

SHIVAJI UNIVERSITY, KOLHAPUR
Biotechnology (Optional/Vocational)
B. Sc III. Biotechnology (Optional/Vocational)

Course Code	Title of the Course	Theory / Practical	Marks	Lectures / Practical hrs.
BT0 - 301	Cell Metabolism, Virology and Animal Cell Culture	Theory	100	90 L
BT0 -302	Plant and Environmental Biotechnology	Theory	100	90 L
BT0 - 303	Microbial Technology	Theory	100	90 L
BT0 - 304	Methods in Biotechnology	Theory	100	90 L
BT0 -305	Techniques in Plant and Environmental Biotechnology	Practical	50	30 P
BT0 – 306	Techniques in Microbiology and Bioinformatics	Practical	50	30P
BT0 – 307	Project	Practical	50	30P
BT0 – 308	Entrepreneurship and Study Tour Report	Practical	50	30P

BT0 - 301 Cell Metabolism, Virology and Animal Cell Culture

Topic no	SECTION I (Cell Metabolism, Virology)	Lectures (45)
	Unit-I	12
1	<p>General Metabolism</p> <p>1.1-Introduction, Definition, Reactions of Metabolic Pathways</p> <p>1.1.1-Concepts of Free energy</p> <p>1.1.2-Methods for study of Metabolic Pathways</p> <p>1.1.3- Using radioisotopes, by using mutant, in vitro studies.</p> <p>1.2– Metabolism of Carbohydrate and Lipids</p> <p>1.2.1- Carbohydrate metabolism- Reaction, Energetics Significance, regulations of- Glycolysis & Gluconeogenesis.</p> <p>1.2.2- Reaction, significance of Pentose Phosphate Pathway</p> <p>1.2.3- Reaction& Energetics of TCA Cycle.</p>	
	Unit-II	11
2	<p>2.1 Lipid Metabolism</p> <p>2.1.1 Biosynthesis of Saturated Fatty acid- Palmitic Acid</p> <p>2.1.2 β-Oxidation of Fatty acid - Palmitic Acid</p> <p>2.2 – Respiratory Electron Transport Chain</p> <p>2.2.1 Components of ETC</p> <p>2.2.2 flow of electrons Redox Values.</p> <p>Mechanism of ATP generation – Chemical coupling hypothesis , Chemiosmotic Hypothesis.</p> <p>2.3- Urea Cycle reaction & Significance.</p>	
	Unit III	10
3	<p>3.1 Introduction to Hormones- Definition, Types of Vertebral Hormones- Steroid, Peptide, Amino acid</p> <p>3.2 Mode of Action- Hormone cascade mechanism</p> <p>3.2.1- Hormone action at Cyclic nucleotide level</p> <p>3.2.2- Induction of Enzyme synthesis at Nuclear level.</p> <p>3.2.3- Stimulation of Enzyme synthesis at ribosomal</p>	

	level 3.2.4- Direct activation at enzyme level.	
	Unit-IV	12
4	4.1 Virology 4.1.1- Introduction.Types on the basis of Host & Nucleic acid 4.2 General Characteristics of Viruses. 4.3- General Structures of Viruses- TMV, Adeno virus, T ₄ Bacteriophage 4.4- Reproduction of Viruses- 4.4.1- Adeno virus 4.4.2- Bacteriophage- T ₄ , λ- Phage 4.5- Isolation & Cultivation of Plant & Animal Viruses- Tissue culture & Embryonated Eggs	
	SECTION II(Animal Cell Culture)	Lectures (45)
	Unit V	12
5	5.1 Introduction to Animal Cell Culture 5.2 Characteristics of Animal Cell Culture 5.3 Substrates for Cell Growth 5.4 Culture media & their Properties.- Natural, Synthetic 5.4.1 Serum Containing 5.4.2 Serum Free Media 5.4.3 BSS- 5.4.4 Growth factors promoting proliferation of Animal Cell- EGF, FGF, PDGF, IL-1, IL- 2,NGF,Erythropoietin 5.5 Sterilization of Glass ware, Reagents ,Culture media. 5.6 Equipments used in Animal Cell culture – Laminar Air Flow, Homogenizer, Haemocytometer, Inverted microscope, Co ₂ Incubator	
	Unit-VI	11
6	6.1 Basic Techniques of Animal Cell Culture 6.1.1 Isolation of Tissue, 6.1.2 Desegregation 6.1.3 Measurement of Cell viability, 6.1.4 Maintenance of Cell Culture.	

	6.2 Cell lines 6.2.1 Types of Cell lines, Primary, Secondary, Established 6.2.2 Evolution of Cell lines. 6.3 Scale up of Animal Cell Culture 6.3.1 Bioreactors of Animal cell culture 6.3.2 Roller Bottle 6.3.3 Spinner culture 6.3.4 Immobilized culture 6.3.5 Suspension culture	
	Unit-VII	10
7.	7.1 Organ Culture- Types of organ culture 7.2 Maintenance of Organ culture 7.2.1 Histotypic culture 7.3 Stem cell culture 7.3.1 Types of Stem Cells 7.3.2 Transplantation of Stem Cells 7.3.3. Applications 7.4 Applications of Animal cell culture 7.4.1 In Transplantation 7.4.2 Monoclonal Antibody production 7.4.3 Culture based Vaccine 7.4.4 Valuable recombinant products 7.4.5 Cloning. 7.4.6 Cell synchronization	
	Unit VIII	12
8	8.1 Transfection of Animal cells 8.1.1 electroporation, microinjection, liposome mediated, gene gun method, virus mediated. 8.1.2 Selection of Transfected cells- Using selective markers, NPT-II, TK, DHFR, XGPRT 8.1.3 karyotyping 8.2 Transgenic Animals 8.2.1 Production of Transgenic Animals 8.2.2 Examples of Transgenic Animals- sheep, mice, rabbit, cattle, pig, fish 8.2.3 Applications of Transgenic Animals 8.3 Bioethics of Animal Genetic Engineering.	

References:-

1. Biochemistry – Lubert Strayer
2. Principles of Biochemistry- Lehninger
3. Virology- Luria & Delbruck
4. Animal cell culture- Fresheny
5. Biotechnology – B.D.Singh
6. Biotechnology- R.C.Dubey
7. Gene Biotechnology- S.N.Jogdand
8. Fundamentals of Biochemistry- J.L.Jain S.Chand

Publication

BT0 – 302 Plant and Environmental Biotechnology

Topic No.	SECTION I (Plant Biotechnology)	Lectures 45
	Unit I	12
1.	<p>1.1 Introduction - History ,concept of cell culture, development of tissue culture, practical applications and recent advances.</p> <p>1.3 Laboratory organization, Tissue culture media, Aseptic manipulation.</p> <p>1.4 Clonal propagation (Micropropagation) - Technique, factors affecting, Applications, limitations.</p> <p>1.5 Meristem culture - Principle, protocol, importance.</p>	
	Unit II	10
2..	<p>2.1 Callus culture technique - Introduction, Principle, protocol, factors affecting, morphology, internal structure, genetic variation, applications, limitations.</p> <p>2.2 Embryogenesis - Introduction, Principle, Protocol, factors affecting, importance.</p> <p>2.3 Organogenesis - Introduction, Principle, Protocol, factors affecting, Applications.</p> <p>2.4 Artificial seeds - Introduction, method, Importance.</p> <p>2.4 Embryo culture - Introduction, Principle, Protocol, Applications.</p>	
	Unit III	12
3.	<p>3.1 Haploid production - Protocol for anther and pollen culture, Development of androgenic haploids, Applications, Problems.</p> <p>3.2 Endosperm culture - Introduction, Technique, Applications.</p> <p>3.2 Somaclonal variation - Introduction, Terminology, origin, Selection at plant level, Selection at cell level, mechanism, Assessment, Applications, Limitations.</p>	

	3.3 Suspension culture technique - Introduction, Principle, protocol, different categories, growth and growth measurement , Synchronization, Applications, Limitations.	
	Unit IV	11
4.	4.1 Protoplast culture - Introduction, Principle, Isolation, culture methods, importance. 4.2 Somatic hybridization - Protoplast fusion techniques, Selection of hybrids, Biochemical complementation, visual and morphological methods, Cybrid production. 4.3 Genetic transformation - <i>Agrobacterium</i> mediated, Electroporation, micro projectile, macro injection, pollen mediated, marker genes, expression of transferred genes. 4.4 Practical applications of tissue and organ culture - application in agriculture, application of horticulture and forestry, applications in industries, transgenic plants.	
	SECTION II (Environmental Biotechnology)	Lectures 45
	Unit V	13
5.	5.1 Conventional and non conventional fuels and their environmental impacts 5.2 Modern fuels 5.2.1 Methanogenesis and biogas production. 5.2.2 Biohydrogen production 5.2.3 Bioethanol production and Gasohol experiment 5.2.4 solar energy converters 5.2.5 Biopolymers (PHA, PHB) and Biodiesel 5.3 Global environmental problems 5.3.1 Green house effect and global warming 5.3.2 Ozone depletion 5.3.3 U.V radiations 5.3.4 Acid rain	
	Unit VI	10

6	6.1 Types of waste 6.2 Solid waste management 6.2.1 Types of solid waste(hazardous and non hazardous) 6.2.2 Treatment and disposal 6.3 Waste water treatment 6.3.1 Methods of treatment- Primary - (screening, grinding, grit removal, flocculation, sedimentation, flotation, equalization, coagulation, clarification) Secondary - (Aerobic-Trickling filters, activated sludge processes, stabilization ponds)(Anaerobic-Up flow anaerobic sludge blanket reactors), Tertiary - (Chemical precipitation, adsorption, chlorination, enzymatic treatment, activated carbon, filtration- micro & nano)	
	Unit VII	12
7	7.1 Bioremediation 7.1.1 Definition & types (in situ & ex situ) 7.1.2 Bioremediation of hydrocarbons, dyes, heavy metals, pesticides 7.1.3 Agricultural bioremediation-composting and vermicomposting 7.2 Biopesticides 7.3 Bioaugmentation 7.4 Biosorption 7.5 Bioleaching-Types, chemistry & e.g. copper & uranium 7.6 Microbial enhancement of oil recovery 7.7 Phytoremediation	
	Unit VIII	10

8.	8.1 Biofertilizers 8.1.1 Rhizobial inoculants 8.1.2 Azotobacter inoculants 8.1.3 Azospirillum inoculants 8.1.4 Cyanobacterial inoculants 8.1.5 Phosphate solubilizing bacteria 8.1.6 VAM 8.1.7 Frankia 8.1.8 Azolla 8.2 Methods of Field applications	
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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
8. Environmental biotechnology- Indu Shekhar Thakur
9. Environmental biotechnology-Chattergy
- 10.Environmental biology-Verma & Agarwal
- 11.Environmental chemistry-B.K.Sharma
- 12.Environmental Pollution- Peavy & Rowe
- 13.Environmental problems & solutions- Asthana & Asthana
- 14.Environmental science-Siago Canninham
- 15.Environmental biotechnology-S.N.Jogdand
- 16.Water engineering- Treatment dispose & reuse-Metcalf & Eddy
- 17.Environmental Biotechnology-C.S.K Mishra & Juwarkar

BT0 - 303- Microbial Technology

Sr. No.	SECTION I Bioprocess Engineering	Lectures 45
	Unit I	12
1.	1.1 Basic design of fermentor 1.2 Construction material used for fermentor 1.3 Accessories associated with fermentor 1.4 Types of fermentor-Tube tower fermentor, bubble cap fermentor, fluidized bed fermentor, air lift fermentor 1.5 Fermentation media 1.6 Sterilization of fermentation media, equipment & air	
	Unit II	12
2..	2.1 Screening of industrially important micro-organisms 2.1.1 Primary screening 2.1.2 Secondary screening 2.2 Pure culture techniques 2.2.1 Methods of isolation of industrially important micro-organisms 2.2.2 Enrichment techniques 2.3 Strain improvement 2.3.1 By mutation 2.3.2 Genetic engineering 2.3.3 Genetic recombination 2.4 Maintenance of industrially important micro-organisms	
	Unit III	09
3.	3.1 Scale up- bench studies, pilot studies, industrial scale 3.2 Building of inoculum & pitching. 3.3 Computer application in fermentation technology 3.4 Types of fermentations 3.4.1 Continuo fermentation 3.4.2 Batch fermentation 3.4.3 Solid state fermentation	
	Unit IV	12

4.	4.1 Down stream processing- Centrifugation, Distillation, Solvent extraction, Filtration, Ultrafiltration , precipitation, Ion exchange chromatography, Gel filtration, Affinity chromatography, Crystallization & drying 4.2 Assay 4.2.1 Physico-chemical assay- Gravimetric, Spectrophotometric, Chromatographic 4.2.2 Microbiological assay- Diffusion assay, turbid metric assay, metabolic response assay, end point determination assay, enzymatic assay	
	SECTION II (Fermentation technology)	Lectures 45
	Unit V	
5.	5.1 Some specific fermentations- 5.1.1 Organic acid –citric acid 5.1.2 Aminoacid-lysine 5.1.3 Vinegar 5.1.4 Antibiotic-Penicillin	12
	Unit VI	
6	6.1 Specific fermentations- 6.1.1 Vitamin- vitamin B12 6.1.2 Enzyme-Amylase 6.1.3 Therapeutic agent- L-asparaginase 6.1.4 Phytohormone - gibberellins 6.1.5 Single cell protein	12
	Unit VII	
7	7.1 Alcoholic beverages-wine, beer fermentation 7.2 Cheese fermentation 7.3 Bread fermentation 7.4 Xanthan gum fermentation 7.5 Lactic acid fermentation	12
8.	8.1 Fermentation economics 8.2 IPR	9

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 fermentations technology-Whittekar
5. Industrial microbiology- Prescott & dunns
6. Industrial microbiology- A.H.Patel
7. Industrial microbiology-Pepler & perlman

BT0 – 304 Methods in Biotechnology

Topic No.	Section I (Biochemical technique)	Lectures 45
	Unit I	12
1	1.1 Cell disruption methods-Grinding, abrasive presses, enzymatic method, sonication. 1.2 Centrifugation 1.2.1 Introduction and Basic principle of sedimentation 1.2.2 Types of centrifuge 1.2.3 Centrifugation- differential centrifugation, Density gradient centrifugation . 1.3 Separation of protein by precipitation- 1.3.1 Salt precipitation - Salting out by ammonium sulphate. 1.3.2 Organic solvent precipitation 1.4 Dialysis	
	Unit II	12
2	2.1 Chromatographic methods – Principle, methodology and applications of 2.1.1 Gel Filtration method 2.1.2 Ion exchange chromatography 2.1.3 Affinity chromatography 2.1.4 GLC –Gas liquid chromatography 2.1.5 HPLC-High Performance Liquid chromatography	
	Unit III	11
3	3.1 Electrophoresis 3.1.1. Introduction, types and general principle 3.1.2 Supporting media – (Agarose. poly acryl amide gel) 3.2 Electrophoresis of nucleic acid 3.2.1 Agarose gel electrophoresis of DNA 3.2.2 DNA sequencing gel 3.2.3 Pulsed field gel electrophoresis 3.2.4 Electrophoresis of RNA 3.3 Electrophoresis of protein 3.3.1 SDS-PAGE electrophoresis- methodology and applications 3.3.2 Isoelectric focusing	
	Unit IV	10
4	4.1 Tracer technique. 4.1.1 Introduction – Radioactivity, radioisotopes,	

	<p>types of radiation (α, β, γ), half life period of radioisotope</p> <p>4.2 Methods of measurement of radioactivity</p> <p>4.2.1 Gas ionization</p> <p>4.2.2 Solvent excitation- Liquid scintillation counter</p> <p>4.2.3 Autoradiography</p> <p>4.3 Application of radioisotope in biological system</p>	
	<p align="center">Section II (Gene biotechnology and Bioinformatics)</p>	Lectures 45
5	Unit V	12
	<p>5.1 Techniques in gene biotechnology- DNA Finger printing (DNA profiling)</p> <p>5.1.1 Introduction</p> <p>5.1.2 Genetic markers</p> <p>5.1.3 Use of minisatellite</p> <p>5.1.4 Multilocus and single locus probes</p> <p>5.1.5 Scheme for DNA Finger printing</p> <p>5.1.6 Applications</p> <p>5.2 Restriction mapping</p>	
	Unit VI	12
6	<p>6.1 Chromosome walking and jumping –introduction and steps</p> <p>6.2 Gene targeting</p> <p>6.2.1 Theory</p> <p>6.2.2 Application</p> <p>6.2.3 Gene targeting in mice</p> <p>6.3 Human gene therapy</p> <p>6.3.1 Introduction</p> <p>6.3.2 Types of gene therapy- 1. Somatic gene 2. Germ Line 3. Enhancement 4. Eugenic genetic engineering.</p> <p>6.3.3 Methods for gene transfer –virus vector,non-viral approach</p> <p>6.3.4 Limitations and requirement in gene therapy</p> <p>6.4 Antisense therapy- introduction, principle, application</p> <p>6.5 DNA micro array</p>	
	Unit VII	10
7	<p>7.1 Introduction to Bioinformatics</p> <p>7.1.1 Definition of bioinformatics</p> <p>7.1.2 Use of computer and internet in biology and medicine</p> <p>7.1.3 Definition and classification of databases (primary and secondary)</p>	

	7.1.4 Sequences and nomenclature 7.1.5 Information sources-introduction, aim and objectives NCBI(National Centre for Biotechnology Information) NLM(National Library of medicine) NIH (National Institute of Health) SRS(Sequence Retrieval System) EBI, Entrez, DBGet	
	Unit VIII	11
8	8.1 Introduction to genomics 8.1.1 Definition 8.1.2 Methods of gene sequencing 1.Direct sequencing of BAC(Bacterial Artificial chromosome) 2.Random shot gun sequencing 3.Whole genome shot gun sequencing 8.1.3 Gene prediction and gene counting 8.1.4Types of genomics (structural and functional) 8.1.5Application of genomics 8.2Human Genome Project 8.2.1 Introduction and definition 8.2.2 Difficulties in mapping and sequencing 8.2.3 Technical strategies 1. Physical mapping 2. Genetic mapping 8..3 Introduction to proteomics 8.3.1 Introduction, definition & scope. 8.3.2 Types of proteomics –1.Expression 2.Structural 3.Functional 8.3.3Application of proteomics	

References:-

1. Practical biochemistry principles and techniques – Wilson and Walkar (edi. VI)
2. Protein purification –Robert Scoop
3. Biophysical chemistry –Nath Upadhyay
4. Textbook of Biotechnology- R.C.Duby
5. Textbook of Biotechnology- B.D.Singh
6. Gene biotechnology -S.N.Jogdand
7. Gene manipulation – Old and Primrose
8. Introduction to Bioinformatics - Rastogi

**BT0 - 305 Techniques in Plant and Environmental
Biotechnology**

Sr. no.	Name of the Practical	30 P
1	Preparation of stock solution & media	1
2	Callus culture technique- initiation of culture, callus morphology.	1
3	Suspension culture technique – initiation, growth measurement	2
4	Initiation of anther culture	1
5	Synthetic seed production	1
6	Initiation of micropropagation- shoot tip or axillary bud culture technique	1
7	Subculture & multiplication of culture	1
8	Root differentiation	1
9	Acclimatization & hardening	1
10	Isolation of <i>E . coli</i> phages from sewage	2
11	Determination of BOD of sewage	2
12	Determination of COD of sewage	1
13	Isolation of <i>Rhizobium</i> from root nodules	2
14	Isolation of PSB from soil.	2
15	Observation of different developmental stages in chick embryo	1

BT0 - 306 Techniques in Microbiology and Bioinformatics

Sr. no.	Name of the Practical	30 P
1	Bioassay of penicillin	1
2	Bioassay of vitamin B12	1
3	Immobilization of yeast(<i>Saccharomyces cerevisiae</i>) cells and production of ethanol by using immobilized yeast cells and determination of alcohol content by specific gravity method	4
4	Production of bacterial amylase by submerged culture method & estimation of amylase by DNSA method	4
5	Determination of molecular weight of DNA	1
6	Browsing and understanding NCBI Web page, Introduction to literature database- PubMed	1
7	Exploring protein sequence database- Introduction to protein databank(PDB) & RasMol to visualize 3D structure of protein	1
8	Exploring Nucleic acid sequence database, Understanding Human genome project	1
9	Purification of proteins by gel filtration chromatography	1

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 staff and certified by the Head of the Department at the end of the year. Candidates are to produce their journal at the time of practical examination. Candidates have to visit the 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.

BT0 - 307

For Vocational Biotechnology-
Project
On Job Training Report

For optional biotechnology –
Project

BT0 - 308

Entrepreneurship
Study Tour Report

Question paper pattern:

BT0 - 305:-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

BT0 - 306:- 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

BT0 - 307

For Vocational Biotechnology-

Project 35 Marks

On Job Training Report 15 Marks

For optional biotechnology –

Project 50 Marks

BT0 - 308

Entrepreneurship 35 Marks

Study Tour Report 15 Marks