Animal cell culture1.9.2 Roller Bottle1.9.3 Cytotoxicity - Assay techniques (e.g- Anticancer effect of phytochemicals) and applications	

2	Credit II	23
	<p>2.1 Organ Culture- Types of organ culture (Organotypic and Histotypic culture)</p> <p>2.2 Stem cell culture</p> <p>2.2.1 Types and Applications of Stem cells</p> <p>2.3 Applications of Animal cell culture</p> <p>2.3.1 In Transplantation-stem cells</p> <p>2.3.2 Monoclonal antibody production</p> <p>2.3.3 Culture based vaccine</p> <p>2.3.4 Valuable recombinant products</p> <p>2.3.5 Cloning.</p> <p>2.3.6 Cell synchronization</p> <p>2.4 Transfection of Animal cells-Electroporation, microinjection, liposome mediated, gene gunmethod, virus mediated.</p> <p>2.5 Selection of Transfected cells- Using selective markers- NPT-II,TK, DHFR, XGPRT</p> <p>2.6 Karyotyping</p> <p>2.7 Transgenic Animals</p> <p>2.7.1 Production of Transgenic Animals- sheep, mice.</p> <p>2.7.2 Applications of Transgenic Animals</p> <p>2.8 Bioethics of Animal Genetic Engineering</p>	

References:

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

Paper XI: Bioprocess Engineering

Topic No.	Topic	No of Lectures
1	Credit I	22
	1.1 Basic design of fermenter 1.2 Construction material used for fermenter 1.3 Accessories associated with fermenter 1.4 Types of fermenters-Tube tower fermenter, bubble cap fermenter, fluidized bed fermenter, air lift fermenter 1.5 Fermentation media 1.6 Sterilization of fermentation media, equipment & air 1.7 Screening of industrially important microorganisms 1.7.1 Primary screening 1.7.2 Secondary screening 1.8 Pure culture techniques 1.8.1 Methods of isolation of industrially important microorganisms 1.8.2 Enrichment techniques 1.9 Strain improvement by- 1.9.1 Mutation 1.9.2 Genetic engineering 1.9.3 Genetic recombination 2.0 Maintenance of industrially important microorganisms- Culture collection centers in India- NCIM	
2	Credit II	23
	2.1 Scale up- Bench studies, pilot studies, industrial scale 2.2 Building of inoculum & pitching. 2.3 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 & 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	

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

Paper XII: Fermentation Technology

Topic No.	Topic	No of Lectures
1	Credit I	22
	1.1 Specific fermentations- 1.1.1 Organic acid –Citric acid 1.1.2 Aminoacid- 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-asparaginase 1.1.8 Phytohormone - Gibbrellins 1.1.9 Single cell protein- spirulina	
2	Credit II	23
	2.1 Alcoholic beverages-Wine- Types –White and Red, Beer Fermentation 2.2 Cheese fermentation- Cheedar,Swiss 2.3 Bread fermentation 2.4 Xanthan gum fermentation 2.5 Lactic acid fermentation 2.6 Fermentation economics 2.7 IPR- introduction 2.7.1-Patents- Introduction, Criteria and process for patenting. 2.7.2 Trademarks 2.7.3 Trade secrets- 2.7.4. Copyrights.	

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

Paper XIII: Plant Biotechnology

Topic No.	Topic	No of Lectures
1.	Credit I	22
	1.1 Introduction - History , concept of cell culture 1.2 Laboratory organization, Tissue culture media, Aseptic manipulation. 1.3 Callus culture technique - Introduction, principle, protocol, factors affecting, morphology, internal structure, genetic variation, applications, limitations. 1.4 Suspension culture technique - Introduction, principle, protocol, different categories, growth and growth measurement, synchronization, applications, limitations 1.5 Different pathways of Clonal propagation 1.6 Somatic Embryogenesis - Introduction, principle, protocol, factors affecting, importance. 1.7 Embryo culture - Introduction, principle, protocol, applications 1.8 Artificial seeds - Introduction, method, importance.	
2.	Credit II	23
	2.1 Organogenesis - Introduction, principle, protocol, factors affecting, applications. 2.2 Haploid production - Protocol for 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. 2.6 Genetic transformation - micro projectile, pollen mediated, marker genes,expression of transferred genes. 2.7 Practical applications of tissue and organ culture - Application in agriculture, application in horticulture and forestry, applications in industries, transgenic plants.	

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.Chawala
4. Plant tissue culture-Kalyankumar dey
5. Textbook of biotechnology- R.C.Dubey
6. Plant tissue culture- U .Kumar.
7. Biotechnology- B.D.Singh

Paper XIV: Environmental Biotechnology

Topic No.	Topic	No of Lectures
1	Credit I	22
	<ul style="list-style-type: none">1.1 Conventional and non conventional fuels and their environmental impacts1.2 Modern fuels<ul style="list-style-type: none">1.2.1 Methanogenesis and biogas production.1.2.2 Biohydrogen production1.2.3 Bioethanol production and Gasohol experiment1.2.4 Biodisel1.3 Global environmental problems<ul style="list-style-type: none">1.3.1 Green house effect and global warming1.3.2 Ozone depletion1.3.3 U.V radiations1.3.4 Acid rain1.4 Types of wastes:1.5 Solid waste management<ul style="list-style-type: none">1.5.1 Types of solid waste(hazardous and non hazardous)1.5.2 Treatment and disposal1.6 Waste water treatment<ul style="list-style-type: none">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	23
	2.1 Bioremediation 2.1.1 Definition & types (in-situ & ex-situ) 2.1.2 Bioremediation of hydrocarbons, dyes, heavy metals, pesticides 2.1.3 Bioremediation for Agriculture.-Composting and vermicomposting 2.2 Biopesticides 2.3 Bioaugmentation 2.4 Biosorption 2.5 Bioleaching-Types, chemistry, Bioleaching of Copper & Uranium 2.6 Microbial enhancement of oil recovery 2.7 Phytoremediation 2.8 Biofertilizers- 2.8.1 Rhizobial inoculants 2.8.2 Azotobacter inoculants 2.8.3 Azospirillum inoculants 2.8.4 Cyanobacterial inoculants 2.8.5 Phosphate solubilizing bacteria 2.8.6 VAM 2.8.7 Frankia 2.8.8 Azolla 2.9 Methods of Field applications	

References:

1. Environmental biotechnology- Indu Shekhar Thakur.
2. Environmental biotechnology-Chattergy.
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 Canninham.
8. Environmental biotechnology-S.N.Jogdand.
9. Water engineering- Treatment dispose & reuse-Metcalf & Eddy.
10. Environmental Biotechnology-C.S.K Mishra & Juwarkar

Paper XV : Cell Metabolism and Virology

Topic No.	Topic	No of Lectures
1	Credit I	22
	1.1- General Metabolism- Introduction, Definition, Reactions of Metabolic Pathways. 1.1.1- Thermodynamic consideration Concepts of Free energy 1.1.2-Methods for study of Metabolic Pathways by using radioisotopes, by using mutants, in vitro studies. 1.2– Metabolism of Carbohydrate 1.2.1- Carbohydrate metabolism- Reactions, Energetics Significance of- Glycolysis 1.2.2- Reactions, significance of Pentose Phosphate Pathway 1.2.3- Reactions & Energetics of TCA Cycle. 1.3 Lipid Metabolism 1.3.1 Biosynthesis of Saturated Fatty acid- Palmitic Acid 1.3.2 β -Oxidation of Fatty acid - Palmitic Acid 1.4 – Respiratory Electron Transport Chain 1.4.1 Components of ETC 1.4.2 Flow of electrons, Redox values. Mechanism of ATP generation – Chemical coupling hypothesis , Chemiosmotic hypothesis.	
2	Credit II	23
	2.1- Urea Cycle- Reactions & Significance. 2.2-Protein and Nucleotide Metabolism. 2.3 Virology-Introduction.Types on the basis of Host & Nucleic acid 2.4 General Characteristics of Viruses. 2.5- General Structures of Viruses- TMV, Adeno virus, T4 Bacteriophage 2.6- Reproduction of Viruses- 4.4.1- Adeno virus 4.4.2- Bacteriophages- T4, λ - Phage 2.7 Isolation & Cultivation of Plant & Animal Viruses- Tissue culture & Embryonated Eggs	

References:

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

Paper XVI: Gene biotechnology and Bioinformatics

Topic No.	Topic	No of Lectures
1.	Credit I	22
	1.1 Techniques in gene biotechnology- DNA Finger printing (DNA profiling) 1.1.1 Introduction 1.1.2 Genetic markers-RFLP,RAPD, AFLP 1.1.3 Uses of Minisatellites & Microsatellites' 1.1.4 Multilocus and single locus probes 1.1.5 Scheme for DNA Finger printing 1.1.6 Applications- Chromosome walking and jumping 1.3 Gene targeting 1.4 Human gene therapy 1.4.1 Introduction 1.4.2 Types of gene therapy- 1. Somatic 2. Germ Line 3. Enhancement 4. Eugenic genetic engineering. 1.4.3 Methods for gene transfer –virus vector,non-viral approach 1.4.4 Limitations and requirement in gene therapy 1.5 Antisense therapy- Introduction, principle, applications	
2.	Credit II	23
	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), and National Institute of Health (NIH), EBI, Sequence retrieval system (SRS):- Entrez, DBGet 2.3 Genomics:- Human Genome Project (HGP)- Goal and applications,final draft of HGP, 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 2.5 Other databases: -Literature database, PubMed, PubMed central 2.6 Structural databases:-Introduction, Difference between Primary structure and 3D structure, Protein databank(PDB), - Molecular modeling databank (MMDB). CATH, SCOP, PdbSum	

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. shanmughavel.

Practical- I: Techniques in Plant and Environmental Biotechnology

Sr. No.	Name of the Practical	Minor/Major Experiment
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 culture technique	Major
6	Determination of BOD of sewage	Major
7	Determination of COD of sewage	Minor
8	Isolation of <i>Rhizobium</i> from root nodules	Major
9	Isolation of PSB from soil	Major
10	Isolation of <i>Azotobacter</i> from soil	Major
11	Isolation of <i>Xanthomonas</i> from infected citrus fruits	Major

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

Sr. No.	Name of the Practical	Minor/Major Experiment
1	Bioassay of penicillin	Major
2	Bioassay of Vitamin B-12	Major
3	Immobilization of yeast(<i>Saccharomyce scerevisiae</i>) 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 Protein data bank (PDB) & RasMol to visualize 3D structure of protein	Minor
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 <i>E. coli</i> .	Major
15	Isolation of <i>E. coli</i> phages	Major
16	Polymerase chain reaction (Demonstration)	
17	Southern Blotting (Demonstration)	
18	SDS-PAGE (Demonstration)	

Practical III:

Project

Practical IV:

Entrepreneurship & Study Tour Report

Practical Examination:-

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

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.

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 Microbial, Biochemical Technology 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
Viva Voce -	10 Marks

Practical IV:

Entrepreneurship -35 Marks

Entrepreneurship Report –	25Marks
Presentation –	05Marks
Viva Voce -	05 Marks

Study Tour Report-	15 Marks
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